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CALCANEAL MINERAL DENSITY IN CHILDREN ATHLETES AND TAKE-OFF LEG

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It is well-known that physical activity has an anabolic effect on the bone tissue. To examine the influence of the take-off lower limb to the bone density we studied a group of prepubertal boys and girls at the initial phase of their peak bone mass acquisition. A sample consisted of 60 subjects ie., 32 soccer players (boys, 10.7±0.5 years old) and 28 swimmers (15 girls and 13 boys, 10.8±0.8 years old), who had performed at least one year of high-level sport training (10-15 hours per week for soccer players, 8-12 hours per week for swimmers). The sample was divided into two groups: the first consisted of 40 subjects, with the left take-off leg, while the second consisted of 20 subjects, with the right take-off leg. The bone mineral density (BMD) measurements of the left and the right calcaneus were performed using ultrasound densitometer "Sahara" (Hologic, Inc., MA, USA). There were no significant differences between the groups in regard to BUA and SOS of both the left and the right take-off lower legs. Mean BUA of the take-off left leg and the take-off right leg were different, but not significantly (p>0.05). Likewise, mean SOS of the take-off left leg and the take-off right leg were different, but it was not significant (p>0.05). The results do not indicate that the take-off lower limb has an influence on calcaneal bone mineral density*. Acta Medica Medianae 2010;49(2):25-28.*

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Introduction

Effect of physical exercise on the skeleton and muscles is the subject of numerous scientific studies (1-4). Scopes that have remained relatively under-investigated include genetic and environmental factors (5), as well as reaction of the bone tissue to the functional load. The bone tissue always responds to the load: if it is present, and even if it is absent. In case when load is in the form of body weight, muscle contraction, external load, the bone reacts in the sense of the bone tissue formation. In the absence of the load, the bone also responds, but in this case, by the loss of the bone tissue (6). Physical activity in children stimulates the metabolism, restores the bone tissue, and maintains the body mass and the density of the tissue (7-9). If the size of the load exceeds the physiological levels in children, the bone hypertrophy appears. Effect of exercise is not conceived in children of secondary school and in younger individuals (10,11). This influence is usually expressed as a local hypertrophy of the muscle and the bone of the limb, which was subjected to load (12-14).

The aim of this study was to determine whether there is an impact of the take- off leg on the bone mineral density (BMD) of calcaneus in children who are actively involved in the sport activities.

Examinees and methods

The sample can be defined as the intentional, since the subjects were selected according to the type of the physical activity and it consisted of 60 subjects, ie. 32 soccer players (boys) and 28 swimmers (15 girls and 13 boys), who were actively engaged in the chosen sport for at least one year (soccer players 10-15 hours per week and swimmers 8-12 hours per week).

The group of soccer players consisted of 10 subjects, with the decimal stature of 10 years, 20 subjects with the decimal stature of 11 years and two subjects with the decimal stature of 12 years (10.7±0.5 years, Mean±St.dev.).

The group of swimmers consisted of 11 subjects with the decimal stature of 10 years, 8 subjects with the decimal stature of 11 years and 9 subjects with the decimal stature of 12 years (10.8±0.8 years, Mean±St.dev.).

Hence, the sample was intentional in relation to the stature, because in that period of life, sexual hormones do not have an important role in the formation of the bone tissue. The sample was divided into the group which involved

40 subjects, with the left take-off leg, and the group, which consisted of 20 subjects, with the right take-off leg. The main criteria for the inclusion of subjects in the study were: 1) age, 2) gender (male and female), 3) sporting experience (at least one year of activity, ie. training) and 4) absence of diseases and conditions with possible secondary influence on the bone metabolism. The examined scope was presented by four variables for the assessment in the skeletal status, ie. the bone density: 1) weakening of the audio signal – the left leg (broadband ultrasound attenuation - Bua, expressed in dB/MHz), 2) Bua – the right leg (dB/MHz), 3) the speed of sound signal – the left leg (Speed of sound - Sos, expressed in m/s), 4) Sos – the right leg (m/s). In order to determine the difference in the density of the left and the right calcaneus, the multivariate analysis of variance (MANOVA) was in use. To determine the difference in the Sos between the take-off and the non-take-off leg, as well as between the soccer players and swimmers, the analysis of variance (ANOVA) was in use. This study has also provided information about the structural integrity of the bone. The research was carried out by using a clinical sonometer "Sahara" (Hologic, Inc., MA 02154, USA), that uses non-ionizing ultrasound to assess bone mineral density. The choice of ultra-sonographic densitometry in determination of bone mineral density was not random, because the method is non-invasive, which is imperative when the subjects are children, and apriori because of the children, the X-ray methods for determining the BMD, are forbidden in many countries. Also, the results obtained by this method, sufficiently correlate with other methods, and the other localizations. In addition, this is the only method that gives information about the structure and density, which is more important for the risk of fracture, compared to the data on density, only.

Results

Central and dispersion parameters of anthropometric and body composition variables in groups of soccer players and swimmers are shown in Tables 1 and 2.

Since the confidence intervals, according to the results of descriptive statistics (Tables 3 and 4), for all the bone density characteristics of the take-off legs (the left and the right) overlap, as well as the confidence intervals of the non-take-off legs (the left and the right), it can be expected that in relation to all variables of the bone density these two groups are similar.

Based on the results of MANOVA (Table 5), the conclusion is that for all or some characteristics in the bone density of the left take-off leg and the right take-off leg, there is no significant difference between the groups ($p>0.100$).

Table 1. Central and dispersion parameters of anthropometric and composition variables in the group of soccer players

N = 32	$\bar{X}$	Sd	min	max	Cv	interval of confidence	
TV	145.58	6.76	129.30	157.50	4.64	143.14	147.03
TM	39.13	6.66	28.20	54.50	17.02	36.73	40.56
BMI	18.36	2.11	15.80	24.22	11.48	17.60	18.81

Table 2. Central and dispersion parameters of anthropometric and body composition variables in the group of swimmers

N = 28	$\bar{X}$	Sd	min	max	Cv	interval of confidence	
TV	151.31	8.45	135.20	173.60	5.59	148.04	153.14
TM	42.71	8.25	28.40	62.80	19.31	39.52	44.50
BMI	18.57	2.69	14.91	24.14	14.47	17.53	19.15

Table 3. Central and dispersion parameters of bone density in the group of subjects with the left take-off leg (n=40)

n = 40	$\bar{X}$	Sd	min	max	Cv	interval of confidence	
BuaO	54.05	13.25	34.20	104.10	24.52	49.81	57.52
SosO	1577.20	25.05	1523.10	1649.70	1.59	1569.18	1583.74
BuaN	55.98	15.63	34.00	108.40	27.91	50.98	60.06
SosN	1578.10	28.10	1524.00	1655.70	1.78	1569.11	1585.44

Table 4. Central and dispersion parameters of bone density in the group of subjects with the right take-off leg (n=20)

n = 20	$\bar{X}$	Sd	min	max	Cv	interval of confidence	
BuaO	53.94	12.01	31.00	78.80	22.27	48.32	57.19
SosO	1581.69	37.91	1526.00	1675.30	2.40	1563.94	1591.93
BuaN	56.97	15.62	31.40	94.20	27.41	49.66	61.19
SosN	1580.24	35.13	1536.30	1671.70	2.22	1563.79	1589.73

Table 5. Multivariate significance of differences between bone density of the left take-off leg and the right take-off leg

	n	F	p
MANOVA	4	0.206	0.934

Table 6. Significance of differences in bone density between the left take-off leg and the right take-off leg

	F	p
BuaO	0.001	0.975
SosO	0.301	0.586
BuaN	0.054	0.817
SosN	0.065	0.799

Table 7. The profile analysis of the left take-off leg and the right take-off leg in regard to the bone density characteristic Sos

	F	p
MANOVA	0.2077	0.8128
Parallelism	0.2308	0.6327
Equality of results	0.0026	0.9598

Table 8. Significance of differences in bone density characteristic Sos in regard to the left take-off leg and the right non-take-off leg and in regard to physical activity

	F	p
take off leg - non-take-off leg	0.080	0.778
soccer players- swimmers	6.020	0.000

Table 9. Significance of differences between the right take-off leg and the left non- take-off leg in regard to Sos between soccer players and swimmers

	F	p
take off leg - non-take-off leg	0.290	0.596
soccer players- swimmers	35.833	0.000

Based on the results of ANOVA (Table 6), and with regard to the fact that, for all the characteristics of the bone density of the left take-off leg or the right take-off leg, p>0.100, the conclusion is that there are no significant differences between the groups, ie. that bone density characteristics of the groups are similar, regardless of the take-off leg

Based on the results of MANOVA procedure (Table 7), the value of p=0.81, indicates that the groups do not differ in regard to the characteristic speed of sound (Sos). The significance of the analysis of the parallelism (p=0.63) indicates that the groups do not differ in regard to the characteristic Sos, in respect to the take-off leg and the non-take-off leg. It means that the relationship in the bone density between the take-off leg and the non-take-off leg is the same, regardless whether the take-off leg is the left or the right one. The significance of the analysis of equality of results (p=0.95) indicates that all the results, ie. values of the bone density characteristics of the take-off leg (SosO) and the non-take-off leg (SosN) are equal.

Based on the results of ANOVA (Table 8), the conclusion is that in 40 subjects with the left take-off leg in regard to the bone density characteristic Sos of the left take-off and the right non-take-off leg, there is no significant difference (p>0.100). However, there is a statistically significant difference in the bone density characteristic Sos between the soccer players and the swimmers (p <0.050).

Based on the results of ANOVA (Table 9), the conclusion is that in 20 subjects with the right take-off leg and the left non-take-off leg in regard to the bone density characteristic Sos, there is no significant difference (p>0.100). However, there is a statistically significant difference in the bone density characteristic Sos between soccer players and swimmers with the right take-off leg (p<0.050). The significant differences in Tables 8 and 9 may be caused by type of physical activity (soccer, swimming) and sport probation (duration of sport practice).

Discussion

The results of this research are in keeping with the results of the research conducted by Yung et al. (15). According to the mentioned authors, in the study which aimed to determine the calcaneal BMD status in 55 subjects of the student population (15 soccer players, 15 swimmers, 10 dancers and 15 non-athletes), statistically significant differences were not found in the values of variables of Sos and Bua, in regard to the take-off and the non-take-off leg. However, when subjects were compared in relation to the type of exercise, the soccer players and dancers had significantly higher values of the bone density characteristics Sos and Bua, compared to the swimmers and the non athletes (p<0.05). The results of the current research are not in keeping with the results of the research conducted by Sone et al., in regard to the BMD of the take-off and the non-take-off leg (16). Namely, the mentioned authors have found in 37 athletes the higher BMD values in the non-dominant compared to the dominant legs. Also, the authors Meszaros et al. (2006), in the study which included 106 women aged 49±0.9 years (Mean±St.dev.) and 44 males aged 46.8±1.7 years (Mean±St.dev.), found that the values of calcaneal BMD and QUS characteristics were higher for the non-dominant compared to the dominant legs (17). The author Tan (18) found that the values of the neuromuscular parameters of the soleus muscle were better on the left side of the body in the right-handed subjects, and on the right side of the body in the left-handed subjects. According to the Frost's Mehanostat theory (from the sixties of the last century), the muscles with better inervation cause greater bone strain ie., increased bone formation (19).

Conclusion

There is no significant difference in the BMD between the groups, in regard to the take-off and the non-take-off leg, ie. the groups are similar regardless of the take-off leg. The characteristics of the BMD, ie., the speed of sound of the take-off leg (SosO) and the speed of sound of the non-take-off leg (SosN) contribute to the discrimination between the soccer players and swimmers, but the difference is latent. In general, there is no significant difference in the BMD between the left take-off leg and the right take-off leg. The same goes for the non-take-off legs.

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MINERALNI DENZITET KALKANEUSA KOD DECE SPORTISTA I ODSKOČNA NOGA

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Fizička aktivnost ima pozitivan uticaj na koštano tkivo. U cilju utvrđivanja uticaja odskočne noge na koštani mineralni sadržaj izmereni su dečaci i devojčice prepubertetskog uzrasta koji se aktivno bave sportom, a nalaze se u početnoj fazi dostizanja maksimalne mase kosti. Uzorak od 60 ispitanika sastojao se od 32 fudbalera (dečaka, 10.7±0.5 godina, Mean±St.dev.) i 28 plivača (15 devojčica i 13 dečaka, 10.8±0.8 godina, Mean±St.dev.), koji se aktivno bave izabranim sportom u trajanju od najmanje godinu dana (fudbaleri 10-15, a plivači 8-12 sati nedeljno). Uzorak ispitanika je podeljen na grupu, koju je sačinjavalo 40 ispitanika, sa odskočnom levom nogom i grupu koju je sačinjavalo 20 ispitanika, sa odskočnom desnom nogom. Koštano mineralna gustina (BMD) leve i desne petne kosti procenjena je pomoću ultrasonografskog denzitometra "Sahara" (Hologic, Inc., MA, USA). Nisu utvrđene značajne razlike između grupa u odnosu na varijable denziteta kosti 1) briznu zvučnog signala (speed of sound – SOS) i 2) slabljenje zvučnog signala (broadband ultrasound attenuation – BUA). Srednja vrednost varijable SOS, odskočne leve i odskočne desne noge se razlikuju, ali ta razlika nije značajna (p>0.05). Srednja vrednost varijable BUA, odskočne leve i odskočne desne noge se razlikuju, ali ta razlika nije značajna (p>0.05). Rezultati istraživanja ne ukazuju na to da odskočna noga utiče na koštani mineralni denzitet petne kosti. Acta *Medica Medianae 2010;49(2):25-28.*

***Ključne reči**: gustina kosti, ultrazvuk, sportista, deca*