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Coffee Consumption Might Reduce the Risk of Osteopenia/Osteoporosis in Premenopausal Taiwanese Women

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Abstract The health impact of osteoporosis on individuals and the population at large is huge and its effect on national economies is negative. The aim of this study was to investigate the association between coffee consumption and osteopenia/osteoporosis in premenopausal and postmenopausal women in Taiwan. Data of 2929 women who completed a questionnaire about their weekly coffee consumption and bone health were retrieved from the Li-Shin Hospital (2006-2011). Coffee consumption was classified into 0, 1-4 and 5-7 cups per week (1 cup was equivalent to 400 mL). Osteoporosis and osteopenia were defined using bone mineral densities measured by quantitative ultrasound (QUS). Multiple logistic regression was used to determine the association between coffee drinking and osteopenia/osteoporosis. After exclusions were made, a total of 2533 participants were included in the final analysis. Adjusted confounders included age, hepatitis B surface antigen (HBsAg), anti-Hepatitis C virus (HCV), waist-hip ratio (WHR), body mass index (BMI), smoking, alcohol, tea, exercise, vegetarian diet, supplements, yogurt, education, and blood type. There were 1336 premenopausal and 1593 postmenopausal women at baseline. Among the premenopausal women, an increase in the weekly coffee consumption significantly decreased the odds for osteoporosis (P-trend = 0.0179). The consumption of 1-4 and 5-7 cups of coffee per week significantly reduced the risk of osteoporosis/osteopenia (OR = 0.677; 95% C.I. = 0.469-0.978) and (OR = 0.607; 95% C.I. = 0.400-0.923), respectively. Among postmenopausal women, however, there was no significant relationship between weekly coffee consumption and osteoporosis/osteopenia. It was concluded that coffee drinking might likely minimize the risk of osteoporosis/osteopenia in premenopausal Taiwanese women.

Keywords: *menopause, osteoporosis, osteopenia, coffee, Taiwan*

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1. Introduction

Osteoporosis is defined as a progressive systemic skeletal disease characterized by reduced quantity and quality of bones. In this condition, the quantity of bone (bone mineral density) is >2.5 standard deviations below the young adult's race/gender-adjusted mean. Osteopenia, on the other hand, is a condition where the bone mineral density is between -1 and -2.5 standard deviations below the young adult's race/gender-adjusted mean. Osteopenia can lead to osteoporosis which in turn can increase the risk of fractures. Most patients are often diagnosed with osteoporosis following bone fractures. In such cases, osteopenia might have become more severe thereby leading to more bone quality deterioration and loss.

Osteopenia and osteoporosis are associated with several modifiable/non-modifiable risk factors [1,2]. Generally, both conditions are more common in the elderly [3,4,5,6], especially in females [7,8,9]. Some preventive modifiable factors for osteoporosis and osteopenia include higher BMI [10,11,12,13,14], calcium and vitamin D intake [15,16], among others. Currently, coffee is among the most consumed beverages and its consumption is global. Several studies have been carried out to assess the

relationship between coffee drinking and osteopenia or osteoporosis. Nonetheless, the results have been inconsistent [17,18,19,20]. For instance, the consumption of 600 mL or more of coffee per day was associated with an increased osteoporotic fracture risk in Swedish women [19]. However, higher amounts of coffee were not associated with increased risk of fractures in Swedish women [18]. Moreover, coffee drinking was shown to be preventive against osteoporosis in postmenopausal women [21]. Most previous studies did not stratify their participants by menopausal status. This study therefore aimed at investigating the association between coffee consumption and osteopenia or osteoporosis in premenopausal and postmenopausal women in Taiwan.

2. Methods

A total of 2929 participants consisting of 1336 premenopausal and 1593 postmenopausal women aged 30 years and above who lived in the Pingzhen District of Taoyuan city from 2006 to 2011 were enrolled in the study. Their information was retrieved from the Li-Shin Hospital, a regional hospital in Northern Taiwan. They responded to a questionnaire about their weekly coffee consumption and other factors including age, smoking, alcohol, tea, exercise, diet, disease history, educational level, and blood type. The BMI and WHR were also determined. Coffee consumption was classified into 0, 1-4 and 5-7 cups per week. A cup of coffee was equivalent to 400 mL. Bone mineral density was measured by quantitative ultrasound (QUS). Osteopenia and osteoporosis were defined as -2.5<T-score<-1 and T-score≤-2.5, respectively. Multiple logistic regression analysis was used to determine the relationship between coffee drinking and osteopenia/osteoporosis. The analysis included 2533 participants comprising 1198 premenopausal and 1335 postmenopausal women after those with missing data (n = 396) were excluded. Osteopenia and osteoporosis (i.e. all T-scores<-1) were considered as a single outcome and odds ratios with their 95% confidence intervals were computed. Multivariate adjustments were performed for confounders including age, hepatitis B surface antigen (HBsAg), anti-Hepatitis C virus (HCV), waist-hip ratio (WHR), body mass index (BMI), smoking, alcohol, tea, exercise, vegetarian diet, supplements (vitamins A, B, C, D, E and calcium), yogurt, education and blood type. The study was approved by the Antai Medical Care Cooperation Antai Tian-Sheng Memorial Hospital Institutional Review Board (No. 15-018-B1).

3. Results

Table 1 shows the baseline data of the study participants. There were 1336 premenopausal and 1593 postmenopausal women with mean ages of 43.161 and 58.878 years, respectively. Table 2 presents the odds ratios for osteoporosis/osteopenia in premenopausal women. After multivariate adjustments, the consumption of 1-4 and 5-7 cups of coffee per week significantly decreased the risk of osteoporosis/osteopenia (OR = 0.677; 95% C.I. = 0.469-0.978) and (OR = 0.607; 95% C.I. = 0.400-0.923), respectively (P-trend = 0.0179). Moreover, higher BMI and education above college level also significantly decreased the risk (OR = 0.906; 95% C.I. = 0.863-0.951) and (OR = 0.487; 95% C.I. = 0.273-0.867), respectively.

Table 1. Baseline data of premenopausal and postmenopausal women

Variable	Premenopausal Women	Postmenopausal Women
Coffee (cup/per week)		
0	800(57.80%)	1272(76.35%)
1-4	324(23.41%)	240(14.41%)
5-7	260(18.79%)	154(9.24%)
Age	43.275(0.19)	58.822(0.21)
Smoking status		
Never	1308(94.78%)	1619(97.36%)
Current	49(3.55%)	36(2.16%)
Former	23(1.67%)	8(0.48%)
Alcohol consumption		
Never	1316(95.71%)	1594(96.55)
Current	55(4.00%)	49(2.97%)
Former	4(0.29%)	8(0.48%)
BMI	23.344(0.10)	24.901(0.09)
WHR	0.798(0.00)	0.835(0.00)
HBsAg		
Yes	152(11.01%)	170 (10.28%)
No	1229(88.99%)	1484(89.72%)
Anti-HCV		
Yes	21(1.52%)	54(3.26%)
No	1360(98.48%)	1600(96.74%)
Tea		
Yes	732(54.95%)	641(39.25%)
No	600(45.05%)	992(60.75%)
Exercise		
Yes	798(57.83%)	1113(66.97%)
No	582(42.17%)	549(33.03%)
Vegetarian		
Yes	136(9.86%)	196(11.86%)
No	1244(90.14%)	1456(88.14%)
Yogurt		
Yes	190(13.94%)	101(6.18%)
No	1173(86.06)	1534(93.82%)
Supplements		
Vitamin A	61(4.48%)	44(2.69%)
Vitamin B	179(13.14%)	120(7.33%)
Vitamin C	148(10.90%)	97(5.93%)
Vitamin D	69(5.07%)	46(2.82%)
Vitamin E	117(8.62%)	89(5.44%)
Calcium	307(22.46%)	500(30.62%)
Blood type		
O	610(45.45%)	713(47.79%)
A	352(26.23%)	392(26.27%)
B	312(23.25%)	310(20.78%)
AB	68(5.07%)	77(5.16%)
Education		
Elementary and below	133(9.68%)	966(58.33%)
High school	857(62.37%)	595(35.93%)
College and above	384(27.95%)	95(5.74%)

1 cup of coffee = 400mL.
Abbreviations
BMI = Body mass index; WHR = Waist hip ratio; HBsAg = Hepatitis B surface antigen; HCV = Hepatitis C virus.

Table 2. Adjusted odds ratios of osteoporosis/osteopenia among coffee drinking premenopausal women (n=1198)

Variable	OR(95%CI)	P-trend
Coffee consumption (cup/per week)		0.0179
0	1.000	
1-4	0.677(0.469-0.978)	
5-7	0.607(0.400-0.923)	
Age	1.046(1.022-1.072)	
Smoking status		
Never	1.000	
Current	0.905(0.397-2.060)	
Former	0.834(0.244-2.849)	
Alcohol consumption		
Never	1.000	
Current	0.905(0.414-1.983)	
Former	1.610(0.130-20.005)	
BMI	0.906(0.863-0.951)	
WHR	1.329(0.101-17.392)	
HBsAg		
No	1.000	
Yes	0.739(0.453-1.206)	
Anti-HCV		
No	1.000	
Yes	1.854(0.667-5.158)	
Tea consumption		
No	1.000	
Yes	0.854(0.636-1.147)	
Exercise		
No	1.000	
Yes	0.839(0.627-1.121)	
Vegetarian		
No	1.000	
Yes	0.803(0.498-1.296)	
Yogurt consumption		
No	1.000	
Yes	0.962(0.616-1.502)	
Supplements		
Vitamin A	0.590(0.218-1.595)	
Vitamin B	0.751(0.440-1.284)	
Vitamin C	1.867(1.060-3.289)	
Vitamin D	0.912(0.329-2.531)	
Vitamin E	0.789(0.397-1.570)	
Calcium	1.157(0.822-1.629)	
Blood type		
O	1.000	
A	0.750(0.530-1.063)	
B	0.916(0.640-1.310)	
AB	1.358(0.743-2.483)	
Education		
Elementary and below	1.000	
High school	0.599(0.365-0.982)	
College and above	0.487(0.273-0.867)	

1 cup of coffee = 400mL.
Abbreviations
BMI = Body mass index; WHR = Waist hip ratio; HBsAg = Hepatitis B surface antigen; HCV = Hepatitis C virus; OR = Odds ratio, CI = Confidence interval.

Table 3. Adjusted odds ratios of osteoporosis/osteopenia among coffee drinking postmenopausal women (n=1335)

Variable	OR(95%CI)	P-trend
Coffee consumption (cup/per week)		0.9334
0	1.000	
1-4	0.829(0.596-1.153)	
5-7	0.950(0.640-1.411)	
Age	1.079(1.059-1.099)	
Smoking status		
Never	1.000	
Current	1.486(0.654-3.379)	
Former	3.830(0.315-46.571)	
Alcohol consumption		
Never	1.000	
Current	0.689(0.352-1.347)	
Former	0.545(0.106-2.805)	
BMI	0.954(0.923-0.987)	
WHR	1.692(0.212-13.539)	
HBsAg		
No	1.000	
Yes	1.257(0.861-1.837)	
Anti-HCV		
No	1.000	
Yes	1.239(0.661-2.323)	
Tea consumption		
No	1.000	
Yes	1.178(0.925-1.500)	
Exercise		
No	1.000	
Yes	0.765(0.596-0.982)	
Vegetarian		
No	1.000	
Yes	1.073(0.755-1.527)	
Yogurt consumption		
No	1.000	
Yes	1.135(0.703-1.835)	
Supplements		
Vitamin A	0.629(0.262-1.509)	
Vitamin B	1.407(0.844-2.346)	
Vitamin C	2.022(1.093-3.741)	
Vitamin D	0.561(0.232-1.357)	
Vitamin E	1.014(0.554-1.855)	
Calcium	1.209(0.942-1.552)	
Blood type		
O	1.000	
A	1.141(0.866-1.505)	
B	1.012(0.751-1.365)	
AB	1.063(0.640-1.767)	
Education		
Elementary and below	1.000	
High school	0.877(0.672-1.145)	
College and above	0.882(0.538-1.448)	

1 cup of coffee = 400mL.
Abbreviations
BMI = Body mass index; WHR = Waist hip ratio; HBsAg = Hepatitis B surface antigen; HCV = Hepatitis C virus; OR = Odds ratio, CI = Confidence interval.

However, increasing age was a significant risk factor of osteoporosis (OR = 1.046; 95% C.I. = 1.022-1.072). The odds ratios for osteoporosis/osteopenia in postmenopausal women are shown in Table 3. After adjusting for covariates, there was no significant association between coffee consumption and osteoporosis/osteopenia. Higher BMI significantly reduced the risk of osteoporosis/osteopenia (OR = 0.954; 95% C.I. = 0.923-0.987). However, high vitamin C and increasing age were significant risk factors of osteoporosis/osteopenia (OR = 2.022; 95% C.I. = 1.093-3.741) and (OR = 1.079; 95% C.I. = 1.059-1.099), respectively. Surprisingly, calcium and vitamin D had no significant effects on osteoporosis/osteopenia in both premenopausal and postmenopausal women.

4. Discussion

To our knowledge, this is the first study to demonstrate that coffee consumption might prevent osteoporosis/osteopenia in premenopausal Taiwanese women. Osteoporosis is common in women [7,8,9] even though the risk is lower in premenopausal than postmenopausal women [22]. While more attention has been paid to postmenopausal osteoporosis, premenopausal osteoporosis, on the other hand, has not been equally explored probably due to its low incidence. Notwithstanding, preventive factors of premenopausal osteoporosis should be identified to avoid damages that might occur later in life. There are controversies regarding the effects of coffee consumption on osteoporosis [17,18,19,20,23]. In a recent study, coffee consumption was protective against osteoporosis in postmenopausal Korean women [17]. However, premenopausal women were excluded from the study. Another study showed no significant association between coffee consumption and bone mineral density of either the femoral neck or lumbar spine among Korean premenopausal women [16,17]. Similarly, a study exploring how someone's smoking and coffee consumption habits in the premenopausal stage could affect the postmenopausal bone mineral density showed no significant effect [24]. Discrepancies between our study and previous studies may be due to different volumes of weekly coffee intake [18,19,23]. Furthermore, differences in sample sizes, study designs, ethnicities, among others might have contributed to these discrepancies. The preventive effect of coffee on osteoporosis has been attributed to some of its biochemical components other than caffeine. For instance, Choi and colleagues [21] explained it based on chlorogenic acids and kahweol which have antioxidant and anti-inflammatory properties, respectively. Higher BMI significantly reduced the risk of osteoporosis in both premenopausal and postmenopausal women. Similar results have previously been shown in women [10,11,12,13,14]. Increase in age is a potential non-modifiable risk factor for osteopenia and osteoporosis [1,4,5,10]. This was evident among both the premenopausal and postmenopausal women included in our study. Over time, both the quantity and quality of bone continue to deteriorate, increasing the chances of developing osteoporotic fractures. Intervention with calcium and vitamin D supplements could help to reduce osteoporosis at old age [15,16]. Nonetheless, both calcium and vitamin D had no significant influence on osteoporosis/osteopenia in the present study. Education above college level was shown to be preventive against osteoporosis/osteopenia among the premenopausal women involved in the current study. This was consistent with some previous studies where higher educational level had a protective role on osteoporosis [25,26,27,28]. Education plays a good role in bringing awareness to individuals about most diseases and their risk factors. This could help these individuals in preventing the diseases by modifying their lifestyles like physical activities and nutritional intake. Osteoclastogenesis and osteoblastogenesis are some potential protective mechanisms of Vitamin C's role on bone health [29,30,31,32]. Previous cross-sectional studies have shown positive though inconsistent effects of Vitamin C on osteoporosis [33,34,35,36]. However, this study negatively associated high vitamin C with the risk of osteoporosis among postmenopausal women. The reason for such an observation cannot be clearly explained.

As a limitation, bone mineral density was measured using quantitative ultrasound (QUS) instead of the recommended dual-energy x-ray absorptiometry (DXA). However, a high precision and reliability have been demonstrated when QUS was used to measure BMD and strong correlations were found between T-scores measured by QUS and those measured by DXA [37,38]. This demonstrates the potential of QUS in osteoporosis and fracture risk screening [39]. Moreover, its use is convenient due to its cost-effectiveness, non-ionizing nature, and portability. Even though QUS is not a recommended diagnostic test for osteoporosis, the guidelines for the diagnosis and management of osteoporosis does not prevent its use in fracture risk assessment especially in the absence of DXA [40]. Another limitation of this study is its cross-sectional nature which could not be used to make causal inferences. However, coffee drinking is a habit and its impact on bone health cannot be rolled out.

5. Conclusion

This study concludes that coffee drinking might be preventive against osteoporosis/osteopenia in premenopausal women. However, there is no significant effect in postmenopausal women. In order to curtail premenopausal osteoporosis/osteopenia, coffee drinking should, therefore, be encouraged. Further studies are warranted to fully confirm the preventive effect of coffee drinking on premenopausal osteoporosis/osteopenia.

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Statement of Competing Interests

The authors have no competing interests.

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