International Journal of the Physical Sciences Vol. 6(16), pp. 4097-4101, 18 August, 2011
Available online at http://www.academicjournals.org/IJPS
DOI: 10.5897/IJPS11.904
ISSN 1992-1950 ©2011 Academic Journals

Full Length Research Paper

The effect of physical activity on bone mineral density

Ruchan IRI

Nigde University School of Physical Education and Sports, Nigde, (51000) / Turkey. E-mail: ruchaniri@nigde.edu.tr. Tel: 0 90 (388) 3130013/112, 0 542 4378022. Fax: 0 90 (388) 3130014.

Accepted 12 July, 2011

The purpose of this study was to find out the physical activity levels of females studying at university and to examine the relation between their physical activity levels and bone mineral densities. 63 female students who study at Nigde University participated in the study. 32 of them have low physical activity levels while 31 of them have high physical activity levels. In the study, a short form of International Physical Activity Questionnaire was used to determine the physical activity levels of the individuals. T-test in independent groups was used to find out the difference between the groups. The relation between bone mineral densities, body composition and physical activity levels was determined by Pearson correlation test. According to the data obtained in the study, a significant difference was found between the fatless body mass, physical activity levels, BMD, t-scores and z-scores of the participants while no significant difference was found in BMI, body fat rate and body fat mass values. In terms of physical activity levels, it was found out that there is a relation between those with high physical activity levels and BMD, t-scores, z-scores, and also a relation between those with low physical activity levels and fatless body mass. The results of the study have revealed that females with high physical activity levels also have high bone mineral densities, showing a direct proportion between physical activity level and bone mineral density.

Key words: Physical activity, bone mineral densities, body fat mass, body fat rate.

INTRODUCTION

Physical activity enables people to live healthier and to feel themselves physically and psychologically better. Physical activity is the main factor to be healthy. Regular and moderate physical activity increases bone density and enables the growth of skeleton muscles in later years. Lack of regular and enough physical activity is a significant problem in many countries. Therefore, increasing the active life style is an important component of national and international public health propositions. According to the American College of Sports Medicine (ACSM) and the American Dietetic Association, adults should do an at least 30-min moderate level activity every day or most days (Pate et al., 1995; Driskell et al., 2005).The results of many researches show that the habit of physical activity plays an important role in health protection and life quality, but fast technological developments cause a decline in physical activity level both in daily routine and in workplace (Haskell, 1996; Kriska and Caspersen, 1997), which increases the risk of catching illnesses such as obesity, coronary heart disease, insulin interdependent diabetes, osteoporosis and some types of cancer (Baumgartner et al., 2003; Chasan-Taber et al., 2002; Kriska and Caspersen, 1997; Norman et al., 2001; Singh et al., 2001). Regular physical activity also has positive effects on muscle power, joint movements, nervous systems and cardiovascular respiration (Ignasiak et al., 2009). Therefore, individuals are suggested to do moderate or/and intensive activities in order to increase their physical activity levels and it is emphasized that first individuals' activity levels must be determined to be able to make suggestions about their

Abbreviations: ACSM, American College of Sports Medicine; **PAQ,** International Physical Activity Questionnaire; **MET-minute/week,** folds of resting oxygen consumption; **BMD,** body mineral density, g/cm^2; **t-score,** the standard deviation of young and healthy individuals form the bmd mean; score of 25/30-year old young-adults of the same gender; **z-score,** the standard deviation of individuals of the same gender and age group from BMD mean. **SPSS,** statistical package for social science; **BMI,** body mass index; **BFR,** body fat rate.

Table 1. Age, height and weight values of the female participants.

Variable	Group 1 (Low physical activity level) (n=32)		Group 2 (High physical activity level) (n=31)	
	Mean	SD	Mean	SD
Age (year)	20.78	1.81	21.48	1.55
Height (cm)	158.16	6.90	164.35	4,57
Weight (kg)	58.297	6.93	55.678	10.710

physical activity levels (Haskell, 1996; Kriska and Caspersen, 1997). However, that there are more than 30 methods in literature for measuring physical activity levels appears as a difficulty in comparing the results (Laporte et al., 1985). Many researchers prefer to use questionnaire because of its feasibility and cost, and many questionnaires are used for this purpose (Kreska and Caspersen, 1997). International Physical Activity Questionnaire (IPAQ), whose validity and reliability studies are done by Öztürk (2005) through university students in Turkey, is one of those questionnaires.

Physical activity, which decreases with aging, is an important factor which affects both bone mass growth in teenagers and natural bone mass loss in adults. To stop this decline requires a lifelong effort to increase physical activity level as from childhood and adolescence (Okut, 2008). Bone mineral intensity is the most important sign of bone mass and the prospective changes in it. There is a relation of a high percentage between bone mineral intensity and bone resistance. Similarly, top bone mass is also an important factor in understanding the bone mass in later years and in showing the sensitivity and resistance to the risk of bone fracture. Top bone mass is the highest level of bone mass gained during normal growth period. In other words, it shows the maximum amount of bone that an individual gains before the bone loss process begins. Assessing the total amount of body bone mineral is the most suitable way to assess the top bone mass (Helveci, 2005). Bone mineral density is thought to be affected by age, gender, weight, height, smoking, alcohol intake, physical activity and especially heredity (Tüzün, 2003; Helveci, 2005).

The purpose of this study is to examine the effect of physical activity on bone mineral density and to encourage individuals to physical activity for a healthier society considering the uses of physical activity.

MATERIALS AND METHODS

The purpose of this study is to find out the relation between the physical activity levels of females with low and enough levels of exercise and their bone mineral densities. The physical activity levels of the participants are found out by the International Physical Activity Questionnaire (IPAQ). In the study, the short form of the questionnaire including the last 7 days is used to assess the physical activity level. The calculation of the total score of the short form involves the sum of the duration (minutes) and frequency (days) of walking, moderate level activity and intensive activity.

The criterion in assessing all the activities is that every single activity is done for at least ten minutes per time. A score of "MET-minute/week" (folds of resting oxygen consumption) is obtained by multiplying minute, day and MET values. Physical activity levels are classified as physically inactive (<600 MET-min/week), low physical activity level (600-3000 MET min/week) and enough physical activity level (<3000 MET min/week) which is considered to be good for health (Craig, 2003; Öztürk, 2005). Every single participant is first informed about the study and a written approval is taken from each one of them. Body mass index, body fat rate, fatless body mass and body fat mass of the participants with low and enough physical activity levels are measured by Tanita electronic bio-impedance and their bone mineral densities are measured from the left femur at shoulder level using a dual energy X-ray absorbiometry (DEXA) bone scanner of Stratos brand. The participants' heights are measured with a 0.01 cm-acurate height meter. BMD (body mineral density, g/cm^2), t-score (the standard deviation of young and healthy individuals form the BMD mean score of 25/30-year old young-adults of the same gender) and z-score (the standard deviation of individuals of the same gender and age group from BMD mean) of the participants are assessed among themselves and are compared with independent variables (weight, age, height, etc).The analysis of the data obtained in the study is done with SPSS program. T-test in independent groups is used to find out the difference between the groups. The significance level was set as $P<0.05$. Pearson correlation test is used to find out the relation between bone mineral density and body composition and physical activity levels.

RESULTS

Table 1 shows a descriptive statistics of the groups' age, height and weight values. In Table 2, the participants' BMI (body mass index), BFR (body fat rate), fatless body, fat mass, total body water and physical activity values are compared and no statistical significance is found in the values of body mass index ($t_{(61)} = 0.770$, $P>0.05$), body fat rate ($t_{(61)} = 1.117$, $P>0.05$) and fat mass ($t_{(61)} = 0.504$ $P>0.05$).A significant difference is found in the participants' fatless body ($t_{(61)} = 3.381$),physical activity ($t_{(61)} = 0.000$,$P<0.05$), BMD neck ($t_{(63)} = -3.21$, $P<0.05$),t score neck ($t_{(63)} = -2.25$, $P<0.05$) and z score neck ($t_{(63)} = -2.44$, $P<0.05$) values. The means of t-values of those with high physical activity levels are higher than those of participants with low physical activity levels, showing a difference in favor of those with high physical activity levels. Table 3 shows a moderate and positive significance between BMD and physical activity levels, ($r = 0.394$, $P<0.05$), t-scores and physical activity levels ($r =$

Table 2. The comparison of the participants' BMI (body mass index), body fat rate (BFR), fatless body, fat mass, total body water and physical activity values.

Variable	Group 1 (Low physical activity level) (n=32)		Group 2 (High physical activity level) (n=31)		Student's t- test	
	Mean	SD	Mean	SD	t	Sig.
BMI(kg/m$^{2)}$	22.18	3.61	21.61	2.10	0.770	0.444
BFR %	24.97	7.30	23.17	5.21	1.117	0.268
Fatless body (kg)	41.12	4.56	44.67	3.71	3.381	0.001*
Fat mass (kg)	14.57	6.87	13.82	4.62	0.504	0.616
Physical activity (MET-min/week)	1394.17	1837.34	4576.82	2260.80	-6.001	0.000*
BMD neck	0 .932	0.137	1.07	0.201	-3.21	0.002*
t-Skor neck	0.964	1.048	2.052	1.790	-2.25	0.030*
Z-Skor neck	1.00	1.30	1.94	1.68	-2.44	0.017*

Table 3. Correlation between the left femur bone mineral density values of females with high physical activity levels and their physical features and physical activity levels.

Variable		Physical activity	Height	Weight	BMI (kg/m$^{2)}$	Body fat rate%	Fatless body (kg)	Fat mass (kg)
BMD(g/cm^{2})	Correlation	0.394*	0.023	-0.135	-0.125	0.014	-0.143	-0.001
	Significance	0.028	902	0.470	0.505	0.942	0.443	0.995
	N	31	31	31	31	31	31	31
T-score	Correlation	0.347*	-0.030	-0.175	-0.141	0.036	-0.218	-0.004
	Significance	0.89	0.887	0.402	0.502	0.863	0.295	0.986
	N	31	25	25	25	25	25	25
z-score	Correlation	0.408*	0.037	-0.167	-0.161	0.006	-0.187	-0.018
	Significance	0.023	0.946	0.368	0.386	0.973	0.313	0.921
	N	31	31	31	31	31	31	31

*Correlation is significant at the P<0.05.

0.347, P<0.05), z-scores and physical activity levels (r = 0.408, P<0.05) while there is no significant relation at P<0.05 level among the other values.Table 4 shows a negative and moderate level of difference between T-score and body fat rate (r = -0.235, P<0.05) and between t-score and fatless body mass (r = -0.488, P<0.05) while there is no significant relation at P<0.05 level among the other variables.

DISCUSSION

In the study, no significant difference is found between the BMI, body fat rate and fat mass values of the groups. It is seen that there is a significant difference between the physical activity levels and fatless body mass of the groups (P<0.05). Hallal et al. (2003) did not find a relation between the physical inactivity and BMI either. Physical activity is important in preventing from putting on weight but it is not proven to be effective in losing weight alone. Physical activity is only one of the factors in weight control such as genetic and behaviorist factors. In addition to this, physical activity enables metabolic adaptations without decrease in measurable body weight, which protects health (Raustorp et al., 2004). In a study conducted by Düzgün (2002), no significant difference was found between age groups when the students' body fat rates are compared according to age (P>0.05). In the studies conducted by Fu and Hao (2002), Mota et al. (2002), Rogol et al. (2002) and Tahara et al. (2002), it is stated that fat rates of females increase with age and that fat mass increases as fatless body mass increases. Regular physical activity by adults causes an increase in fatless body weight and a decrease in fatty tissue. That is why there is not much change in body weight at the early stage of training program. Fatless body weight stabilizes and weight loss becomes faster after about 3 months (Kokino et al., 2006).That the BMI, body fat rate and fat mass values are statistically not significant is thought to arise from the fact that Turkish society's diet consists of

Table 4. Correlation between the left femur bone mineral density values of females with low physical activity levels and their physical features and physical activity levels.

Variable		Physical activity	Height	Weight	BMI (kg/m^2)	Body fat rate%	Fatless body (kg)	Fat mass (kg)
BMD (g/cm^2)	Correlation	-0.089	-0.322	-0.290	-0.116	-0.190	-0.144	-0.199
	Significance	0.647	0.082	0.120	0.540	0.314	0.446	0.292
	N	29	30	0.030	30	30	30	30
T-score	Correlation	-0.052	0.145	0.161	-0.235	-0.320*	-0.488*	-0.306
	Significance	0.849	0.579	0.538	0.364	0.211	0.047	0.232
	N	16	17	17	17	17	17	17
z-score	Correlation	-0.093	-0.160	-0.251	-0.107	-0.113	-0.160	-0.111
	Significance	0.632	0.399	0.181	0.573	0.551	0.400	0.559
	N	29	30	30	30	30	30	30

*Correlation is significant at the P <0.05

natural food and that Turkish society make less use of facilities which restrains activity.

Considering the bone mineral densities of females with both high and low physical activity levels, a statistically significant difference between females with high physical activity levels and those with low physical activity levels in terms of BMD neck, T score neck and Z score neck values is found. There is a relation between BMD and physical activity level, t-score and physical activity level, and z-score and physical activity level of females with high physical activity levels. It is found that females with high activity levels have higher bone values. In several studies, it is stated that the bone masses of people who actively do sports are higher but their body fat rates are lower (Nichols et al., 1995; Dana et al., 2001; Viola et al., 2004; Risser et al., 1990; Lee et al., 1995; Calbet et al., 1999; Alfredson et al., 1997; Fehling et al., 1995). In addition, it is seen that intensity of physical activities is a significant factor affecting the bone mineral densities. Bozkurt (2010) has found that people doing wrestling have higher bone mineral densities than those who do judo, running and taekwondo, which shows a direct proportion between physical activity level and bone mineral density.

Witzke et al. (1999) found a close relation between total fatless body weight and bone mineral density in their study. It is stated that the fatless body weight and leg strength of females of juvenile age have positive effect on bone mineral density and that muscle mass during growth plays an important role in this effect. Henderson et al. (1995) state that the body weight and muscle power of 18-year-old females is the most evident determinants of bone mass. Similarly, Young et al. (1994) stated that having low body weight till the age of twenty decreases top bone density and therefore weight has an important effect on bone mineral density in declining years. Nonetheless, it is known that the intensity of the activity also affects these values. Cassel et al. (1996) have found that the bone mineral densities of female gymnasts are higher than those of swimmer and sedentary females. It is stated that gymnastics has an important effect on bone mineral density because of its explosive and forcible power on bones. Davison et al. (2008) noted in their study that hard and intensive physical activities have stimulating effects on bones. Baker et al. (2006) stated in their study that physical activity is more effective on females who have matured earlier. In conclusion, when considered according to physical activity levels, no significant difference is found in body fat rate, body mass index and fat mass while there is a significant difference in bone mineral densities.

RECOMMENDATIONS

Based on the conclusions of this study, similar studies can be conducted to find out the relation between BMD and different age groups, different intensity levels of various activities, different gender, etc.

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