International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:12, No:8, 2018

Hormones and Mineral Elements Associated with Osteoporosis in Postmenopausal Women in Eastern Slovakia

M. Mydlárová Blaščáková, J. Poráčová, Z. Tomková, Ľ. Blaščáková, M. Nagy, M. Konečná, E. Petrejčíková, Z. Gogaľová, V. Sedlák, J. Mydlár, M. Zahatňanská, K. Hricová

Abstract**—**Osteoporosis is a multifactorial disease that results in reduced quality of life, causes decreased bone strength, and changes in their microarchitecture. Mostly postmenopausal women are at risk. In our study, we measured anthropometric parameters of postmenopausal women (104 women of control group – CG and 105 women of osteoporotic group - OG) and determined TSH hormone levels and PTH as well as mineral elements - Ca, P, Mg and enzyme alkaline phosphatase. Through the correlation analysis in CG, we have found association based on age and BMI, P and Ca, as well as Mg and Ca; in OG we determined interdependence based on an association of age and BMI, age and Ca. Using the Student's t test, we found significantly important differences in biochemical parameters of Mg ($p < 0,001$) and TSH ($p < 0,05$) between CG and OG.

Keywords**—**Factors, bone mass density, Central Europe, biomarkers.

I. Introduction

OSTEOPOROSIS as well as cardiovascular and oncological diseases belongs to civilization diseases. The occurrence of osteoporosis in postmenopausal women is associated with a decrease in sex hormone production, leading to faster resorption of bone mass. In terms of mortality, morbidity, financial costs osteoporosis is considered as a serious disease of the present age. It affects both sexes, by its consequences greatly aggravate the quality of life of the individual [1]. Risk factors for osteoporosis include excessive body weight loss, chronic kidney and gastrointestinal disorders, estrogen deficiency in women and testosterone in men, bad habits (smoking, sedentary lifestyle, excessive alcohol use, high salt intake), nutrition, and so on [2]. Non-influenced risk factors for osteoporosis include gender, population age, somatotype, genetic predisposition, and others [3]. Endocrine disorders - primary hypoparathyroidism and hyperthyroidism increase the rate of bone turnover and thereby induce bone mass loss. Also, nutritional factors that cause bone mass loss, lack of calcium, vitamin D, and proteins are associated with skeletal growth deficiency and accelerated bone mass loss [4]. Biochemical examination is necessary to assess bone metabolism.

Basic examinations include osteodensitometry, osteoform and osteoresorption markers, serum and urinary concentrations of mineral elements of calcium, phosphorus and magnesium and hormones - PTH, TSH.

Marta Mydlárová Blaščáková is from the Department of Biology. Mária Zahatňanská ist from the Department of Pedagogy, Faculty of Human and natural Sciences, Prešov University in Prešov, 080 01 Prešov, Slovak Republic (corresponding author, phone: + 421 51 75 70 640; e mail: martablascakova@gmail.com, marta.blascakova@unipo.sk).

Janka Poráčová, M. Konečná, Eva Petrejčíková, Zuzana Gogaľová, Katarína Hricová are from the Department of Biology. Mária Zahatňanská ist from the Department of Pedagogy, Faculty of Human and Natural Sciences, Prešov University in Prešov, 080 01 Prešov, Slovak Republic.

Melinda Nagy is with the Department of Biology, Faculty of Education, J. Selye University in Komárno, Slovak Republic.

Ľudmila Blaščáková is with the Department of Biophysic, Faculty of Science, Pavol Jozef Šafárik University in Košice, Slovak Republic.

Zlatica Tomková is with the Osteocentre s.r.o. in Prešov, Slovak Republic.

II. Materials and Methods

A. Subject

The study included 209 individuals – (postmenopausal women), who were divided into two groups based the clinical screening. The first was a control group (CG) with a number of 104 individuals, the second group was formed by postmenopausal women (n=105) with diagnosed postmenopausal osteoporosis (OS). The study was conducted after obtaining a written informed agreement from all individuals and implemented in accordance with the ethical principles based on the Helsinki Declaration.

B. Anthropometric Measurements

In the observed groups of postmenopaual women, we measured body weight (kg), body height (cm), waist circumference (cm), hip circumference (cm). Body weight was measured on a digital personal scale DM – 117 Dimarson with accuracy 100 g, body height was measured barefoot in light clothing by digital height (DIN 862 with a precision of 0.01 mm) as an average of two consecutive measurements. Subsequently, data were taken from weight and height and we calculated body mass index – BMI (kg/m^2). Waist circumference was measured periumbilical and hip circumference peritrochanteric, while we used the textile belt rate. From the measured data – waist circumference and hip circumference, we calculated index WHR (waist circumference – cm/ hip circumference – cm).

C. Biochemical Measurements

Venous blood samples were collected from all individuals from vena mediana cubital into tubes without anticoagulant content. By centrifugation, Selecta R, (Spain; 5000 rpm/10 min.) of blood samples, we separated blood serum which

selected biochemical markers (PTH and TSH) were subsequently measured using a full-automated immunochemical analyzer Cobas e411 (Roche Diagnostics, Japan), based on the principle of electrochemiluminiscence. Other biochemical markers – ALP, Ca, P and Mg were measured by a biochemical analyzer Cobas Integra 400plus (Roche Diagnostics, Switzerland).

D.Statistical Analysis

The measured data were processed by Excel 2010, Statistika ver. 10. The particular parameters were evaluated by using the statistical characteristics of the position and variability (standard deviation and variation range). For detection of the significance of differences between groups in each parameter, we used parametric methods Student´s T-test. We used the Spearman coefficient to indicate correlation between two parameters.

III. Result and Discussion

From anthropometric parameters, we determined the biological age, measured body weight and body height. On the basis of the parameters that we determined, we calculated the BMI index. Table I presents the average values of the selected parameters in both groups of women (CG and OG).

TABLE I
AVERAGE VALUES OF THE SELECTED ANTHROPOMETRIC AND BIOCHEMICAL MARKERS IN OBSERVED GROUPS OF WOMEN

Parameter	Average values ± SD	
	CG (n=104)	OG (n=105)
age (years)	54.38±7.45	54.64±12.65
Body height (cm)	163.19±5.86	163.29±5.30
Body weight (kg)	74.71±12.44	73.27±9.72
BMI (kg/m^2)	28.09±4.75	27.50±3.60
PTH (pg/ml)	28.73±7.96	28.83±14.42
TSH (mIU/l)	2.08±2.24	2.91±3.24
ALP (ukat/l^{-1})	1.12±0.36	1.63±0.37
Ca (mmol/l^{-1})	2.52±0.14	2.42±0.83
P (mmol/l^{-1})	1.32±0.22	1.26±0.34
Mg (mmol/l^{-1})	0.88±0.08	1.61±0.34

PTH – parathyroid hormone, TSH – thyroid-stimulating hormone, Ca – calcium, P – phosphor, Mg – magnesium, n –number, BMI – Body Mass Index

The body weight index, called the Quetelet Index, is one of the most commonly used indicators in measuring obesity. By simple calculations, we can determine the category of the individual involved and the high health risk associated with their body weight.

In our group of postmenopausal women, a higher average value of BMI index was calculated in the control group of postmenopausal women (28.09±4.75 kg/m^2), which falls into the overweight category. The average value of BMI of women with diagnosed osteoporosis was 27.50±3.60 kg/m^2, which can also be classified as overweight. On the basis of the measurements and the calculation, we found that 40 women of the control group were in the overweight category, 27 women in the category of I. grade obesity, 6 in the category of II. grade obesity and 2 women in the category of III. grade obesity. In the group of osteoporotic women, we found that 60 women were overweight, 17 women with I. grade obesity, three women with II. grade obesity.

Osteoporosis is a serious problem of public health. The results of the study [5] show that a higher body mass index (BMI) is like a "protective factor" of bone mineral density. The density of the bone mass and BMI index are among the commonly used quantitative characters for osteoporosis and obesity.

Through correlation analysis, we found a statistically significant association ($p<0.05$) between age and BMI in the control and osteoporotic group.

From the biochemical markers (Table I), we focused on hormones (PTH and TSH) and mineral elements (calcium – Ca, phosphorus – P, magnesium – Mg). On the basis of the measured results, we can conclude that the average values of PTH, in both groups of women were in accordance with the reference values.

We did not find a statistically significant difference between CG and OG in the biochemical parameter of PTH through the Student T-test. The average value of TSH in the group of healthy postmenopausal women was lower (2.08±2.24 mIU/l) than in the osteoporotic women group (2.91±3.24 mIU/l), yet the average TSH values were consistent with the reference values. Through the T-test, we found a statistically significant difference ($p<0.05$) in the biochemical parameter TSH between CG and OG.

In a scientific study [6] that was carried out in 2001 in the north of Norway, they looked at whether the serum levels of parathyroid hormone and calcium are associated with the BMI, or what their role is in predicting obesity. In the study, participants provided information on their medical history, lifestyle factors, and anthropometric data. Data on the intake of calcium and vitamin D were also found. Levels of serum calcium and parathyroid hormone were measured in 3447 males and 4507 females. The average value of PTH in female blood serum was 32.06±1.7 pg/ml. At the conclusion of the study, the authors conclude that serum PTH levels with respect to age, physical activity and serum occlusion are positively associated with BMI in both sexes, while PTH in a serum is an independent predictor of obesity. The average values of PTH in the group of postmenopausal women with osteoporosis (28.83±14.42 pg/ml) and in the group of healthy postmenopausal women (28.73±7.96 pg / ml) are lower in our study than those measured by study [6]. We assume that, in our work, it was a smaller research group of women.

Reference [7] conducted a scientific study to confirm the relationship between serum TSH and BMI in healthy adults. They found that the elevated BMI also increased the level of TSH. The association of TSH and BMI was also dealt with by study [8]. In their research, men and women who had no endocrine disorder were observed. The observed TSH levels were compared with age and BMI. In our research, the association of TSH and BMI was not confirmed in both groups, we suppose that it was a smaller sample of individuals.

The reference range of alkaline phosphatase values for

women aged over 50 is 0.88 – 2.35 μkat.l^{-1}, it can be concluded that the average values of ALP in both groups were within this range. We found a statistically significant difference ($p<0.001$) between the CG and the OG in the biochemical parameter ALP. In a group of postmenopausal women with osteoporosis, a correlation analysis revealed a statistically significant effect ($p<0,05$) of concentration of ALP to magnesium and ALP and parathyroid hormone. In the control group of postmenopausal women, associations were found ($p<0,05$) between ALP a BMI index and also between age and ALP (Figs. 1 and 2).

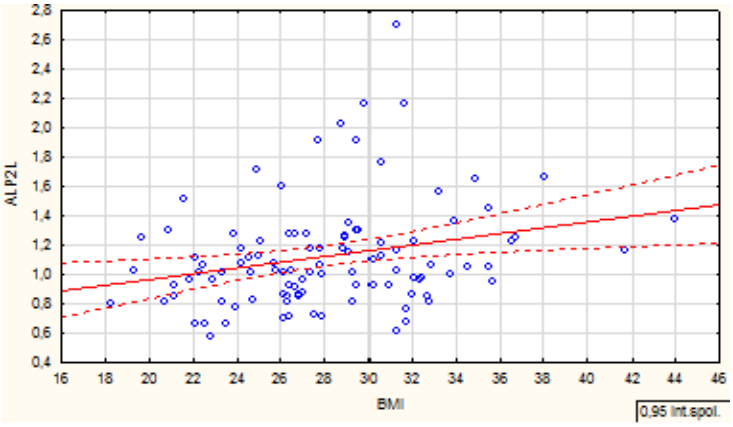

Fig. 1 The association between ALP and BMI in the control group of postmenopausal women

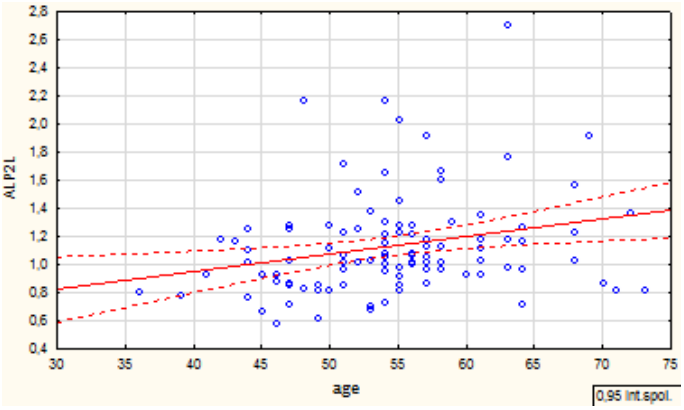

Fig. 2 The association between ALP and age in the control group of postmenopausal women

Authors [9] measured and compared serum bone-level alkaline phosphatase isoenzyme (B-ALP) in patients with metabolic bone disease - Paget's disease and a control group of healthy subjects comprising 173 women and 180 men aged 20-88 years. B-ALP levels have been found to increase linearly with increasing age in both sexes. Mean Serum B-ALP values were not significantly different in females and males (11.3±4.8 ng/mL in females and 11.0±4.0 ng/mL in males). It was also found that post-menopausal increases B-ALP significantly higher than total alkaline phosphatase (T-ALP). Serum levels of ALP were gradually increased in patients with Paget's disease, primary hyperparathyroidism, and patients with chronic renal failure. In subjects with Paget's disease, B-ALP was highly correlated with T-ALP ($p<0.001$). The results of our work partly coincide with the results of this study because we did not include men in our surveyed file. Our study also confirmed that ALP in CG values increase linearly with increasing age.

The average values of mineral elements of calcium and phosphorus were in accordance with the reference values (Ca: 2.15 – 2.55 mmol/l, P: 0.85 – 1.50 mmol/l^{-1}) in both groups (CG and OG) [10]. In the biochemical parameter of magnesium, we found a higher average value in OG than the reference range of 0.70 – 1.10 mmol/l. We also obtained a statistically significant difference ($p<0.001$) between CG and OG in the biochemical parameter of Mg. By correlation analysis, we found mutual association of age and Ca in the OG and mutual association of P and Mg to Ca concentration in the CG (Figs. 3 and 4).

Correlation of calcium, phosphorus and magnesium with bone mass content was dealt with by a study [11] that looked at qualitative and quantitative differences in dietary habits in postmenopausal women that affect bone mass density and they also dealt with effect on the development of osteoporosis. Analyses confirmed that the intake of calcium, phosphorus and magnesium was significantly reduced in women with

osteoporosis and correlated with bone mass content. Even in the postmenopausal group of healthy women, a lower intake of calcium and magnesium was found in comparison with the recommended daily doses.

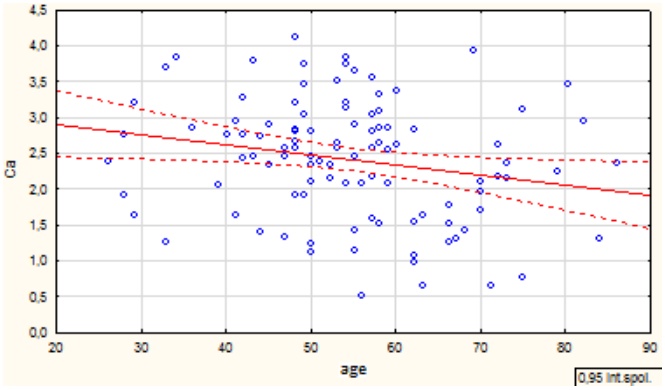

Fig. 3 The association between Ca and age in the osteoporotic group of postmenopausal women

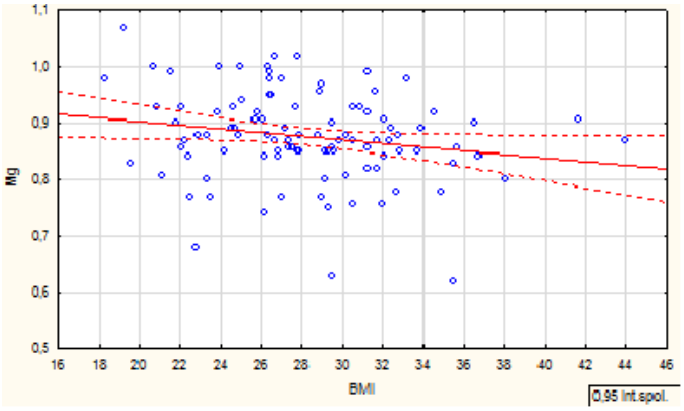

Fig. 4 The association between Mg and BMI in the osteoporotic group of postmenopausal women

IV. Conclusion

Our results indicate that nutritional factors are important for the proper functioning of bone metabolism in postmenopausal women. Their supplementation through nutrition can be helpful for the prophylaxis of osteoporosis. Hormones play a crucial and inseparable function in maintaining the body's homeostasis, affect a wide range of physiological processes. The results of biochemical parameters cannot be interpreted directly, it is necessary to follow the method of bone marker release, biological variability conditioned by circadian rhythms, and take into account seasonal influences, nutrition and genetic predisposition.

Acknowledgment

This work was supported by the project KEGA, No. 018PU-4/2018 and project VEGA 1/0783/18 Ministry of Education, Science, Research and Sport of the Slovak Republic.

References

[1] V. Palička, J. Blahoš, S. Býma, "Osteoporóza: Doporučený diagnostický a léčebný postup pro všeobecné praktické lékaře." Online. Available: http://www.svl.cz/files/files/Doporucene-postupy-2008-2012/osteoporoza-2011-novelizace.pdf.

[2] E. M. Lewiecki, "To Treat or Not to Treat: Reducing Fracture Risk in Postmenopausal Women," *The Female Patient,* vol. 37, no. 1, pp. 1-16.

[3] N. K. Arden, R. W. Keen, J. S. Lanchburg, T. D. Spector, T. D., Polymorphism of the vitamin D receptor gene do not predict quintitative ultrasound of the calcaneus or hip axis lenght, "*Osteoporosis International*, vol. 6, no. 4, pp. 334-337.

[4] J. Payer, M. Borovský, P. Jackuliak, K. Brázdilová, Z. Killinger, E. Némethová, D. Čierny, A. Baňárová, S. Tomková, M. Kužma, J. Kollerová, "Osteoporóza pri vybraných ochoreniach". Bratislava, Herba 2014. p.192, ISBN 978-80-89631-19-3.

[5] L. W. Turner, J. E. Taylor, S. Hunt, "Predictors for osteoporosis diagnosis among postmenopausal women: results from a national survey," *J. Women Aging,* vol. 10, no. 3, pp.79-96.

[6] E. Kamycheva, R. Jorde, J. Sundsfjord, "Serum parathyroid hormone level is associated with body mass index", *European Journal of Endocrinology,* vol. 151, pp. 167-172.

[7] A. Solanki, S. Bansal, S. Jidal, V. Saxena, U. S. Shukla, "Relationship of serum thyroid stimulating hormone with body mass index in healthy adults," *Indian. J. Endocrinol. Metab.,* vol. 17, no. 3, pp. 167-169.

[8] C. M. Kitahara, E. A. Platz, P. W. Ladenson, P. W. (ed.), "Body Fatness and Markers of Thyroid Function among U. S. Men and Women." Online. Available:http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0034979.

[9] P. Garnero, P. D. Delmas, "Assessment of the serum levels of bone alkaline phosphatase with a new immunoradiometric assay in patients with metabolic bone disease", *Journal of Clinical Endocrinology and Metabolism*, vol. 77, no. 4, pp. 1046-1053.

[10] Klinická biochémia, "Referenčné hodnoty biochemických parametrov

u dospelých. Online. Available: http://www.klinickabiochemia.sk/download/biochemia.pdf, October 2017.

[11] A. L. Tranquilli, E. Lucino, G. G. Garzetti, C. Romanini, "Calcium, phosphorus and magnesium intakes correlate with bone mineral content in postmenopausal women," *Gynecological Endocrinology*. Online. Available:http://www.researchgate.net/publication/15138867_Calcium_phosphorus_and_magnesium_intakes_correlate_with_bone_mineral_content_in_postmenopausal_women.