ORIGINAL ARTICLE

Changes in bone density measured by ultrasound of calcaneus in sedentary workers

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ABSTRACT

Aim To determine a degree of change in the bones of workers who spend their full time job in sitting position and to find a correlation between smoking and changes in bone structure. **Methods** Examinees were 213 female workers who worked full time sedentary work in front of computer. Each worker was subjected to physical examination and ultrasonic osteodensitometry of calcaneus.

Results The average age of patients was 45.4 years. Changes in bone density were found in 110 (51.64%) workers. Correlation between smoker and non-smoker groups was positive, but "r" was higher in smokers than in non-smokers. It is worrying that 10 out of 22 persons in the group up to 30 years of age have osteopenia.

Conclusion Recommendation for regular annual control of bone density of the working group at risk regardless of age should be followed. Prescribing exercise for the working group at risk should be a significant part of preventive work in clinics of occupational medicine and sports.

Key words: bone diseases, occupational health, osteopenia

INTRODUCTION

Bone weight loss per unit volume is called osteopenia or osteoporosis, depending on the degree of decrease. Osteoporosis is a disease associated with aging, but the process is influenced by genetic, epigenetic and environmental factors. Aging is a high risk factor for osteoporosis (1). Sedentary lifestyle implies too much sitting at work or at home. This way of life is directly related to the increased risk of developing a disease, most of which is the degeneration of the musculoskeletal system (2,3).

Regardless of work, each body or extremity position at work causes a certain load of physiological function of the worker. People who work full time sedentary are often exposed to an ergonomically inadequate work space (4).

Multi-year work in such conditions, with inadequate nutrition and tobacco products abuse, can lead to changes in bone structure that can progress over time. Nicotine has a direct adverse effect on bone density because it interferes with their metabolism (5).

Women who smoke have more frequent menstrual disorders, and 2-3 years earlier menopausal occurrence and hence early termination of the protective effect of estrogen in the sense of osteoporosis (6). Changes in bone density are most commonly associated with menopausal women, while changes in pre-menopausal women are often associated with their lifestyle (7).

Practical cases show that it is also necessary for young women to undergo an annual ultrasound examination of calcaneus in order to prevent osteoporosis, and also for successful treatment (8).

Changes in the structure of the bones are more and more frequently occurring earlier (9).

In addition to densitometric methods based on DXA (dual energy X-ray absorption), which is a gold standard in the diagnosis of osteoporosis, the ultrasonic densitometric method has been developed over the past years. The ultrasound method is simple, fast, without ionizing radiation and most importantly, accessible (10).

Sedentary lifestyle implies too much sitting, taking into account the time a person spends in the car, sitting at work or at home. This way of life is directly related to the increased risk of developing the disease, the most common of which is the degeneration of the musculoskeletal system (11). Regardless of the work performed at the workplace, each position of the body or extremity causes a certain load of the corresponding physiologic functions of the worker (12). In the sitting position, due to the long-lasting static contraction of the spinal cord extender muscle, their excessive fatigue occurs and the end result is the spasm of the muscles and severe pain (13). Nicotine has a direct adverse effect on bone density as it interferes with the metabolism. Females who smoke have more frequent menstrual disorders and 2-3 years earlier menopausal occurrence and hence early termination of the protective effect of estrogen in the sense of osteoporosis (14,15).

This work aims to determine the degree of changes in the bones of female workers who worked full time sedentary according to the age and to investigate a correlation between smoking and changes in the bone structure.

PATIENTS AND METHODS

Examinees and study design

This prospective study was conducted at the Department of Occupational Health of Sarajevo during 2015. The survey included 213 females full-time employed with sedentary work in front of computer: up to 30 years 23, 31-40 years 44, 41-50 years 66, 51-60 years 69 and more than 61 years of age there were 11 females. Examinees were divided into two groups: first group included 100 (46.9%) smokers and second group 113 (53.1%) non-smokers. In the smoker group no examinees were younger than 30 years, 22 were in 31-40, 30 in 41-50, 39 in 51-60 and nine were older than 61 years of age. Non-smoker group consisted of 13 examinees younger than 30 years, 22 in 31-40, 30 in 41-50, 39 in 51-60 and nine in more than 61 years of age group (Table 1). Exclusion criteria were workers with hyper- or hypothyroidism, workers taking corticosteroid therapy, workers who do not work full time in the sedentary position, workers who are physically active at work, workers who were pregnant in the last 2 years, breast-feeding workers.

Prior to the start of the study, a brief education of respondents was made and relevant information provided, explaining the purpose and objectives of the study. All examinees signed informed consent forms. The study was approved by the Ethics

Committee of the Department of Occupational Health Centre of Sarajevo.

Methods

During a systematic examination in the Institute of Occupational Health, a general examination was carried out, including work history, personal and family history, as well as physical examination.

The ultrasound osteodensitometry of calcaneus was performed on the ultrasound osteodensitometer (Osteosys BTL, Czech Republic) at the Department of Physical Medicine of the Institute. Testing was done by a direct method and the results of bone density measurements were expressed by T-scale (16). Osteoporosis was diagnosed when T-score <-2.5 and osteopenia when T-score was between 1.0 and 2.5. Bone density was considered normal if T was ≥ -1.0. Decreasing of the bone mineral density (BMD) for one standard deviation increases the risk of bone fractures by 1.5-3 times.

Statistical analysis

One part of the study results were processed by the statistical correlation method by Pearson. Accepted statistical significance was at p <0.05. Pearson's correlation coefficient was used in cases where there was a linear link between the variables of the observed model and a continuous normal distribution. The Pearson correlation coefficient value ranged from +1 (perfect positive correlation) to -1 (perfect negative correlation). Pearson's correlation coefficient r was based on comparison of the actual influence of observed variables on each other in relation to the maximum possible influence of two variables.

RESULTS

The average age of 213 females was 45.4 years; the majority were in the age group 41 to 60 years, 138 (65%) (Table 1).

Changes in bone density were found in 121 (out of 213; 56.8%) females: 110 (51.6%) were with osteopenia and 11 (5.2%) with osteoporosis.

Both, osteopenia and osteoporosis were most represented in the 51-60 years age group, in 39 (out of 121; 32.3%) and eight (out of 121; 6.6%) females, respectively.

Out of 100 examinees in the smoker group (46.9% of total examinees), 40 (40.0%) examinees had osteopenia and seven (7.0%) had osteoporosis; both, osteopenia and osteoporosis were most represented in the 51-60 years of age smoker group, 15 (37.5%) and six (85.7%) females, respectively. Out of 113 non-smoker examinees (53.1% of total examinees), 70 (61.9%) had osteopenia and four (3.5%) had osteoporosis (Table 1).

The correlation between bone changes and age in the smoker group was r = 0.2822 (positive correlation) (p <0.05), and in the non-smoker group it was r = 0.2030 (positive correlation) (p <0.05).

DISCUSSION

Changes in bone density were found in 121 (56.8%) females. It is particularly worrying that 10 out of 13 females younger than 30 years of age had osteopenia. The correlation between bone changes and age in both smoker and non-smoker group was positive, but it was higher in smokers than non-smokers group due to nicotine adversity. There was also a high probability of further bone loss combined with all further consequences. It is known that in women who smoke earlier menopause may occur and that osteoporosis development is more present (17). This work has confirmed this finding.

Comparing the results of this work with other authors, it can be seen that in all studies the prevalence ranges from moderate to high. A study in Italy found prevalence of 18% of women suffering from osteoporosis (18). The research conducted in

Table 1. Changes in bone density in 213 smoker and non-smoker examinees according to age

| Age (years) | No (%) of respondents | | | | | | | | Total |
| | Smokers | | | | Non-smokers | | | | |
	Osteopenia	Osteoporosis	Without changes	Total	Osteopenia	Osteoporosis	Without changes	Total	
≤30	0	0	0	0	10 (14.2)	0	3 (7.6)	13 (11.5)	13 (6.1)
31-40	11 (27.5)	0	11 (20.7)	22 (22.0)	11 (15.7)	0	11 (28.2)	22 (19.4)	44 (20.7)
41-50	11 (27.5)	1 (14.2)	18 (33.9)	30 (30.0)	19 (27.1)	1 (25.0)	10 (25.6)	30 (26.5)	60 (28.1)
51-60	15 (37.5)	6 (85.7)	18 (33.9)	39 (39.0)	24 (34.2)	2 (50.0)	13 (33.3)	39 (34.5)	78 (36.6)
>61	3 (7.5)	0	6 (11.3)	9 (9.0)	6 (8.5)	1 (25.0)	2 (5.1)	9 (7.9)	18 (8.4)
Total	40 (100.0)	7 (100.0)	53 (100.0)	100 (100.0)	70 (100.0)	4 (100.0)	39 (100.0)	113 (100)	213 (100)

Colombia also showed a high prevalence of osteoporosis, as many as 97.3% of women had at least one risk factor for osteoporosis (19). A US study has shown the prevalence of osteoporosis of 10.3% (20). So far, it has been a practice for women younger than 45 years old not to measure bone density. This study has shown that even younger women should be included in the screening. If bone loss is not noticed in time, osteoporosis may arise, which can lead to disability, which disturbs the overall quality of life of the affected person (21).

In conclusion, osteoporosis becomes a public health problem. Prevention should include a regular annual control of bone density of persons with the predominantly sedentary lifestyle regardless of their age to determine the risk of osteoporosis. Individuals at risk should be annually controlled for bone density and outpatient clinics of medicine and sports medicine should offer rehabilitation programs for sedentary workers as a preventive measure.

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Conflict of interest: None to declare.

REFERENCES

1. Anderson JB. Nutrition and bone health. In: Mahan LK, Escott-Stump S, eds. Krause's Food and Nutrition Therapy. 12th ed. Philadelphia: Elsevier; 2008:614-35.
2. Tremblay MS, Colley RC, Saunders TJ, Healy GN, Owen N. Physiological and health implications of a sedentary lifestyle. Appl Physiol Nutr Metabol 2010; 35:725-40.
3. Gianoudis J, Bailey CA, Daly RM. Associations between sedentary behaviour and body composition, muscle function and sarcopenia in community-dwelling older adults. Osteoporos Int. 2015; 26:571-9.
4. Commissaris D, Huysmans MA, Mathiassen SE, Srinivasan D, Koppes LJ, Hendriksen IJ. Interventions to reduce sedentary behavior and increase physical activity during productive work: a systematic review Scand J Work, Environ & Health 2016; 42:181-91.
5. Akhter MP, Iwaniec UT, Haynatzki GR, Fung YK, Cullen DM, Recker RR. Effect of nicotine on bone mass and strength in aged female rats. J Orthopedic Res 2003; 21:14-9.
6. Hrbar-Zerjavic V, Kralj V. Pušenje – čimbenik rizika za zdravlje. Hrvatski casopis za javno zdravstvo 2007; 11:1-6.
7. Ishimi Y. Osteoporosis and lifestyle. J Nutr Sci Vitaminol (Tokyo) 2015; 61:139-41.
8. Anderson KD, Chad KE, Spink KS. Osteoporosis knowledge, beliefs, and practices among adolescent females. J Adolescent Health 2005; 36:305-12.
9. Sandstrom L, McGuigan FE. Peak bone mass and quantitative ultrasound bone properties in young adulthood: A study in the peak-25 cohort of women. Clin Densitom 2016; 19:477-84.
10. Njeh CF, Boivin CM, Langton CM. The role of ultrasound in the assessment of osteoporosis: A review. Osteoporosis Int 1997; 7:7-22.
11. Chen S-M, Liu M-F, Cook J, Bass S, Lo SK. Sedentary lifestyle as a risk factor for low back pain: a systematic review. Int Arch Occup Environm Health 2009; 82:797-806.
12. Gasset RS, Hearne B, Keelan B. Ergonomics and body mechanics in the work place. The Ortop Clin North America 1996; 27:861-79.
13. Jakob F; Seefried L, Schwab M. Age and osteoporosis. Effects of aging on osteoporosis, the diagnostic and therapy. Internist 2014; 55:755-61.
14. Hartvigsen J, Leboeuf-Yde C, Lings S, Corder EH. Is sitting-while-at-work associated with low back pain? A systematic, critical literature review. Scand J Pub Health 2000; 28:230-39.
15. Benowitz NL. Clinical pharmacology of nicotine: implications for understanding, preventing, and treating tobacco addiction. Clin Pharmacol Ther 2008; 83:531-41.
16. Windham GC, Elkin EP, Swan SH, Waller KO, Fenster L. Cigarette smoking and effects on menstrual function. Obstet Gynecol 1999; 93:59-65.
17. Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. Report of a WHO Study Group. (WHO Technical Report Series, No. 843). Geneva: World Health Organization, 1994.
18. Hornsby PP, Wilcox AJ, Weinberg CR. Cigarette smoking and disturbance of menstrual function. Epidemiology 1998; 9:193-8.
19. Cavalli L, Guezzini A, Parri S, Prevalence of osteoporosis in the Italian population and main risk factors: result of bone tour campaign. BMC Musculoscelet Disord 2016; 17:396:1-11.
20. Londono J, Valensia P, Santos AM. Risk factor and prevalence of osteoporosis of premenopausal women from poor economic backgrounds in Columbia. Int J Womens Health 2013; 5:425-30.
21. Wright NC, Looker AC, Curtis JR. The recent prevalence of osteoporosis and low bone mass in the United States based on bone mineral density at the femoral neck or lumbal spine. J Bone Miner Res 2014; 29:2520-6.
22. Harvey N, Dennison E, Cooper C. Osteoporosis: impact on health and economics. Nat Rev Rheumat 2010; 6:99-105.