

The state of bone and mineral metabolism in underweight pregnant women

L. P. Shelestova

Donetsk National Medical University, Lyman, Ukraine

Key words:

body weight, pregnancy, bone density, densitometry.

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E-mail:

larysa.shelestova@gmail.com

In the available literature there are various data about changes in calcium-phosphorus and bone metabolism during pregnancy.

The aim of the research – to study the state of bone-mineral metabolism in underweight pregnant women.

Materials and methods. The research included 41 pregnant women with body weight deficiency at the beginning of pregnancy and 37 of them before labor, and also 35 pregnant women with normal body weight. The content of total calcium, nonorganic phosphorus, parathyroid hormone, osteocalcin, vitamin D total (25(OH)D) were defined in blood serum. The study of bone tissue mineral density was held with the use of ultrasound densitometry.

Results. It has been found the statistically considerable decreasing of total calcium content in the underweight pregnant women pregnant in comparison with women who have normal body weight at the beginning of pregnancy – 2.25 (2.21; 2.32) against 2.34 (2.36; 2.41) mmol/l, $P=0.001$ and before labor – 2.20 (2.07; 2.30) against 2.27 (2.23; 2.35) mmol/l, $P=0.003$, phosphorus (1.18 (1.12; 1.24) against 1.21 (1.17; 1.29) mmol/l, $P=0.024$ and 1.16 (1.08; 1.21) against 1.20 (1.14; 1.25) mmol/l, $P=0.027$), parathyroid hormone (19.4 (14.9; 28.9) against 34.5 (30.8; 38.6) pg/ml, $P<0.001$ and 14.8 (13.5; 24.4) against 30.5 (18.1; 34.3) pg/ml, $P<0.001$), osteocalcin (13.8 (9.3; 18.2) against 21.2 (15.4; 23.8) ng/ml, $P<0.001$ and 12.3 (8.8; 16.9) against 18.3 (15.2; 20.3) ng/ml, $P<0.001$), vitamin D (27.1 (24.1; 30.0) against 29.9 (27.8; 33.3) ng/ml, $P=0.004$ and 23.8 (20.5; 27.8) against 28.0 (25.8; 29.9) ng/ml, $P<0.001$). At the beginning of pregnancy 36.6 % women with body weight deficiency and 5.7 % women with normal body weight ($P=0.003$) had signs of osteopenic syndrome, before labor their amount increased up to 51.4 and 11.4 % ($P<0.001$) respectively.

Conclusions. The gestation in underweight women develops with affection of bone and mineral metabolism, as evidenced by the statistically considerable decrease of calcium-phosphorus indexes and bone tissue markers and the existence of osteopenic syndrome signs. Aggravation of these changes takes place before delivery.

Ключові слова:

маса тіла, вагітність, кістки щільність, денситометрія.

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Стан кістково-мінерального метаболізму у вагітних жінок із дефіцитом маси тіла

Л. П. Шелестова

У доступній науковій літературі є неоднозначні дані про зміни кальцій-фосфорного обміну та кісткового метаболізму протягом вагітності.

Мета роботи – вивчити стан кістково-мінерального метаболізму в жінок із дефіцитом маси тіла під час вагітності.

Матеріали та методи. У дослідження включили 41 вагітну з дефіцитом маси тіла на початку вагітності та 37 із них напередодні пологів, а також 35 вагітних із нормальною масою тіла. У сироватці крові визначали вміст загального кальцію, неорганічного фосфору, паратгормона, остеокальцину, вітаміну D загального (25(OH)D). Дослідження мінеральної щільності кісткової тканини здійснили з використанням ультразвукової денситометрії.

Результати. У вагітних із дефіцитом маси тіла порівняно з жінками з нормальною масою тіла встановили статистично значуще зниження вмісту загального кальцію (на початку вагітності – 2,25 (2,21; 2,32) проти 2,34 (2,26; 2,41) ммоль/л, $P=0,001$ і напередодні пологів – 2,20 (2,07; 2,30) проти 2,27 (2,23; 2,35) ммоль/л, $P=0,003$), фосфору (1,18 (1,12; 1,24) проти 1,21 (1,17; 1,29) ммоль/л, $P=0,024$ та 1,16 (1,08; 1,21) проти 1,20 (1,14; 1,25) ммоль/л, $P=0,027$), паратгормона (19,4 (14,9; 28,9) проти 34,5 (30,8; 38,6) пг/мл, $P<0,001$ і 14,8 (13,5; 24,4) проти 30,5 (18,1; 34,3) пг/мл, $P<0,001$), остеокальцину (13,8 (9,3; 18,2) проти 21,2 (15,4; 23,8) нг/мл, $P<0,001$ і 12,3 (8,8; 16,9) проти 18,3 (15,2; 20,3) нг/мл, $P<0,001$), вітаміну D (27,1 (24,1; 30,0) проти 29,9 (27,8; 33,3) нг/мл, $P=0,004$ і 23,8 (20,5; 27,8) проти 28,0 (25,8; 29,9) нг/мл, $P<0,001$). На початку вагітності ознаки остеопенічного синдрому мали 36,6 % жінок із дефіцитом маси тіла та 5,7 % – з нормальною масою тіла ($P=0,003$), напередодні пологів їхня кількість збільшилась до 51,4 та 11,4 % ($P<0,001$) відповідно.

Висновки. У жінок із дефіцитом маси тіла розвиток вагітності відбувається на тлі порушення кістково-мінерального обміну, про що свідчить статистично значуще зниження показників кальцій-фосфорного обміну та маркерів кісткової тканини, а також наявність ознак остеопенічного синдрому. Напередодні пологів відбувається посилення цих змін.

Ключевые слова:

масса тела, беременность, кости плотность, денситометрия.

Состояние костно-минерального метаболизма у беременных женщин с дефицитом массы тела

Л. П. Шелестова

В доступной научной литературе имеются неоднозначные данные об изменениях кальций-фосфорного обмена и костного метаболизма в течение беременности.

Цель работы – изучить состояние костно-минерального метаболизма у женщин с дефицитом массы тела во время беременности.

Материалы и методы. В исследование вошла 41 беременная с дефицитом массы тела в начале беременности и 37 из них накануне родов, а также 35 беременных с нормальной массой тела. В сыворотке крови определяли содержание общего кальция, неорганического фосфора, паратгормона, остеокальцина, витамина D общего (25(OH)D). Исследование минеральной плотности костной ткани проводилось с использованием ультразвуковой денситометрии.

Результаты. У беременных с дефицитом массы тела по сравнению с женщинами с нормальной массой тела установлено статистически значимое снижение содержания общего кальция (в начале беременности – 2,25 (2,21; 2,32) против 2,34 (2,26; 2,41) ммоль/л, $P=0,001$ и накануне родов – 2,20 (2,07; 2,30) против 2,27 (2,23; 2,35) ммоль/л, $P=0,003$), фосфора (1,18 (1,12; 1,24) против 1,21 (1,17; 1,29) ммоль/л, $P=0,024$ и 1,16 (1,08; 1,21) против 1,20 (1,14; 1,25) ммоль/л, $P=0,027$), паратгормона (19,4 (14,9; 28,9) против 34,5 (30,8; 38,6) пг/мл, $P<0,001$ и 14,8 (13,5; 24,4) против 30,5 (18,1; 34,3) пг/мл, $P<0,001$), остеокальцина (13,8 (9,3; 18,2) против 21,2 (15,4; 23,8) нг/мл, $P<0,001$ и 12,3 (8,8; 16,9) против 18,3 (15,2; 20,3) нг/мл, $P<0,001$), витамина D (27,1 (24,1; 30,0) против 29,9 (27,8; 33,3) нг/мл, $P=0,004$ и 23,8 (20,5; 27,8) против 28,0 (25,8; 29,9) нг/мл, $P<0,001$). В начале беременности признаки остеопенического синдрома имели 36,6% женщин с дефицитом массы тела и 5,7% с нормальной массой тела ($P=0,003$), накануне родов их количество увеличилось до 51,4 и 11,4% ($P<0,001$) соответственно.

Выводы. У женщин с дефицитом массы тела развитие беременности происходит на фоне нарушения костно-минерального обмена, о чём свидетельствует статистически значимое снижение показателей кальций-фосфорного обмена и маркеров костной ткани, а также наличие признаков остеопенического синдрома. Накануне родов происходит усугубление данных изменений.

In the available literature there are various data about the changes in calcium-phosphorus metabolism and bone metabolism during pregnancy. Some authors note the decrease of total calcium level in blood serum with increase in the term of pregnancy [1,2]. There are different points of view about ionized fraction of calcium during pregnancy: its decrease, no changes or gradual increase during pregnancy [1–4]. The researches have [5,6] revealed the increase in blood serum calcitriol concentration during pregnancy and insignificant changes of parathyroid hormone level (PTH). There are different data that the decrease of mineral density of bone tissue is diagnosed in 27% of examined women. Due to the fact that among the causes of bone tissue metabolism affection progress in pregnant women the body weight deficiency plays the significant role as the result of alimentary factor, in particular insufficient consumption of protein, calcium, vitamin D with food [7,8], it is actual to conduct the researches that have the aim to study bone and mineral metabolism in underweight pregnant women.

Aim

To study the state of bone-mineral metabolism in underweight pregnant women.

Materials and methods

The research included 41 pregnant women with body weight deficiency (BWD) at the beginning of pregnancy (8–10 weeks). Due to spontaneous abortions and premature delivery the repeated laboratory tests before delivery (36–38 weeks) were held for 37 women. Also 35 pregnant women with normal body weight (NBW) were examined.

The body weight deficiency was defined according to WHO recommendations (1997) on body weight index.

To find out the total calcium in blood serum the following methods were used: the colorimetric method, nonorganic phosphor – spectrophotometric, parathyroid hormone (PTH), osteocalcin and vitamin D (25(OH)D) total – immunochemical with electrochemiluminescent detection (ECLIA) with usage of test-system Roche Diagnostics (Switzerland) on Cobas analyzer 6000 (with 501 module) of Roche Diagnostics (Switzerland).

The examination of bone tissue mineral density was carried out with the usage of ultrasound densitometric apparatus Omnisense 7000. According to recommendations of World Health Organization the examination of bone tissue state was made on T-criterion which reflected the deviation from peak values of bone tissue mineral density in young healthy women.

The processing of statistical information data was carried out with the usage of software SPSS Statistics 17.0. As the majority of variables didn't correspond to normal distribution, they were represented by median (Me) and interquartile range – 25 and 75 percentile (25; 75%). The comparison of quantitative data of two independent groups was made with the help of Mann-Whitney U test. Comparison of quantitative data of two associated groups was carried out with the help of nonparametric Wilcoxon signed rank test at the beginning of pregnancy and before labor. 95% confidence interval (CI) using Wilson's method was defined to the frequency. Spearman's rank correlation coefficient (r_s) was calculated to define strength and direction of interconnection between variables and as well as 95% CI. The comparison of quantitative features was done with the help of two-sided Fisher's exact test.

Results and discussion

With the increase of pregnancy term the decrease of total calcium level was marked both in women with BWD (from 2.25 (2.21; 2.32) to 2.20 (2.07; 2.30) mmol/l; $Z=-4.3$, $P<0.001$) and in women who had NBW (from 2.34 (2.26; 2.41) to 2.27 (2.23; 2.35) mmol/l; $Z=-2.7$, $P=0.007$). At the same time in pregnant women with BWD the concentration of total calcium was considerably lower comparing with NBW women both at the beginning of pregnancy ($U=400$, $Z=-3.3$, $P=0.001$) and before delivery ($U=389$, $Z=-2.9$, $P=0.003$) (Fig. 1).

The referential ranges of calcium, phosphorus and bone tissue markers given by the laboratory do not consider the condition of pregnancy. It is stated that ranges of total calcium were less than referential at the beginning of pregnancy in 8 women out of 41 women with BWD (19.5%; 95% CI: 10.2–34.0%) and in 1 out of 35 with NBW (2.9%; 95% CI: 0.6–13.2%), the statistical significance between indexes was noted ($P=0.033$), before delivery the amount of these

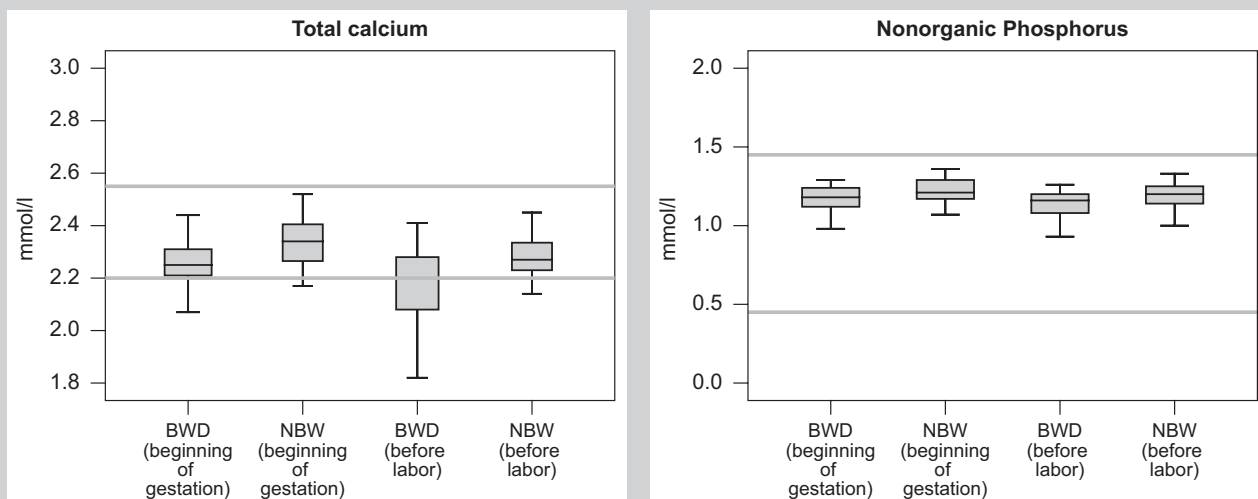


Fig.1. Content of calcium-phosphorus metabolism indexes. Horizontal lines – referential ranges.

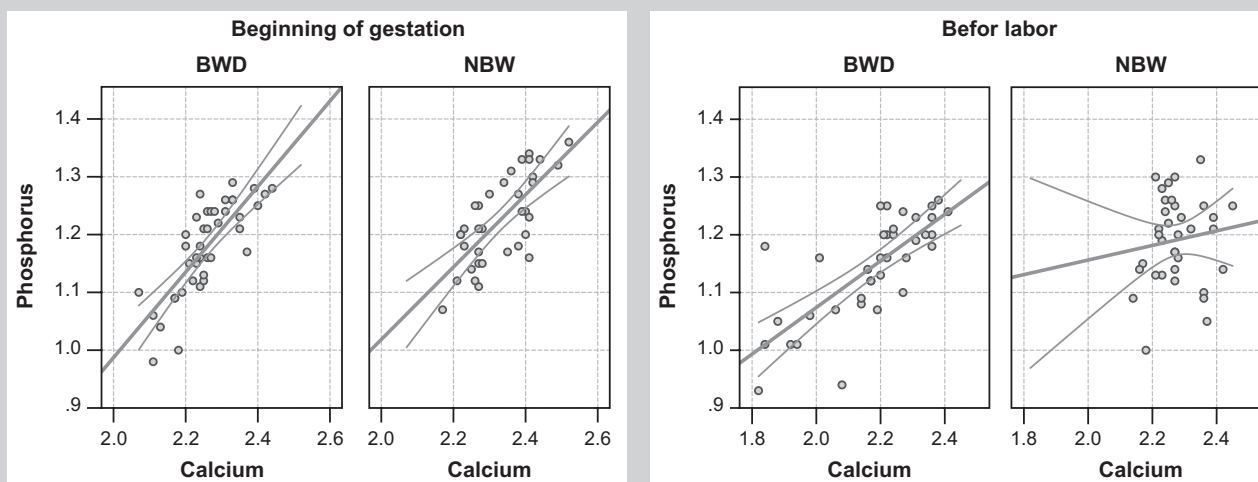


Fig. 2. Correlation interconnection between concentration of total calcium and nonorganic phosphorus.

women increased up to 16 out of 37 (43.2%; 95% CI: 28.7–59.1%) and 4 out of 35 (11.4%; 95% CI: 4.6–25.5%) ($P=0.004$) (Fig. 1).

Phosphorus metabolism in organism is closely connected with calcium metabolism, that is illustrated by strong direct correlation dependence between levels of total calcium and nonorganic phosphorus in BWD women at the beginning of pregnancy $r_s=0.81$ (95% CI: 0.69–0.89), $P<0.001$; in NBW $r_s=0.69$ (95% CI: 0.43–0.84), $P<0.001$, before delivery in BWD $r_s=0.79$ (95% CI: 0.66–0.88), $P<0.001$; with NBW $r_s=0.73$ (95% CI: 0.49–0.87), $P<0.001$) (Fig. 2).

Whereas studying of nonorganic phosphorus content in blood serum revealed that despite the body weight its concentration in the pregnant women was within norm. At the same time the decrease in its level was noted before delivery (BWD from 1.18 (1.12; 1.24) up to 1.16 (1.08; 1.21) mmol/l; $Z=-3.1$, $P=0.002$; NBW from 1.21 (1.17; 1.29) to 1.20 (1.14; 1.25) mmol/l; $Z=-3.2$, $P=0.001$). Also there was stated statistically considerable decrease of indexes in BWD women in comparison with NBW women (at the beginning

of pregnancy – $U=502$, $Z=-2.3$, $P=0.024$; before delivery – $U=451$, $Z=-2.2$, $P=0.027$), but this difference was less expressed than in ranges of total calcium (Fig. 1).

For detailed analysis of bone and mineral metabolism the calcium-regulating hormone – PTH was studied. Comparing the quantity of PTH at the beginning of pregnancy in BWD women its considerable reduction was noted, in comparison with the NBW pregnant women (respectively 19.4 (14.9; 28.9) against 34.5 (30.8; 38.6) pg/ml; $U=219$, $Z=-5.2$, $P<0.001$). With the gestation term increase the level of PTH statistically considerable decreased both in BWD ($Z=-5.3$, $P<0.001$) and with NBW ($Z=-4.1$, $P<0.001$), but in the case of BWD it was lower (respectively 14.8 (13.5; 24.4) against 30.5 (18.1; 34.3) pg/ml; $U=233$, $Z=-4.7$, $P<0.001$). As it has been mentioned earlier there were no referential ranges for the pregnant, already at the beginning of the pregnancy in 11 women out of 41 with BWD (25.8%; 95% CI: 15.7–41.9%) the level of PTH was lower than normal standards, whereas in NBW woman it wasn't gone beyond the standards. During pregnancy the concentration of PTH

decreased and before delivery it was lower than standard already in half of the pregnant with BWD (19 out of 37 (51.4%; 95% CI: 35.9–66.6%) and even in two women with NBW (5.7%; 95% CI: 1.6–18.6%) the indexes had significant difference ($P < 0.001$) (Fig. 3).

The measurement of osteocalcin concentration showed the decrease of osteoblastic activity in the BWD pregnant women in comparison with the NBW pregnant women (at the beginning of pregnancy 13.8 (9.3; 18.2) against 21.2 (15.4; 23.8) ng/ml; $U = 314$, $Z = -4.2$, $P < 0.001$; before delivery – 12.3 (8.8; 16.9) against 18.3 (15.2; 20.3) ng/ml; $U = 291$, $Z = -4.0$, $P < 0.001$). The considerable decrease of indexes before delivery is traced visually on the median ranges, but as Wilcoxon test indicates its decrease in BWD women was more considerable ($Z = -3.6$, $P < 0.001$) than in NBW ($Z = -3.1$, $P = 0.002$). The correlation of ranges with referential ranges detected that nearly in every third BWD woman (15 out of 41 (36.6%; 95% CI: 23.6–51.9%) at the beginning of pregnancy they were lower than standards and before delivery their frequency was 15 out of 37 (40.5%; 95% CI: 23.6–51.9%) (Fig. 3).

At the study of vitamin D status during pregnancy it was found out that its changes in BWD women were the same. At the beginning of pregnancy its rates were 27.1 (24.1; 30.0) ng/ml and at the end of pregnancy they decreased up to 23.8 (20.5; 27.8) ng/ml ($Z = -4.7$, $P < 0.001$) and the same was typical for women with NBW – 29.9 (27.8; 33.3) and 28.0 (25.8; 29.9) ng/ml ($Z = -2.3$, $P = 0.024$) respectively. Although the difference between the indexes in both groups had statistical ranges in BWD women it corresponded to the maximal ranges. In BWD pregnant women lower levels of vitamin D were found, which got verse with the pregnancy term increase, that is seen from the difference between groups BWD and NBW at the beginning of pregnancy ($U = 439$, $Z = -2.9$, $P = 0.004$) and before delivery ($U = 310$, $Z = -3.8$, $P < 0.001$). The positive thing is that the level of vitamin D wasn't gone beyond the referential standards in patients.

During the complex examination by ultrasound densitometer, there were examined 41 women with BWD at the beginning of pregnancy and the osteopenic syndrome was registered in 15 women with NBW (36.6%; 95% CI: 23.6–51.9%) and in 2 out of 35 (5.7%; 95% CI: 1.6–18.6%) that was considerably less than in BWD ($P = 0.002$). Before delivery the number of pregnant women with osteopenic syndrome increased among BWD women from 19 up to 37 (51.4%; 95% CI: 35.9–66.6%) and among NBW women up to 4 (11.4%; 95% CI: 4.5–26.0%); statistically considerable difference between groups ($P < 0.001$) was stated. The relative risk of osteopenia in the BWD pregnant was 4.5 times higher (95% CI: 1.7–11.9) in comparison with the NBW pregnant woman.

Conclusions

1. The course of pregnancy in women with BWD is accompanied by the affection of bone-mineral metabolism, that is seen from statistically considerable decrease in total calcium, phosphorus, PTH, osteocalcin and vitamin D indexes.

2. At the beginning of pregnancy 36.6% of women with BWD have signs of osteopenic syndrome which is statistically much oftener than in women with NBW (5.7%, $P = 0.003$). Before delivery the number of the pregnant wom-

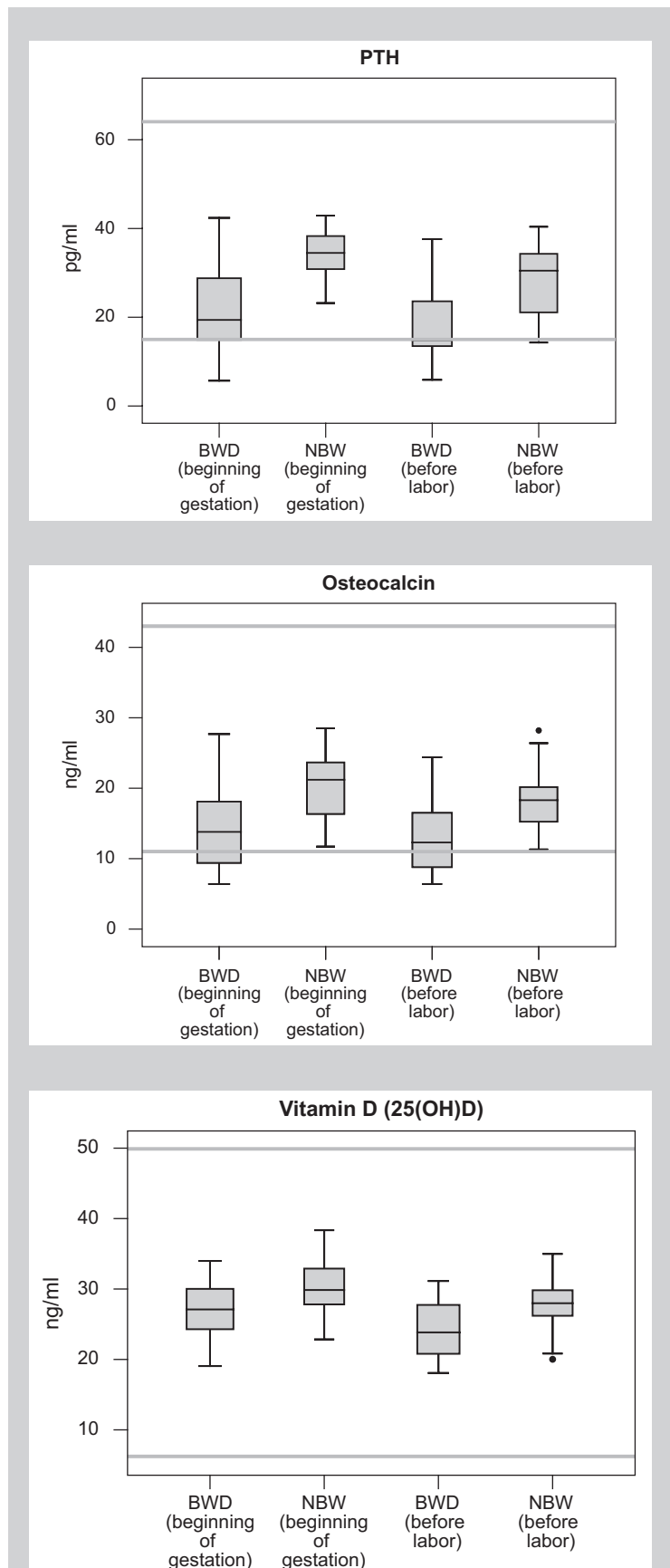


Fig. 3. Content of bone tissue markers in women with BWD and NBW. Horizontal lines – referential ranges.

en with osteopenic syndrome increases up to 51.4 % among women with BWD and up to 11.4 % among women with NBW ($P < 0.001$), the relative risk of osteopenia in the BWD pregnant women is 4.5 times higher (95 % CI: 1.7–11.9).

Prospects for future scientific research. Due to the fact that dismetabolism in BWD affects the bone-mineral metabolism and leads to obstetric complications, it is necessary to start their prevention from renewal of bone tissue function and its protection. The understanding of this problem determines that the osteoprotective medicines inclusion into treatment and preventive measures is highly necessary.

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Відомості про автора:

Шелестова Л. П., д-р мед. наук, доцент каф. акушерства та гінекології, Донецький національний медичний університет, м. Лиман, Україна.

Сведения об авторе:

Шелестова Л. П., д-р мед. наук, доцент каф. акушерства и гинекологии, Донецкий национальный медицинский университет, г. Лиман, Украина.

Information about author:

Shelestova L. P., MD, PhD, Associate Professor, Department of Obstetrics and Gynecology, Donetsk National Medical University, Lyman, Ukraine.

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