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Using a simple preliminary screening tool to explore related factors of osteoporosis in the elderly of southern Taiwan

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Abstract

The aims of this study were to use a simple screening tool to explore related factors with osteoporosis in the elderly in the community of southern Taiwan.

This was an observational cross-sectional study using Osteoporosis Self-Assessment Tool for Asia (OSTA), Osteoporosis Self-Assessment Tool for Taiwanese (OSTAi), and the basic demographic information to identify osteoporosis in the participants. This study collected data from 200 participants aged 65 and above and living in southern Taiwan.

The prevalence of osteoporosis among elders in the community was 30.5% (OSTA) and 58.0% (OSTAi), respectively. The prevalence of osteoporosis determined by OSTA and OSTAi in female (33.1% and 63.1%, respectively.) was higher than in male (25.7% and 48.6%, respectively.). Risk factors such as gender, age, and body mass index (BMI) were significantly associated with osteoporosis ($P < .001$). Using OSTA and OSTAi to assess the risk for osteoporosis, for every 1 year of age increase, the odds ratio (OR) value of osteoporosis increased by 1.84 and 1.50 times, respectively ($P < .001$); for every 1 kg/m^2 increase in BMI, the OR of osteoporosis decreases by 0.36 and 0.44 times, respectively. The results of this study can be used a simple tool of OSTA and OSTAi self-examination to screen potential high-risk groups for osteoporosis in the community.

OSTA and OSTAi can screen for possible high-risk groups early and without invasive examinations and self-examination tools in a hospital. Low BMI poses higher risks of osteoporosis for the elderly, so increasing functional ability, improving muscle strength, maintaining exercise habits and keeping proper weight could prevent osteoporosis in the seniors.

Abbreviations: BMI = body mass index, DXA = dual energy X-ray absorptiometry, OR = odds ratio, OSTA = Osteoporosis Self-Assessment Tool for Asia, OSTAi = Osteoporosis Self-Assessment Tool for Taiwanese, QUS = quantitative ultrasound.

Keywords: Osteoporosis, Osteoporosis Self-Assessment Tool for Asia, Osteoporosis Self-Assessment Tool for Taiwanese

1. Introduction

Taiwan will become a super-aged country by 2026, with the elderly making up 20% of the population.[1] Consequently, the prevalence of chronic diseases (e.g., osteoporosis) and physical dysfunction is increasing. A 2005 to 2008 survey in Taiwan showed that the osteoporosis prevalence in men and women over 50 was 23.9% and 38.3% respectively.[2] Lacking obvious initial symptoms, osteoporosis is often not diagnosed until a fracture occurs. About 9 million people worldwide had osteoporotic fractures in 2000,[3] and 45.0% of women over 50 with osteoporosis will have a fracture within 10 years,[4] making early detection and prevention of osteoporosis an important public health issue.

According to research, identifying and treating osteoporosis before a fracture has occurred can greatly reduce the long-term risk of fracture. Early prevention and treatment of osteoporosis also reduce the risk of first fracture from 8% to 2% and reduce the 5-year fracture rate from about 34% to 10%. Thus, the 5-year fracture rate of osteoporosis is prevented and treated as soon as possible.[5]

The relative risk factors are age, gender, smoking, drinking, a medical disease known to affect calcium or bone metabolism, obesity protective,[6] and a fatty liver.[7]

Dual energy X-ray absorptiometry (DXA) has been the gold standard for bone density testing. However, DXA instruments

are unportable and inaccessible to some people. The quantitative ultrasound (QUS) instruments are portable and often used for initial osteoporosis screening. A suspected result in the QUS test must be confirmed with a DXA bone density test.[8] However, in order to screen patients at high risk of osteoporosis, it is not worth recommending that all people receive an examination. It is best to have an assessment method that can correctly distinguish between osteopenia, osteoporosis, and normal osteoporosis and to continue to further identify more dangerous osteoporosis situations for patients. This will reduce the need for bone density identification tests and increase the screening rate of high-risk patients with osteoporosis.

OSTA (Osteoporosis Self-assessment Tool for Asia),[9] calculates the osteoporosis risk index in Asian postmenopausal women using age and weight. Its sensitivity and specificity range from 79.0% to 97.5% and 45.0% to 69.5%,[10–12] respectively. OSTA can identify most patients with osteoporosis, but its specificity is not high. This means that the screening results will have a considerable proportion of false positives, and about half of normal people will be misjudged as having osteoporosis, and thus unnecessary DXA bone density tests will be recommended. OSTA is considered an effective self-assessment tool for initial osteoporosis screening that could replace ultrasound bone densitometry. An osteoporosis screening in 65,533 subjects using QUS and OSTA showed consistent results between the 2 methods in low-risk groups, with both specificities greater than 90%.[13] The Osteoporosis Self-assessment tool for Taiwanese (OSTAi)[14] was developed based on OSTA and was adopted in the 2019 Consensus and Guidelines for Osteoporosis Control for self-examination,[15] especially for women. The sensitivity and specificity of OSTAi range from 62.0% to 73.1% and 45.7% to 78.3%, respectively.[14] As OSTA is common for Asian populations, OSTAi is a useful tool to identify Taiwan postmenopausal women with osteoporosis. In comparison with the National Osteoporosis Foundation recommendations in 2013 (NOF 2013), OSTAi may be an easier and better tool for referral to BMD measurement in postmenopausal women with osteoporosis.[14]

This study aimed to investigate osteoporosis prevalence in the elderly (over 65-year-old) population in southern Taiwan using preliminary osteoporosis screening tools, analyze associated risk factors, and compare OSTA and OSTAi screening results. The goal is using a community-based screening strategy by screening potential high-risk osteoporosis cases and then referring cases to a hospital to confirm through DXA testing, in order to achieve the goal of early detection and early treatment.

2. Subjects and methods

2.1. Subjects

The participants enrolled in the current investigation must fulfill the inclusion criteria: Taiwanese, elderly who are 65 years old and above, a willingness to participate in the study, and an ability to read and provide informed consent. As this project was a screen program, no specific exclusion criteria were set. However, those subjects who could not access the machine or both of their hips had previously been fractured or replaced were excluded from the sample. We enrolled 200 subjects aged 65 and over from Kaohsiung City in southern Taiwan.

This study was approved by the Institutional Review Board, Kaohsiung Veterans Hospital (VGHKS19-CT2–12). Data collection started only after the purpose of the study, the way it

would be conducted, and the rights of the participants were explained, and the consent was given by the elderly or their family members. Names, identities, and other relevant information were removed from the data. The study was conducted in the non-hospital setting; therefore 2 to 3 nurses aided onsite in all the tests.

2.2. Measurement and tool

This study was conducted by using a self-administered structured questionnaire, which enquired about the basic information of the study subjects, their lifestyle habits, and disease history of the subject and the family. The basic information included gender, age, height, weight, and education level; questions on lifestyle included smoking habits, alcohol consumption, tea consumption, and exercise habits; the disease history included a survey of 17 diseases including hypertension, hyperglycemia, diabetes, and related medications; and the family history of diseases such as heart, diabetes, hypertension, osteoporosis, and fracture were also enquired.

The subject must wear light clothing and not wear shoes in an upright position. An anthropometric scale is employed to weigh the person (kg) and measure his/her height (cm). Both OSTA and OSTAi use age and body weight to assess the risk of osteoporosis. Risk calculation formula of OSTA is $0.2 \times$ [body weight (kg)–age (years)]. The risk categories in OSTA include low risk (values > -1), medium risk (values between -4 and -1), and high risk (values <-4). Risk calculation formula of OSTAi is $0.2 \times$ (age (years)–body weight (kg)). The risk categories in OSTAi include low risk (values <-1), medium risk (values between 2 and -1), and high risk (values ≥ 2). The chances of acquiring osteoporosis for a person in the low, medium, and high-risk category are 3%, 15%, and more than 60%, respectively. Our data collection process sees Figure 1

2.3. Statistical analyses

Average numbers were shown as mean±standard deviation. Student t test was used to determine the significance of difference between groups. The association between demographic variables and the osteoporosis risks was analyzed by t test and Chi-Squared test, and only significant variables entered into multivariable logistic regression analysis. Cohen Kappa coefficient was used to compare the results of OSTA and OSTAi. The strengths of the association between risk factors and osteoporosis risks were determined by calculating the odds ratios (OR) and performing multivariable logistic regression analysis. Statistical processing of all data was done by SPSS ver. 20.0 (IBM Corp., Armonk, NY). Statistical significance was set $P<.05$.

3. Result

3.1. Demographics and osteoporosis prevalence

There were 130 (65.0%) females and 70 (35.0%) males in this study, with a mean age of 74.90±7.58 years and a predominance of 113 (56.5%) elders aged between 65 and 74 years. The average height and weight were 157.75±8.34cm and 62.52±10.30kg, respectively, and the average body mass index (BMI) was 24.96± 3.54kg/m², with 85 people (42.5%) in the normal BMI range. Regarding the lifestyle habits and disease history, 182 (91.0%) were non-smokers, 123 (61.5%) were non-tea drinkers, 70 (35.0%) had a family history of hypertension, 44 had diabetes (22.0%) and 14 had fatty liver (7.0%). As for sun exposure, some
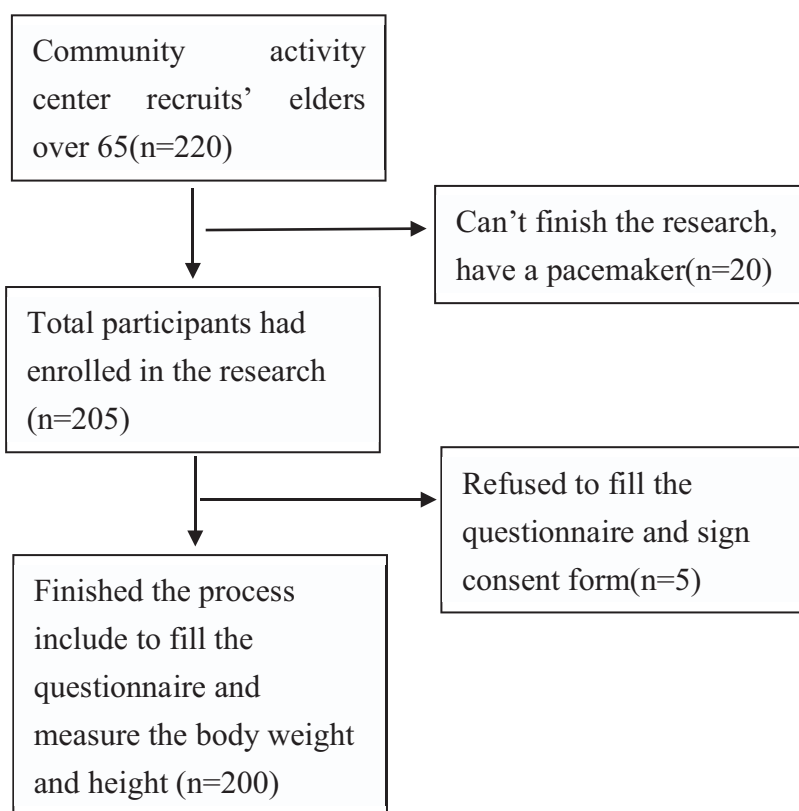
Figure 1. Data collection flowhart.

163 (81.5%) take Vitamin D, and some 136 (68.0%) take a milk/calcium tablet. For exercise habits, 172 (86.0%) exercised more than 3 times per week, and 160 (80.0%) exercised for more than 30 minutes each time (Table 1).

Using OSTA in participants over 65 years of age, the risk assessment found that the rough estimate for overall prevalence of osteoporosis in the high-risk group was 30.5%, with 33.1% in women and 25.7% in men. Differentiated by age, the rough estimate for prevalence of osteoporosis in the high-risk group was 7.1% for ages 65 to 74, 50.8% for ages 75 to 84, and 82.1% for ages 85 and above. When using OSTAi, the rough estimate for overall prevalence of the high-risk group'i osteoporosis in the elderly aged over 65 years was 58.0%, with 63.1% in women and 48.6% in men. Differentiated by age, the rough estimate prevalence of osteoporosis in the high-risk group was 36.3% for ages 65 to 74, 83.1% for ages 75 to 84, and 92.9% for ages 85 and above. The prevalence rate of osteoporosis estimated roughly by OSTA was 27% in the low-risk group, 42.5% in the medium-risk group, and 30.5% in the high-risk group, but via OSTAi, the prevalence rate in the low-risk group was 10%, 32% in the medium-risk group, and 58% in the high-risk group. OSTA or OSTAi is used to estimate the prevalence of osteoporosis in the age variable, and the middle- and low-risk groups are mostly screened from the 65 to 74 year-old group, while the high-risk group is mostly those over 85 years old (Table 2).

3.2. Association between osteoporosis and various variables

The association between each variable and the degrees of osteoporosis risk (divided into 2 groups: low-/medium-risk group and high-risk group) assessed by OSTA and OSTAi was analyzed by *t*test. The study subjects in each osteoporosis risk groups assigned by OSTA shared similar characteristics in terms of age, height, weight, and BMI to those in the equivalent group assigned by OSTAi. For example, regardless of OSTA or OSTAi assessment, individuals at low and moderate risk groups were younger, taller, heavier, and had a relatively higher BMI than individuals at high risk (all $P < .001$).

Chi-Squared test analysis revealed a significant difference ($P < .05$) for diabetes or fatty liver, family members with hypertension, tea drinking habits, the duration of exercise time, weekly exercise frequency and sun exposure/take Vitamin D, and take milk/calcium tablet, between the osteoporosis risk groups in both OSTA and OSTAi assessments. Osteoporosis risk groups determined by OSTAi also showed significant differences ($P < .05$) in gender (Table 3).

3.3. Risk factors associated with osteoporosis

The association of risk factors identified by using OSTA, such as gender, age, BMI, diabetes or fatty liver, family members with hypertension, tea drinking habits, the duration of exercise time, weekly exercise frequency, sun exposure/take Vitamin D, and take milk/calcium tablet with osteoporosis was further tested by logistic regression analysis. Men were less likely to develop osteoporosis than women (adjusted OR = 0.001, $P < .001$) and the adjusted OR of developing osteoporosis increased 1.89-fold ($P < .001$) for each additional year of age and decreased 0.32-fold ($P < .001$) for each additional 1 kg/m^2 of BMI. Those with sun

Table 1

General characteristics of the research subjects.

Variables	Total number = 200
Female gender (%)	130 (65.0%)
Age (years)	74.9 ± 7.6 (65–98)
65–74	113 (56.5%)
75–84	59 (29.5%)
>85	28 (14.0%)
Height (cm)	157.8 ± 8.3 (125–181)
Body weight (kg)	62.5 ± 10.3 (41.4–98.0)
Body mass index (kg/m^2)	24.96 ± 3.5 (18.0–36.5)
≦ 18.4	2 (1.0%)
18.5 ~ 23.9	85 (42.5%)
24.0 ~ 26.9	57 (28.5%)
≧ 27.0	56 (28.0%)
Diabetes (%)	44 (22.0%)
Fatty liver (%)	14 (7.0%)
Weekly exercise (%)	
<3 times	28 (14.0%)
> 3 times	172 (86.0%)
Exercise time (%)	
< 30 minutes	40 (20.0%)
> 30 minutes	160 (80.0%)
Habit of drinking tea (%)	77 (38.5%)
Smoking habit (%)	
No	182 (91.0%)
Quit	9 (4.5%)
Yes	9 (4.5%)
Family history-hypertension (%)	70 (35.0%)
Sun exposure/ take vitamin D	
Yes	163 (81.5%)
No	37 (18.5%)
Take a milk/calcium tablet	
Yes	136 (68.0%)
No	64 (32.0%)

Data were presented as number (%) or mean ± standard deviation (range).

exposure/take Vitamin D were less likely to develop osteoporosis than those who did not have it (adjusted OR = 5.099, P = .025), and a fatty liver is more likely to develop osteoporosis in people versus those who do not have a fatty liver (Table 4).

Logistic regression analysis of the association between osteoporosis and the risk factors identified by using OSTAi also showed that men were less likely to develop osteoporosis (adjusted OR = 0.02, P < .001), the incidence of osteoporosis increased 1.50-fold (P < .001) with each additional year of age, and decreased 0.32-fold (P < .001) for each additional 1 kg/m^2 of BMI. Those with sun exposure/take Vitamin D were less likely to

develop osteoporosis than those who did not have sun exposure/ take Vitamin D (adjusted OR = 2.434, P = .032). Moreover, participants with a fatty liver were more likely to develop osteoporosis than those without a fatty liver. However, the effects of tea drinking habit, family history of hypertension, with or without diabetes, family members with or without hypertension, duration of exercise time, weekly exercise frequency, and take milk/calcium tablet were not statistically significant (P > .05, Table 4).

4. Discussion

4.1. Prevalence of osteoporosis

The overall prevalence of osteoporosis among community elders in southern Taiwan was estimated to be 30.5% and 58.0% by OSTA and OSTAi, and the prevalence among women and men was 33.1% and 25.7% by OSTA and 63.1% and 48.6% by OSTAi, respectively. The prevalence in men was higher than previously reported likely because previous studies used DXA to diagnose osteoporosis and OSTA was originally intended for postmenopausal women.[16] It has been suggested that cutoffs should be adjusted for osteoporosis risk assessment in men while using OSTA.[17] OSTAi also reported higher osteoporosis prevalence in women than in previous studies using DXA.[2,18] OSTA is currently the only simple self-assessment method developed in Asia, using 2 risk factors, age and weight, to identify high-risk groups of osteoporosis.[9] The advantages of these risk assessment questionnaires are their low economic cost and harmlessness. The sensitivity of the above questionnaire used by women over 45 years old is more than 90%, and the specificity is between 30% and 60%.[19,20] The sensitivity of using the above questionnaire in men over 65 years old is about 90%, and the negative predictive value is about 97%. This can be reduced by about 1/3 for people who do a bone mineral density examination.[20] According to the 2013 to 2016 National Nutrition Survey Report, the prevalence rate of osteoporosis in men and women over 50 years old is 23.9% and 38.3%, respectively.[21] In this study's results, those filtered by OSTA seem closer to official statistics than those from OSTAi, but in postmenopausal women, the prevalence of osteoporosis is estimated to be more similar to OSTAi than OSTA, which may be more sensitive to OSTAi's original screening for menopausal women.[15] The results show that the prevalence rate of osteoporosis in elderly women in this study was 63.1%. They are similar to the prevalence rate of women over 50 in Denmark (40.8%) and the prevalence rate of women aged 65 to 74 in South Korea (52.5%).[22,23]

Table 2

Prevalence of osteoporosis in each risk group based on OSTA and OSTAi.

Total number = 200	Gender		Age (years)		
	Female (n = 130)	Male (n = 70)	65–74 (n = 113)	75–84 (n = 59)	> 85 (n = 28)
OSTA					
Low risk	27 (20.8%)	27 (38.6%)	50 (44.2%)	3 (5.1%)	1 (3.6%)
Medium risk	60 (46.2%)	25 (35.7%)	55 (48.7%)	26 (44.1%)	4 (14.3%)
High risk	43 (33.1%)	18 (25.7%)	8 (7.1%)	30 (50.8%)	23 (82.1%)
OSTAi					
Low risk	7 (5.4%)	13 (18.6%)	20 (17.7%)	0 (0.0%)	0 (0.0%)
Medium risk	41 (31.5%)	23 (32.9%)	52 (46.0%)	10 (16.9%)	2 (7.1%)
High risk	82 (63.1%)	34 (48.6%)	41 (36.3%)	49 (83.1%)	26 (92.9%)

OSTA = Osteoporosis Self-Assessment Tool for Asians, OSTAi = Osteoporosis Self-Assessment Tool for Taiwanese.

Table 3

Associated Factors of Osteoporosis in each risk group based on OSTA and OSTAi N = 200.

	OSTA			OSTAi		
	Low and medium risk (n=139)	High risk (n=61)	P value	Low and medium risk (n=84)	High risk (n=116)	P value
Female gender	87 (62.6%)	43 (70.5%)	.28	48 (57.1%)	82 (70.7%)	.047[*]
Age (years)[†]	71.8±5.53	82.0±6.89	<.001[***]	70.5±4.79	78.1±7.70	<.001[***]
65–74	105 (75.5%)	8 (13.1%)	<.001[***]	72 (85.7%)	41 (35.3%)	<.001[***]
75–84	29 (20.9%)	30 (49.2%)		10 (11.9%)	49 (42.2%)	
>85	5 (3.6%)	23 (37.7%)		2 (2.4%)	26 (22.4%)	
Height (cm)	159.2±8.02	154.6±8.22	<.001[***]	160.8±7.8	155.5±8.05	<.001[***]
Body weight (kg)	66.4±9.38	53.7±5.97	<.001[***]	70.9±8.60	56.4±6.42	<.001[***]
Body mass index (kg/m^2)[†]	26.01±3.44	22.58±2.43	<.001[***]	27.16±3.44	23.37±2.65	<.001[***]
≤ 18.4	0 (0.0%)	2 (3.3%)	<.001[***]	0 (0.0%)	2 (1.7%)	<.001[***]
18.5 ~ 23.9	42 (30.2%)	43 (70.5%)		15 (17.9%)	70 (60.3%)	
24.0 ~ 26.9	44 (31.7%)	13 (21.3%)		24 (28.6%)	33 (28.4%)	
≥ 27.0	53 (31.7%)	3 (4.9%)		45 (53.6%)	11 (9.5%)	
Diabetes	34 (24.5%)	10 (16.4%)	.041[*]	25 (29.8%)	19 (16.4%)	.02[*]
Fatty liver	11 (7.9%)	3 (4.9%)	.045[*]	10 (11.9%)	4 (3.4%)	.02[*]
Family history of hypertension	54 (38.8%)	16 (26.2%)	.049[*]	36 (42.9%)	34 (29.3%)	.047[*]
Habit of drinking tea	58 (41.7%)	19 (31.1%)	.047[*]	44 (52.4%)	33 (28.4%)	<.001[***]
Weekly exercise						
<3 times	24 (17.3%)	4 (6.6%)	.044[*]	19 (22.6%)	9 (7.8%)	.003[**]
>3 times	115 (82.7%)	57 (93.4%)		65 (77.4%)	107 (92.2%)	
Exercise time						
<30 minutes	32 (23.0%)	8 (13.1%)	.01[*]	25 (29.8%)	15 (12.9%)	.003[**]
>30 minutes	107 (77.0%)	53 (86.9%)		59 (70.2%)	101 (87.1%)	
Smoking habit						
No	124 (89.2%)	58 (95.1%)	.13	73 (86.9%)	109 (94.0%)	.20
Quit	6 (4.3%)	3 (4.9%)		5 (6.0%)	4 (3.4%)	
Yes	9 (6.5%)	0 (0.0%)		6 (7.1%)	3 (2.6%)	
Sun exposure/ Take Vitamin D						
Yes	107 (77.0%)	56 (91.8%)	.013[*]	62 (73.8%)	101 (87.1%)	.017[*]
No	32 (23.0%)	5 (8.2%)		22 (26.2%)	15 (12.9%)	
Take a milk/calcium tablet						
Yes	92 (66.2%)	44 (72.1%)	.041[*]	50 (59.5%)	86 (74.1%)	.029[*]
No	47 (33.8%)	17 (27.9%)		34 (40.5%)	30 (25.9%)	

[*] P<.05.
[**] P<.01.
[***] P<.001.
[†] Data were shown as mean±SD and the results of t tests were indicated.
OSTA = Osteoporosis Self-Assessment Tool for Asians, OSTAi = Osteoporosis Self-Assessment Tool for Taiwanese.

There was a disagreement between OSTA and OSTAi in determining the degree of osteoporosis risk (Cohen Kappa = 0.326, Table S1 in the Supplementary Material online, http://links.lww.com/MD/F816). OSTA reported a significantly higher proportion of individuals at low and moderate risks and a significantly lower proportion of individuals at high risk of osteoporosis than OSTAi. This suggests that OSTA is more suitable for individuals at low risk for osteoporosis and postmenopausal women.[13,24] Both OSTA and OSTAi are simple tools for the public to self-examine for the risk of osteoporosis. Therefore, a certain degree of accuracy is still required. It is recommended that the difference between the 2 tools in screening for osteoporosis can be compared in the future.

4.2. Association between subject characteristics and osteoporosis risks

Subject characteristics such as gender, age, height, weight, family history of hypertension, tea drinking habits, diabetes, fatty liver, BMI, Sun exposure/take Vitamin D, take milk/calcium tablet, weekly exercise frequency, and duration of exercise were associated to various degrees with the risk of osteoporosis determined by OSTA or OSTAi. Similarly, previous reports found that gender, age, height, weight, BMI, tea drinking habits, and exercise habits were associated with osteoporosis or bone density.[25,26] Past studies have found that type 1 diabetes patients usually have a lower bone density whereas type 2 diabetes patients have a normal or higher bone density, but both are still at higher risk of fracture.[27] In diabetic patients, osteoporosis may occur due to insulin deficiency, causing abnormalities in the metabolism of sugar, protein, fat, calcium, etc., resulting in a decrease in bone density. A significant association between fatty liver and osteoporosis in men has been reported.[28] Individuals with a fatty liver may suffer from chronic high blood glucose and inadequate insulin secretion, ultimately resulting in decreased bone density and osteoporosis.[29,30]

As age increases, the function of osteoblasts decreases, the production and absorption of vitamin D decrease, the secretion of parathyroid glands increases, the absorption of calcium from the gastrointestinal tract decreases, and calcium from the bones into the blood may cause bone loss. In addition, insufficient exercise

Table 4

The risk factors with osteoporosis based on OSTA and OSTAi N = 200.

Variable	Number	OSTA			OSTAi		
		Adjusted OR	95% CI	*P value*	Adjusted OR	95% CI	*P value*
Gender							
Female	130	1.000	(reference)	–	1.000	(reference)	–
Male	70	0.001	0.000–0.028	<.001***	0.021	0.000–0.016	<.001***
Age	200	1.889	1.490–2.395	<.001***	1.503	1.530–2.630	<.001***
Body mass index	200	0.323	0.205–0.507	<.001***	0.416	0.170–0.485	<.001***
Sun exposure/ Take Vit D							
Yes	163	1.000	(reference)	–	1.000	(reference)	-
No	37	5.099	1.643–15.826	.025*	2.434	1.534–11.101	.032*
Weekly exercise							
< 3 times	28	1.000	(reference)	-	1.000	(reference)	–
> 3 times	172	0.209	0.010–4.480	.317	0.862	0.008–16.290	.600
Exercise time							
< 30 minutes	40	1.000	(reference)	-	1.000	(reference)	–
> 30 minutes	160	1.315	0.149–1.444	.658	1.675	0.049–4.444	.508
Take a milk/calcium tablet							
Yes	136	1.000	(reference)	–	1.000	(reference)	–
No	64	2.315	0.541–9.579	.453	1.355	0.401–4.579	.625
Habit of drinking tea							
No	123	1.000	(reference)	–	1.000	(reference)	–
Yes	77	0.331	0.191–1.111	.089	0.383	0.124–1.178	.094
Family history-hypertension							
No	130	1.000	(reference)	–	1.000	(reference)	–
Yes	70	0.593	0.213–1.347	.512	0.619	0.197–1.946	.412
Diabetes							
No	156	1.000	(reference)	-	1.000	(reference)	–
Yes	44	0.386	0.116–1.835	.089	0.368	0.106–1.283	.117
Fatty liver							
No	186	1.000	(reference)	–	1.000	(reference)	–
Yes	14	0.111	0.025–0.912	.041*	0.111	0.015–0.832	.032*

* *P* < .05.
** *P* < .01.
*** *P* < .001.
Adjusted OR = adjusted odds ratio, CI = confidence interval, OSTA = Osteoporosis Self-Assessment Tool for Asians, OSTAi = Osteoporosis Self-Assessment Tool for Taiwanese.

and dietary calcium intake by the elderly may also cause osteoporosis. In addition to being an indicator of obesity status, BMI can also be regarded as an indicator of personal nutritional status. Therefore, a smaller BMI means that a person's nutritional intake is insufficient, and there is a higher risk of causing osteoporosis. Many studies have also confirmed that a smaller BMI is a risk factor for hip fracture.[31,32] Taller subjects have lower risk for osteoporosis. Similar results have been found in other literature, but there is no hypothesis to explain its detailed mechanism.[33,34] We find that people with the habit of drinking tea are less likely to get osteoporosis similar to other findings in the literature. Tea contains fluoride and flavonoid. Fluoride can slow down the process of bone loss, while flavonoid can improve bone density. In addition, tea extracts and additives, such as polyphenol and tannin, can also increase bone density.[35,36]

The study subjects' marital status, education, occupation, fracture history, and smoking habits were not significantly different among the osteoporosis risk groups determined by OSTA or OSTAi, suggesting that these factors were not associated with the risk of osteoporosis. Similarly, previous reports found that However, this study did not further break down the cause and the site of the fracture and the age of occurrence and therefore failed to show significant difference. This study did not show any difference in smoking habits among risk groups either, probably because 91.0% of the subjects in this study were nonsmokers and years of smoking, cigarettes consumption, and the nicotine intake, etc., had not been considered. These should be considered in future studies. OSTA and OSTAi were not totally consistent in identifying factors associated with osteoporosis. This could be due to the different cutoffs demarcating the risk groups.

4.3. Osteoporosis risk factors

Logistic analysis identified female, old age, and low BMI as the risk factors for osteoporosis. Gender and age are inherent risk factors that cannot be altered. The results seem to suggest that obesity is a protective factor for osteoporosis. However, BMI does not represent the actual amount of body fat. About 30% of women with normal BMI values are actually obese, and 70% of men with overweight or obese BMI values actually have normal body fat percentages.[37] Nevertheless, the relation between fat and bone density is still debatable. Obese women have higher bone density in the spine and femur than non-obese women,[38] suggesting a lower risk of osteoporosis in obese people. However, a body weight stratification study found that individuals with higher body fat percentages had less bone density.[39] Meanwhile, a study showed that middle-aged men with fatty liver were more susceptible to osteoporotic fractures.[20] Therefore, the results of present study differ from previous findings likely because in this

study body fat percentage were not considered, and the sample size of women was larger than men.

4.4. Study limitations

The questionnaire data were limited and susceptible to recall bias. The disease and medication information obtained from the participants might not represent the complete disease history. In addition, only 200 participants were enrolled in this study. Risk assessment of osteoporosis by OSTA or OSTAi was used in this study while the actual cases of osteoporosis have to be determined by physicians using bone densitometry testing. This study only included elderly participants in southern Taiwan, so the results may not fully apply to other communities across Taiwan.

5. Conclusion

The results of this study can be used a simple tool of OSTA and OSTAi self-examination to screen potential high-risk groups for osteoporosis in the community. The screening results were similar to domestic and foreign studies. OSTAi was used as a simple screening test for osteoporosis in postmenopausal women in Taiwan. OSTA is a simple screening tool for osteoporosis in adults. Thus, community healthcare people can screen for possible high-risk groups early and without invasive examinations and self-examination tools in a hospital. Those people can then receive treatment early, thus reducing unnecessary travel and inspections.

This study showed that the risk of osteoporosis was higher in elders who were female, older, or with lower BMI. To achieve the goal of early detection and prevention of osteoporosis, the sensitivity and specificity of osteoporosis self-assessment tools require constant improvement. In light of our findings, health education campaigns on bone maintenance and fall prevention should be enhanced and the public should maintain exercise habits and proper weights to reduce bone loss.

Author contributions

Conceptualization: Hong-Jhe Chen.
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Correction

Dr. Hsueh-Hui Kao's name was spelled incorrectly when first published as Hsueh-Huib Kao and has since been corrected.

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