Habitual Tea Drinking and Bone Mineral Density in Postmenopausal Turkish Women: Investigation of Prevalence of Postmenopausal Osteoporosis in Turkey (IPPOT Study)

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Abstract: *Aim:* In this epidemiological report, we assessed the prevalence of osteopenia and osteoporosis (OP) in postmenopausal Turkish women and the relationship between body mass index (BMI), and some nutritional factors (habitual tea, coffee, tobacco, and milk product consumption) with OP.

Methods: This multicenter study was done in postmenopausal women residing in five big cities, in four different regions of Turkey between August and November 2005. An inclusion criterion was being in the postmenopausal period for at least 12 months. A semi-structured questionnaire was completed by face-to-face interview, consisting of closed- and open-ended questions about demographic characteristics, nutritional status, and habits with two or more choices as possible responses. Bone mineral density (BMD) measurements were performed with a MetriScan® Densitometer (Alara Inc., Ca, USA).

Results: Seven hundred twenty-four women were included in the study. The mean age was 57.6 ± 9.6 years, and mean age at natural menopause was 46.4 ± 5.6 years. Of the participants, 51% were illiterate. According to WHO classification; 42.5% were normal in terms of BMD, 27.2% had osteopenia, and 30.2% had OP. Women with high education levels had better T-scores ($p = 0.019$). Increase in BMI also had a positive effect on T-scores ($p < 0.0001$). A linear correlation was found between age ($r = –0.386$, $p < 0.0001$), BMI ($r = –0.175$, $p < 0.0001$), and education ($r = –0.317$, $p < 0.0001$), with T-scores. The T-scores of women who consumed tea on a regular basis were found to be higher than non-consumers (–1.51 ± 1.68 vs. –1.09 ± 1.66; $p = 0.070$) [when smokers, those who received hormonal therapy (HT), and those > 65 years were excluded].

Conclusion: OP was determined in 1/3 of the women. Advanced age (> 65) and being illiterate were negative factors, while high education levels, being overweight, and being treated with HT had a positive effects on BMD. Habitual tea drinking also may have a positive effect on BMD. However, tea drinking was not found to be a statistically significant factor in the present study.

Key words: Postmenopausal women, osteoporosis, prevalence, education, habitual tea consumption

Introduction

The postmenopausal period may present important health problems for women, and osteoporosis (OP) is one of the most prevalent. Symptoms of OP may not arise until a fracture becomes evident. Identifying risk factors and measuring bone mineral density (BMD) is a must in order to define osteoporosis earlier, which is a duty of family physicians in the name of preventive medicine. It appears to be an effective method to screen populations for OP with practical and economic BMD measurements in order to identify high risk groups for OP [1].

Along with increasing the risk of fracture, OP is one of the leading causes of morbidity, mortality, and disability in the elderly [2]. Due to the high cost of treatment, preventing OP is becoming a more popular approach, worldwide [3]. In 1998, the National Osteoporosis Foundation, in collaboration with other professional organizations, issued screening guidelines recommending bone density testing for all women aged 65 or older, and younger postmenopausal women who have had a fracture or who have one or more risk factors for OP [4]. In the USA, including all races, an estimated 14 million women older than 50 have osteopenia, and over 5 million have OP [5]. The actuarial risk of a 65-year-old white woman sustaining a fracture by age 90 is 16% for the hip, 9% for distal forearm, and 5% for proximal humerus [6]. Sixteen percent of postmenopausal women have OP of the lumbar spine [7]. Based on the WHO criteria and dual energy X-ray absorptiometry (DXA) measurements at the femoral neck, population-based studies estimate that 41% of white women older than 50 have osteopenia. When bone density is measured at the hip, spine, and wrist, 15% of white women aged 50–59 and 70% of white women older than 80 have OP by WHO criteria at least one site [8].

In Turkey, during 1990–2000, the increase in the young population (between 0–18 years of age) was nearly zero, as was that of the productive working population, whereas the aging population (> 65 years) was the group with the greatest increase in number. The annual growth rate of the population in Turkey is 0.183%, but the growth rate of the aging population is much higher 0.468% [9]. For this reason, wide epidemiologic studies evaluating prevalence of OP and fracture incidence is needed in Turkey. In this cross-sectional epidemiological report, we assessed the prevalence of osteopenia and OP in postmenopausal Turkish women and the relationship between body mass index (BMI), and some nutritional factors (tea, coffee, tobacco, and milk product consumption) with OP.

Subjects and Methods

The **I**nvestigation of the **P**revalence of **P**ostmenopausal **O**steoporosis by **T**urkish Family Physicians – IPPOT study is a two-stage design. The first stage is a cross-sec-

tional epidemiological study; in the second stage, the patients will be reevaluated after one year for prevalence of OP and fracture formation.

Study population

The size of the population was calculated by using the formula of "population in known place" and 838 postmenopausal women were included in the study. Women experiencing amenorrhea for 12 consecutive months were considered to be in natural menopausal status. The consumption of mineral supplements was not allowed in the study. Subjects who took bisphosphonates and other antiresorptive agents were also excluded from the study. Use of drugs which may cause OP and climacteric were other exclusion criteria. Therefore, 724 women met the inclusion criteria (86.4% of the target). This study took place in five cities of four different regions of Turkey (207 in Diyarbakir in Southeastern Anatolia region, 136 in Adana and 231 in Antalya in the Mediterranean region, 103 in Aydın in the Aegean Region, and 47 in Edirne in the Marmara Region).

A questionnaire with closed- and open-ended questions was prepared by the IPPOT study group and the Family Medicine Department in the Dicle University School of Medicine. Questions consisted of demographic features, smoking status, and dietary factors (tea, coffee, milk consumption). Dietary status of participants was determined by a questionnaire developed from a WHO-derived Turkish questionnaire [10, 11]. This questionnaire determined meat, milk and milk products, and coffee/tea consumption on a daily, weekly, monthly, and yearly level (Appendix 1). A pilot study was conducted in 26 females (postmenopausal age) and Spearman's rho correlation analysis revealed high test-retest reliability in some items (coffee and milk consumption) ($r = 0.79–0.93$, $p < 0.05$). A face-to-face interview method was used.

Our study is in accordance with the declaration of Helsinki-II and Good Clinical Practice. It was approved by the Dicle University Local Ethical Committee and written informed consent was obtained from each of the participants.

Measurement of bone mineral density (BMD)

We used an ALARA Metriscan Densitometer (Alara Inc., Hayward, CA, USA) to screen for and determine the level of OP in postmenopausal women through measurement of BMD. This device works by digital radiographic absorption method. It is free from the radiation-governing status of TAEK *(Turkish Atom Energy Council)* which sets restrictions for x-ray devices. Patients received radiation doses as 0.001 μSV (microsievert) and administrator received 0.0001 μSV radiation dose (from a distance of 1 meter). As the radiation doses are low when using this device, there is no need for a radiology specialist.

We measured BMD from three different phalanges and from these average findings; we estimated the T-score for the whole body. This method is FDA-approved and has been used in the U.S. since 2000 [12]. To avoid precision error, the room temperature must be stable at 25°C during measurement. The machine was calibrated by the relevant company each day. Women were classified according to the OP definition of World Health Organization [13]. T-scores between –1.0 and –2.5 were accepted as osteopenia and T-scores higher than –2.5 as OP.

Obesity definition

WHO developed an obesity grading system in 1997 [14]; thin (BMI < 18.50), normal (BMI = 18.50–24.99), overweight (BMI = 25.00–29.99), obese (BMI = 30.00–34.99), and morbidly obese (BMI 35+). We measured height and weight with an error range of ± 0.1 cm or kg, respectively. For the measurements, a standard balance and height scale is used. Measurements were performed with light clothes and without shoes.

Education levels

Education levels were obtained via self-report of subjects. It was estimated according to highest level attained. Illiterate status was demonstrated by an absence of primary school education and the inability to read and write. Literate status was demonstrated by attendance at primary school for at least some duration, with the ability to read and write. Primary school is 8 years in length and obligatory for all people who live in Turkey.

Hormone therapy (HT)

The term HT signifies either administration of estrogen alone (women who have had a hysterectomy), or combined estrogen/progestin therapy (women with an uterus). Use of postmenopausal hormone therapy (HT) (estrogen with or without progesterone) was categorized as current user (HT: Yes) and never or former user (HT: No).

Smoking status

Women smoking cigarettes regularly everyday or who had quit smoking were accepted as *current smokers* while women who never smoked were classified as *non-smokers.*

Tea consumption

Women who regularly consumed more than 2 cups of tea per day were classified as *habitual drinkers* and women who never drank tea, or drank 1 or 2 cups per day (not regularly) were classified as *non-drinkers.* Daily intake of *tea consumption* of *habitual drinkers* is equivalent to approximately 2 cups (200 mL) of black tea.

Coffee consumption

Women who consumed coffee (did they include tea in this category?) more than 2 cups per day regularly were classified as *habitual drinkers* and women who never drank coffee or drank 1 or 2 cups per day (not regularly) were classified as *non-drinkers.* Consumption of one cup (100 mL) of coffee corresponded to an intake of 50 mg of caffeine. It should be noted that decaffeinated coffee is not typically consumed in the Turkish diet.

Milk consumption

Daily drinkers were in the *regular consuming group* (daily intake of milk consumption is equivalent to approximately 1 water glass (120 mL = 160 g) of milk or milk products such as yoghurt (1 water glass = 160 g), or two slices of cheese (1 match box = 30 g), etc., and women who never drank milk or drank 1–2 glasses per week were in the *irregular consuming group.* Additional open questions regarding consumption of dairy products were included (number of slices of cheese per day, type of milk, and number of glasses of milk per day).

Statistical Analysis

For statistical analysis, the SPSS (Statistical Package for Social Sciences) 10.0 program was used. Evaluation of the groups was made by one-way ANOVA (*post hoc* Bonferroni) test. In the correlation analysis, the Pearson correlation test was used; the chi-square test was used to analyze the categorical variables. Results are given as mean ± SD and $p < 0.05$ was accepted as significant.

Results

Seven hundred twenty-four women were included in the study. The mean age was 57.6 ± 9.6 yrs, and mean age at natural menopause was 46.4 ± 5.6 yrs. Of the participants, 51% were illiterate. 7.2% of women received HT, and 12% had history of hysterectomy. According to WHO classification, 42.5% were normal (n = 308), 27.2% had osteopenia (n = 197), and 30.2% had OP (n = 219). Of the total, 11.2% (n = 81) of the women were normal, 65.1% (n = 471) were overweight, and 15.1% (n = 109) were obese according to BMI.

Women with high education levels had better T-scores ($p = 0.019$). An increase in BMI also had a positive effect on T-scores ($p < 0.0001$). A linear correlation was found between age ($r = –0.386$, $p < 0.0001$), BMI ($r = –0.175$, $p < 0.0001$), and education ($r = –0.317$, $p < 0.0001$) with T-scores. The T-scores of women who consumed tea on a regular basis were found to be higher than non-consumers (–1.51 ± 1.68 vs. –1.09 ± 1.66; $p = 0.070$) (smokers, received HT and those who were older than 65 years were excluded).

Highest prevalence of OP was detected in the southeastern part of Turkey (Diyarbakır) (%36.2, n = 207), followed by the Aegean region (Aydın) (%34.0, n = 103). The lowest prevalence was in the Trakya region (Edirne in the western part of Turkey) (%12.8, n = 69) ($p = 0.010$).

BMI ($p = 0.009$), educational level ($p < 0.0001$), age ($p < 0.0001$), and coffee consumption ($p = 0.021$) were found to have significantly positive effects on BMD. OP was more common among the elderly (> 65 yrs) (63.6%), the illiterate (8.7%), women having normal BMI (48.1%), and women who did not have HT (30.9%) (Table I). According to our results, daily coffee consumption had a positive effect on T-scores.

The T-scores of *habitual tea drinkers* were found to be higher than non-drinkers but it is not statistically significant ($p = 0.222$). Women who consumed tea on a regular basis had lower OP prevalence (29.1%) than non-consumers (37.8%), but the result was not statistically significant ($p = 0.073$) (Table II). Although women older than 65 years, smokers, and those having HT were excluded and, BMI and age of the rest (n = 453) equated, there was no statistical significance between the T-scores of women who consumed tea on a regular basis, compared to non-consumers (–1.51 ± 1.68 vs. –1.09 ± 1.66; $p = 0.070$) (Table III).

Although statistically not significant (p=0.493) (Table I), women who regularly consumed milk products had higher T-scores. No difference was detected between T-scores of smokers and non-smokers, although T-scores of non-smokers were higher ($p = 0.904$). This may be related to the higher mean age in the non-smoker group (57.8 ± 9.8 vs. 54.9 ± 7.6).

T-scores of women with higher education were better than the illiterate group (–0.20 ± 1.81 vs. –1.91 ± 1.61; $p = 0.019$) (Table IV). Increase in BMI also had a positive effect on T-score ($p < 0.0001$) (Table V) while advanced age (> 65) had a significantly negative effect on T-scores ($p < 0.0001$) (Table VI). An inverse correlation between the age of the participants and T-score was observed (Figure 1).

Discussion

There have been many epidemiologic studies worldwide in the field of postmenopausal OP. Generally data of many countries are not sufficient, or they use Western data (es-

Table I: Demographic and nutritional status of cases according to BMD groups

Parameter	WHO Classification Normal n (%)	Osteopenia n (%)	Osteoporosis n (%)	Total	p
City					
Adana	62 (45.6)	34 (25.0)	40 (29.4)	136	*= 0.010*
Antalya	114 (49.4)	54 (23.4)	63 (27.2)	231	
Aydın	37 (35.9)	31 (30.1)	35 (34.0)	103	
Diyarbakır	73 (35.3)	59 (28.5)	75 (36.2)	207	
Edirne	22 (46.8)	19 (40.4)	6 (12.8)	47	
BMI (WHO)					
Thin	1 (33.3)	1 (33.3)	1 (33.3)	3	*= 0.009*
Normal	28 (34.6)	14 (17.3)	39 (48.1)	81	
Overweight	201 (42.7)	138 (29.3)	132 (28.0)	471	
Obese	52 (47.7)	32 (29.4)	25 (22.9)	109	
Unidentified	14 (41.2)	10 (29.4)	10 (29.4)	34	
Education					
Illiterate	114 (30.9)	112 (30.4)	143 (38.7)	369	*< 0.0001*
Literate	34 (57.6)	14 (23.7)	11 (18.7)	59	
Primary school	126 (59.7)	50 (23.7)	35 (16.6)	211	
Secondary school	10 (43.5)	8 (34.8)	5 (21.7)	23	
University	5 (71.4)	1 (14.3)	1 (14.3)	7	
Undefined	19 (34.6)	12 (21.8)	24 (43.6)	55	
Age (years)					
< 40	10 (83.3)	2 (16.7)	0	12	*< 0.0001*
40–65	280 (49.2)	161 (28.3)	128 (22.5)	569	
> 65	18 (12.6)	34 (23.8)	91 (63.6)	143	
Hormonal Therapy					
No	264 (41.6)	174 (27.5)	196 (30.9)	634	*= 0.080*
Yes	25 (48.1)	17 (32.7)	10 (19.2)	52	
Undefined	19 (50.0)	6 (15.8)	13 (34.2)	38	
Tea consumption					
None	36 (40.0)	20 (22.2)	34 (37.8)	90	*= 0.073*
Habitual	265 (43.3)	169 (27.6)	178 (29.1)	612	
Undefined	7 (31.8)	8 (36.4)	7 (31.8)	22	
Coffee consumption					
None	75 (35.1)	57 (26.6)	82 (38.3)	214	*= 0.037*
Habitual	60 (46.9)	35 (27.3)	33 (25.8)	128	
Undefined	173 (45.3)	105 (27.5)	104 (27.2)	382	
Milk products consumption					
None	134 (40.2)	94 (28.2)	105 (31.6)	333	*= 0.493*
Regular	157 (44.7)	91 (25.9)	103 (29.4)	351	
Undefined	17 (42.5)	12 (30.0)	11 (27.5)	40	
Total	308	197	219	724	

pecially USA data) for reference. We expect the IPPOT study to be a leading investigation for postmenopausal OP prevalence in Turkey and we included in the study women experiencing amenorrhea for 12 consecutive months, (not five-years), who were considered to be in natural menopausal status.

Luckey *et al* [15] found the average menopause age of the participants as 46.2 ± 5.7 years. They found average BMI as 26.2 ± 4.5 kg/m^2, the prevalence of having a higher level of education as 40%, smoking as 7.1%, and hormone therapy use as 15.6%. Compared to this study, although our population had lower educational level and

Table II: Comparison of T-scores and Z-scores of tea consumers and non-consumers

	Habitual Tea Consumption		
Parameter	Non-drinkers *n = 90*	Regular drinkers *n = 612*	*p*
T-score (Mean ± SD)	–1.63 ± 1.71	–1.41 ± 1.73	= 0.263
Z-score (Mean ± SD)	–0.45 ± 1.13	–0.40 ± 1.11	= 0.773
Age yrs (Mean ± SD)	58.8 ± 9.0	57.4 ± 9.8	= 0.777
BMI kg/m² (Mean ± SD)	30.6 ± 5.9	30.5 ± 5.7	= 0.887
Height (cm)	155 ± 6	155 ± 7	= 0.783
Weight (kg)	74 ± 14	73 ± 14	= 0.807

Table III: Comparison of T-scores and Z-scores of habitual tea consumers and non-consumers (After cases > 65 years, taking or had taken HT, or smoking are excluded)

	Habitual Tea Consumption		
Parameter	Non-consumers *n = 60*	Consumers *n = 393*	*p*
T-score (Mean ± SD)	–1.51 ± 1.68	–1.09 ± 1.66	= 0.070
Z-score (Mean ± SD)	–0.53 ± 1.07	–0.44 ± 1.12	= 0.623
Age, years (Mean ± SD)	55.6 ± 7.5	53.8 ± 6.9	= 0.079
BMI kg/m² (Mean ± SD)	31.5 ± 5.9	30.5 ± 5.3	= 0.183
Height (cm)	155 ± 6	156 ± 6	= 0.676
Weight (kg)	76 ± 15	74 ± 13	= 0.200

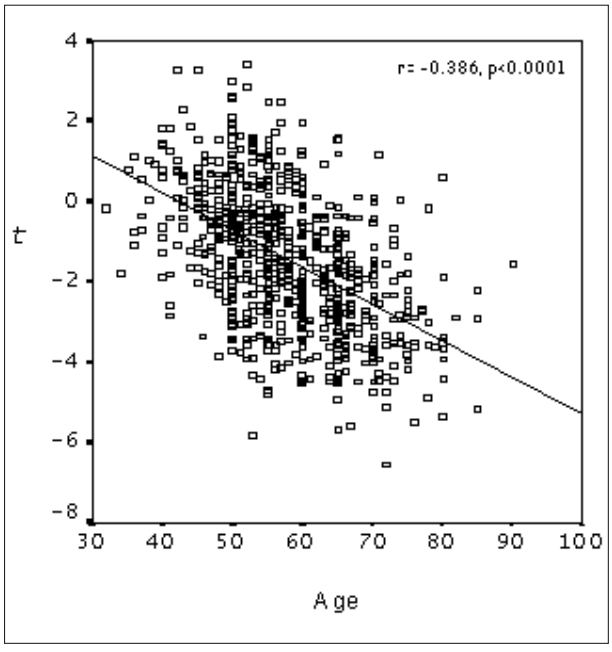

Figure 1: Correlation between age (years) and T-scores.

higher BMI, the menopausal age is similar in both studies.

Siris *et al* [12] arranged an important epidemiological study using an ALARA Metriscan densitometer in 4236 primary care units in 34 states of the U.S. This study examined postmenopausal women over 50 years of age, and according to WHO criteria found a prevalence of 39.6% for osteopenia and 7.0% for OP. It is published in the literature that age, a familial history of fractures, being from Asia or Spain, smoking, and cortisone use are risk factors for OP. In our study, OP was found in 30.2% (n = 219) and osteopenia was found in 27.2% (n = 197) of the women. As our prevalence rates are higher than those in the U.S., one may conclude that fracture risk is also higher in our population. Especially in the group of those over 65, illiteracy and normal BMI increased the prevalence of OP; women not being treated or who not been treated with HT also had higher prevalence rates. High education levels, being overweight and obese, being treated or having been treated with HT, and regular coffee consumption were positive factors for BMD (Table I).

It is reported that consuming excessive amounts of caffeine may decrease BMD in women. In almost all studies, coffee drinking is a positive indication for caffeine consumption [16, 17]. In some of the women, the relationship between caffeine consumption and BMD decrease can not be proven. Hegarty *et al* [17] could not find a significant association between coffee consumption and BMD. Basaran *et al* [10] also found that caffeine consumption had negative effects on L2-L4 BMD for men, but they couldn't find the same relationship for women. Similarly, caffeine is found in tea but there are many different sub-

stances (like flavonoids) in tea as well. These substances augment bones by different mechanisms [17]. Wu *et al* [18] showed that drinking tea for more than 10 years had a constructive effect on BMD in the vertebral and hip regions.

In an epidemiological study from the UK, BMDs of the aged female tea-consumers were higher than those of non-consumers [17]. In the Women's Health Initiative (WHI) study, the same positive correlation between tea consumption and an increase in BMD was detected ($p < 0.05$), but by Cox Regression hazard model, no correlation between tea consumption and fracture risk of hip, wrist, or forearm was shown [19]. There are recent studies about a phytoestrogenic substance that is found in black tea. In oophorectomized rats, this compound is shown to be preventive for OP by increasing the estrogen levels [20]. In predecessor studies, it has been shown that phytoestrogens show an affinity for estrogen, estradiol, and estrogen receptors in mammals [21]. Again, in *in vitro* studies, phytoestrogens have been shown to be preventive for bone resorption (like estrogen) and isoflavones have been shown to be stimulatory for formation of some cells (like osteoblast) [22, 23].

Western women typically eat diets low in phytoestrogens, containing less than 3 mg per day [24]. According to the U.S. Department of Agriculture Nutrient Data Laboratory dietary tables [25], a cup of tea contains 3 mg phytoestrogens per serving (average). Therefore, we considered that daily consumption of two cups of tea supplied approximately 5–6 mg phytoestrogens in postmenopausal women.

An advantage of our study design is the focus not only on caffeine intake but also on the exposure to tea separately. This might be an important point because some previous studies have indicated that tea could have a positive influence on maintaining BMD [17–19]. In the Turkish community, traditional black tea is the most frequently consumed soft drink. In Turkey, Ceylon tea is the most frequently consumed tea type in the eastern and southeastern parts, whereas Turkish black tea is generally consumed in the western (Marmara and Aegean) parts. The T-scores of women who consumed tea on a regular basis were found to be higher than non-consumers, but this result was not statistically significant. Women who consumed tea on a regular basis had lower OP prevalence (29.1%) than non-consumers (37.8%), but this was also not statistically significant ($p = 0.073$). Therefore, we conclude that much larger population studies will be required to discern a statistically significant effect of tea consumption on BMD. Also, regular milk and dairy product consumption is related with less frequent osteoporosis according to our results, but this relationship did not reach statistical significance ($p = 0.493$) (Table I).

Gerdhem and Obrant [26] conducted a social study in women aged 75 (and over?) (n = 1042) (Osteoporosis Prospective Risk Assessment – OPRA). They found that smoking had a negative effect on bone density, independent of weight and physical activity. In our study population, no significance was determined between smokers and non-smokers ($p = 0.904$). It is notable that non-smokers had higher T-scores but this may be related to the higher mean age in the non-smoker group (57.8 ± 9.8 vs. 54.9 ± 7.6 years).

Previously, Gür *et al* [27], in our region (Southeast Anatolian Region of Turkey), revealed a negative relationship between the prevalence of OP and the level of education, in 560 postmenopausal women who were between the ages of 45–86 (average age 60.4 ± 7.2) yrs. In the educated group, the prevalence of OP was 18.6% whereas in the non-educated group, the prevalence was 34.4%. Similarly our results revealed better T-scores in the more highly educated group compared to the less educated group (especially illiterate cases) (-0.20 ± 1.81 vs. -1.91 ± 1.61; $p = 0.019$) (Table IV).

It has been previously reported that BMD was higher in women receiving HT than in those not receiving HT [28]. In addition, some researchers report that being overweight has a protective effect on the BMD of the hip [29]. In our study, taking HT is also associated with lower OP and osteopenia prevalence (19.2% vs. 30.9%; $p = 0.080$) and the preventive effect of being overweight is confirmed (Table V).

In some societies, it is reported for white women that by advanced age, loss of bone density is generally observed [30], but this is not a rule for all societies [31, 32]. Luckey *et al* [15] investigated the prevalence of osteoporotic fractures in the U.S. In that study, in which women who were postmenopausal for at least five years were recruited, the BMD loss in forearm was found to be higher in white women than in black women. Bone loss in advanced age can be explained by reduced physical activity, weight loss, chronic inflammatory diseases, secondary hyperparathyroidism, decrease in growth factors, and steroid sex hormones [33, 34].

In our study, as expected, an inverse correlation was detected between age and T-scores ($r = -0.386$, $p < 0.0001$, Figure 1). Especially in the over-65 age group, OP prevalence was 63.6%, whereas in the 45–65 age group, OP prevalence appeared to be only 22.5%.

Hegarty *et al* [17] excluded women who smoked and took HT, and made the analysis again. They found that the positive relationship between habitual tea consumption and BMD was still valid. Between habitual tea consumption and smoking or HT use, no effect was detected. Habitual tea consumption had a positive effect on lumbar, trochanteric, and Ward's triangle BMDs. This effect does

Table IV: Comparison of T-scores and Z-scores according to education levels

	Education					
Parameter	Illiterate *n = 369*	Literate *n = 59*	Primary *n = 211*	Secondary *n = 23*	University *n = 7*	*p*
T-score (Mean ± SD)	–1.91 ± 1.61	–1.07 ± 1.54	–0.70 ± 1.59	–1.09 ± 2.01	–0.20 ± 1.81	= 0.019
Z-score (Mean ± SD)	–0.69 ± 1.01	–0.11 ± 1.19	–0.14 ± 1.08	–0.67 ± 1.20	–0.50 ± 1.83	= 0.094
Age, years (Mean ± SD)	60.2 ± 9.6	58.4 ± 9.9	52.9 ± 7.6	52.5 ± 9.5	51.3 ± 7.4	= 0.213
BMI kg/m² (Mean±SD)	67.7 ± 15.7	57.5 ± 10.4	57.2 ± 9.4	57.2 ± 9.4	57.2 ± 9.4	= 0.213
Height (cm)	155 ± 7	156 ± 7	155 ± 7	155 ± 7	161 ± 6	= 0.001
Weight (kg)	72 ± 13	77 ± 15	75 ± 13	72 ± 17	75 ± 20	< 0.0001

Table V: Comparison of T-scores and Z-scores according to body mass indices

	BMI				
Parameter	Thin *n = 3*	Normal *n = 81*	Overweight *n = 471*	Obese *n = 109*	*p*
T-score (Mean ± SD)	–2.07 ± 1.48	–1.96 ± 1.82	–1.36 ± 1.70	–1.28 ± 1.64	< 0.0001
Z-score (Mean ± SD)	–0.29 ± 0.23	–0.62 ± 1.05	–0.47 ± 1.14	–0.17 ± 1.02	< 0.0001
Age, years (Mean ± SD)	67.7 ± 15.7	57.5 ± 10.4	57.2 ± 9.4	58.3 ± 9.7	< 0.0001

Table VI: Comparison of T-scores and Z-scores of cases with respect to age groups

	Age groups (years)			
Parameter	< 40 *n = 12*	40–65 *n = 569*	> 65 *n = 143*	*p*
T-score (Mean ± SD)	–0.04 ± 0.93	–1.13 ± 1.66	–2.76 ± 1.38	< 0.0001
Z-score (Mean ± SD)	–1.08 ± 0.85	–0.39 ± 1.13	–0.45 ± 1.04	= 0.525
Age, years (Mean ± SD)	29.6 ± 4.3	30.8 ± 5.7	29.7 ± 5.8	= 0.147
BMI kg/m² (Mean ± SD)	159 ± 5	155 ± 6	152 ± 8	< 0.0001
Height (cm)	76 ± 13	74 ± 14	69 ± 14	< 0.0001

not depend on age, BMI, HT use, coffee consumption, or smoking. Similarly in our study, the T-scores of women who consumed tea on a regular basis were found to be higher than non-consumers (_–1.51 ± 1.68 vs. –1.09 ± 1.66; p = 0.070) (smokers, received HT, and > 65 years were excluded) (Table III).

Moreover, our study has several potential limitations. We lack data on important lifestyle characteristics such as physical activity. Another limitation is that data on actual intake of caffeine or tea are lacking as no direct measurements of the beverages were made.

In conclusion, one-third of our cases were osteoporotic. In particular, advanced age (> 65) and illiteracy affected BMD negatively; high education level, being overweight or obese, and receiving HT were factors that were shown to have a positive effect on BMD. Habitual tea drinking also may have a positive effect on BMD, however, this was not found to be a statistically significant factor in the present study.

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