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RESEARCH

Relationships between Known Risk Factors for Osteoporosis and Heel Bone Mineral Density in Asian Populations

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BACKGROUND
Asian immigrants are exposed to different lifestyles in the United States (U.S.) and may have different osteoporosis risk factors. This study investigated relationships between known risk factors for osteoporosis in general U.S. populations and heel bone mineral density (BMD) in Asian populations in San Diego County. A secondary aim was to correlate observed heel BMD T-scores with the Osteoporosis Self-Assessment Tool for Asians (OSTA).

METHODS
This was a cross-sectional study of 150 Asians aged 50 years and older in San Diego County in 2014. An osteoporosis risk factor survey was administered, OSTA indices were calculated, and heel BMD T-scores were obtained using a portable GE Achilles bone densitometer.

RESULTS
Participants aged 50 to 64 years (n=77, mean T-score: -0.62) had lower osteoporosis risk compared to participants 65 years and older (n=73, mean T-score: -0.90) (p-value=0.036). Body weight was higher in normal participants (median weight: 57.1 kg) than participants with osteopenia risk (median weight: 56.7 kg) or osteoporosis risk (median weight: 48.4 kg) (p-value=0.0059). Osteoporosis risk was not associated with female sex (n=109, p-value=0.218), previous osteoporotic fracture or family history of osteoporotic fracture (n=22, p-value=0.260), or early menopause or oophorectomy (n=31, p-value=0.536). The OSTA showed a weak correlation with T-scores (p-value=0.0029, r=0.24) and had moderate sensitivity (66%) and specificity (51%).

CONCLUSION
Older and lower-weight participants had higher osteoporosis risk by heel BMD T-scores. Other risk factors were not associated with osteoporosis risk. The OSTA showed a weak correlation with heel BMD T-scores and had moderate sensitivity and specificity in predicting the T-score classifications.

Background

Osteoporosis is a progressive bone disease that affects men and women of all races but is more prevalent in postmenopausal women and older adults.[1] Osteoporosis is typically a silent disease until a bone fracture occurs.[1] Therefore, it is important to know a patient's osteoporosis risk factors to provide early intervention. Known risk factors for osteoporosis include being Caucasian or Asian, female sex, increased age, low body weight, nontraumatic fracture after age 50 or family history of osteoporotic fracture, and early menopause or surgical removal of the ovaries.[2] Asian immigrants are exposed to different dietary and lifestyle habits when living in the United States (U.S.) compared to in their countries of origin and may have different osteoporosis risk factors than the general U.S. population.[3]

While a spine and hip dual-energy X-ray absorptiometry (DXA) scan is the gold standard for evaluating bone mineral density (BMD) and is used for the diagnosis of osteoporosis, many people in the Asian community in San Diego may not have easy or affordable access to BMD screening. Heel BMD T-scores can be used as the reference value in lieu of central DXA T-scores, as the latter is not portable. Another easier and low-cost method to predict the risk of osteoporosis would be helpful. The Osteoporosis Self-Assessment Tool for Asians (OSTA) is a simple tool that calculates the risk of osteoporosis based on age and weight [(Weight in kg - Age) x 0.2 and removing the decimal]. This tool has been validated in a number of Asian populations.[4] The World Health Organization (WHO) diagnostic classification uses BMD by central DXA at the spine and hip to calculate T-scores in determining diagnosis of osteopenia or osteoporosis.[5] A patient has normal BMD if T-score is ≥ -1, low bone mass or osteopenia if T-score is between -1 and -2.5, and osteoporosis if T-score is ≤ -2.5.[5] Similarly, OSTA indices classify osteoporosis risks as low risk if OSTA index is > -1, intermediate risk if OSTA index is

between -1 and -4, and high risk if OSTA index is < -4.[4]

Objectives

This study aimed to investigate relationships between known risk factors for osteoporosis in the general U.S. population and heel BMD, reported as T-scores, in Asian populations in San Diego County. The secondary aim was to correlate observed heel BMD T-scores with OSTA indices to determine the effectiveness of the OSTA tool in these populations.

Methods

This was a cross-sectional study of Asian men and women aged 50 years and older in San Diego County, California. Participants were recruited at health fairs between June and October 2014. All individuals interested in their bone health were screened. Exclusion criteria included those aged 49 and younger, non-Asians, people who were unable to understand the survey or consent forms, and people who failed to follow the instructions of the study personnel. Informed Consent, HIPAA and Bill of Rights forms were provided in English, Vietnamese, and Chinese (Mandarin). A risk factor survey was administered that included gender, age, body weight, previous osteoporotic fracture or family history of osteoporotic fracture, and menopause before age 45 or oophorectomy. Each participant's heel BMD T-score was measured with a portable GE Achilles bone densitometer. For purposes of this study, participants were classified as normal, at risk for osteopenia, or at risk for osteoporosis based on heel BMD T-scores.

For the primary endpoint (relationships between heel BMD T-score and risk factors), chi-squared tests were performed for gender, age, previous osteoporotic fracture or family history of osteoporotic fracture, and early menopause or oophorectomy. The median body weights of each risk group were compared to one another by the Kruskall-Wallis rank test. For the secondary endpoint, a linear regression was performed to find correlation between heel BMD T-scores and OSTA indices. Sensitivity and specificity of the OSTA were also calculated. Data were analyzed with STATA statistical software (Revision October 22, 2012. StataCorp LP, College Station, Texas).

The study was approved by the university's Human Research Protections Program.

Results

A total of 228 subjects were seen at nine health fairs between June and October 2014. One hundred and fifty subjects met the inclusion criteria. The study population included 110 Vietnamese (73%), 38 Chinese (25%), 1 Korean (1%), and 1 Filipino (1%). One hundred and nine participants (73%) were female, and 41 (27%) were male. Ages ranged from 50 to 87 years old (Figure 1).

Participants aged 50 to 64 years had lower osteoporosis risk compared to participants 65 years or older (Table 1). Body weight was higher in normal participants (n=88; median weight: 57.1 kg [42.9 - 92.5 kg]) compared to participants at risk for osteopenia (n=52; median weight: 56.7 kg [35.4 - 75.7 kg]) or osteoporosis (n=10; median weight: 48.4 kg [36.7 - 63.5 kg]) (p=0.0059; Figure 2). Osteoporosis risk was not significantly associated with being female, having a history of fracture, early menopause, or oophorectomy (Table 1).

The OSTA showed a weak correlation (r=0.24) with heel BMD T-scores and moderate sensitivity (66%) and specificity (51%) in predicting normal bone density versus at risk for osteopenia or osteoporosis as measured by heel BMD T-scores (Figure 3).

Discussion

Five known risk factors for osteoporosis in the general U.S. population were evaluated in this study. As body weight decreased or as age increased, risk for osteoporosis measured by heel BMD T-scores increased as expected. However, being female, having a history of osteoporotic fracture or family history of osteoporosis, and having early menopause or oophorectomy were not associated with osteoporosis risk, possibly because the study was underpowered to detect these differences. A PubMed literature search revealed limited studies in Asian immigrant populations in the U.S. related to osteoporosis risk factors.

A cross-sectional study of 469 immigrant Chinese Americans aged 50 and older in Chicago's Chinatown studied factors related to low BMD.[6] Lower body mass index, low educational attainment, and older age at immigration were associated with lower BMD assessed by a heel bone densitometer.[6] Smoking, exercise, and dairy consumption were not associated with BMD. In addition, this study showed that Chinese-American immigrants may be a high-risk group for osteoporosis.[6] Female immigrants had lower average BMD than U.S.-born Asian-American women, while male immigrants had lower BMD than white men at ages 70 and older.[6]

Lifestyle changes from living in the United States compared to Asia may affect the risk for osteoporosis. Acculturation level, milk consumption, and rates of osteoporosis were examined in Korean immigrant women aged 18 and older living in California.[7] Higher acculturation level and immigration to the U.S. before the age of 18 were significantly associated with consuming at least one serving of milk per day between the ages of 12 and 18.[7] Milk consumption during these early years significantly related to osteoporosis in bivariate analyses, and lower acculturation was significantly related to higher likelihood of osteoporosis among postmenopausal women.[7] A separate study conducted in our study population assessed relationships between current calcium and vitamin D intake (dietary or supplements) and exercise with heel BMD T-scores. No significant associations were found.[8]

The accuracy of the OSTA tool has been validated in a number of Asian populations.[4] Our study showed a weak correlation of OSTA with heel BMD T-scores. Also, it showed moderate sensitivity (66%) and specificity (51%) in predicting the heel BMD T-score classifications for normal versus low heel BMD. In our study, the risk category was defined as heel BMD T-score ≤ -1.0 and OSTA index ≤ -1 due to a small number of participants with heel BMD T-score ≤ -2.5. A study of Nepalese women used the same risk category as ours, and the sensitivity and specificity of the OSTA compared to heel BMD were 85.2% and 89.1%, respectively.[9] In a study of Taiwanese women, the sensitivity and specificity were 84% and 61%, respectively, when the risk category was defined as heel BMD T-score ≤ -2.5 and OSTA index ≤ -1.[10]

Limitations

Data collection for history of osteoporotic fracture or family history of osteoporosis relied on self-reports. While body weight was obtained, body mass index was not recorded for participants, as it was not a required measurement for the OSTA tool. Smaller subgroup sample sizes for comparisons of gender, history of fracture,

and early menopause or oophorectomy may have decreased the power to detect real differences. In addition, heel BMD T-scores were used as a reference group, as DXA T-scores of the spine or hip were not feasible in a community screening setting. Although a DXA scan is used as a diagnostic tool, heel BMD screening can be a useful prescreening tool for assessing risk of osteoporosis.[11] Another limitation of our study was that we did not collect the age at immigration to the U.S. of each participant. Since immigrants could have arrived as children or as adults, this may have impacted the applicability of our findings. Participants' general health was not asked in our survey, but all participants were ambulatory and presented themselves for the health fairs. We also did not ask about medication usage in our survey, as many of the participants spoke little English and may not be familiar with the names of medications they may be taking. A pilot study that we had conducted prior to this study showed that very few of our Asian patient population at our health fairs were smokers or alcohol users. In an effort to keep survey questions brief, we excluded questions related to tobacco or alcohol use. Lastly, our survey did not collect information about milk consumption during adolescence.

Conclusion

In Asian populations in San Diego County, California, participants aged over 65 or over 50 with low body weight should be screened for osteoporosis to evaluate the need for earlier intervention. The OSTA may be a moderately effective tool to identify patients at high risk for osteoporosis in these populations when peripheral heel BMD testing is not available.

About the Authors

Esther Park, PharmD, the corresponding author, was a PharmD candidate, class of 2016, at the University of California, San Diego, Skaggs School of Pharmacy and Pharmaceutical Sciences at the time she completed this project. She has no bias to report.

Binh Tran, MS, PharmD, MBA, is an assistant clinical professor at the University of California, San Diego, Skaggs School of Pharmacy and Pharmaceutical Sciences, and executive director at Asian Pacific Health Foundation, San Diego, with 15 years of experience in community screening work. She has no bias to report.

Brookie M. Best, PharmD, MAS, is a professor of clinical pharmacy and pediatrics at the University of California, San Diego, Skaggs School of Pharmacy and Pharmaceutical Sciences and Pediatrics Department, School of Medicine, with over 15 years of experience in clinical research study design, conduct, and analysis. She has no bias to report.

Renu Singh, PharmD, BCACP, CDE, is a clinical professor at the University of California, San Diego, Skaggs School of Pharmacy and Pharmaceutical Sciences. Dr. Singh has over 20 years of experience in adult ambulatory care practice and provides lectures in the area of osteoporosis. She has no bias to report.

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Osteoporosis Screening & Educational Program
Subject Survey Form

Name: _____
Last First Middle
Date of birth: ____ ___ _____ Age: _____ Phone: _____
_____

Please answer the following questions:

1- Gender: □ M □ F

2- Race:
□ Vietnamese
□ Chinese
□ Indian
□ Korean
□ Filipino
□ Other (please specify): _____

3- Previous osteoporotic fracture in you or family history of osteoporotic fracture
□ Yes □ No

4- For women only.
Early menopause (before age 45) or surgical removal of the ovaries
□ Yes □ No

5- Taking calcium supplement □ Yes □ No

If yes,
What kind?
□ Calcium supplement
□ Multivitamins
□ I don't know
□ Others (please specify): _____

How much?
□ 200 mg tablets
□ 1000 mg tablets
□ I don't know
□ Others (please specify): _____

6- Taking vitamin D? □ Yes □ No

If yes,
What kind?
□ Vitamin D supplement
□ In combination with calcium
□ I don't know
□ Others (please specify): _____

(form continued on next page)

How much?

- □ 400 IU
- □ 800 IU
- □ 1000 IU
- □ more than 1000 IU
- □ I don't know
- □ Others (please specify): _____

7- Calcium-rich foods that you eat are
Serving size: 1 cup, 2 cups, etc.
How often: once a day, more than once a day, once a week, etc.

Food Type	**Serving Size**	**How Often**
Milk		
Cheese		
Yogurt		
Sardines		
Soybeans		
Dark leafy greens (such as spinach, kale, turnips, collard greens)		
Dried figs		
Fortified cereal (such as Total, Raisin Bran, Corn Flakes)		
Fortified soy milk		

Others (please specify): _____

8- Regular exercise 2.5 hours per week : □ Yes □ No
IF yes,
What kind of exercise?

Exercise	**hours/week**
Walking	
Running	
Swimming	
Hiking	
Weight lifting	
Yoga	
Tai chi	
Dancing	
Aerobics	
Golf	
Tennis	

Others (please specify): _____

(form continued on next page)

Subject's weight: _____**kg**
OSTA index: _____

Index > -1:	Low risk
Index -1 to -4 :	Intermediate risk
Index < -4:	High risk

Subject's bone densitometry results: **T-score**: _____

T score ≥ -1:	Normal
T score -1 to -2.5 :	Risk for osteopenia
T score < -2.5:	Risk for osteoporosis

Consent:
I hereby authorize all medical procedures. I agree to be tested by a physician, or all medical personnel under the supervision of a physician.

Signature: _____ Today's Date: _____

End Of Form

Table 1: Heel BMD T-scores by Risk Factor Groups

	Categories	Number of subjects	Mean T-score	Standard Deviation	p-value
Age	50 - 64 years old	77	-0.62	1.14	0.036*
	65 years or older	73	-0.90	1.16	
Gender	Male	41	-0.39	1.12	0.218
	Female	109	-0.89	1.14	
History of fracture	No	128	-0.73	1.15	0.260
	Yes	22	-0.89	1.17	
Early menopause or oophorectomy	No	119	-0.77	1.11	0.536
	Yes	31	-1.21	1.17	

*Significant at p-value < 0.05

Figure 1: Age of Study Participants

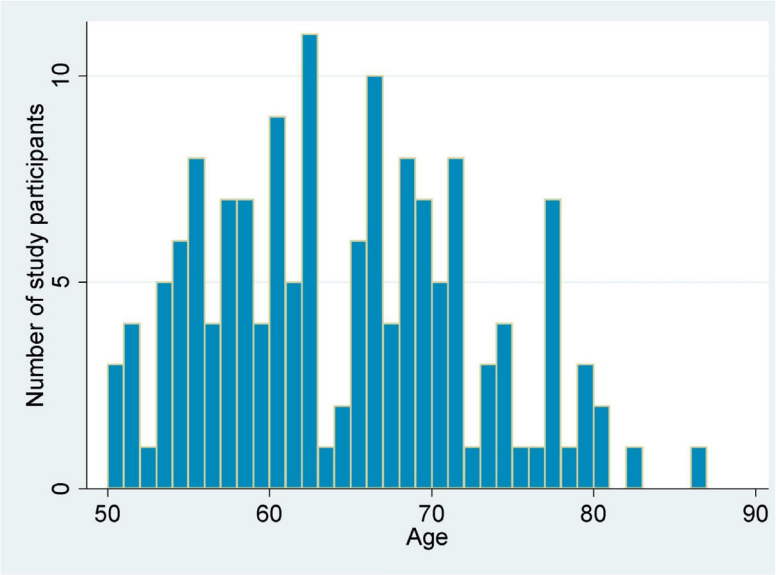

Figure 2: Median Body Weight (kg) of Each Osteoporosis Risk Class

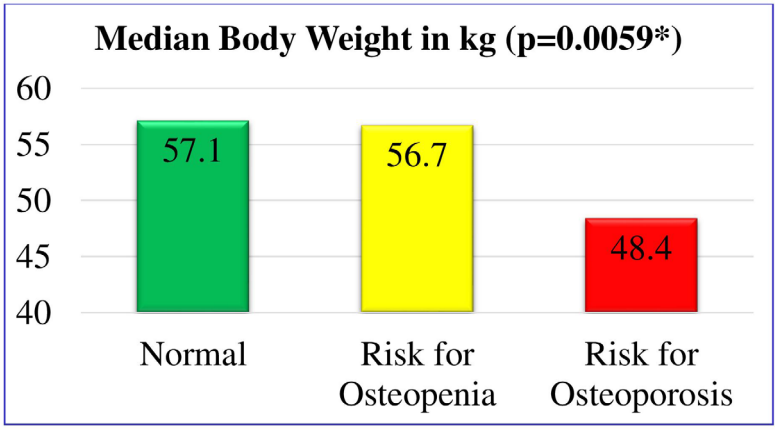

Figure 3: Correlation between heel BMD T-scores and OSTA indices using linear regression