ELSEVIER

Bone 42 (2008) 498 – 504

BONE

www.elsevier.com/locate/bone

Parathyroid hormone is predictive of low bone mass in Canadian Aboriginal and White women ☆

Hope A. Weiler [a,*], William. D. Leslie [b], Charles N. Bernstein [b]

[a] *Human Nutritional Sciences, University of Manitoba, Winnipeg, MB, Canada*
[b] *Faculty of Medicine, University of Manitoba, Winnipeg, MB, Canada*

Received 20 December 2006; revised 8 November 2007; accepted 30 November 2007
Available online 8 December 2007

Abstract

Canadian Aboriginal women have lower age- and weight-corrected bone mineral density (BMD) and lower vitamin D status than White women. This study was undertaken to describe the differences in biomarkers of bone metabolism and vitamin D in Aboriginal and non-Aboriginal women and to establish which biomarkers were predictive of BMD. In total, 41 rural Aboriginal, 212 urban Aboriginal and 182 urban White women were studied for BMD of the distal radius, calcaneus, lumbar spine, femoral neck, total hip and whole body using dual-energy X-ray absorptiometry. Serum biomarkers measured included calcium, phosphate, alkaline phosphatase (ALP), C-telopeptide of type 1 collagen (CTX), osteocalcin (OC), osteoprotegerin (OPG), parathyroid hormone (PTH) and 25(OH)D. Data were analyzed for differences among the three groups stratified by age (25 to 39, 40 to 59 and 60 to 75 y) using factorial ANOVA. Predictors of BMD including ethnicity, age and body weight were identified using step-wise regression. Unadjusted BMD of all sites declined with age regardless of ethnic grouping. Prediction models for 5 of 6 BMD sites included PTH accounting for age and body weight. Other predictors of BMD included OC for the radius and calcaneus; OPG for spine and total hip; and ALP for whole body and calcaneus. Serum 25(OH)D was not included in any model of BMD. After accounting for all variables in the regression equation, an average Aboriginal woman of 46 y and 79 kg was predicted to have 6% lower calcaneus BMD and 3% lower radius BMD compared to a White woman of the same age and weight. In conclusion, PTH is a better predictor of BMD than 25(OH)D in this population of Aboriginal and White women.

Keywords: Parathyroid hormone; Bone mass; Aboriginal; Women; Vitamin D

Introduction

Canadian Aboriginal women[1] have lower age- and weight-corrected bone mineral density (BMD) [1] and vitamin D status than White women [2]. Similarly, American Indians have higher rates of bone loss with aging and in association with low vitamin D status [3]. These associations are thought to contribute to fracture rates that are 2 times higher in Aboriginal women compared to non-Aboriginal women [4]. To date, it remains unclear if vitamin D status or other biomarkers of bone metabolism might be useful as screening tools to guide interventions for fracture prevention in this population.

Various threshold cut-offs in serum 25-hydroxy vitamin D [25(OH)D] have been proposed for deficiency of vitamin D. The concentration of serum 25(OH)D used to set dietary recommended intakes in the USA and Canada for vitamin D intake was 37.5 nmol/L for adults [5]. While this concentration is known to relate to risk of bone abnormalities, the concentration consistent with optimal bone health is likely at least two times higher. Serum 25(OH)D levels from 75–80 nmol/L [6–9] and even up to 100 nmol/L [10,11] may be required to achieve a plateau reduction in serum parathyroid hormone (PTH). Serum 25(OH)

☆ This research was funded by the Canadian Institutes of Health Research and the Manitoba Health Research Council.

* Corresponding author. School of Dietetics and Human Nutrition, McGill University, Macdonald Campus, 21,111 Lakeshore Road, Ste. Anne-de-Bellevue, Québec, Canada H9X 3V9. Fax: +1 514 398 7739.
E-mail address: hope.weiler@mcgill.ca (H.A. Weiler).

[1] In Canada, the terms Aboriginal or Native are used to refer to "Indians", and includes First Nations, Metis and Inuit peoples. First Nations are Aboriginal peoples signatory to Treaties and/or recognized by the federal government as a fiduciary responsibility. This paper reports on data derived exclusively from First Nations Populatios which present the large majority of Aboriginal persons living in canada.

8756-3282/$ - see front matter © 2007 Elsevier Inc. All rights reserved.
doi:10.1016/j.bone.2007.11.013

D values below this level are associated with elevated PTH and may lead to loss of bone mass if extended over years [9].

While PTH has received much attention as a complementary biomarker for vitamin D status and adverse conditions for bone health, bone formation markers (e.g., osteocalcin [OC] or alkaline phosphatase [ALP]), bone resorption markers (e.g., N-terminal [NTx] or C-terminal [CTX] peptides), or osteoprotegerin (OPG)) may augment PTH and 25(OH)D concentrations for predicting bone mass. OC, a marker of osteoblast origin, rises following vitamin D intervention [12]. OPG, also synthesized by the osteoblast and a potent inhibitor of bone resorption [13], is inversely related to PTH and bone resorption in men [14]. Since sustained elevations in PTH inhibit OPG [15,16], it follows that optimization of vitamin D status should reduce PTH and elevate OPG thus favouring bone mineralization. Changes in OPG and bone resorption markers are observed across seasons [17] that might be reflective of vitamin D status and/or change in diet [18]. The objectives of this report were to describe the differences in biomarkers of bone metabolism and vitamin D in Aboriginal and non-Aboriginal women and to establish which biomarkers were predictive of BMD.

Methods

Study population

The study population consisted of 435 urban Aboriginal, rural Aboriginal, and urban White females stratified by age (25–39 y, 40–59 y, 60–75 y) (Table 1). The younger age group was intentionally over-sampled to more accurately define peak bone mass. Cut-offs between the age categories were based on the presence of stable BMD prior to age 40 [19] and the substantial increase in the incidence of hip fractures in our population after age 60 [4]. The study was approved by the University of Manitoba Research Ethics Board. Study recruitment was conducted from June 2002 through March 2004.

Women for the urban cohort (operationally defined as current residence within 50 km of the provincial capital, Winnipeg, Manitoba) were selected randomly from the Manitoba Health population registry. Aboriginal ethnicity was determined from the Canadian government's 1994–1999 Status Verification System maintained by First Nations and Inuit Health Branch and Indian and Northern Affairs Canada, with the presence of a treaty status code in the provincial health registry file providing a secondary indicator of Aboriginal ethnicity as described in detail in Leslie et al. [1]. Rural Aboriginal women were recruited from two representative rural Aboriginal reserves, one northern and the other southern, using community band lists.

Measurements

After enrolment, consenting subjects completed detailed baseline measurements that included an interviewer-administered subject questionnaire, BMD measurements from multiple skeletal sites, and fasting biochemical markers of bone metabolism. Weight was measured without shoes to the nearest 0.5 lb with a portable digital scale (Tanita TBF-612) and subsequently converted to kg. Height was measured to the nearest 0.1 cm with a Harpenden pocket stadiometer (Holtain Ltd, Crosswell, United Kingdom).

Bone mineral density

All subjects underwent peripheral dual-energy X-ray absorptiometry (pDXA) of the distal forearm and calcaneus (PIXI; GE Lunar, Madison WI). Urban subjects also underwent measurement of the lumbar spine (L1-4), femoral neck, total hip and whole body with a central dual-energy X-ray absorptiometry (cDXA) device (Hologic QDR-4500W; Waltham, MA). cDXA was not performed in the non-urban subjects as the cost of transporting subjects to Winnipeg and the lack of portability of cDXA renders this measurement impractical. Daily quality control of the pDXA and cDXA

Table 1
Characteristics of participants stratified by age and ethnic group

	Rural Aboriginal			Urban Aboriginal			Urban White			ANOVA *P*-values		
	25–39 y (n=16)	40–59 y (n=16)	>60 y (n=9)	25–39 y (n=103)	40–59 y (n=74)	>60 y (n=35)	25–39 y (n=83)	40–59 y (n=49)	>60 y (n=50)	Age	Ethnic group	Interaction effect
Age (y)	32.3±4.6	47.4±4.6	64.7±4.7	33.9±3.9	47.7±5.8	66.2±4.5	33.4±4.1	50.2±5.4	66.7±4.7	–	0.036[a]	–
Weight (kg)	90.4±21.5[x]	91.0±10.7[x]	80.0±20.0[x]	80.8±19.9[y]	78.8±14.6[y]	76.9±15.3[y]	77.0±20.1[y]	74.5±15.7[y]	77.0±17.3[y]	0.266	0.003	0.550
Height (cm)	166.6±7.0[Ax]	164.7±6.2[Bx]	163.0±4.5[Bx]	164.5±6.0[Ay]	161.0±5.7[By]	158.3±6.2[By]	165.5±6.3[Ax]	162.8±5.6[Bx]	160.9±5.0[Bx]	<0.001	0.007	0.804

Data are mean±SD. Differences are denoted by different superscripts. Values with A, B, C indicate main effect of age while x, y, z indicate main effects of ethnic grouping.
[a] Post-hoc analysis yielded non-significant differences.