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Influence of vitamin D deficiency on bone densitometry data

Abstract. *The aim* of study was to determine the influence of vitamin D deficiency and age on the ultrasound densitometry data in healthy subjects. **Materials and methods.** The study involved 227 subjects aged 20-85 years. The average age of men was (52.79±14.44) years, and women (51.12±13.72) years of age ($p>0.05$). Serum 25(OH)D total level was determined by electrochemiluminescence (ECL) method in Elecsys analyzer with cobas test systems. The structural and functional state of the bone tissue was measured on the heel by quantitative ultrasound densitometer «Sahara» (Hologic). **Results.** The study has found vitamin D deficiency in 50.7 % subjects, insufficiency in 33.0%, and normal serum 25(OH)D level in 16.3% of subjects. It was evaluated that speed of sound parameter was significantly higher in subjects with optimal 25(OH)D level (1552.87 ± 37.66 m/s) compared to subjects with vitamin D deficiency (1538.27 ± 28.71 m/s, ($p < 0,01$)) and insufficiency (1547.99 ± 9.51 m/s, ($p < 0.05$)). To establish the power of influence of serum 25(OH)D level and age on the ultrasound densitometry parameters it was used univariable and multivariable linear regression analysis. According to the results of univariable linear regression analysis, it was found that 25(OH)D level ($\beta = 0.15-0.18$) and age ($\beta = -0.24- -0.26$) is effecting the ultrasound densitometry data. Due to the results of multivariable linear model with serum 25(OH)D parameter (independent variable) and adjusted for age the influence of 25(OH)D level on the bone densitometry data is graded. So, our results demonstrate that serum 25(OH)D level is not an independent predictor of osteopenia and osteoporosis. **Conclusion.** The observations revealed that subjects with vitamin D deficiency and insufficiency have significantly lower parameters of bone densitometry data compared to subjects with optimal vitamin D level. It is proved that serum 25(OH)D level is not an independent predictor of deterioration of structural and functional state of bone tissue. Only an age is independent factor of osteoporosis.

Keywords: the structural and functional state of the bone tissue; vitamin D deficiency; age

Vitamin D plays an important role in the maintaining of the calcium and phosphorus homeostasis. Vitamin D increases calcium absorption from the intestine, and indirectly inhibits the secretion of parathyroid hormone. Vitamin D deficiency (VDD) can be the reason of the secondary hyperparathyroidism and consequently leads to the increased rate of remodeling and resorption of bone tissue [1, 2]. The elevated resorption influences on bone microarchitecture and results into development of osteomalacia and osteoporosis. It is found the direct correlation between bone mineral density and fracture risk [2-5]. Also, it is proved that decreased strength and bone density increased incidence of fractures [6]. Usually osteoporotic fractures (fractured femur, vertebral and forearm in a typical place) increase mortality and reduce quality of life [6-10].

The aim of the study: to determine the influence of vitamin D deficiency and age on the ultrasound densitometry data in healthy subjects.

Materials and methods

The study involved 227 healthy subjects aged 20-85 years. The average age of men was (52.79±14.44) years, and women (51.12±13.72) years of age ($p>0.05$). Serum 25(OH)D total level was determined by electrochemiluminescence (ECL) method in Elecsys analyzer with cobas test systems. The structural and functional state of the bone tissue was measured on the heel by quantitative ultrasound densitometer «Sahara» (Hologic).

The optimal vitamin D status was defined when serum 25(OH)D level was 30-50 ng/ml, vitamin D insufficiency

and deficiency were noted for 25(OH)D levels between 20 and 30 ng/ml and for 25(OH)D levels lower than 20 ng/ml, respectively [11].

Results and discussion

The study has found, that vitamin D deficiency was registered in 50.7 % subjects, insufficiency in 33.0 %, and normal serum 25(OH)D level in 16.3 % of subjects (fig. 1).

It was estimated that speed of sound parameter was significantly higher in subjects with optimal 25(OH)D level (1552.87 ± 37.66 m/s) compared to subjects with vitamin D deficiency (1538.27 ± 28.71 m/s, ($p < 0,01$)) and insufficiency ($1547,99 \pm 9,51$ m/s, ($p < 0,05$)).

Also, it was determined that in subjects 45-60 years with vitamin D deficiency had ultrasound densitometry data significantly lower compared to those who had vitamin D insufficiency (particularly, stiffness index: 88.57 ± 14.78 vs 97.82 ± 17.69 , % ($p = 0.02$), speed of sound: 1538.68 ± 25.13 vs 1552.87 ± 27.98 m/s ($p = 0.03$), broadband ultrasound attenuation: 69.29 ± 13.32 vs 78.41 ± 16.05 , dB/MHz ($p = 0,006$) and compared to those who had optimal serum 25(OH)D level (stiffness index: 88.57 ± 14.78 vs 100.55 ± 22.17 , % ($p = 0.02$), speed of sound: 1538.68 ± 25.13 vs 1561.05 ± 40.04 , m/s ($p = 0.009$)). It was found that serum 25(OH)D level had a significant positive influence on the parameters of structural and functional state of bone tissue ($r = 0.15-0.18$, $p < 0.05$) (fig. 2).

It is well known that age is influencing on the structural and functional state of bone tissue [12, 13]. To establish the power of influence of serum 25(OH)D level and age on the ultrasound densitometry parameters it was used univariable and multivariable linear regression analysis. According to the results of univariable linear regression analysis, it was found that 25(OH)D level ($\beta = 0.15-0.18$) and age ($\beta = -0.24- -0.26$) is effecting the ultrasound densitometry data (table).

Due to the results of multivariable linear model with serum 25(OH)D parameter (independent variable) and adjusted for age the influence of 25(OH)D level on the bone densitometry data is graded. So, our results demonstrate

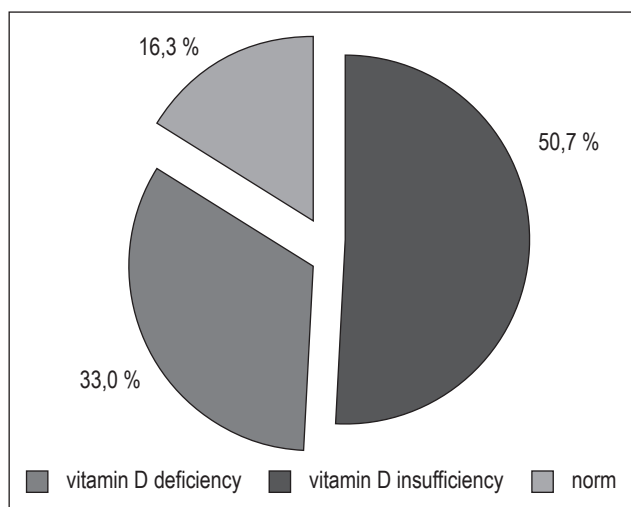


Fig. 1. Frequency of vitamin D deficiency and insufficiency among practical healthy subjects

that serum 25(OH)D level is not an independent predictor of osteopenia and osteoporosis. However, serum 25(OH)D level reduces the intensity of age influence on the structural-functional state of bone tissue (tab.).

In scientific literature we found controversial data about influence of vitamin D on bone mineral density (BMD) measured by different methods. In the OFELY study which included 669 postmenopausal women who were followed

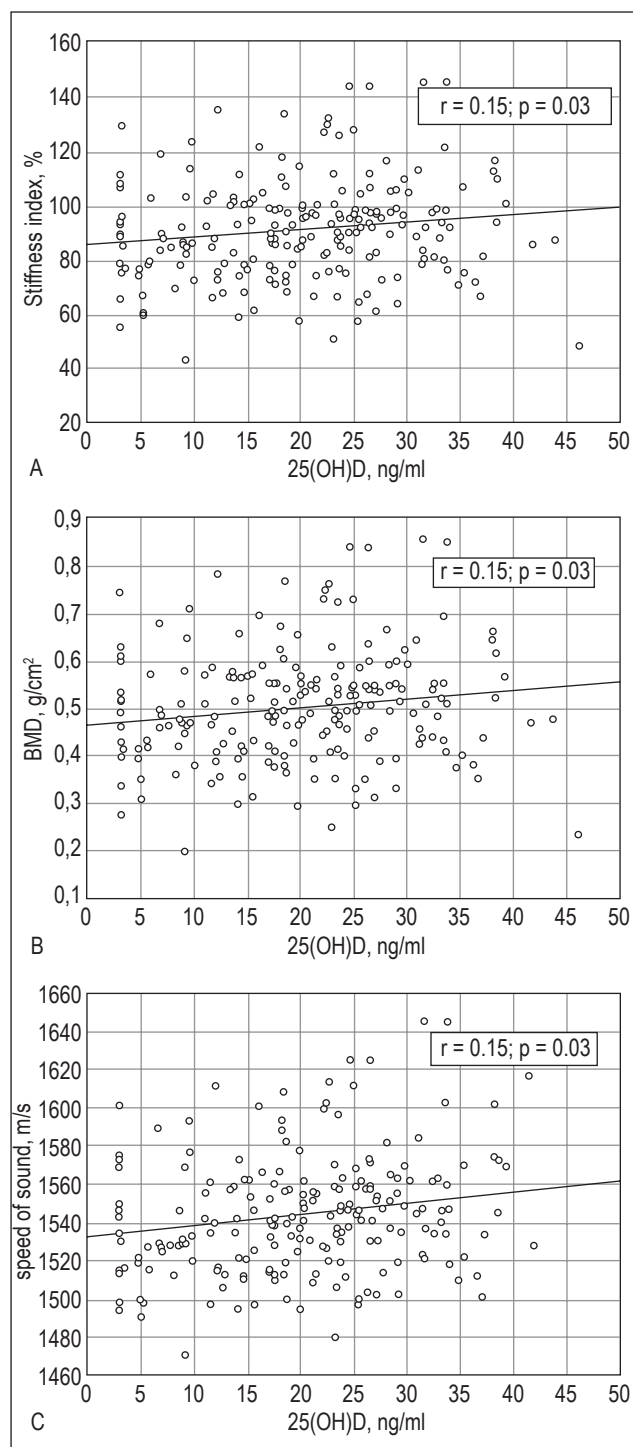


Fig. 2. Influence of serum 25(OH)D level on Stiffness Index (A), eBMD (B), on speed of sound (C) in practical healthy subjects

Table – Associations between bone densitometry data (dependent variables) and serum 25(OH)D (ng/ml; independent variable) and age (yrs.; independent variable) in practical healthy subjects

Dependent variable	β (95 % CI)	P	R ²
Univariable linear regression model with serum 25(OH)D parameter (ng/ml; independent variable)			
Stiffness index, %	0.15 (0.23; 0.54)	0.03	0.02
eBMD, g/cm ²	0.15 (0.00; 0.003)	0.03	0.02
Speed of sound, m/s	0.18 (0.16; 1.01)	0.01	0.03
Multivariable linear regression model with serum 25(OH)D parameter (ng/ml; independent variable) and adjusted for age			
Stiffness index, %	0.12 (-0.03; 0.48)	0.086	0.07
BMD, g/cm ²	0.12 (0.00; 0.003)	0.086	0.07
Speed of sound, m/s	0.15 (0.06; 0.89)	0.025	0.09
Univariable linear regression model with age parameter (yrs.; independent variable)			
Stiffness index, %	-0.24 (-0.52; -0.15)	0.000	0.06
eBMD, g/cm ²	-0.24 (-0.003; 0.00)	0.000	0.06
Speed of sound, m/s	-0.26 (-0.89; -0.29)	0.000	0.07
Multivariable linear regression model with age parameter (yrs.; independent variable) and adjusted for serum 25(OH)D level			
Stiffness index, %	-0.23 (-0.50; -0.13)	0.001	0.07
eBMD, g/cm ²	-0.23 (-0.003; 0.00)	0.001	0.07
Speed of sound, m/s	-0.24 (-0.84; -0.25)	0.000	0.09

prospectively for 11.2 years. The scientists did not find the significant association between 25(OH)D levels and radius BMD loss or fracture risk. After adjustment for age, there was no significant difference in incidence of fracture, BMD, radius BMD loss, bone turnover marker between women with 25(OH)D levels below or above 75, 50 or 30 nmol/l [14].

Arya V. has examined 92 healthy hospital staff in some Indian clinic. He revealed that the serum 25(OH)D level correlated with BMD at the femoral neck and Ward's triangle ($r = 0.50$, $P = 0.020$ and $r = 0.46$, $P = 0.037$, respectively) [15].

Di Monaco M. et al. have examined 405 women who had serum 25-hydroxyvitamin D below 12 ng/ml during first month after a hip-fracture. They showed that women, with hip-fracture, and severe vitamin D deficiency, and secondary hyperparathyroidism have significantly lower BMD of unfractured femoral neck compared with women with hip-fracture, and only severe vitamin D deficiency.

Sundh D. et al., in his study which included 444 elderly men (80.2 ± 3.5 years), found that vitamin D is associated with cortical porosity and areal BMD of the femoral neck [17].

Conclusions. The observations revealed that subjects with vitamin D deficiency and insufficiency have significantly lower parameters of bone densitometry data compared to persons with optimal vitamin D level. It is proved that serum 25(OH)D level is not an independent predictor of deterioration of structural and functional state of bone tissue. Only an age is independent factor of osteoporosis.

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Вплив дефіциту вітаміну D на показники ультразвукової денситометрії

Резюме. Метою роботи було дослідити вплив дефіциту вітаміну D та віку на показники ультразвукової денситометрії. **Матеріали та методи.** Було обстежено 227 осіб віком 20–85 років. Середній вік чоловіків склав 52,79±14,44 р., у жінок — 51,12±13,72 р. (p>0.05). Рівень 25(ОН)D у сироватці крові визначали за допомогою електрохемілюмінесцентного методу. Дослідження структурно-функціонального стану кісткової тканини проводили за допомогою ультразвукового кісткового денситометра «Sahara» (Hologic). **Результати.** Встановлено, що дефіцит вітаміну D реєструвався в 50,7 % обстежених, недостатність — у 33,0 %, а нормальний рівень 25(ОН)D у сироватці крові — в 16,3 %. Достовірно вищі показники швидкості поширення ультразвуку реєструвалися в обстежених з рівнем 25(ОН)D у сироватці крові в межах норми (1552,87±37,66 м/с) у порівнян-

ні з особами, в яких діагностувався дефіцит (1538,27±28,71 м/с, p<0,01) та недостатність вітаміну D (1547,99±9,51 м/с, p<0,05). Для вивчення сили впливу 25(ОН)D у сироватці крові та віку на показники ультразвукової денситометрії було використано аналіз однофакторної та багатфакторної лінійної регресії. Згідно однофакторного регресійного аналізу встановлено, що 25(ОН)D ($\beta=0,15-0,18$) та вік ($\beta=-0,24- -0,26$) впливають на показники ультразвукової денситометрії. **Висновки.** Згідно багатфакторної лінійної регресійної моделі встановлено, що вітамін D не є самостійним предиктором показників ультразвукової денситометрії. Лише вік можна розглядати як самостійний чинник остеопенічного синдрому ($\beta=-0,26$, ДІ: -0,89; -0,29, p < 0,000).

Ключові слова: структурно-функціональний стан кісткової тканини; дефіцит вітаміну D; вік

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Влияние дефицита витамина D на показатели ультразвуковой денситометрии

Резюме. Целью работы было исследовать влияние дефицита витамина D и возраста на показатели ультразвуковой денситометрии. **Материалы и методы.** Было обследовано 227 человек в возрасте 20–85 лет. Средний возраст мужчин составил 52,79 ± 14,44 р., у женщин 51,12 ± 13,72 р. (P>0.05). Уровень 25(ОН)D в сыворотке крови определяли с помощью электрохемилуминесцентного метода. Исследование структурно-функционального состояния костной ткани проводили с помощью ультразвукового костного денситометра «Sahara» (Hologic). **Результаты.** Дефицит витамина D зарегистрирован у 50,7% обследованных лиц, недостаточность у 33,0%, а нормальный уровень 25(ОН)D в сыворотке крови у 16,3%. Достоверно более высокие показатели скорости распространения ультразвука регистрировались у обследованных лиц с уровнем 25(ОН)D в сыворотке крови в пределах нормы (1552,87 ± 37,66 м/с) по сравнению с лицами, у которых диагностировался дефицит

(1538,27 ± 28,71 м/с, p < 0,01) и недостаточность витамина D (1547,99 ± 9,51 м/с, p < 0,05). Для изучения силы влияния содержания 25(ОН)D в сыворотке крови и возраста на показатели ультразвуковой денситометрии было использовано анализ однофакторной и многофакторной линейной регрессии. Согласно однофакторному регрессионному анализу установлено, что 25(ОН)D ($\beta = 0,15-0,18$) и возраст ($\beta = -0,24- -0,26$) влияют на показатели ультразвуковой денситометрии. **Выводы.** Согласно многофакторной линейной регрессионной модели установлено, что витамин D не является самостоятельным предиктором показателей ультразвуковой денситометрии. Только возраст можно рассматривать как самостоятельный фактор остеопенического синдрома ($\beta = -0,26$, ДИ: -0,89; -0,29, p < 0,000).

Ключевые слова: структурно-функциональное состояние костной ткани; дефицит витамина D; возраст