
Smoking is associated with osteoporosis development in Primary care population

Kleisiaris F. Christos^{1, *}, Plaiti E. Maria¹, Papathanasiou V. Ioanna², Papaioannou Polina¹, Kastrinakis Ioannis¹, Diakantoni Sofia¹, Fradelos Evangelos³, Kourkouta Lamprini⁴

¹Department of Nursing, Technological Institute of Crete, Heraklio, Greece

²Department of Nursing, Technological Institute of Thessaly, Larisa, Greece

³Psychiatric Department, State Mental Hospital of Attica "Daphne", Athens, Greece

⁴Department of Nursing, Technological Institute of Thessaloniki, Thessaloniki, Greece

Email addresss:

chriskleisiaris@staff.teicrete.gr (Kleisiaris F. C.), maria-plaiti@hotmail.com (Plaiti E. M.), papathan@teilar.gr (Papathanasiou V. I.), pwlina18@hotmail.com (Papaioannou P.), katsrinakisg@hotmail.com (Kastrinakis I.), evangelosfradelos@hotmail.com (Fradelos E.), lkourkouta@nurse.teithe.gr (Kourkouta L.)

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Abstract: Introduction: Osteoporosis is a disease of bones and it has been associated with various risk factors such as female gender, advanced age and smoking habit. However, evidence has shown that the true figures between osteoporosis and smoking are conflicted. Aim: This study was aimed to screen individuals for potential risk factors related to osteoporosis and to assess whether smoking habit is associated with osteoporosis development in Primary care population aged 45 years and over. Materials and Methods: A screening program for osteoporosis was conducted in two Primary care settings in the island of Crete – Greece, during a 3-month period (April to June 2013). We studied 400 participants aged 45 years old and over for risk-factors associated with osteoporosis development using the *ONE Minute Osteoporosis Risk Test*. Participants were screened for to 19 risk-factors related to osteoporosis such as fracture, diagnosis of Thyroid, Alcohol Consumption and smoking responding to Yes or No. Statistically, chi square and/or Variance analysis were used for the descriptive characteristics of the study participants and the significance of association among demographic characteristics. The method of variance analysis was applied to determine associations between risk factors and demographic characteristics. Bivariate associations were described using Odds Ratio (OR) with 95% Confidence Intervals (CI). P-values \leq 0.05 was considered significant using the SPSS version 21.0. Results: The mean age of participants (50% males) was 61.94 ± 11.6 . Males were smoked significantly more often (75.5% vs. 43%, $p < 0.001$) than females and, current smokers both females (OR=1.12; 95%CI: 0.25-1.99, $p=0.012$) and, males (OR=0.85; 95%CI: 0.10-1.59, $p=0.027$) were significantly more likely to report an increased number of risk-factors for osteoporosis compared to never smokers. We also found that obese participants were less likely to report an increased number of risk-factors (OR=-1.87; 95%CI: -3.54, -0.20, $p=0.029$) compared to reference category suggesting that obesity was a protective factor for osteoporosis, but this association was significant only for males. Conclusion: Although a number of risk-factors did not differ among non-smokers, former and current smokers, current smokers had a greater likelihood of reporting a number of risk-factors related to osteoporosis, suggesting that smoking is an important risk factor for osteoporosis development.

Keywords: Osteoporosis, Female Gender, Age, Smoking, Bone Fracture

1. Introduction

Osteoporosis is the most common systemic skeleton illness that characterized by reduce of bone mass and disruption of

bone architecture resulting an increased risk of fragility fractures which represent the main clinical consequence of the disease. It is often called the *silent disease* because the loss of bone occurs silently and progressively and there are

no symptoms until the first fracture occurs [1]. Worldwide, osteoporosis is considered a global public health problem currently affecting over than 200 million people [2]. In particular, 1 in 3 women over 50 years old will experience osteoporotic fractures in contrast with 1 in 5 men [3]. Evidently, the overall prevalence of osteoporosis is higher in females approaching 80% [4], morbidity and mortality for osteoporotic fractures was found higher in males, even though the mean age of fractures appearance was about 5-10 years later than females [5].

In the international literature, factors such as age, female gender and/or rheumatoid arthritis mental have been evaluated as risk-factors for osteoporosis development due to having lower bone density, presenting a twice probability to experience mortality [6, 7]. Mental disorders have also a negative impact on bone health with most common depression and eating disorders (anorexia nervosa) in accordance with the National Osteoporosis Foundation statement [8]. In addition, the World Health Organization (WHO) recommended that females are much more likely to develop osteoporosis that gradually increased with age [9]. Furthermore, low dietary calcium and lifestyle (smoking and alcohol consumption) have also been associated for an increased risk for osteoporosis, especially tobacco use as recently reported for the Greek citizens with 40% proportion [10, 11]. Therefore, due to the fact that Greek population was classified in the first position for smoking among European countries, we consider that smoking might be related to an increased risk for osteoporosis development, especially in primary care population.

Subsequently, this study was aimed to investigate the frequency of factors related to a risk for osteoporosis and to evaluate whether smoking habit is associated with an increased risk for Osteoporosis in Primary care population aged 45 years and over. Our secondary aim was to explore possible differences between males and females.

2. Materials and Methods

2.1. Study Design

In this cross-sectional study we carried out a pre-screening test for Osteoporosis in two Primary care settings during a 3-month period (April to June 2013) in the island of Crete – Greece. We enrolled patients who visited the specific settings for any reason and were willing to be involved after the *oral briefing* by researchers for the procedures of the study. Critically, patients with previous diagnosis for osteoporosis and aged less than 45 years were excluded from the study. Finally, 470 self-administrative questionnaires were distributed and, a total of 400 questionnaires were fully completed and included in the statistical analysis – (response rate of 85.1 %).

2.2. Study Instrument

The Greek version of the *One Minute Osteoporosis Risk Test* was used to access risk-factors for osteoporosis.

Originally, it is a self-assessment test by the International Osteoporosis Foundation (IOF) and it has been widely used for a short screening health status bones and the potential risk of fracture [12]. It is consisted of 19 questions and was divided into modifiable (5 questions) and non modifiable (14 questions) risk factors taking into consideration gender, family history, personal clinical and lifestyle factors. From the total of 19 questions, 18 are concerned females and 16 questions males, based on participants responses (Yes/No). More positive answers “yes” to these questions it does not necessarily mean that a person has or develop Osteoporosis, it is however indicative for seeking medical advice.

Smokers were defined as tobacco users of ≥ 30 packs per year (20 cigarettes/pack) following the WHO recommendations. As far concerning the estimation of risk factors, alcohol consumption was evaluated as a unit of alcohol which is equivalent to 10 ml (or approximately 8 grams) of pure ethanol. Especially, the active chemical ingredient in alcoholic beverages, one unit of beer or cider (4% alcohol) is 250 ml/8.75 oz., one unit of wine (12.5% alcohol) is 80 ml/2.80 oz., and one unit of spirits (40% alcohol) is 25 ml/0.88 oz. [12]. Body Mass Index (BMI) was also assessed and expressed as fraction (kg/m^2) into 4 categories as follows; a BMI less than 18.5 indicates underweight (reference category), a BMI 18.5 - 24.9 indicates Normal, while a BMI greater than 25 is considered Overweight and above 30 indicates Obese according to the World Health Organization [13].

2.3. Ethics

The study was approved by the Scientific Council of Nursing Department of Technological Institute of Crete as a part of nursing intervention in Primary care population. Completing the questionnaire, all the participants gave informed consent while underlining that their participation was voluntary.

2.4. Statistical Analysis

The descriptive characteristics of the study participants were controlled for the significant of differences using χ^2 and Student t test were appropriate. Additionally, variance analysis was applied to determine associations between risk factors and demographic characteristics. Logistic regression was also applied to evaluate the likelihood of reporting risk-factors to the number of risk-factors (Mean Value) among genders and presented as odds ratio (OR) with 95% corresponding Interval consistency (CI). All reported P-values were two-tailed, and P-values ≤ 0.05 was considered statistically significant using the SPSS version 21.0.

3. Results

Demographic characteristics of the study participants were presented in Table 1. The mean age of our sample was 61.94 ± 11.6 years old, and was significantly greater for males than females (63.91 ± 11.9 vs. 59.96 ± 11.2 , $p=0.001$),

respectively. Underweight and normal BMI (18.5% and 59%, $p=0.001$) for males and was greater in comparison to (10% and 52%) of females. However, males were presented more

overweight (34% vs. 18%, $p=0.001$) and, were smoked significantly more frequent (36.5% vs. 21.5%, $p<0.001$) than females.

Table 1. Patients' characteristics

Demographic characteristics	Male (n=200)	Female (n=200)	P value
Age (years), Mean \pm SD*	63.91 \pm 11.9	59.96 \pm 11.2	0.001
BMI (kg/m ²), N (%)			0.001
Underweight	20 (10.0)	37 (18.5)	
Normal	104 (52.0)	118 (59.0)	
Overweight	68 (34.0)	36 (18.0)	
Obese	8 (4.0)	9 (4.5)	
Smoking Status N (%)			<0.001
Never	53 (26.5)	113 (56.5)	
Former	74 (37.0)	44 (22.0)	
Current	73 (36.5)	43 (21.5)	
Packs per year**			<0.001
< 30	53 (26.5)	113 (56.5)	
\geq 30	147 (73.5)	87 (43.5)	

*Standard Deviation

**cigarettes

3.1. Frequency of Potential Risk Factors between Males and Females

The distributions of potential risk factors for developing osteoporosis were presented as positive responses (Yes). Practically, males reported more frequently alcohol consumption (32.5% vs. 6.5%, $p<0.001$) than females and smoking status (75.5% vs. 43.0%, $p<0.001$), respectively. Males were also reported bone's break after a minor fall, as

an adult (63.0%) in comparison to females (49.0%), $p=0.005$. However, females were reported more frequent thyroid disease (37.0% vs. 14.5%, $p<0.001$), and fearing of falling (29.0% vs. 20.0%), $p=0.036$ than males. No other significant differences among genders were found regarding risk factors such as parents' history, rheumatoid arthritis, less activity and taking medications – (Table 2).

Table 2. Frequency of potential risk factors with respect to gender

Risk factors for Osteoporosis	Male n (%)	Female n (%)	P value
1. Parent's history for osteoporosis	105 (52.5)	108 (54.0)	0.764
2. Parents - "dowager's hump"	61 (30.5)	58 (29.0)	0.743
3. \geq 40 years	194 (97.0)	199 (99.5)	0.122
4. Fracture -adult	126 (63.0)	98 (49.0)	0.005
5. Frequency or fear – falling due frail	40 (20.0)	58 (29.0)	0.036
6. \geq 40 –loss 3cm	72 (36.0)	89 (44.5)	0.083
7. Low BMI	26 (13.0)	40 (20.0)	0.059
8. Taking Drugs for disease >3 months	68 (34.0)	75 (37.5)	0.465
9. Rheumatoid arthritis	56 (28.0)	70 (35.0)	0.132
10. Diagnosis – Thyroid or Diabetes	29 (14.5)	74 (37.0)	<0.001
11. (Female) - Menopause <45	-	71 (35.5)	-
12. (Female) - Frequency menstruation	-	41 (20.5)	-
13. (Female) - Ovaries removed <50	-	25 (12.5)	-
14. (Male) - Low Testosterone	43 (21.5)	-	-
15. Alcohol Consumption	65 (32.5)	13 (6.5)	<0.001
16. Smoking Status	151 (75.5)	86 (43.0)	<0.001
17. Activity <30 min	49 (24.5)	45 (22.5)	0.637
18. Avoiding calcium supplements	56 (28.0)	54 (27.0)	0.823
19. Stay Outside <10min – Without taking vitamin D	56 (28.0)	51 (25.6)	0.593

3.2. Associations between a Number of Risk Factors and Demographic Characteristics

A number of risk-factors for osteoporosis did not differ between males and females (5.99 \pm 2.2 vs. 6.28 \pm 2.8, $p=0.565$). Also, a number of risk-factors for osteoporosis did not differ

among underweight individuals (6.93 \pm 2.8), normal (6.05 \pm 2.5), overweight (5.85 \pm 2.1) and individuals with obesity (6.18 \pm 2.8), $p=0.162$. We also found no significant differences among non-smokers, former and current smokers ($p=0.282$). However, significant associations were observed

among age groups. Specifically, a number of risk-factors for osteoporosis were gradually increased with age <55 yrs old compared to ≥ 68 yrs (6.99 ± 2.4 vs. 4.95 ± 2.0 , $p < 0.001$), respectively - (Table 3).

Table 3. Associations between demographic characteristics and a (M) number of risk factors

Demographic characteristics	Mean \pm SD	P value
Gender		0.565
Male	5.99 \pm 2.2	
Female	6.28 \pm 2.8	
Age Groups		<0.001
<55 years	4.95 \pm 2.0	
55 – 67 years	6.34 \pm 2.6	
≥ 68 years	6.99 \pm 2.4	
BMI (kg/m ²)		0.162
Underweight	6.93 \pm 2.8	
Normal	6.05 \pm 2.5	
Overweight	5.85 \pm 2.1	
Obese	6.18 \pm 2.8	
Smoking Status		0.282
Never	5.88 \pm 2.6	
Former	6.25 \pm 2.3	
Current	6.37 \pm 2.6	
Packs per year		0.112
< 30	5.88 \pm 2.6	
≥ 30	6.31 \pm 2.4	

3.3. An OR Comparisons among Demographic Characteristics for a Number of Risk-Factors with Respect to Gender

Former Female smokers (OR=1.07; 95%CI: 0.22-1.91, $p=0.013$) and current Female smokers (OR=1.12; 95%CI: 0.25-1.99, $p=0.012$) were significantly more likely to report an increased number of risk-factors for osteoporosis compared to non-smokers (reference category), while these associations were significant only for current Male smokers (OR=0.85; 95%CI: 0.10-1.59, $p=0.027$).

As expected, we found significant association with respect to age. In particular, females aged 55-67 yrs old and aged ≥ 68 yrs old were significantly more likely to report an increased number of risk factors (OR=2.24; 95%CI: 1.45-3.04, $p < 0.001$) and, (OR=3.05; 95%CI: 2.15-3.94, $p < 0.001$), respectively, compared to reference category. However,

males aged 55-67 yrs old and aged ≥ 68 yrs were less likely to report an increased number of factors related to osteoporosis (OR=0.49; 95%CI: -0.27-1.26, $p < 0.001$) and, (OR=1.44; 95%CI: 0.68-2.20, $p < 0.001$) respectively, compared to reference category.

We also found a decreased likelihood for Males to report a number of risk factors with respect to BMI. Particularly, participants with normal (OR=-1.41; 95%CI: -2.42, -0.40, $p=0.006$), overweight (OR=-1.84; 95%CI: -2.88, -0.80, $p=0.001$) and obese BMI (OR=-1.87; 95%CI: -3.54, -0.20, $p=0.029$) were significantly less likely to report an increased number of risk factors for osteoporosis compared to reference category, suggesting that a higher BMI or obesity is protective factor for developing osteoporosis. However, these associations were not significant for female gender - (Table 4).

Table 4. OR comparisons in participants' characteristics toward a number of risk-factors for Osteoporosis according to gender.

Participants' characteristics	Females		Males	
	OR(95% CI)	P value	OR(95% CI)	P value
Age Groups				
<55 years	Ref.*		Ref.	
55 – 67 years	2.24 (1.45, 3.04)	<0.001	0.49 (-0.27, 1.26)	<0.001
≥ 68 years	3.05 (2.15, 3.94)	<0.001	1.44 (0.68, 2.20)	<0.001
BMI (kg/m ²)				
Underweight	Ref.		Ref.	
Normal	-0.78 (-1.68, 0.12)	0.089	-1.41 (-2.42, -0.40)	0.006
Overweight	-0.98 (-2.12, 0.16)	0.091	-1.84 (-2.88, -0.80)	0.001
Obese	-0.24 (-2.01, 1.53)	0.790	-1.87 (-3.54, -0.20)	0.029
Smoking Status				
Never	Ref.		Ref.	
Former	1.07 (0.22, 1.91)	0.013	-0.12 (-0.84, 0.60)	0.751
Current	1.12 (0.25, 1.99)	0.012	0.85 (0.10, 1.59)	0.027

*Reference category

4. Discussion

In this pre-screening test for risk-factors related to osteoporosis we found that current smokers had a greater likelihood of presenting an increased number of risk-factors, despite the fact that smoking status did not differ among smokers and non-smokers. Also, a greater BMI was protective factor for developing osteoporosis. Finally, both, males and females were more likely to report an increased number of risk factors as age increased.

The main finding of this study was that both; female and male current smokers were more likely to report a number of risk-factors suggesting that increasing the risk for osteoporosis development. In agreement with our findings, a previous meta-analysis survey based on hip fracture studies reported that smokers were almost once more likely in risk factor than non-smokers both in case-control (OR=1.33) and prospective studies (OR=1.63) – [14]. These findings were also similar to another meta-analysis showing that smoking was associated with an increased risk of any fracture compared to non-smokers [15]. Moreover, hip fractures among smokers and non-smokers in accordance with age have been suggested that there were similar odds ratios of hip fracture between smokers and non-smokers at the age of 50 yrs. However, the ratios were increased for smokers by an estimated 17% in patients aged >60 years old [16].

We also found that a likelihood of reporting number of risk-factors was decreased as BMI increased suggesting that greater BMI is a protective factor for osteoporosis development. In comparison to our results, data of meta-analysis focused on BMI evaluated that a lower BMI was a significant risk factor for future fracture independently of age and gender [17]. In our study, these associations were significant only for males. Additionally, obesity was a protective factor due to the increased synthesis of estrogen from adipose tissue in postmenopausal females [18]. Moreover, results of cross-sectional study showed that females with lower BMI were at increased risk of osteoporosis and it could be appropriate to maintain a normal weight [19].

Interestingly, both males and females were more likely to report an increased number of risk factors as age increased. In agreement with our results, numerous studies have been demonstrated that osteoporosis is an age-related disorder that affects the bones as people get older [20, 21]. Moreover, the risk for osteoporosis is greater for females after the age of 50 years old (usually occurs between the ages of 45 and 55) according to the International Osteoporosis Foundation due to being post menopause, as a consequence broken bones, because of hormonal changes during menopause that could lead to rapid loss bone mass [22, 23]. Furthermore, evidence has shown that osteoporosis is also a serious health issue for male as age increased. Specifically, during males' lifetime, at least 1 in 5 men over age 50 will suffer from an osteoporotic fracture that is increased to 1 in 3 over 60 years [24], but it

was also found that males were more prospective to die than females within a year after breaking a hip depending on problems related to the break [25].

5. Study Limitations

Though the study provides reliable findings, it has certain limitations as well bone mineral density (BMD) was not measured as the most common method of Dual-energy X-ray absorptiometry (DXA). In addition, the questionnaire data was based on self-reports and thus, could lead to incorrect results. It is however a wide-reaching screening tests supplying useful and comparative outcomes.

6. Conclusion

According to our data analysis, we concluded that smoking is an important risk factor for developing osteoporosis suggesting that smokers were presented with an increased number of risk-factors. Also, the presence of obesity has a central role in development of osteoporosis. Finally, our data indicates that smoking be required to taking into consideration in screening programs in primary care population and thus, health care professionals in order to manage the osteoporosis disease have to focus on “change behavior” of individuals in Primary care.

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