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The Effects of the Level of Physical Activity on Calcaneal Ultrasound Measurements: Bone Properties of Medical and Physical Education Students

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A B S T R A C T

The aim of the study was to compare bone properties of two groups of students which strongly differ in the level of their everyday physical activity; the School of Medicine (SM) students and the Faculty of Physical Education (FPE) students, University of Zagreb. Quantitative ultrasound parameters – broadband ultrasound attenuation (BUA) and speed of sound (SOS) were measured. Quantitative ultrasound index (QUI) and estimated bone mineral density (BMD) were calculated by the device software. The final study sample consisted of 165 students from SM (94 males and 71 females) and 215 students from the FPE (164 males, 51 females). Sixty eight percent of FPE students and 21% of SM students reported a high level of everyday physical activity ($P<0.001$). All ultrasound parameters were significantly higher in FPE students than in SM students (at the $P<0.001$ level). The multiple regression model of the QUI confirmed that the school students attended was the single significant predictor variable for both genders. Our data indirectly showed the beneficial role of physical activity on bone properties.

Key words: *quantitative ultrasound, bone, physical activity, students, Croatia*

Introduction

In the first decades of life, genetic factors play the major role in the bone mass gain[1,2], but different lifestyle behaviors also have a significant influence on bone. Physical activity is an example of lifestyle behavior described as an important factor leading to the bone mass accretion in youth, and the reduction of bone loss later in life. Several studies assessed the relationship between different patterns of physical activity and bone properties, estimated by dual-energy x-ray absorptiometry (DXA) and quantitative ultrasound (QUS)[3–7]. However, the main problem of these studies was inaccurate assessment and difficulties in comparing different levels of physical activity, i.e. frequency, intensity and duration.

A recent study showed that the peak of the bone mass gain is achieved in early twenties[8], emphasizing this period as the most appropriate to estimate the influence of physical activity on the bone.

Although DXA is a widely used method for measuring bone density (BMD), clinical assessment of bone properties has been greatly improved by the use of QUS because of its simplicity, low cost and absence of ionising radiation. It has been shown that QUS indices highly correlate to the BMD measured by DXA in adolescents and adults[9,10]. Moreover, QUS parameters, broadband ultrasound attenuation (BUA), speed of sound (SOS) and quantitative ultrasound index (QUI) represent bone structure and elasticity[11]. Furthermore, numerous studies have shown that QUS parameters have the ability to identify males and females at risk of fragility fracture[12–14]. Some studies revealed that the heel BUA and SOS have been higher in athletes than in non-athletic controls[15,16].

The purpose of the present study was to evaluate the influence of physical activity on bone properties by com-

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paring calcaneal QUS parameters between students from the School of Medicine (SM) and the Faculty of Physical Education (FPE), University of Zagreb, Croatia. We hypothesized that the active sports participation in students from the FPE would be associated with higher QUS values, compared to SM students.

Subjects and methods

Study population

We performed the study among 380 students from the University of Zagreb. A total of 165 (94 males and 71 females) were from the SM and 215 (164 males, 51 females) were from the FPE. The participants were recruited based on the official students' census of each school during the 2004/2005 academic year. Only those who signed the informed consent were included in the study. Forty-four students from SM and none from FPE withdrew the consent. Data on smoking habits, alcohol consumption, history of fracture, height and weight were collected with a survey. The level of physical activity was self-reported on a scale from 1 to 5.

Table 1 shows anthropometric characteristics of the study population. FPE students were about 2 years younger than students from SM (P <0.001). FPE females had a significantly higher body weight (P <0.005) and body mass index (P <0.001) than females from SM. One SM female (1.4%) and 7 FPE females (13.7%) had irregular menstrual cycles. With regard to QUS parameters, no differences were observed between eumenorrhoeic and oligomenorrhoeic female participants. The study was approved by the Local Ethics Committee.

Bone measurements

QUS of the left heel was performed using the Sahara sonometer (Hologic). A well-trained technician performed all ultrasound measurements, using the same device during the entire study. The machine was calibrated on a daily basis, using a calibrating phantom. BUA and SOS of the left calcaneus were measured for each subject. QUI and estimated BMD were calculated by the device software. The right heel was used if there was a history of fracture, or other relevant disease or disorder of the left foot. Paired measurements were performed in twelve subjects, with foot reposition between each scan. Coefficients of variation were 3.1% for BUA, 0.2 % for SOS, 1.4% for QUI and 1.5% for estimated BMD.

Statistical analysis

QUS measurements were entered into an individual sheet, along with the survey data. Initial bi-variate analysis was performed with the Student t-test, after checking the normal data distribution using the Kolmogorov-Smirnov test. Physical activity was scored on an ordinal scale, and analysed with the Chi-square test. Multivariate analysis of the QUI was separately performed for two genders, using a multiple linear regression model, with age, body mass index, and the school attended by the students as the predictor variables. Analysis was performed with the SPSS, version 12.0.0 (SPSS Inc., Chicago, USA), with statistical significance set at P<0.05.

Results

The final sample consisted of 165 students from the SM and 215 students from the FPE. Gender distribution was significantly different between the two schools, with 94 males and 71 females from SM, and 164 males and 51 females from FPE (χ^2_1=16.0, P<0.001). Investigation of the self-reported level of physical exercise revealed high FPE predominance, with 113 (69.3%) FPE and 23 (24.2%) SM men (χ^2_1=49.0, P <0.001) and 33 (64.7%) FPE and 12 (16.9%) SM women (χ^2_1=29.1, P <0.001) reporting a high level of everyday physical activity. No difference was observed between the two schools in smoking habits for men (χ^2_2=2.7, P =0.266) or women (χ^2_2=0.6, P =0.432), previous fracture history for men (χ^2_1=0.4, P =0.523) or women (χ^2_1=0.1, P =0.737), or alcohol consumption for men (χ^2_1=0.2, P =0.634) or women (χ^2_1=1.1, P=0.285).

Comparison of the bone parameters revealed significant differences between the two schools in both genders (Table 2). The multiple regression model of the QUI confirmed that the students' school was the most important predictor variable for both men (adjusted R^2=0.10), and women (adjusted R^2=0.20), while age and body mass index (BMI) did not appear to be significant predictor variables (Table 3).

TABLE 1
ANTHROPOMETRIC CHARACTERISTICS OF THE STUDY POPULATION

Parameter	Men			Women		
	SM	FPE	Statistics (t, P)	SM	FPE	Statistics (t, P)
Age (years)	25.3±2.1	23.3±1.9	7.8; <0.001	26.3±2.1	24.4±1.7	5.2; <0.001
Weight (kg)	80.6±12.2	78.7±12.9	1.9; NS	59.4±6.4	63.2±7.3	–2.9; <0.005
Height (cm)	181.7±19.9	178.7±16.9	1.2; NS	168.6±5.6	170.2±6.7	–1.4; NS
BMI	24.2±2.4	25.4±17.1	–0.7; NS	20.9±2.2	21.8±1.9	–2.3; <0.001

SM – School of Medicine, FPE – Faculty of Physical Education

TABLE 2
COMPARISON OF THE QUS INDICES BETWEEN STUDENTS FROM THE SM AND THE FPE

Parameter	Men			Women		
	SM	FPE	Statistics (t, *P*)	SM	FPE	Statistics (t, *P*)
BMD (g/cm^2)	0.57±0.12	0.65±0.11	–5.32; <0.001	0.53±0.13	0.67±0.16	–5.51; <0.001
QUI	102.7±18.9	115.0±17.6	–5.28; <0.001	95.3±20.1	117.7±24.8	–5.48; <0.001
SOS (m/s)	1526.5±28.6	1581.6±29.4	–2.33; 0.022	1549.0±33.1	1591.2±52.9	–5.41; <0.001
BUA (db/MHz)	82.0±20.3	91.6±15.7	–4.22; <0.001	76.6±17.2	92.6±22.8	–4.40; <0.001

SM – School of Medicine, FPE – Faculty of Physical Education

TABLE 3
MULTIPLE LINEAR REGRESSION MODEL OF THE QUI AMONG THE MALE AND FEMALE STUDENTS FROM THE SM AND THE FPE

	B	Std. Error	T	P
Men				
Faculty of education	0.101	–0.09	4.31	<0.001
Age	–0.007	0.01	–1.28	0.202
Body mass index	0.101	0.023	0.32	0.748
Women				
Faculty of education	0.186	0.04	4.20	<0.001
Age	–0.007	0.01	–0.61	0.523
Body mass index	0.011	0.01	1.15	0.255

SM – School of Medicine, FPE – Faculty of Physical Education

Discussion

This study supports the hypothesis that regular involvement in physical exercise has beneficial effect on bone properties. Our study differs from other studies in the field[4,15,17] because it has examined two student groups, which strongly differ in the level of physical activity probably due to differences in the curriculum. The curriculum in SM includes lectures and seminars with minimal physical activity, combined with long study periods. On the other hand, the curriculum of FPE includes everyday involvement in different sports, resulting in high intensity of daily exercises. Our results showed increased BUA, SOS and QUI values among FPE students, present in both genders. However, Neville et al. demonstrated association of sports activity with peak bone mass in men but not in women[6]. They assumed that women did not participate in high peak strain activity frequently enough to increase their bone density.

Compared to the results of the normative data of calcaneus ultrasound in Croatian males[18], FPE male students had higher SOS, BUA and QUI values than the general population of the same age. In contrast, SM male students had lower ultrasound values than the general population, most prominent in SOS. The same pattern was found among FPE and SM female students and the Croatian general female population (data not published).

Some studies showed that the physical activity affected BUA level rather than SOS and QUI[19,20,] while other studies observed the most pronounced effect on SOS and QUI[17]. Our study demonstrated the equal influence of physical activity on all QUS parameters. However, our data are limited by the fact that the study populations consisted of two highly different study groups regarding their physical activity levels.

Other lifestyle factors apart from physical activity have also been found as important determinants of bone status[17,21]. However, we did not find a significant association of QUI with age or BMI by using the multiple linear regression.

Sixty-eight percent of FPE students compared to 21% SM students reported a high level of everyday physical activity. However, the accuracy of self-reported physical activity may be questionable, due to possibly different perceptions of the level of physical activity among the study groups. SM students might have the tendency to overestimate the level of their physical activity, contrary to FPE students who might underestimate it. Therefore, we did not include physical activity as a parameter in our regression model.

Our study was not designed to analyse the correlation of physical activity with lumbar spine and femoral neck BMD, which still have the best predictive value of fracture risk. However, calcaneal bone seems to be an appropriate site to estimate the level of bone response to physical activity. Some studies revealed a greater effect of physical activity on the heel than lumbar spine or femoral neck[17,22]. Blanchet et al. observed significant association between leisure physical activity level and calcaneal BUA, SOS and QUI but not with lumbar spine or femoral neck BMD[17].

A relatively high percentage of SM students refused to participate in calcaneal measurement compared to FPE students which is another important issue of the study. FPE students probably felt more compliant to present their healthy lifestyle in terms of physical activity. On the other hand, SM students may have felt uncomfortable and inferior in that way thus avoiding the testing in larger numbers percent than their FPE colleagues.

In conclusion, this study confirmed that the students' school was the most important predictor variable, indi-

cating that a lifestyle associated with an increased level of physical activity had a protective effect on the bone. With a large proportion of the Croatian population experiencing vertebral fractures[23], we hope that our findings will have further implications on the Croatian health prevention and education programs in terms of the importance of physical activity.

REFERENCES

1. KELLY PJ, EISMAN JA, SAMBROOK PN, Osteopor Int, 1 (1991) 56. — 2. SLEMENDA CW, CHRISTIAN JC, WILLIAMS CJ, NORTON JA, JOHNSTON CC JR, J Bone Miner Res, 6 (1991) 561. — 3. YUNG PS, LAI YM, TUNG PJ, TSUI HT, WONG CK, HUNG VW, QIN L, Br J Sports Med, 39 (2005) 547. — 4. WETTER CA, ECONOMOS CD, Osteoporos Int, 15 (2004) 799. — 5. LEHTONEN-VEROMAA M, MOTTONEN T, NUOTIO I, HEINONEN OJ, VIIKARI J, Calcif Tissue Int, 66 (2000) 248. — 6. NEVILLE CE, MURRAY LJ, BOREHAM CA, GALLAGHER AM, TWISK J, ROBSON PJ, SAVAGE JM, KEMPER HC, RALSTON SH, DAVEY SMITH G, Bone, 30 (2002) 792. — 7. PROCTOR DN, MELTON LJ, KHOSLA S, CROWSON CS, O'CONNOR MK, RIGGS BL, Osteoporos Int, 11 (2000) 944. — 8. TEEGARDEN D, PROULX WR, MARTIN BR, ZHAO J, MCCABE GP, LYLE RM, PEACOCK M, SLEMENDA C, JOHNSTON CC, WEAVER CM, J Bone Miner Res, 10 (1995) 711. — 9. LUM CK, WANG MC, MOORE E, WILSON DM, MARCUS R, BACHRACH LK, J Clin Densitom., 2 (1999) 403. — 10. ZERAHN B, BORGWARDT A, HOJSGARD C, Eur J Exp Musculoskel Res, 4 (1996) 154. — 11. NJEH CF, FUERST T, DIESSEL E, GENANT HK, Osteoporos Int, 12 (2001) 1. — 12. HANS D, DARGENT-MOLINA P, SCHOTT AM, SEBERT JL, CORMIER C, KOTZKI PO, DELMAS PD, POUILLES JM, BREART G, MEUNIER PJ, Lancet, 348 (1996) 511. — 13. BAUER DC, GLUER CC, GENANT HK, STONE K for the Fracture Intervention Trial Research Group, J Bone Miner Res, 10 (1995) 353. — 14. KHAW KT, REEVE J, LUBEN R, BINGHAM S, WELCH A, WAREHAM N, OAKES S, DAY N, Lancet, 363 (2004) 197. — 15. HOSHINO H, KUSHIDA K, YAMAZAKI K, TAKAHASHI M, OGIHARA H, NAITOH K, TOYOYAMA O, DOI S, TAMAI H, INOUE T, J Bone Miner Res, 11 (1996) 412. — 16. BRAHM H., STROM H, PIEHL-AULIN P, MALLMIN H, LJUNGHALL S, Calcif Tissue Int, 61 (1997) 448. — 17. BLANCHET C, GIGUERE Y, PRUD'HOMME D, TURCOT-LEMAY L, DUMONT M, LEDUC G, COTE S, LAFLAMME N, ROUSSEAU F, DODIN S, Calcif Tissue Int, 73 (2003) 339. — 18. KASTELAN D, KUJUNDZIC TILJAK M, KRALJEVIC I, KARDUM I, GILJEVIC Z, KORSIC M, J Endocrinol Invest, 29 (2006) 221. — 19. YANAGIMOTO Y, OSHIDA Y, SATO Y, Scand J Med Sci Sports, 10 (2000) 103. — 20. JAKES RW, KHAW K, DAY NE, BINGHAM S, WELCH A, OAKES S, LUBEN R, DALZELL N, REEVE J, WAREHAM NJ, BMJ, 322 (2001) 1. — 21. YAMAGUCHI J, TRUMAN G, CAMERON ID, Calcif Tissue Int, 66 (2000) 43. — 22. HEINONEN A, KANNUS P, SIEVANEN H, PASANEN M, OJA P, VUORI I, J Bone Miner Res, 14 (1999) 125. — 23. GRAZIO S, KORSIC M, JAJIC I, Wien Klin Wochenschr, 117 (2005) 42.

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UČINAK FIZIČKE AKTIVNOSTI NA ULTRAZVUČNE PARAMETRE PETNE KOSTI: ZNAČAJKE KOŠTANOG STATUSA U STUDENATA MEDICINSKOG FAKULTETA I STUDENATA FAKULTETA ZA FIZIČKU KULTURU

SAŽETAK

Cilj istraživanja bio je usporediti značajke koštanog statusa u dvije grupe studenata koji se bitno razlikuju u razini svoje svakodnevne fizičke aktivnosti; studenata Medicinskog fakulteta (MF) i studenata Fakulteta za fizičku kulturu (FFK), Sveučilišta u Zagrebu. Ispitanicima su izmjereni ultrazvučni parametri kosti – slabljenje ultrazvučnog vala pri prolasku kroz kost (BUA) i brzina ultrazvučnog vala pri prolasku kroz kost (SOS). Indeks kvatitativnog ultrazvuka (QUI) i procijenjena mineralna gustoća kosti (BMD) su izračunati pomoću programske podrške aparata. U istraživanje je uključeno 165 studenata MF (94 muškarca i 71 žena) i 215 studenata FFK (164 muškarca, 51 žena). U 68% studenata FFK, u odnosu na 21% studenata MF, nazočna je bila visoka razina svakodnevne fizičke aktivnosti ($P<0,001$). Svi ultrazvučni parametri petne kosti bili su značajno viši u studenata FFK u usporedbi sa studentima MF ($p<0,001$). Metoda multiple regresije pokazala je da je u oba spola fakultet koji ispitanici pohađaju nezavisni predskazatelj vrijednosti QUI. Rezultati ovog istraživanja indirektno ukazuju na povoljan učinak fizičke aktivnosti na koštani status.