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ANTHROPOMETRIC AND PHYSIOLOGICAL PROFILE OF ADOLESCENT BASKETBALL PLAYERS

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SUMMARY

The purpose of the present study was to reveal the differences in physical fitness between trained adolescents (basketball players, with regular training of six 90 minute training sessions pro week) and untrained pubertal boys of the same age (16 years), through several physical fitness tests (Åstrand's submaximal aerobic test to predict VO_{2max}, vertical and standing long jumps, grip strength test, sit and reach test, joint mobility of lower limbs, speed shuttle run test and skinfold measurements). The second aim was to compare the fitness level between adolescent basketball players with the same training program but living and training in urban and/or rural areas. Altogether 33 pubertal basketball players (BBP) and 33 untrained adolescents (UA) of the same age (16 years) participated in this study. Basketball players (BBP) were divided into urban (n = 17) a rural area (n = 16) subgroups. It had been found that BBP had higher values in aerobic capacity (VO_{2max}), in vertical and horizontal jump, in joint mobility and they attained lower percentages of body fat in comparison with the control group (UA). Between the two subgroups of BBP, urban BBP had higher values in body weight, joint mobility (sit and reach test) and absolute values of aerobic capacity (but not in relative values) in comparison with rural BBP subgroup.

In summary, the results suggest that regularly training in adolescents, such as basketball as applied here, improves VO_{2max}, muscle power and flexibility, and cause a decrease of percentages of body fat, independently the effect of biological and bodily maturation.

Key words: basketball, adolescence, aerobic capacity, joint mobility, body fat

INTRODUCTION

During the last decades a great emphasis is given to the role and the significant profits of the physical activity for the children's health (ACSM, 2006; Blair et al., 1989; Cavill et al., 2001; Dietz, 2004; Lee, 2003; Matthews et al., 2002; Sallis & McKenzie, 1991). Physical activity constitutes one of the most important factors for the normal growth of children and adolescents, as it influences positively the physical and psychological health and it is also very important for all the stages of a person's life. It determines the level of health and the life quality of young persons. Researches have shown that children and adolescents, who participate in a certain physical activity, have spiritual, psychological, and bodily health (Hagger et al., 2001a; Hagger et al., 2001b).

Fitness is a strong indicator of health and it can be considered as an indicator of the various functions and structures that are related to the efficiency in the bodily exercise (Castillo et al., 2005; Ruiz et al., 2006).

The course of the school physical education is related to the vigor and the well-being, and it can constitute an important factor for the promotion of health in the life condition, of a modern society (Sallis & McKenzie, 1991). Nevertheless, despite the recognized importance of exercise, the results of researches of the last 25 years, show that the current way of life does not include sufficient physical activity and also that the children's levels of physical activity have been decreased (Armstrong & Welsman, 1997; Campagna et al., 2001; Dietz & Gortmaker, 1993; Ross & Gilbert, 1985; Ross & Pate, 1987; Sallis et al., 2000).

Worldwide, it has been observed, that the children's and adolescent's efficiency in the tests of muscular strength and velocity have been decreased since 1990 (Tomkinson et al., 2003a; Tomkinson et al., 2003b). There is also a characteristic decrease in the cardiovascular endurance in the various field tests, in the developed countries (Tomkinson et al., 2003a; Tomkinson et al., 2003b).

Although physical activity contributes positively in the strengthening of physical and psychological health of individuals of all years (U.S. Department of Health and Human Services, 1996), it is true that a great percentage of children and adolescents are insufficiently active and that's why they do not derive the desirable profits for their health (Armstrong & Welsman, 1997). Comparisons of young athletes with their sedentary counterparts typically show that the athletes have a lower percent body fat and higher fat-free weight values. There is also evidence from training studies that a decrement in percent body fat results from systematically applied exercise programs (Boileau et al., 1985; Plowman, 1989).

A lot of researchers report that the positive adaptations of exercise are greater during the phase of rapid growth (Shephard, 1982; Malina & Bouchard, 1991). During the bodily growth and maturation, as well as during the growth of dexterities and behaviors, there are some periods, when children and adolescents are more sensitive in the effects they acce pt from the environment, either they are positive or negative.

Researches have shown that the processes of growth can be more easily modified during these periods (Scott, 1986; Bronstein, 1989).

Basketball is one of the most popular sports in Greece, as well as in the world. It is a dynamic sport, that has a lot of rhythm, alternations, jumps and it is related to the aerobic and anaerobic ability, the muscle strength, the velocity, the joint mobility and the bodily constitution. The aerobic ability of the basketball players, as it is expressed by the maximum oxygen intake, it exceeds as a rule the 4.4 l min^{-1} and it is considered, in absolute values, as a high value (Vamvakoudis et al., 2007). It is due to the fact that basketball players are tall and heavy. In relative to the body weight values their aerobic ability is not very high, it is about 57–62 ml kg^{-1} min^{-1} and it is about at the same level with that of other team sports like football, volleyball, and handball (Tokmakidis et al., 1986).

PURPOSE

The purpose of the present study was: to compare the level of fitness between adolescent basketball players and untrained adolescents of the same age. In addition, the second aim of the study was to compare the fitness level between adolescent basketball players, who live and are trained in big urban centers and adolescent basketball players, who have the same training program, but they live in rural areas.

PROCEDURES

The research sample consisted of 66 adolescent boys of the same age – 16 years. Experimental group (n = 33) were involved into school basketball program that was the same for the subgroup of basketball players who live and are trained in big urban centers (BBP-U, n = 17) and for the subgroup of basketball players who live and train in rural areas (BBP-R, n = 16). The regular basketball training in the experimental group consisted of six 90 minute weekly training sessions. Specifically, training consisted of 10–15 minutes of warm-up exercises (jogging, stretching, and calisthenics of approximately 40–50% of the maximal heart rate intensity), followed by alternating heavy (75–85% for 8–10 minutes), and light (50–65% for 40–45 minutes) periods of running with the ball (dribbling, fast break drills), and without the ball (defensive drills). Instructional game was also part of each daily session (20–25 minutes of light intensity). Jumping to the basket and sprinting exercises (10–30 m) were also a regular part of their practice. Telemetry (Sport Tester, Finland) was used on all subjects for several training sessions to record heart rate (HR) and adjust the intensity of the training session to the HRmax, measured during field tests.

Subjects were given instructions to abstain from eating three hour prior to the scheduled test time, as well as to avoid any hard physical exercise the previous day. They were also instructed not to change their physical activity pattern during the active period of testing.

Anthropometric assessment included measurement of body height, mass and body composition. Percentage of body was calculated on the basis of measurement of the triceps and sub scapular skinfolds using standardised procedures (Pollock & Wilmore, 1990), and equation developed by Slaughter et al. (1988) and Lohman (1990) for white prepubescent boys was used to estimate the percentage of body fat.

Vertical jump: Hands were on the hips, thumbs pointing backwards, during the jump test. Subjects were instructed to jump vertically, and to land on the same spot as they jumped from. Jump height was measured as the vertical displacement of the hip. A measuring tape was attached to a belt running around the subject's waist. The measuring tape then ran under a plastic profile attached to the floor. Jump height was calculated as the difference between the reading on the measuring tape before and after the jump, to the nearest 0.5 cm.

Standing long jump: subjects were instructed to straddle with feet parallel, about shoulder width apart, and toes behind the starting line. From this position subjects squat and then jump horizontally as far as possible. The test was scored in meters and cm to the nearest cm. Three trials were performed and the best trial was recorded.

Speed shuttle run test: speed shuttle run is a measure of agility that is a component of athletic fitness. The adolescents run a total distance of 60 m as fast as possible. They start behind the starting point and run to the 30 m sign, and then return to the starting point. The score is the time that takes to complete the shuttle run to the nearest tenth of a second.

Sit and Reach test: Following a demonstration, participants sat on the floor, with knees straight and legs together, and feet placed against the box relative to the 23 cm point (AAHPERD, 1988), performing a maximal trunk flexion. With the extended legs as straight as possible, hands on top of each other (tips of the middle fingers even) the participant slowly reached forward as far as possible and holds the position for approximately 2 s. The final position that the participant reached was score for the test. Reaching distance was recorded as centimeters past the toes where the value 0 denoted having just reached the toes. All subjects had normal flexibility on the angle, knee and hip joints, and had experienced no pain during exercise.

Range of motion: The measurements were taken with a Myrin flexometer (Lic Rehab. 17183, Solna, Sweden), according to the method of Ekstrand et al. (1982). The flexometer is a modification of the Leighton flexometer, and consists of a circular scale with a weighed pointer controlled by gravity attached to the center. The coefficient of variation for the goniometric measurement was 1.9 ± 0.7%.

Hip flexion: With the subject supine on the bench, the flexometer was strapped to the lateral side of the thigh 5 cm above the patella and was adjusted to zero. Velcro bands immobilized the pelvis and opposite leg. Examiner 1 placed the subject's ankle on the examiner's shoulder and asked the subject to relax. Examiner 1 then slowly raised the subject's leg, keeping both hands on the knee, and examiner 2 read the result when examiner 1 felt the knee flexion.

Knee flexion: The subject lay prone on the bench while the flexometer was strapped to the leg above the lateral malleolus and adjusted to zero. Examiner 1 passively flexed the knee, and examiner 2 read the result at the moment hip flexion started.

Hand grip test: Isometric hand grip strength test was measured using a hand grip dynamometer (GRIP-D, TKK, 5101; Takei Scientific Instruments Co, Tokyo, Japan) individually adjusted to a hand size. The subjects were asked to stand with the arms held straight at their sides and the dynamometer was gripped as much as possible for 3 sec without pressing the instrument against the body and without any flexion at the elbow. Three attempts were given and the mean values were calculated. The results were recorded in kilopond (kg) with one decimal. There was a 2 min interval between measures. Subjects performed the test using with both the dominant and non-dominant hand.

Maximum oxygen uptake (VO_{2max}) was predicted from the Åstrand and Rhyming submaximal aerobic test. A mechanical bicycle ergometer (Monark, Vaberg Sweden) was used for the experiments on which work load and time of muscular exercise were recorded. The saddle was adjusted so that the knee was nearly extended (between 170°–180° extensions) with the tip of the foot on the pedal at the bottom of the arc. Before the test the values of resting heart rate and systolic and diastolic brachial artery blood pressures (BPs and BPd) were measured by mercury manometer after 5 min rest in supine position. The pedaling rate was set at 50 rpm. For each test, the subjects started with a 6 min submaximal work loads of 50 W and 100 W and/or 150 W. Heart rate was continuously recorded on an electrocardiograph (ECG) and maximal oxygen uptake was predicted using the Åstrand formula (Åstrand, 1960).

Statistics: A one-way analysis of variance was used to detect differences between adolescent basketball players and controls and/or basketball players from urban and rural areas on selected variables. When a significant F ratio was found, a post hoc procedure was employed to compare the means. The level of 0.05 was used to indicate significance.

RESULTS

Body height and body weight in sixteen-year-old basketball players (BBP) was similar as in their non-athletic counterparts (UA), however BBP exhibited a significantly lower body fat ($p < 0.001$) and resting heart rate ($p < 0.001$) than untrained adolescents (UA) (Table 1). There were not found neither in systolic nor in diastolic blood pressure. In both vertical and standing long jumps, as well as in the test sit and reach test, the basketball players showed higher values compared with the untrained adolescents of the same age ($p < 0.05$, $p < 0.001$, and $p < 0.001$ respectively). The basketball players group had significantly higher values in the knee flexion measurements of both for right and left lower limbs ($p < 0.01$). With regard to running ability, hip flexion and handgrip values, there were no significant differences between both groups. Absolute and relative to body weight values of VO_{2max} were statistically higher in basketball players group when compared to the untrained adolescents of the same age ($p < 0.001$ and $p < 0.05$, respectively).

Table 1. A comparison of anthropometrical and physiological profile between basketball players (BBP) and untrained adolescents (UA)

	BBP (n = 33)	UA (n = 33)	Significance of difference
Height [cm]	179.95 ± 6.9	177.2 ± 7.1	n.s.
Body weight [kg]	73.6 ± 9.7	71.3 ± 12.4	n.s.
Body fat [%]	15.11 ± 4.01	19.39 ± 5.06	p < 0.001
Resting heart rate [b min^{-1}]	69.6 ± 9.0	81.2 ± 9.7	p < 0.001
Systolic blood pressure [mm Hg]	128.7 ± 9.2	128.8 ± 8.1	n.s.
Diastolic blood pressure [mm Hg]	71.6 ± 10.1	74.2 ± 8.0	n.s.
Standing long jump [cm]	205 ± 18	191 ± 27	p < 0.05
Vertical jump [cm]	50.09 ± 7.40	42.27 ± 8.99	p < 0.001
Running ability [s]	10.52 ± 0.41	10.63 ± 0.89	n.s.
Sit & Reach [cm]	30.55 ± 6.94	23.67 ± 7.98	p < 0.001
Range of motion – knee flexion – right [º]	146.06 ± 9.25	137.58 ± 11.05	p < 0.01
Range of motion – knee flexion – left [º]	146.82 ± 9.40	138.94 ± 10.95	p < 0.01
Range of motion – hip flexion – right [º]	83.33 ± 10.43	79.85 ± 11.01	n.s.
Range of motion – hip flexion – left [º]	82.73 ± 9.80	80.91 ± 11.07	n.s.
Hand grip – right [%]	42.46 ± 5.65	40.02 ± 5.33	n.s.
Hand grip – left [%]	40.32 ± 5.53	39.86 ± 5.42	n.s.
VO_2max [l min^{-1}]	2.92 ± 0.45	2.45 ± 0.35	p < 0.001
VO_2max [ml kg^{-1} min^{-1}]	40.12 ± 7.62	35.09 ± 6.46	p < 0.05

A comparison of adolescent basketball players from urban and rural areas (Table 2) evidenced similar mean body height but urban basketball players were significantly ($p < 0.05$) heavier and tended to have a higher percentage of body fat, however this difference (16.1 versus 13.7 %) was non-significant ($p > 0.05$). There were no significant differences in resting heart rate ads systolic and diastolic blood pressures, standing long jump, vertical jump and running ability between urban and rural basketball players. The urban basketball players subgroup had significantly higher values in sit and reach test ($p < 0.05$), however range of motion in knee and hip flexions and handgrip values were not significant different between the both subgroups. Values of VO_{2max} relative to body weight were very close and not significantly different in the both subgroups but urban basketball players who were heavier than urban basketball players exhibited significantly ($p < 0.05$) higher absolute values of VO_{2max}.

Table 2. A comparison of anthropometrical and physiological profile between urban and rural basketball players (BBP). Values are mean ± SD

	Urban BBP (n = 17)	Rural BBP (n = 16)	Significance of difference
Height [cm]	179.3 ± 7.3	180.9 ± 6.6	n.s.
Body weight [kg]	76.9 ± 10.9	69.2 ± 5.6	p < 0.05
Body fat [%]	16.14 ± 4.41	13.71 ± 3.29	n.s.
Resting heart rate [b min^{-1}]	68.5 ± 8.6	71.0 ± 9.6	n.s.
Systolic blood pressure [mm Hg]	129.3 ± 9.6	127.9 ± 8.8	n.s.
Diastolic blood pressure [mm Hg]	71.7 ± 8.6	71.5 ± 12.2	n.s.
Standing long jump [m]	2.026 ± 0.20	2.084 ± 0.17	n.s.
Vertical jump [cm]	49.89 ± 6.94	50.36 ± 8.24	n.s.
Running ability [s]	10.44 ± 0.37	10.62 ± 0.46	n.s.
Sit & Reach [cm]	32.63 ± 5.89	27.71 ± 7.46	p < 0.05
Range of motion – knee flexion – right [º]	143.95 ± 8.09	148.93 ± 10.22	n.s.
Range of motion – knee flexion – left [º]	144.47 ± 7.80	150.00 ± 10.56	n.s.
Range of motion – hip flexion – right [º]	82.11 ± 10.71	85.00 ± 10.19	n.s.
Range of motion – hip flexion – left [º]	84.47 ± 8.15	80.36 ± 11.51	n.s.
Hand grip – right [%]	42.63 ± 5.82	42.24 ± 5.62	n.s.
Hand grip – left [%]	40.65 ± 6.09	39.86 ± 4.99	n.s.
VO_2max [$l \cdot min^{-1}$]	3.03 ± 0.42	2.77 ± 0.46	p < 0.05
VO_2max [$ml \cdot kg^{-1} \cdot min^{-1}$]	40.05 ± 8.25	40.21 ± 6.97	n.s.

n.s. – not significant

DISCUSSION

The purpose of the present study was to compare the level of physical ability between young basketball players and untrained individuals of the same age. The results of the study showed differences in the most parameters of physical ability between trained and untrained youngsters, and it was obvious the superiority of trained individuals over the untrained, in these parameters. More specifically, differences were found at the physical characteristics of the two subgroups. Adolescent basketball players who live in the city were heavier than rural ones. This finding may be due to the different way of living because of the urbanization, of the different nutritional habits, or the every day activities of adolescents living in the country (e.g. transport by feet, not by car). As for the height, there were no significant differences between BBP and UA groups. Studies relative to the effect of the athletic activity to the elongated body sizes, during the development age, showed that its contribution is not significant (Bailey & Mirwald, 1988; Reznickova et al., 1981; Wanne & Valmaki, 1983). Changes that are observed on the body height, or the length of the arms and legs, are because of genetic and nutritional factors (Bailey & Mirwald, 1988; Baxter-Jones & Helmes, 1996).

The body fat measurements have become widely known and consists an index of good health among people, and good physical capacity index among athletes. At the present study, it was found that BBP had lower level of body fat, compared to group UA, while when we compared subgroups U and R, there was no significant difference. This result is in agreement with several studies (Doinne et al., 2000; Malina, 1994; Tremblay & Willms, 2000), which demand that low body fat levels, are connected with high levels of physical capacity. All these are confirmed at the present study as children, who were playing basketball, had lower body fat than those children who didn't exercise at all. Any sport activity during the developmental ages, leads to reduce of body fat levels and increased muscle mass (Douda et al., 1997). It has been reported that young people, who participate in sport activities have lower percentage of body fat compared to untrained people of the same age (Malina et al., 1991; Parizkova, 1977). It is also accepted that resistance training has great effects in body mass composition over young people of development age (Parizkova et al., 1975).

Muscle force of the lower limbs evaluated by vertical and the horizontal jumps was considerably higher in the BBP group compared to UA group. These results are in accordance with other studies, which prove that increased and regular physical activity is associated with higher explosive strength (Okley et al., 2001; Katic et al., 2001). Running ability, evaluated by 60 m run (two 30 m sprints) were not different between the trained and untrained adolescents, regardless the youngsters from BBP group had slightly better records than the control group.

In the "sit and reach" test, that is a mobility index of dorsal and back thigh muscles, boys of BBP had higher records compared to boys from UA group. The same differences have found at comparison of the subgroups of basketball players where the players from urban areas had better records. These differences in joint mobility in young athletes could be probably caused by the different training plans.

Also, joint mobility of knee muscles, was higher in BBP group than in untrained controls. These results agree with other studies, which mention that children who participate in after school sport programs (Katic et al., 2001), or excessive school sport programs, have better mobility than children who only exercise due to school activities (Stephens & Wentz, 1988).

The BBP group had higher aerobic capacity than those of UA, not only for absolute values, but also for the values relative to the body weight. Between the two BBP subgroups, adolescents of “urban” subgroup had a higher VO_{2max}, that may be due to the differences in body weight and also possible differences in their training age over “rural” subgroup. Similar findings were evidenced by previous research according to which, increased physical activity influences high aerobic ability, especially at the age of adolescence (Kemper et al., 1995; Kain et al., 2004). Studies that deal with the results of sport training programs in young athletes usually showed increase of VO_{2max} after training (Obert et al., 2003). Other studies (Rowland, 1985; Vaccaro & Mahon, 1987), present great improvement of VO_{2max} level as a consequence of participation in training procedure after the appropriate training motivation, over the volume, the frequency and the duration of the training. On the other side, researchers such as Borms (1986), and Bar-Or (1989), support that aerobic exercise does not significantly improve aerobic ability in young people and children. The benefits of exercise are still questionable (Rowland, 1990), however, the appropriate resistance exercise of children, besides the increase of VO_{2max} may promote good health and quality of life. In spite of this, the level of VO_{2max} of adolescent BBP group seems to be relatively low in comparison to the VO_{2max} values evidenced in basketball players of the same age (Nidhal et al., 2006). This finding is possibly connected with the short-term training history in adolescent BBP, as well as with the fact that most coaches focus mainly on technique and tactics training, rather than on conditioning and/or resistance training.

CONCLUSIONS

We conclude that the cross sectional study in adolescent level of UA group adolescent’s VO_{2max}, is lower compared to the average level of basketball players’ VO_{2max}, of the same age. Systematic basketball training improves joint mobility and muscle strength of legs, apart from the biological maturation. Static force of arm muscles is not affected by basketball training. Probably, for its improvement, needs more specific muscle boosting program. Moreover, the percentage of body fat concentration is lower in adolescents who practice systematically. Finally, the physical education lesson doesn’t improve enough the parameters factors connected with good health (aerobic ability, reduction of body fat level).

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ANTROPOMETRICKÝ A FYZIOLOGICKÝ PROFIL ADOLESCENTNÍCH HRÁČŮ BASKETBALU

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SOUHRN

Cílem studie bylo prosoudit rozdíly ve fyzické zdatnosti u adolescentů trénujících basketbal (pravidelný devadesátiminutový trénink, šestkrát týdně) a u stejně starých chlapců kontrolní skupiny shodného věku (16 let), kteří nebyli zapojeni do pravidelného tréninku. Obě skupiny adolescentů byly vyšetřeny submaximálním testem dle Åstranda k predikci VO_{2max}, testy vertikálního výskoku a skoku dalekého z místa, testem stisku ruky a dosahovým testem „sit and reach“, testy mobility kolenních a kyčelních kloubů, rychlostním člunkovým během a kaliperací kožních řas. Druhým záměrem studie bylo porovnat fyzickou zdatnost u podskupin adolescentních hráčů basketbalu rozdělených dle místa pobytu na městskou a venkovskou populaci, ale se shodným basketbalovým tréninkem. Vyšetření se celkem zúčastnilo celkem 33 adolescentních hráčů basketbalu a 33 chlapců kontrolní skupiny. Podskupina hráčů z městských oblastí byla tvořena 17 hráči a podskupina hráčů z venkova 16 adolescenty. Výsledky prokázaly, že adolescentní chlapci trénující basketbal dosáhli vyšší úroveň aerobní kapacity (VO_{2max}), lepší výsledky testů vertikálního výskoku a skoku dalekého z místa, dosahového testu i testů mobility kolenních a kyčelních kloubů a také vykazovali nižší procento tělesného tuku než chlapci kontrolní skupiny. Srovnání dvou podskupin adolescenčních hráčů basketbalu prokázalo, že hráči z městských oblastí vykazovali vyšší tělesnou hmotnost, lepší výsledky dosahového testu i vyšší absolutní, ale nikoli relativní hodnoty aerobní kapacity ve srovnání s hráči z venkovských oblastí. Výsledky celkově ukazují, že pravidelný sportovní trénink u adolescentů, jako např. basketbalový trénink 90 minut šestkrát týdně v této studii, může zvyšovat VO_{2max}, svalovou sílu a flexibilitu a navozovat pokles tělesného tuku, nezávisle na účincích biologického a tělesného dozrávání.

Klíčová slova: basketbal, adolescence, aerobní kapacita, kloubní pohyblivost, tělesný tuk

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