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EDITORIAL

With this second number we reach our initial goal: two issues per year. Further more, this is probably our last printed number. We hope that the next issue will be available only on line. I tis a common project with the Coimbra University Press that we expect to have high quality and visibility in internet.

The content of this issue, although more centered in our research unity, aims to keep the quality standards presented in our scope and intentions. The publication of the best abstracts of the second edition of the Intensive Programme "Sport Performance: a Lifespan Challenge", held in Roma, in May 2011, shows our commitment to disseminate the work of young researchers across Europe.

Until now we had the precious contribution of high quality and demanding reviewers. But the future of the project depends of our capacity to attract authors searching for showing their work to the scientific community. We expect to have two issues in 2012, respecting our editorial standards.

SUMMARY

RESEARCH ARTICLES PHYSICAL ACTIVITY 1

SALIVARY IGA RESPONSE DURING ONE WEEK OF ADVENTURE SPORTS ACTIVITIES WITH ALTITUDE EXPOSURE

Ana MariaTeixeira[1], Amândio Cupido dos Santos[1], Miguel Oliveira[1],
Maria de Fátima Rosado[1], M. Martins[2] and M. R. Cunha.[2]

ABSTRACT

Salivary IgA has been used as a marker for the mucosal immune system status and may decrease after periods of intense exercise. The aim of this research was to investigate the changes in salivary IgA levels after a week at 2140m above sea level and the salivary IgA (sIgA) response to three different exercise activities at altitude, and to evaluate the recovery time needed to restore the baseline sIgA concentration and secretion rate levels.

Eighteen participants (12 male and 6 female, aged between 20 and 38 years old) were enrolled in the study. Saliva samples were collected at wake up, 2h and 24h after the sports activities. Nine collection points were analyzed for saliva flow rate, sIgA concentration and secretion rate. Heart rate data was collected using heart rate monitors.

The adventure sports activities consisted of a mountain trekking activity, fulfilled on the 1st day with a positive altitude difference of 339m above sea level (ASL) a mountain climbing activity, fulfilled on the 3rd day with a positive altitude difference of 1340m ASL and a canyoning activity, fulfilled on the 5th day with a positive altitude difference of 230m ASL. No altitude effects were seen on salivary IgA values after 5 nights at 2140m ASL. Salivary IgA concentration and secretion rates showed statistically significant decreases 2h after the mountain trekking activity, 2h after the mountain climb event (Aneto, 3404m) and 2h after the canyoning descent. 24h hours after these activities sIgA values had not yet recovered, and were still significantly different from the baseline values.

KEYWORDS: salivary IgA, exercise, altitude, immune suppression

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INTRODUCTION

The production of salivary immunoglobulin A (IgA), is the major effector function of the mucosal immune system and together with innate mucosal defences such as alpha-amylase, lactoferrin and lysozyme, provides the first line of immunological defence against colonization of infectious agents on the mucosal surface by the exclusion, neutralization and elimination of pathogens (Pedersen & Hoffman-Goetz, 2000). A high incidence of infections was reported in individuals with selective deficiency of IgA (Hanson et al, 1983) or very low saliva flow rates (Fox et al, 1985). It has been shown that low levels of IgA are associated with increased risk of infection, especially with upper respiratory symptoms (URS) (Gleeson, 2000; Walsh et al, 2011). Salivary IgA has been used as a marker for the mucosal immune system status and many studies have reported a decrease in concentration and secretion rate for high-performance endurance athletes undertaking intensive training (Libicz et al, 2006; Gleeson et al, 2004, Walsh et al, 2011). Also, salivary IgA levels have been shown to decrease 1h30 to 2h30 after maximal aerobic exercise and return to background levels 24h after exercise (Teixeira et al, 2006). Very few studies have looked at the effect of adventure sports activities in IgA secretion and none when done at altitude. The purpose of this study was to look at the effect of 6 days at altitude on mucosal IgA levels and the 24h response of salivary IgA to three different exercise activities.

METHODS

Eighteen participants (12 male and 6 female, aged between 20 and 38 years old) were recruited for this study. Sixteen were physical education students that practiced regular weekly exercise activities, and 2 teachers with experience in adventure sports at altitude. All the participants were informed of the objectives and procedures of the study and gave their written informed consent.

Sleeping accommodation was located at 2140m. The sport activities performed consisted on: a mountain trekking activity, fulfilled on the 1st day, in fine weather conditions with temperature ranging between 15 and 25ºC, accomplished in 4h30min over a 11200m itinerary, with a positive altitude difference of 339m ASL, at an average speed of 2,8Km/h; a mountain climbing activity, fulfilled on the 3rd day, in fine weather conditions, with a starting temperature of 5ºC (5 a.m.), reaching up to 25ºC during the mountain ascent and with a temperature of 5ºC registered at the Aneto mountain peak, accomplished in 10h over a 11000m route, with a positive altitude difference of 1340m ASL, at an average speed of 1,1Km/h; a canyoning activity, fulfilled on the 5th day, in fine weather conditions with temperatures ranging from 10 to 25ºC in the water and 15 to 20ºC en route, accomplished

in 6h for a 7000m up itinerary plus the canyon descent, with a positive altitude difference of 230m ASL. Altitude was measured using a GPS. To access the intensity of the sport activities performed, heart rate monitors were used (Polar S-810i, Finland).

Saliva samples were collected, without stimulation, using the saliveTM system (Sarstedt, Denmark), for 2min at the following time points: after waking up before breakfast (at 7 am on the 1st day, at 5 am on the third day and at 6am on the 5th day), 2h after each sport activity was finished (at 3pm on the 1st day, at 6pm on the 3rd day and at 3pm on the 5th day) and 24h after this last collection (at 3pm on the 2nd day, at 6pm on the 4th day and at 3pm on the 6th day). In total nine collection points were analyzed (see chronogram – Table I).

The saliva samples were stored at -20°C until analysis. They were then centrifuged for 15min at 3000rpm. The sample volume measured in other to obtain the salivary flow rate. Salivary concentration was evaluated by nephelometry (BN2 analyser, DadeBhering, USA). The IgA secretion rate (srIgA) was calculated by multiplying the IgA absolute concentration by the saliva flow rate, which in turn was calculated by dividing the total saliva volume obtained in each sample by the time taken to produce the sample.

To compare the behavior of IgA and srIgA between time points the non-parametric Wilcoxon test was used, with a confidence level of 95%. This statistical option avoids the errors associated with the small dimension of the sample and prevents the absence of a normal distribution of the variables. Data is presented as mean and standard deviation of means.

Table I - Chronogram of the time points for the saliva collection. Baseline (bl), trekking (tk), mountain ascent (ma) and cannyoning (cn).

1st time point (bl1)	2nd time point (tk2)	3rd time point (tk24)	4th time point (bl2)	5th time point (ma2)	6th time point (ma24)	7th time point (bl3)	8th time point (cn2)	9th time point (cn24)
At wake up and before breakfast	2h after the trekking activity	24h after the 2nd time point collection	At wake up and before breakfast	2h after the ascent of the Aneto Peak	24h after the 5th time point collection	At wake up and before breakfast	2h after the can-yoning activity	24h after the 8th time point collection
Day1 at 7am	**Day1 at 3pm**	**Day2 at 3pm**	**Day 3 at 5am**	**Day 3 at 6pm**	**Day 4 at 6pm**	**Day 5 at 6am**	**Day 5 at 3 pm**	**Day 6 at 3pm**

RESULTS

For the trekking activity the average heart rate was 120±15bpm and the maximal heart rate average was 181.3±11.1; for the mountain climbing activity the average heart rate was

132.7+ 12.9bpm and the maximal heart rate average was 178.9±2.6; for the canyoning activity the average heart rate was 95.8±11.2bpm and the maximal heart rate average was 155.5±9.9. The percentage of time spent in the different beats over 20 minute intervals are shown in Figures 1, 2 and 3.

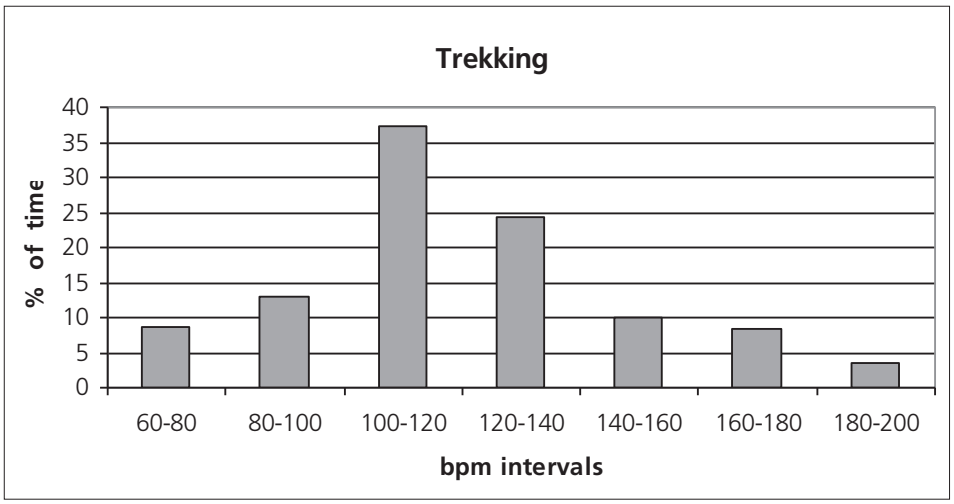

Figure 1 - Media values of heart rate effort. Percentage (%) of time at different heart rate (bpm) intervals during 4h30min of trekking

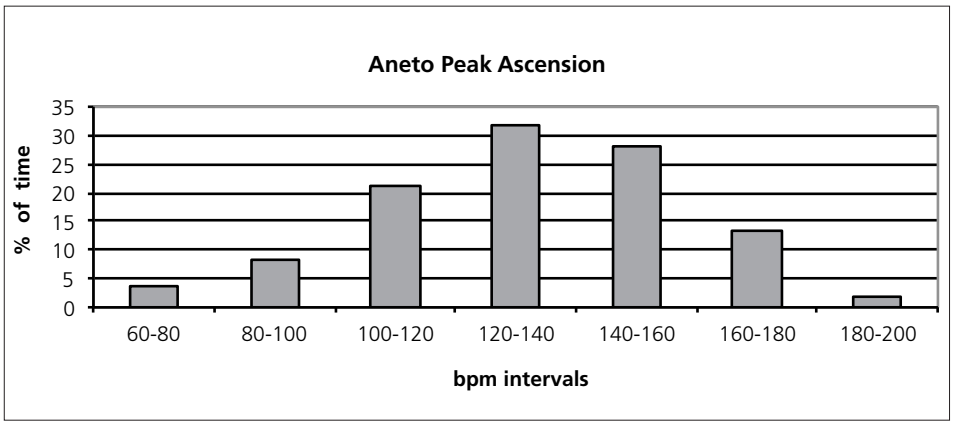

Figure 2 - Media values of heart rate effort. Percentage (%) of time at different heart rate (bpm) intervals during the 9h52 min of the Aneto peak ascent.

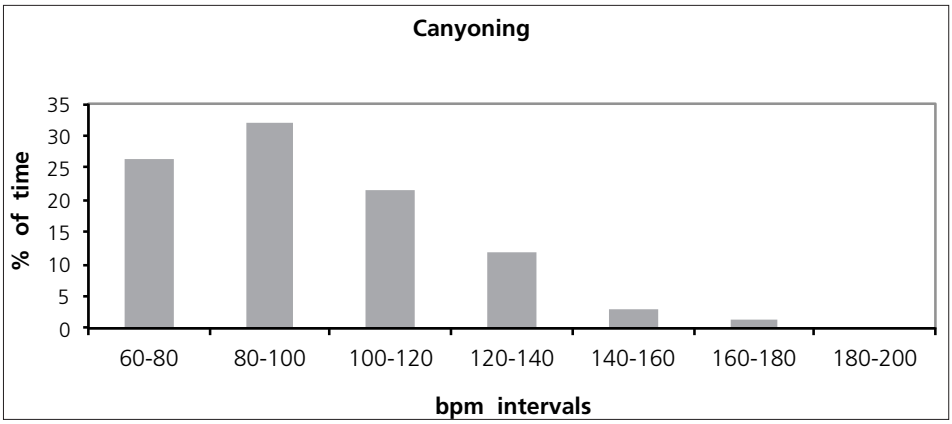

Figure 3 - Media values of heart rate (%) of time at different heart rate (bpm) intervals during the 6h16 min of canyoning. effort. Percentage

No differences were found between the morning baseline values obtained on the 1st, 3rd and 5th days for saliva flow rate, IgA and srIgA (Table 2).

Salivary IgA concentration and secretion rates showed statistically significant decreases 2h after the mountain trekking activity (P<0,001), 2h after the mountain climb event (Aneto, 3404m) (P<0,001) and 2h after the canyoning descent (P<0,001) (Table 2), when compared to the baseline morning values. The lowest values were obtained after the mountain climb event (table 2), which was also the most demanding both in terms of duration and intensity (figure 2). 24h hours after these activities sIgA concentrations and secretion rates had not yet recovered, and were still significantly different from the 1st, 3rd and 5th day at wake up values (P<0,001). However 24h after the mountain climbing to the Aneto peak, the sIgA concentrations were higher (P=0,046) then the ones recorded 2h after this event. The fact that only 7 of the participants were able to finish this climb may account for the differences obtained (the rest of the sample having rested more time and started recovery earlier). Recovery was only achieved on the morning of the 3rd and 5th days. This represents a gap of time greater than 40h between the term of the activities and the final collection time points. Day four was a resting day and this caused some differences as higher sIgA values were obtained in the following morning (Day 5 - Figures 4 and 5). In the last day, 24h after the canyoning activity, sIgA concentration and secretion rate was still decreasing and was significantly lower than the ones obtained on days1, 3 and 5 at wake up (table 2).

Table 2. Saliva flow rate, salivary IgA and secretion rate IgA results for the saliva samples collected during the 6 days of adventure sports activities with altitude exposure. Results are shown as median and standard deviation

	Trekking		
	1st day 8am	1st day 2h post	2nd day 24h post
Flow Rate (ml/min)	844.4+263,5	1023,6+236,5*	993,1+298,3
IgA (mg/dl)	37,34+44,38	8,42+6,57*	7,38+4,99*
srIgA (mg/min)	0.273+0,233	0,084+0,062*	0,072+0,047*
	Aneto ascent		
	3rd day 5 am	3rd day 2h post	4th day 24h post
Flow Rate (ml/min)	780,5+204,1	920,8+276,2*	822,2+267,3
IgA (mg/dl)	26,01+20,72	8,34+6,41*	13,65+11,83*
srIgA (mg/min)	0,185+0,125	0,076+0,059*	0,106+0,078*
	Canyoning		
	5th day 6 am	5th day 2h post	6th day 24h post
Flow Rate (ml/min)	754,7+245,3	887,5+282,1	930,6+265,8*
IgA (mg/dl)	44,74+46,98	16,92+15,29*	10,78+8,57*
srIgA (mg/min)	0,306+0,293	0,133+0,114*	0,097+0,079*

p<0.05 when compared to the corresponding a.m. samples

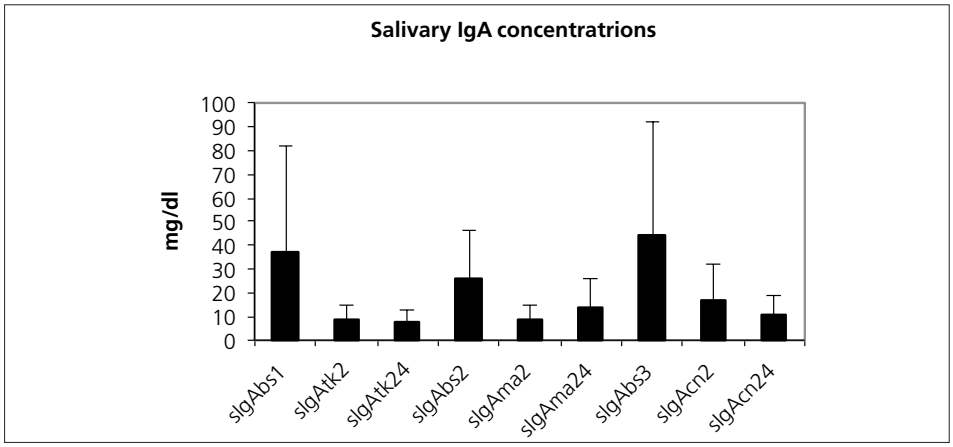

Figure 4 - Median and standard deviation values of the salivary IgA concentration for the different time points analysed. Baseline (bl), trekking (tk), mountain ascent (ma) and cannyoning (cn).

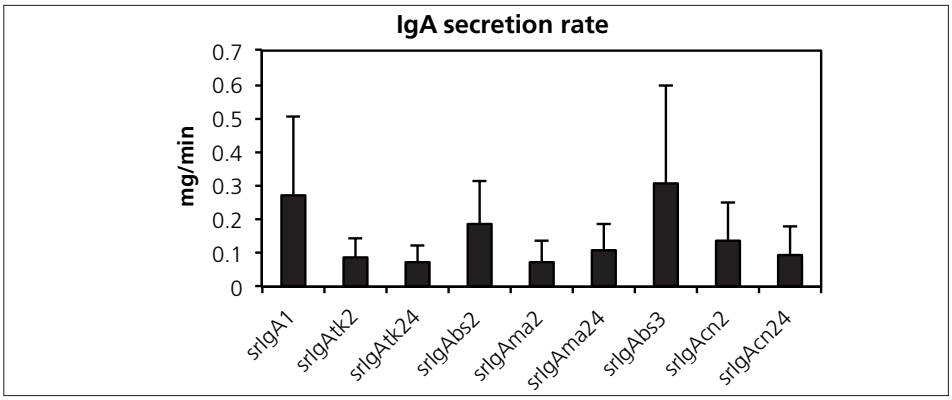

Figure 5 - Median and Standard deviation values of the salivary IgA secretion rates for the different time points analysed. Baseline (bl), trekking (tk), mountain ascent (ma) and cannyoning (cn).

DISCUSSION

Sleeping at 2140m ASL for 5 nights did not decrease the salivary IgA wake-up levels or saliva flow rate of the participants in this investigation. Similar results were obtained by Tiollier and colleagues (Tiollier et al, 2005a), for salivary IgA concentration, after 3 weeks of commando training at 1600m ASL. A study examining the effect of living high training low on mucosal immunity (Tiollier et al, 2005) found that the salivary IgA concentrations decreased significantly after 6 days of sleeping in hypobaric tents at a simulated altitude exposure of 2500m and 3500m ASL (Tiollier et al, 2005b) but not in the control participants that lived and trained at 1200m.

Although the exercise performed in the course of the different adventure sport activities was not very intense it was very prolonged. The long time duration of the activities performed may account for the decrease of the salivary IgA levels. Recovery between tasks took longer than 24h which may be due to the fact that the sport activities performed during this study were done at altitudes higher than 2000m. Studies have reported inhibition of interferon, cytokine and lymphocyte proliferative responses and a decrease in salivary IgA concentrations with high altitude exposure (Tiollier et al, 2005b; Pyne et al, 2000). The fact that at day 6, 24 hours after the last activity, a period consisting mainly of resting, the salivary IgA concentrations and secretion rates were still decreasing, suggests that intense exercise repeated daily has a cumulative negative effect on salivary IgA levels. There have been very few studies that have examined the effect of exercise on immune function while at altitude. It is likely that hypoxia may represent an added stressor to that imposed by exercise

alone. Klokker et al (Klokker et al, 1993) have shown that the combined effect of exercise and hypoxia resulted in a more dramatic effect on the NK cell response when compared to exercise in normoxic conditions. These results suggested a cumulative adverse effect of exercise training and altitude on mucosal immunity over time. An acute bout of exercise at altitude is an added stressor that can exacerbate immune suppression, most likely through sympathoadrenal mediated pathways (Mazzeo, 2007) increasing the risk of infection. Other stressors like sleep disturbance (which was reported by some of the participants), food restriction or deficient fluid intake have also been shown to influence mucosal immunity (Walsh et al, 2011) and may also have influenced recovery. These were not controlled and represent one of the drawbacks of this investigation.

At altitude, monitoring of salivary IgA levels, as well as other markers of mucosal immunity like lactoferrin, alpha-amylase and lysozyme, may be of some importance in order to prevent upper respiratory tract symptoms in athletes.

REFERENCES

Gleeson M, Pyne DB, Callister R. The missing links in exercise effects on mucosal immunity. Exercise Immunology Review 2004; 10:107-28.

Gleeson M. Mucosal Immunity and respiratory illness in elite athletes. Int J Sports Med 2000; 21:33-43.

Klokker M, Kharazmi A, Galbo H, Bygbjerg I, Pederson BK. Influence of in vivo hypobaric hypoxia on function of lymphocytes, neutrocytes, natural killer cells, and cytokines.J. Appl. Physiol. 1993, 74: 1100-1106.

Libicz S, Mercier B, Bigou N, Le Gallais D, Castex F. Salivary IgA response of triathletes participating in the French Iron Tour. Int Sports Med 2006;27:389-94.

Mazzeo RS. Altitude, stress and exercise. in Conferences in exercise immunology, Ed. AM Teixeira, Centro de Estudos Biocinéticos, 2007, pp71-83.

Mazzeo, RS. Altitude, exerciseandimmunefunction.Exercise Immunology Review 2005; 11:6-16.

Pedersen BK, Hoffman-Goetz L. Exercise and the immune system: regulation, integration, and adaptation. Physiol Rev 2000; 80:1055-1081.

Pyne DV, McDonald WA, Morton DS, Swigget JP, Foster M, Sonnenfeld G, Smith JA. Inhibition of interferon, cytokine, and lymphocyte proliferative responses in elite swimmers with altitude exposure. J Interferon CytokineRes. 2000 Apr;20(4):411-8.

Teixeira AM, Rama L, Martins M and Cunha MR. Kinetic response of salivary IgA to several exercise protocols performed by well trained swimmers. Revista Portuguesa de Ciências do Desporto 2006; 6(supl2): 177-179.

Tiollier E, Gomez-Merino D, Burnat P, Jouanin C, Bourrilhon C, Filaire E, Guezennec CY, Chennaoui M. Intense training: mucosal immunity and incidence of respiratory infections. Eur J of Appl Physiol. 2005a; 93(4): 421-428.

Tiollier E, Schmitt L, Burnat P, Fouillot JP, Robach P, Filaire E, GuezennecC,Richalet JP. Living high-training low altitude training: effects on mucosal immunity. Eur J Appl Physiol. 2005b; 94(3):298-304.

Walsh NP, Gleesom M, Pyne DB et al. Position Statement Part two: Maintaining immune health. Exercise Immunology Review, 2011; 17: 64-103.

1 • RESEARCH ARTICLES PHYSICAL ACTIVITY

HEALTH BEHAVIOUR, BODY COMPOSITION AND MOTOR PERFORMANCE IN FEMALE UNIVERSITY STUDENTS

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ABSTRACT

The aims of this study were 1) to present the health awareness characteristic of the female students, 2) to characterize the differences by groups along the comparison of health behaviour**,** selected body composition attributes and cardio-respiratory performances variables.

The two groups of the sample; one group consisted of students majoring in teacher training, social pedagogy, tourism and catering, the others are majors in recreation, health promotion courses (n=109); were selected from full-time female students at the University of West Hungary. In our research we used questionnaire (for investigate health behaviour and attitude), the Rockport Fitness Walking Test (for the measurement of cardio-respiratory performance in the sub-max zone to estimate relative VO_2max) and InBody 720 bioelectrical impedance scanner (for analyzing body composition). For the analysis, descriptive statistics, one-way ANOVA and Mann Whitney U test were used testing significance at the 95% level of confidence.

Differences between the group members' health behaviour was found in only one examined dimension, namely physical activity. The results of other indicators (the hours of tiredness, state of health, habits of smoking and alcohol consumption) showed identical values. We have find significant difference between the groups in the following variables: frequency of physical activity, the muscle percentage and the cardio-respiratory performance. With the exception of one segment of body composition and the results of physical activity indicators; probably due to differences in physical activity; the groups can be viewed as strongly heterogeneous.

KEYWORDS: health behaviour, body composition, motor performance, cardio respiratory system

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INTRODUCTION

The political system, the general socio-economic conditions and physical environment has been changed continuous and remarkably during the past 30 years due to the transition from the socialist model to the market economy in Hungary (Bayer and Boda 2009). Therefore the women's social expectations (work - life balance) grew significantly in this period and for this reason the examination of the women's health conditions and health behaviour comes into the foreground rather continually (Pongrácz 2001, Kopp and Skrabski 2007). Unfortunately with these positive modifications negative consequences were also associated; namely remarkable and general decrease in the people habitual physical activity (Szeitz-Szabó et. al. 2011, Paulik et al. 2010).

Since the 1970s, common changes in living standards and lifestyles have resulted in the decreasing physical performance of children, adolescence, and young adults, while body fat as a percentage of body mass has increased (Malina and Bouchard 1991, Bouchard 2000). Gáldi (2002) stated that only 30% of those aged between 15 and 84 years perform regular physical activity in Hungary, and there is a linear decrease in sports participation with an increase in age. According to his study, regular physical activity is performed by 49.9% of those aged between 20 and 29 years and there is a significant correlation (r=0,85) between the frequency of physical activities performed and qualification level.

The transition in Hungarian society with its negative characteristic appears in a considerable extent in higher education. During the academic years of college and university, sedentary lifestyles tend to be typical, the direct outcome of which is a change in body composition and cardio-respiratory performance (Kovács et al. 2002). This research area is very important because the effect of future intellectuals for the society; as pattern of healthy life style, of forming attitudes towards physical activity is significant. That is why it is pertinent to observe and measure college student's health behaviour and the factors related to them during their studies, in order to make the necessary changes.

The general aim of this study was to present the health awareness characteristic of the female students. The specific aim was to characterize the differences by groups along with the comparison of health behaviour**,** selected body composition attributes and cardio-respiratory performances variables. Therefore our research question was: Does previous habitual physical activity have an effect on the characteristics of fitness?

This manuscript will help to clarify the results of the literature in the healthy behaviour, motor performance and body composition in adults. Additionally our paper will give further insights into the connection between physical activity level and body composition, due to the results.

METHODS

A stratified random sample was used in selecting the year and date of enrollment; all of them attended the first semester. The sample (n=109) were selected from teacher training, social pedagogy, tourism and catering, recreation, health promotion courses from full-time female students at the University of West Hungary. The sample was divided into two groups according to mandatory regular physical activity. In this behavioural characteristic, there are significant differences between the two groups. The recreation and health promotion students (n=27) (M_{age}=19.52±1.4) are engaged in daily compulsory regular physical activity depend on the semester between 2-4 times a week (60-80 minutes each). This health behaviour of the teacher training, social pedagogy, tourism and catering students (n=82) (M_{age}=19.26±0.1) are at only 30-40 minutes performed ranging from 0-2 times a week.

During our research the following methods were also used. For the measure their health behaviour we used the *questionnaire* the Györ- Moson- Sopron County ÁNTSZ Health Protection Department's "Survey of habitude of the Adult Population" method (Bajtay1999). A questionnaire was used which consisted of closed-ended questions and scales in the following fields: self-evaluation (self-confidence, shyness), future prospects (hope, hopelessness), nutritional habits (quality, frequency), harmful addictions (smoking, drug use, and alcohol consumption), and physical activity (regularity, quantity) (Page et al. 2005). Questions were directed to determine the frequency of twenty-minute physical activity periods during the previous seven days, the level of satisfaction in relation to health, the number of hours of tiredness per week, and any harmful addictions, such as smoking or alcohol consumption.

A motor performance test was used for the measurement of cardio-respiratory performance in the sub-max zone with the *Rockport Fitness Walking Test* to estimate relative VO_2max ($ml*kg^{-1}*min^{-1}$). The elapsed time was measured with the Rockport Fitness Walking Test, and the relative maximum pulse rate was detected with the Polar Accurex Pulse Rate Monitor and processed and analyzed with Polar Precision Performance 3.0 Software (Version 4.00.020). The relative aerobic capacity of the tested persons was estimated with the program on the website (http://www.brianmac.dempn.co.uk/rockport-htm). In selecting the test, it was thought, from a methodological point of view, that testing the motor performance of hypoactive persons suitable for their level of activity is the primary criteria of the objective data recording. Based on this, it was assumed that the walk test would be acceptable for the students, and at the same time it would motivate them to perform better. The equation to predict max VO_2 according to Fox's physiological basis for exercise and sport is as follows: Equations to predict max VO_2 use two common field tests. Rockport one-mile fitness walking test: VO_2max ($ml * kg^{-1} * min^{-1}$) = 132.853 – (0.0769 * body weight) – (0.3877 * age) + (6.315 * gender) – (3.2649 * time) – (0.1565 * Heart Rate). The students covered the one-mile distance in windless weather conditions with fast walking, the time of which was measured and recorded by a time-measuring appliance.

To determine body composition we measured the height and weight of the students and used the *InBody 720 bioelectrical impedance scanners* for the estimation of relative body fat

and muscle mass content (www.e-inbody.com/Tech/paper.html). The InBody 720 (Biospace Co, Korea) is a multi-frequency impedance plethysmograph body composition analyzer which takes readings from the body using an eight-point tactile electrode method, measuring resistance at five specific frequencies (1 kHz, 50 kHz, 250 kHz, 500 kHz, and 1 MHz) and reactance at three specific frequencies (5 kHz, 50 kHz, and 250 kHz). From these body size measures, the body mass index (BMI) was also calculated. The World Health Organization (WHO) has established 11 different categories of BMI. We used three fused categories on the basis of WHO's categories for the nutritional status (*thin* = underweight, shevere thinness, moderate thinness, mild thinness; *normal* = normal range; *overweight* = overweight, pre-obese, obese, obese class I, obese class II, obese class III) (WHO 2004). We used the technical prescriptions of the International Biological Program [Weiner JES, Lourie JA (eds). (1969)].

Statistics for Windows (version 7.1, StatSoft Inc., Tulsa, OK 74104, USA, 2006) was used for the measured and derived data. As the first step of the statistical analysis the conventional descriptive statistical parameters were calculated (mean, variance and variation range) in each group. Differences of the mean values of the groups were analyzed with Analysis of Variance (ANOVA) test, and Mann Whitney U test. During the evaluation of statistical results the maximal allowed random error was 5% for a 95% level of confidence.

RESULTS

The statistical parameters of the examined groups' anthropometric characteristics are presented in Table 1. Our samples are homogenous regarding age, the relative variances of means are low (0.06% and 0.05%). The examined students regarding their height and weight as in normal/healthy development status (Bodzsár 1999, Fehérné 1999). There were not any significant differences between means of height and body weight, the variance similar to other Hungarian samples (Szakály 2002, Szakály et al. 2003). Relative variance (coefficient of variance) of the mean body weight mainly among social pedagogue-tourism-teacher (STT) students and the differences of end values refer to the body composition's differences derivate from nutritional status. Variances of the average body weight of students from STT faculty (STT: 19.6%), recreation organizer and health developer (RHE) faculty (RHE: 11.7%) and differences of end values (STT: 40-99 kg, RHE: 45-74 kg) refer to significant heterogeneity of the group.

According to the WHO categories, four (14.8%) and eight (9.7%) students were thin from RHE and STT respectively. Twenty one (77.0%) and 54 (65.8%) students belonged to normal categories from the RHE and STT faculty, respectively. And two (7.4%, RHE) and 20 (24.4%, STT) individuals were overweighed. We have not found significant differences between two groups. We measured and analyzed two component of body composition. In Table 1 we are presenting the body fat content and the muscle mass values as well. The

muscle mass values are the following: RHE students 41.2 ±4.6 (35.0 – 46.6) and STT students 39.1 ±5.0* (25.6 – 46.5). We have found in this characteristic significant difference between two examined groups.

Characteristics of the groups' health behavior are presented in Table 2. Frequencies of answers for some questions in our questioner regarding health awareness can be seen. We asked about the frequency of free time physical activity lasting for at least 20 minutes per day when examining habits of physical activity. Regarding this question the following scale was used: from never (1) to 7 times a week (8). For the evaluation of own health a 3-point-scale was used (very healthy (1), healthy (2), not properly healthy (3), for the relative fatigue a 4-point-scale (rarely (1), occasionally (2), 3 times a week (3), 4 times a week or more (4), and for the assessment of harmful habits a 5-point-scale (never (1), rarely (2), monthly (3), weekly (4), every day (5).

The frequency of regular physical activity in the RHE group is very diverse. It is thought-provoking that there are nine students whose regular physical activity does not reach the healthy limit, which means 3 times a week. In the STT group the "never" and the 1-2 times a week were the most common answers. This group can be considered hypoactive regarding physical activity. There are no significant differences between the groups regarding the evaluation of own health condition and the presence of fatigue during the week. No significant differences could be revealed between the groups regarding harmful behaviors, like smoking and alcohol consumption. The groups did not differ significantly regarding the evaluation of health condition, the feeling of morning fatigue and the harmful habits – smoking, alcohol consumption. Significant difference between the groups could only be found in the physical activity.

Using tests which measures motor abilities and examining body structure the physical condition of an actual age-group can be estimated. The use of these in the general education is a part of the curricular requirement, but is not very wide-spread in higher education.

For describing the physical activity the Rockport Fitness Walking test was used. Results of the test and estimated, relative aerobe capacity values can be seen in Table 3. The RHE students' time is "excellent", while STT students' time is "good". Differences between the groups' means value were significant. Relative variances are mild (RHE 2.1 %, STT 6.4 %), the differences of the end values are not considerable. Variances of mean pulses are between 14.6% and 12.4%, differences of end values are significant in both groups.

DISCUSSION

The results of our examination are represent the student's health behaviour well. We have found similarities between the examined groups in the following lifestyle characteristics: the hours of tiredness, state of health, habits of smoking and alcohol consumption. The

difference of means in frequency of weekly physical activity at muscle mass percent and cardio-respiratory performance are significant.

The height and weight are the most commonly analyzed anthropometric features. These are basic values, both are characteristic index number, although the structure or the body composition cannot be reliably estimated with the body mass index (*BMI*), calculated either from one value or both (Nagy et al. 1996/97). It needs to be presented, because there are more and more comprehensive and reference data on it. Body mass index was used to assess the nutritional condition. In Hungary no current references of BMI have been prepared, so the mean values of BMI are necessarily evaluated according to the WHO recommendation.

According to the WHO's categorization both of our groups belong to the normal range. The body mass index is normal in the biggest proportion of the students, in both group (RHE 77.0%, STT 65.8%), but the number of students in the thin and overweight category is also important. Although there is not any statistically significant difference between the groups according mean BMI, but variance of means and differences of the end values shows the heterogeneity of the students' nutritional status. In the evaluation of frequencies, based on the BMI, the chain of ideas of Cole has to be considered. The authors consider the frequency of thin subjects to be also important while evaluating the nutritional status, although in the developed societies it is a consequence of fashion not the current efficiency (Cole et al. 2007).

The positive benefit of frequent physical activity on body composition is a well-known fact. Ideal amount of body fat content and muscle mass are seen among physically active subjects. There are many methods for the estimation of relative muscle mass. It is more difficult to find valid references when evaluation the data. Recommendations from American data are used during the evaluation of the results. According to Drinkwater and Ross (1980) the *optimal body* fat content is in five RHE students (18.5%) and 13 STT students (15.8%), *average* fat content can be found in seven RHE students (25.9%) and 18 STT students (66.7%) people and there are *more than the average* (dangerous) fat content in 15 RHE students (55.6%) and 41 STT students (50.0%). Frequencies of relative body fat and the differences between the end values are high and need some attention. However in case of relative muscle mass there were significant difference between the groups, although the value of the mean relative muscle mass in the relative physically acting group hardly reaches the minimum level which is required physiologically. The development of the organs of movements among STT students are under the required level due to the slight amount of physical activity. There is not any difference between the mean values of the relative body fat content. Variances are high similarly to other same samples in Hungary (Reigl, 1984, Dallos, Mészáros and ifj. Dallos 1999, Szakály 2002).

Examining the relative body components (body fat and muscle mass) significant difference between the groups was found only in relative muscle mass. However the mean relative muscle mass even in the physically active group only minimally reached the physiologically required limit. Among the STT students, due to the mild intensity of physical activity, the development of the organs of movement is under the required level. Significant proportion of RHE students' physical activity does not reach three occasions per week, while STT students

are mainly hypoactive. Anthropometric features of the optimal body fat content and muscle mass have only been proved with physically active subjects.

Significant differences between the two groups, regarding healthy behavior, have only been found in the frequency of physical activity from all characteristic. Among Hungarian college students smoking and alcohol consumption are the most frequent harmful behavior. Smoking was reported in 67% of boy and in 61% of girls. Regular alcohol consumption is in 49% of boys and in 27% of girls (Audrain-McGovern, Rodriguez and Moss 2003, Kopp and Skrabski 1995). Our results are well comparable with the results of the European Health and Behavior Survey reported by Kopp and Skrabski (1995). In the healthcare, regarding preventive health-activity, RHE students come closer to the required level only in the field of physical activity. Full awareness of health can only be reached if students change their life style towards health maintenance, so physically active lifestyle only worth if it is associated with healthy habits (Frenkl, 1993).

Analyzing cardio respiratory achievements, by the means values of the groups, significant association was found regarding relative aerobic capacity's value. Variances are mainly low and the end values are similar. Estimated, active ability of oxygen uptake is closely under the desired value 31,0-34,9 ml/kg/min. (Mészáros 1990). Evident consequence of hypo activity in STT group is that the mean values of the estimated, relative oxygen uptake only reach the lower, required limit. Coefficient of variance pulses are between 14.6% and 12.4%. Differences of end values are prominent in both groups, which illustrate properly the differences of the fitness level. The status of the cardio respiratory system significantly depends on regular physical activity, by the help of moving the process of the decrease of aerobe achievement can be slowed down. Maffeis and colleagues (1994) claim that decreased aerobic activity is basically the consequence of a lifestyle, with decreased occasion for doing exercises. According to the authors the question is more difficult when examining the aerobic achievement's development in comparison with young people with normal body weight and with overweighed people's samples. Similar consequences are seen in articles (Fletcher et al. 1992, Bouchard 2000, Cole at al. 2000, Cole et al. 2007). According to the working teams, leading by Cureton et al (1991), interpretation in evaluating cardio respiratory achievements must include the person's body components or at least the relative body fat level. Among RHE students, the detected optimal muscle mass and the body fat's level (which is in the normal area) prove the beneficial effect of body component. The effect of unfavorable proportion of muscle and fat effecting aerobe achievement can be clearly associated with the significantly lower cardio respiratory achievements among STT students.

CONCLUSIONS

Results of the tests should be analyzed with the students on theoretical lessons, during which they can be given advices on healthy special condition. We have to pay attention to

recognize that for healthy living, there is a need for reaching and maintaining the proper condition. Some words need to say about relational effect of the preventive and mental hygienic habits, proper diet, physical activity and sports. In addition should be make students conscious of body compositions and the cardio respiratory system's fitness can be significantly improved by physical activity. These facts also support the need for physical education and the importance of differentiation in the higher education.

SPECIFIC SUGGESTIONS FOR FUTURE RESEARCH AND LIMITATION

In the future it is needed to add many subject and it should be (e.g. longitudinal measurements) detecting the effects and changes with additional examinations as well.

Our examination is not representative therefore the result cannot be using for generalization applying to Hungarian population.

REFERENCES

Audrain-McGovern, J., Rodriguez, D., & Moss, H.B. (2003). Smoking progression and physical activity. *Cancer Epidemiology Biomarkers & Prevention*, 12, 1121-1129

Bajtay A. (ed) (1999) Gyor-Moson-Sopron MegyeEgeszsegTerkepe 1991-1996. Antsz Gyor-Moson-Sopron MegyeiIntezete.

Bayer, J. & Boda, Zs. (eds) (2009). A rendszerváltás húsz éve: változások és válaszok (Twenty years of transition: changes and responses). Budapest: L'Harmattan MTA PTI

Blair, S.N., &Brodney, S. (1999). Effects of physical inactivity and obesity on morbidity and mortality: current evidence and research issues. *Medicine and Science in Sports and Exercise,* 11(Suppl.),646-662

Bodzsár, É. (1999). Humanebiology. Budapest: ELTE ÖtvösKiadó. 289, 88-89

Bouchard C (2000) Physical Activity and Obesity. Human Kinetics Champaign, Illinois

Cole, T.J., Bellizzi, M.C., Flegal, K.M., & Dietz, W.H. (2000). Establishing a standard de-finition for child overweight and obesity worldwide: *international survey. British Medical Journal, 320, 1-6*

Cole, T.J., Flegal, K.M., Nicholls, D., & Jackson, A.A. (2007). Body mass index cut offs to define thinness in children and adolescents: international survey. *British Medical Journal*, 335, 194-202

Cureton, K.J., Baumgartner, T.A., & McManis, B.G. (1991). Adjustment of 1-mile run/walk test scores for skinfold thickness in youth. *Pediatric Exercise Science*, 3, 152-167

Dallos S., Mészáros J., ifj. Dallos S. (1999): Rendszeresen nem sportoló férfiak testösszetétele és fizikai teljesítménye. *III. Országos Sporttudományi Kongresszus II. kötet,* 174-176.

Drinkwater, D.T. & W.D. (1980). Anthropometric fractionation body mass. In Ostyn, M. Beunen,G. And Simons, J. (Eds): Kinanthropometry II. Baltimore: University Park Press.

Fehérné M. I. (1999). Neither better, neither lesser Györ: SzéchenyiNyomda. 7-13

Fletcher, G.F., Blair, N., & Blumenthal, J. (1992). Statement on exercise. Benefits and re-commendations for physical activity programs for all Americans. Circulation, 86, 340-344

Frenkl R. (1993): *Testkultúra - Mentálhigiéné- Megelözés*. I. OrszágosSporttudományosKongresszus. Bp. 43 - 46

Gáldi, G. (2002). FizikaiaktivitásMagyarországonazezredfordulón. [Physical activity in Hungary at the turn of the century] *Magyar SporttudományiSzemle,* 3-4, 16-18

Kopp, M., &Skrabski, Á. (1995). Practical behaviour science Budapest: CorvinusKiadó.

Kopp, M., &Skrabski, Á. (2007). Nöiszerepek a maimagyartársadalomban. http://www.vigilia.hu/2007/7/kopp.htmAccessed on 04.06. 2011-10-21

Kovács, E., Keresztesi, K., Gombocz, J., András-Teleki J., &Kovács, I. (2002). Role of physical education in higher education and possibilities for its development. *Kalokagathia,* 40, 114-121

Maffeis, C., Schena, F., Zaffanello, M., Zoccante, L., Schulyz, Y., &Pinelli, L. (1994). MaximaAl aerobic power during running and cycling in obese and non-obese children. *ActaPaediatrica,* 83, 113-116

Malina, R.M., & Bouchard, C. (1991). Growth, Maturation, and Physical Activity. Human Kinetics Books, Champaign, Illinois

Mészáros, J. (1990). A gyermeksportbiológiailapjai. Sport Kiadó, Budapest

Morris, J., & Hardman, A. (1997). Walking to Health. *Sports Medicine*23, 306-332

Nagy, N.K., Mészáros, J., &Farkas, A. (1996/97). Assessment of body composition of physically active male youth. *AnthropologiaiKözlemények*, 38, 93-100

Page, R.M., Zarco, E.P., Suwanteerangkul, J., Lee, C.M., Miao, N.F., &

Paulik, E.Bóka, F., Kertész, A., Balogh, S., Nagymajtényi, L. (2010): Determinants of health-promoting lifestyle behaviour in the rural areas of Hungary. Health Promotion International Volume 25, Issue 3, 277-288

Pongrácz Tné (2001). A család és a munka szerepe a nök életében. http://www.tarki.hu/adatbank-h/kutjel/pdf/a503.pdf. Accessed on 04.06. 2011-10-27

Reigl M. (1984): 18-22 éves egyetemi hallgatók fizikai erönléte. *A Testnevelési Föiskola közleményei,*1: 145-167

SzakályZs. (2002). Physique, body composition and motor performances in college students. *Hungarian Review of Sport Science.* Special Issue, 24-29

Szakály, Zs.,Ihász, F., Király, T., Murai, B., &Konczos, Cs. (2003). Testalkat, testösszetétel és az aerob teljesítmény hosszmetszeti vizsgálatának tapasztalatai nöi föiskolai hallgatóknál. *Magyar Sporttudományi Szemle*. 3 (1), 30-32

Szeitz-Szabó, M. , Bíró, L. , Bíró, Gy. , Sali, J. (2011): Dietary survey in Hungary, 2009. Part I. Macronutrients, alcohol, caffeine, fibre. ActaAlimentaria Volume 40, Issue 1, 1. 142-152

Weiner, J.E.S., Lourie, J.A., (Eds.). (1969). *Human Biology. A Guide to Field Methods.* IBP Handbook, No. 9. Oxford: Blackwell Scientific Publishers

WHO 2004, http://apps.who.int/bmi/index.jsp?introPage=intro_3.html

www.e-inbody.com/Tech/paper.html

www.brianmac.dempn.co.uk/rockport-htm

SPORT TRAINING 2

2 • SPORT TRAINING

GROWTH, MATURITY PROFILE AND PEAK VO2 OF 11 YEAR-OLD MALE SOCCER PLAYERS

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ABSTRACT

This study examined the relationship between body size, biological maturity, total amount of practice, and aerobic fitness of youth soccer players. The sample included 30 male soccer players aged 11 years old. Morphological variables (weight, height, sitting height and subcutaneous skinfolds), maturity (maturity offset, percentage of predicted mature height and skeletal maturity using the Fels method), quantity of annual practice and years of federate practice were considered. Assessment of aerobic power was obtained using a direct, maximal and progressive treadmill protocol. Data analysis considered general and comparative descriptive statistic. Pearson's correlation coefficient was calculated in order to consider the association between aerobic power outputs and morphology, maturity and sport participation parameters**. ANOVA** was used to compare variables by tactical playing position and among maturity status groups. Significance was maintained in 5%. The maturity status-associated analysis classifies more subjects on time (53%) followed by early mature (27%) and late mature (20%). Subjects classified as early matures showed higher average results for the morphological parameters (excluding sitting height/standing height ratio), amount of playing minutes and absolute aerobic power, while maturity delayed subjects showed higher relative aerobic power marks. Results illustrate defenders as taller, heavier, higher in adiposity, with superior amount of playing minutes and better in absolute aerobic power. We found strong correlations between absolute aerobic power and weight (r=+0.90, p<0.01), height (r=+0.76, p<0.01), maturity offset (r=+0.80, p<0.01) and percentage of predicted adult height (r=+0.77, p<0.01).Moderate correlation between absolute aerobic power and amount of playing minutes (r=+0.34, p<0.05) was also found. Aerobic power seems to be associated with body size and maturity status. It seems that the process of sportive selection favours body size and maturity advanced athletes. Nevertheless, it seems that youth soccer coaches tend to select those players to defensive playing positions.

KEYWORDS: YouthSoccer. Biological maturity. Aerobic power.

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INTRODUCTION

Soccer is unarguably the most popular sport in the world (Reilly, Bangsbo& Franks, 2000). In the particular case of Portugal, soccer occupies a social position of great prominence (Ramos, 2002). On the other hand, as stated by Morris (2000), early identification of future elite athletes will offer greater competitive potential to the sport organizations with that kind of capability. Paradoxically, the sports models used by most of professional clubs still seem to use too much support from empirical knowledge (Vaeyens et al., 2006).

Studies related to multidimensional research on youth soccer players (Malina et al., 2000; Seabra, Maia &Garganta, 2001; Fragoso et al., 2004; Malina et al., 2005; Philippaerts et al., 2006; Vaeyens et al., 2006; Malina, Ribeiro, Aroso& Cumming, 2007; Figueiredo, Gonçalves, Coelho e Silva &Malina, 2009) have been increasing in the last decade, but still left open more discriminating analysis considering factors of metabolic response trough the use of laboratory tests.

Due to the length of the game, aerobic metabolism is the main source in soccer (Bangsbo, 1994; Impellizzeri, Mognoni, Sassi&Rampinini, 2005; Stølen, Chamari, Castagna&Wisløff, 2005; Svensson&Drust, 2006). According to Reilly, Bangsbo& Franks (2000), the energy expenditure associated with match play revolves around 5700 kJ for a male soccer player with total body mass of about 75 kg. Maximal oxygen uptake has been studied in several studies with elite adult soccer players. Considering mean values, these are located between 56 and 69 $ml.kg^{-1}.min^{-1}$ (Reilly, Bangsbo& Franks, 2000). Although Wisløff, Helgerud& Hoff (1998) point out that the average values for elite player can be greater than 65 $ml.kg^{-1}.min^{-1}$ (considering variability associated with tactical playing position), Reilly (2004) suggests that there is a threshold value of about 60 $ml.kg^{-1}.min^{-1}$, which represents the minimum for a soccer player succeed in a contemporary elite team. Although players of different tactical playing positions have a different workload during a game, which demonstrates that some of the training sessions should be dedicated to training specific to each position, few studies of young soccer players are available to date (Gil et al., 2007).

VO2max develops just like other process related to growth and maturation during childhood and adolescence (Helmantel, Elferink-Gemser&Visscher, 2009), appearing to occur a stabilization of values expressed per unit body mass as a result of aging (Malina, Bouchard & Bar-Or, 2004b). Furthermore, Beunen et al. (2002) found that although VO2max is largely explained by body mass, factors such as regular physical activity and his interaction with maturity status contribute independently to the VO2max. Maturity advanced boys attain higher absolute ($L.min^{-1}$) VO2max compared with delayed maturity subjects. When regarding to relative results ($ml.kg^{-1}.min^{-1}$), late maturity boys achieve higher rate of oxygen absorption per unit body mass, except in early adolescence.

Boys, as they enter puberty, experience a significant increase of VO2max that reaches maximum gains during peak height velocity (PHV), continuing to increase up to 16 years of age despite the decline in growth rate, suggesting that puberty influences improvement

in aerobic fitness by increasing body size, particularly of cardiac dimensions, lungs, muscles and circulatory system (Geithner et al., 2004; Malina, Bouchard & Bar-Or, 2004b; Armstrong &Welsman, 2005; Rowland, 2004).

Although VO2max is the most commonly used term for maximal achieved oxygen uptake, the term more appropriated and suitable for children and youth is peak oxygen uptake (Armstrong, 2006; Mamen, Resaland, Mo & Anderson, 2009), which is a stout variable that is positively associated with the determination of VO2max in adults (Welsman, Bywater, Farr, Welford & Armstrong, 2005). The purpose of this study is to examine the association between morphology, maturity assessed using more than a single methodology, amount of annual practice, and aerobic fitness of youth soccer players, considering as well tactical playing position and maturity associated patterns.

METHODS

The sample included 30 male soccer players aged 11.3 –12.3 years (11.9 ± 0.3) from three clubs in the midlands of Portugal. The athletes were grouped in four playing position categories: Goalkeepers (n = 2), Defenders (n=9), Midfielders (n=11) and Forwards (n=8). All subjects were informed of the procedures involving data recording, giving authorization for data recording and divulgation, but not personal information.

Weight, height and sitting height were taken. The triceps, biceps, subscapular, suprailiac and medial calf skinfolds (Carter and Heat, 1990) were measured. The body mass index (BMI, kg/m^2) and sitting height/standing height ratio (%) were also calculated.

Maturation was assessed through somatic indicators such as *maturity offset* (Mirwald, Baxter-Jones, Bailey, &Beunen, 2002) and *percentage of predicted adult height* (%PAH) (Khamis& Roche, 1994 and 1995). Hand-wrist radiographs were also taken in order to provide an estimate of skeletal maturity. The Fels method was used to estimate a skeletal age for each child (Roche, Chumlea&Thissen, 1988). A single experienced individual assessed all the radiographs.

Chronological age (CA) was subtracted from skeletal age (SA) for each child to provide an estimate of the skeletal maturity status (Peña Reyes, Cardenas-Barahona&Malina, 1994; Malina et al., 2000; Peña Reyes &Malina, 2004) for each subject as follows:

- *Late* (delayed) = SA behind CA by more than one year;
- *Average* (on time) = SA within plus or minus one year of CA;
- *Early* (advanced) = SA ahead of CA by more than one year.

Assessment of aerobic power (peak VO2) was obtained using a direct, maximal and progressive treadmill protocol. Initially the children were habituated to both the general

environment and the specific experimental procedures and then they warmed up by running on the treadmill at a speed of 5 km/h for 3 minutes, ending at the initial speed of the protocol, 8 km/h. The test had its beginning at aspeed of 8 km/h with an increment of 1 km/h for every stage of 3 minutes. After setting the speed of 12 km/h on the fifth stage the load increments were promoted trough slope, where in each stage increased 2.5%.

The test was performed until voluntary exhaustion of the subject. After finishing the test, every subject performed an active recovery (5 minutes) on a bicycle ergometer Monarc 824E, without charge, at a constant speed of 60 rpm. If thechild showed signs of intense effort (hyperpnea, facial flushing, unsteady gait, sweating), supported by a heart rate leveled about 220 bpm^{-1} minus age in years (range ±5%) and a respiratory exchange ratio at least 1.0, peak VO2 was accepted as a maximal index. Also, when an increase not exceeding 2 $ml.kg^{-1}.min^{-1}$ despite an increase in load was verified, the attainment of VO2max was accepted as well (Armstrong, Welsman&Winsley, 1996; Armstrong, Welsman& Kirby, 1998; Armstrong &Welsman, 2001; Geithner et al., 2004; Malina, Bouchard & Bar-Or, 2004b).

Throughout the tests, inspired and expired gases were monitored continuously using an analysis system (*MetamaxErgospirometry System;Cortex Biophysite GmbH 1991-1998*) that was recalibrated prior to each test. Heart rate was monitored using a cardiofrequencimeter Polar S – 810.

The authors individually registered the number of training sessions, games and respective minutes over one season (2009 – 2010) on a weekly basis. Information about the number of seasons in federate sport was also gathered for each subject.

A sample of 10 players was measured on a second occasion within one week. Intra-observer technical errors of measurement and coefficients of reliability for anthropometric dimensions were calculated. The technical error of measurement is the square root of the squared differences of replicates divided by twice the number of pairs:

$$\sigma_e = \sqrt{\sum d^2/2N}$$ (Malina, Hamill and Lemeshow, 1973).

It is also known as the measurement error standard deviation. The coefficient of reliability is based on the ratio of within-subject (r) and inter-subject (s) variances:

$$R = 1 - (r^2/s^2)$$ (Mueller and Martorell, 1988).

Higher values indicate greater reliability. Technical errors and reliability coefficients for the present study are summarized in Table 1. Technical errors for anthropometric dimensions compare favorably with corresponding intra-observer errors in several health surveys in the United States and a variety of field surveys (Malina, 1995), while reliability coefficients indicate high reliabilities.

Table 1.Intra-observer technical errors of measurement (σe) and reliability coefficients (R) for anthropometric dimensions (n=10).

	σ_e	R
Weight, kg	0.25	1.00
Height, cm	0.75	0.99
Sitting height, cm	0.72	0.97
Skinfolds, mm		
Triceps	0.50	0.98
Biceps	0.47	0.97
Subscapular	0.32	0.98
Suprailiac	0.52	0.97
Medial calf	0.42	0.99

Data analysis considered general and comparative (maturity status and playing position) descriptive statistic. Pearson's correlation coefficient was calculated in order to analyse the association between aerobic power outputs and morphology, maturity and sport participation parameters. One-way analysis of variance (ANOVA) was used to compare CA, maturity variables, body size and proportions, annual amount of practice and aerobic power by tactical playing position and among late, average (on time) and early maturing players within competitive age group. Significance was maintained in 5%.

RESULTS

Descriptive statistics for variables of biological maturity and years of federate practice are summarized in table 2. There is a greater range of variance of skeletal age (5.9 years) compared to chronological age (1.0 years), within this age group of soccer players. It was estimated that, on average, peak height velocity (PHV) will occur at about 13.8 years of age and also, moreover, the subjects of our sample are currently approximately 2.2 years from achieving this biological event.

Table 2.Descriptive statistics (mean ± sd) and range values (maximum – minimum) for biological maturity and years of federate practice (n=30).

	Minimum	Maximum	Range	Mean ± SD
Chronological Age, yrs	11.3	12.3	1.0	11.9 ± 0.3
Skeletal Age, yrs	8.7	14.6	5.9	12.0 ± 1.5
Maturity Offset, yrs	-3.10	-0.60	2.5	-2.20 ± 0.60
Age PHV, yrs	12.7	14.6	1.9	13.8 ± 0.4
PAH, %	78.8	90.7	11.9	83.6 ± 2.6
FederatePractice, yrs	1	6	5	3.8 ± 1.5

Table 3 summarizes descriptive statistics for morphology, total amount of annual practice and aerobic power. The absolute and relative mean values for peak VO2were estimated in 2.33 $L.min^{-1}$ and 60.9 $ml.kg^{-1}.min^{-1}$ respectively. There is a significant range of variation within this age group of soccer players for body mass and height, 53.7 kg and 35.0 cm respectively. The average annual volume for each player, concerning sport participation, (training sessions and games) was estimated in 7179.4 minutes.

Table 3.Descriptive statistics (mean ± sd) and range values (maximum – minimum) for morphology variables, amount of annual practice and aerobic power (n=30).

	Minimum	Maximum	Range	Mean ± SD
Weight, kg	29.4	83.1	53.7	38.8 ± 10.0
Height, cm	132.5	167.5	35.0	146.0 ± 8.1
BMI, kg/m^2	15.3	33.4	18.1	18.1 ± 3.2
SitHt/Ht Ratio, %	48.7	54.2	5.5	51.7 ± 1.3
Sum ofskinfolds, mm	19	78	59	32.0 ± 12.3
Training sessions, #	47	102	55	81.4 ± 16.1
Game sessions, #	4	24	20	15.5 ± 5.2
Annualsessions, #	54	126	72	96.9 ± 20.1
Training minutes, min	2820	9060	6240	6596.0 ± 2044.0
Game minutes, min	113	1350	1237	583.4 ± 239.6
Annual minutes, min	3210	10410	7200	7179.4 ± 2146.1
Treadmill – stage	3	8	5	5.8 ± 1.1
Treadmill – final HR, bpm	179	212	33	197.2 ± 8.8
Treadmill – RER	0.90	1.02	0.12	0.96 ± 0.03
Peak VO2, $L.min^{-1}$	1.66	3.88	2.22	2.33 ± 0.43
Peak VO2, $ml.kg^{-1}.min^{-1}$	46.7	70.1	23.4	60.9 ± 5.9

The average values and standard deviations for biological maturation and years of federate practice, grouping the subjects according to their tactical playing position, are considered in table 4. Defenders showed higher mean results for skeletal age and percentage of predicted adult height (%PAH), as well as they are significantly older (CA) and have more years in the competitive formal process (F=4.74, p<0.01). Data further demonstrates that defenders are, significantly, closer to peak height velocity (PHV) and therefore they are expected to reach that point at earlier ages, comparing to the remaining groups.

Table 4 Descriptive statistics (mean ± sd) and results of ANOVAs for biological maturity and years of federate practice, considering tactical playing position (n=28).

	Tactical Playing Position			F	p
	Defenders (n=9)	Midfielders (n=11)	Forwards (n=8)		
Variable	Mean ± SD	Mean ± SD	Mean ± SD		
Chronological Age, yrs	12.1 ± 0.2	11.7 ± 0.2	11.9 ± 0.3	6.19	<0.01
Skeletal Age, yrs	12.8 ± 1.8	12.1 ± 1.0	11.6 ± 1.2	2.80	-
Maturity Offset, yrs	-1.73 ± 0.72	-2.38 ± 0.45	-2.39 ± 0.44	3.22	<0.05
Age PHV, yrs	13.6 ± 0.6	13.8 ± 0.3	14.1 ± 0.3	1.75	-
PAH, %	85.0 ± 3.7	83.0 ± 1.8	83.1 ± 1.9	1.43	-
Federate Practice, yrs	4.8 ± 1.0	3.9 ± 1.6	2.5 ± 0.9	4.74	<0.01

* Goalkeepers (n=2) were not considered

Table 5 considers descriptive statistics for morphology, total amount of annual practice and aerobic power, according to maturity status groups - given by the difference between skeletal and chronological age. When regarding to the indicators of external morphology, we verified a growing trend for weight and height considering delayed, average and early mature groups. This trend was also established for peak VO2($L.min^{-1}$). On the other hand, when peak VO2was considered in relation to body mass ($ml.kg^{-1}.min^{-1}$) the results were significantly (F=4.42, p<0.05)higher in the late maturity group. It is also observable that the advanced maturity soccer players attained higher mean results for game sessions (16.8 annual game sessions) and game minutes (622.1 annual game minutes).

Table 5 Descriptive statistics (mean ± sd) and results of ANOVAs for morphology variables, amount of annual practice and aerobic power, considering maturity status (n=30).

	Maturity Status			F	p
	Late (n=6)	Average (n=16)	Early (n=8)		
Variable	Mean ± SD	Mean ± SD	Mean ± SD		
Weight, kg	33.1 ± 3.3	39.8 ± 12.3	41.3 ± 6.9	1.34	-
Height, cm	140.7 ± 5.4	145.6 ± 6.8	150.9 ± 10.1	3.17	-
BMI, kg/m^2	16.7 ± 0.7	18.6 ± 4.2	18.0 ± 1.4	0.75	-
SitHt/Ht Ratio, %	51.5 ± 1.0	52.2 ± 1.0	50.9 ± 1.6	2.99	-
Sum ofskinfolds, mm	23.2 ± 3.4	35.5 ± 15.3	31.6 ± 4.7	2.41	-
Training sessions, #	87.0 ± 19.7	79.1 ± 15.5	81.8 ± 15.8	0.51	-
Game sessions, #	15.2 ± 8.9	15.0 ± 4.3	16.8 ± 3.4	0.31	-
Annualsessions, #	102.2 ± 27.5	94.1 ± 18.6	98.5 ± 18.7	0.37	-
Training minutes, min	7495.0 ± 2305.3	6135.0 ± 1910.4	6843.8 ± 2107.9	1.05	-
Game minutes, min	585.2 ± 441.0	563.3 ± 197.5	622.1 ± 112.8	0.15	-
Annual minutes, min	8080.2 ± 2590.8	6698.3 ± 1962.4	7465.9 ± 2171.8	1.00	-
Treadmill – stage	6.3 ± 1.0	5.7 ± 1.3	5.6 ± 0.9	0.84	-
Treadmill – HR, bpm	201.7 ± 7.6	194.8 ± 9.1	198.8 ± 8.4	1.53	-
Treadmill – RER	0.97 ± 0.04	0.96 ± 0.04	0.97 ± 0.03	0.46	-
Peak VO2, L.min^{-1}	2.18 ± 0.22	2.29 ± 0.49	2.55 ± 0.38	1.55	-
Peak VO2, ml.kg^{-1}.min^{-1}	65.9 ± 2.4	58.5 ± 6.4	62.1 ± 4.2	4.42	<0.05

Descriptive statistics for morphology, total amount of annual practice and aerobic power, considering tactical playing position groups are summarized in table 6. Defenders are significantly heavier (F=2.87, p<0.05) and showed higher mean results for height, as well as for sumof skinfolds and body mass index. In addition to body size, defenders also attained significantly better results for absolute peak VO2 (F=3.01,p<0.05). In the meantime, when the variable is considered in relation to body mass, the mean results are higher in forwards (62.2 ml.kg^{-1}.min^{-1}) followed by midfielders (62.0 ml.kg^{-1}.min^{-1}) and defenders (59.1 ml.kg^{-1}.min^{-1}). Further more, defenders have accumulated significantly more game minutes during the previous season(F=3.84,p<0.05).

Table 6 Descriptive statistics (mean ± sd) and results of ANOVAsfor morphology variables, amount of annual practice and aerobic power, considering tactical playing position (n=28).

Variable	Tactical Playing Position			F	p
	Defenders (n=9)	Midfielders (n=11)	Forwards (n=8)		
	Mean ± SD	Mean ± SD	Mean ± SD		
Weight, kg	46.3 ± 15.6	35.7 ± 4.2	35.1 ± 2.9	2.87	<0.05
Height, cm	151.5 ± 10.4	144.2 ± 6.1	142.6 ± 6.2	2.33	-
BMI, kg/m^2	19.9 ± 5.1	17.2 ± 1.8	17.3 ± 1.4	1.44	-
SitHt/Ht Ratio, %	51.4 ± 1.3	52.1 ± 1.6	51.8 ± 0.8	0.64	-
Sum ofskinfolds, mm	37.2 ± 16.0	29.9 ± 11.3	28.1 ± 7.2	0.96	-
Training sessions, #	87.9 ± 10.2	75.6 ± 16.4	77.8 ± 19.2	1.97	-
Game sessions, #	17.8 ± 3.1	15.4 ± 3.7	12.9 ± 7.0	1.34	-
Annualsessions, #	105.7 ± 12.9	91.0 ± 19.7	90.6 ± 24.6	1.79	-
Training minutes, min	7053.3 ± 1772.5	6283.6 ± 2047.2	6322.5 ± 2495.0	0.35	-
Game minutes, min	712.8 ± 158.5	535.9 ± 140.3	433.4 ± 200.1	3.84	<0.05
Annual minutes, min	7766.1 ± 1768.2	6819.6 ± 2100.7	6755.9 ± 2582.2	0.56	-
Treadmill – stage	5.2 ± 1.2	6.2 ± 1.1	6.0 ± 1.1	1.40	-
Treadmill – HR, bpm	195.6 ± 6.2	198.7 ± 9.9	198.9 ± 9.0	0.73	-
Treadmill – RER	0.96 ± 0.04	0.98 ± 0.04	0.95 ± 0.02	1.16	-
Peak VO2, L.min^{-1}	2.66 ± 0.60	2.21 ± 0.28	2.18 ± 0.19	3.01	<0.05
Peak VO2, ml.kg^{-1}.min^{-1}	59.1 ± 7.5	62.0 ± 5.4	62.2 ± 3.9	0.66	-

* Goalkeepers (n=2) were not considered

Correlations between peak VO2 and morphology, biological maturity, and sport participation parameters are summarized in table 7. Results suggests, for absolute peak VO2, strong correlations with weight, height, body mass index, maturity offset, age at peak height velocity and percentage of predicted adult height. Moderate correlations were also found for sum of skinfolds, chronological age, skeletal age and annual game minutes. Regarding to relative peak VO2, we found a strong, negative correlation with sum of skinfolds and also negative, moderate correlations with weight and body mass index. A positive, moderate correlation with age in peak height velocity was found as well. The results suggest that maturity advanced soccer players, with larger body size, achieved better absolute peak VO2 results and, furthermore, youth soccer players with higher absolute peak VO2were more often selected by coaches during the previous season.

Table 7 - Correlations between peak VO2 outputs and morphology, biological maturity, years of federate practice and amount of annual practice (n=30).

	Peak VO2, $L.min^{-1}$	Peak VO2, $ml.kg^{-1}.min^{-1}$
Weight, kg	+0.90**	-0.56**
Height, cm	+0.76**	-0.20
BMI, kg/m^2	+0.72**	-0.63**
SitHt/Ht Ratio, %	-0.18	-0.05
Sum ofskinfolds, mm	+0.51**	-0.77**
Chronological Age, yrs	+0.46*	+0.09
Skeletal Age, yrs	+0.42*	-0.19
Maturity Offset, yrs	+0.80**	-0.32
Age PHV, yrs	-0.71**	+0.39*
PAH, %	+0.77**	-0.24
Federate Practice, yrs	+0.21	+0.09
Training sessions, #	+0.13	-0.05
Game sessions, #	+0.23	+0.11
Annualsessions, #	+0.16	-0.02
Training minutes, min	+0.04	+0.09
Game minutes, min	+0.34*	+0.03
Annual minutes, min	+0.08	+0.09

n.s. (not-significant). * (p<.05). ** (p<.01).

DISCUSSION

Assuming data from the *Centers for DiseaseControl and Prevention* – United States of America(2001) as a reference, mean heights from our sample are between the 25th and 50th percentiles. If we split the sample into tactical playing position groups, this same trend is only observed for midfielders, while forwards are located close to the 25th percentile. Defenders, on the other hand, are between the 50th and 70th percentiles. Considering mean weights, similar trends were found. However, results approximate the 75th percentile in the defenders group, taking into account tactical playing position. Physical contact, concerning soccer, is crucial in areas closer to the goals. Thus, youth soccer coaches seem to select heavier and taller players to those field areas – defenders and forwards (Figueiredo, 2007). The results from our investigation seem to fit into this conjecture, but only when regarding to defenders.

Age at peak height velocity was estimated using the maturity offset (Mirwald, Baxter-Jones, Bailey, &Beunen, 2002). Malina et al. (2006) described this method as noninvasive and efficient, whilst acknowledging some reservations to its applications. According to Mirwald, Baxter-Jones, Bailey, &Beunen (2002) the age of occurrence of this biological event can be determined in 95% of cases, with an accuracy of 1.0 years. Thus, it seems that this methodology enables to gather the subjects, with some certainty, in equivalent maturity groups (Figueiredo, 2007).

Apart from the conceptual sphere of scientific research, we believe that the ability to fit young soccer players in the growth curve rate can be quite useful as we can place the period in which the subject is growing faster, consequently more vulnerable to inadequate training plans or, therefore, more in need of a specific, individualized, training intervention. Our results suggest that peak height velocity will occur, on average, at 13.8 years of age. Similar results were already found for European population (Malina, Bouchard & Bar-Or, 2004b) and for youth soccer players (Philippaerts et al., 2006).

The distribution of soccer players in the categories resulting from the discrepancy between skeletal age and chronological age evidence that the group classified as average or "on time" has a higher presence (53.3%), followed by early matures (26.7%) and late matures (20.0%). These results are in line with the evidence reported by Malina (2004a), in which young athletes (boys) tend, with some exceptions, to be "on time" or early matures. In the meantime, Le Gall, Carling & Reilly (2007) found, with a considerably larger sample of soccer players (n=233) but with an older age group (Under 14), a substantial lower percentage of late matures. This evidence seems to meet the trends reported by Malina et al. (2000), Peña Reyes &Malina (2004) and Figueiredo, Gonçalves, Coelho e Silva &Malina (2009), regarding that with sport experience and aging maturity advanced athletes seem to appear more frequently within their respective specific sports. We have, however, to establish a limitation when approaching to Le Gall, Carling & Reilly (*op cit.*) study, since the skeletal age method used (Greulich-Pyle) was different from the one we used in the present study (Fels).

Young athletes tend to have higher levels of aerobic power per unit body mass than the general population children and youth non-athletes (Malina, Bouchard & Bar-Or, 2004). This trend finds echo in previous researches (Eisenman, Pivarnik&Malina, 2001; Chamari et al., 2004; Montfort-Steiger, Williams & Armstrong, 2005; Metaxas, Koutlianos, Kouidi&Deliggianis, 2005; Castagna, Impellizzeri, Rampinini, D´Ottavio&Manzi, 2008). Our results strengthen the framework of evidence and show youth soccer players as athletes who demonstrate values of relative peak VO2 similar to those find for their peers from other sports. Yet, it must be considered that among the referenced studies only the investigation of Eisenman, Pivarnik&Malina (*op cit.*) corresponds to the age group of our sample. The other sample sets are between 15.7 and 18.1 years of age. In the meantime, and considering only age groups similar to our sample of soccer players, our results were higher than those found in groups of healthy children reported in the studies of Armstrong, Kirby & McManus (1995), Rowland, Goff, Martel &Ferrone (2000), Vinet et al. (2003) and Gursel, Sonel, Gok&Yalçin

(2004). This trend is also verifiable if the results are compared with healthy trained children (Nourry et al., 2004). When the values are considered in absolute terms, the evidence remains, considering all the studies already referenced.

Our study does not fit the perspective characterized by Stølen, Chamari, Castagna&Wisløff (2005), which stated that youth soccer players tend to show lower values of relative VO2max (<60 $ml.kg^{-1}.min^{-1}$) compared to adult athletes. However, there is still a gap to be filled when it comes to analyzing studies with young soccer players in pubescent ages.

There is a strong association between maximum oxygen consumption and body size (Malina, Bouchard & Bar-Or, 2004b). The same authors reported that there appeared to be a stabilization of the values expressed per unit body mass, as a result of aging, suggesting a proportional increase between the maximum oxygen consumption and body size. These evidences seem to be observable in our study, as it is clear a very high degree of association between absolute aerobic power and body mass. We found, as well, high correlations with height and body mass index. When the values of aerobic power are considered in relation to body mass, the most obvious sign is that all associations are to be inversely proportional and of lesser magnitude of correlation, except the sum of skinfolds, which still presents a strong, negative correlation.

Our study seems to point towards that young soccer players who are advanced in maturity, achieve better results in the test of aerobic power. However, when peak VO2 considers body mass, late mature athletes seem to get better results. These findings are in line with Malina& Bouchard (1991) and Armstrong &Welsman (2001). This trend is further strengthened by the values of aerobic power in young soccer players according to maturity status given by the discrepancy between skeletal age and chronological age. In the present investigation the highest values of absolute aerobic power were estimated for the advanced maturity status group. On the other hand, when the figures take into account the body weight, it appears that is the group of delayed maturity status that presents the higher results.

The present investigation seem to confirm the trends that, on the one hand, improvements in aerobic fitness are associated with maturation and increased body size (Armstrong &Welsman, 2005; Geithner et al., 2004; Malina, Bouchard & Bar-Or, 2004b) and, secondly, young athletes who are maturity advanced are privileged in relation to their peers "on time" and delayed (Peña Reyes &Malina, 2004; Figueiredo, Gonçalves, Coelho e Silva &Malina, 2009).

The sample from the present investigation corresponds to the same specific age group (11-year-olds), which restraint in the comprehension and inference about the sport training process. Upcoming studies should extend the sample and the number of subjects for each tactical playing position, as well as to monitor the data quality control for skeletal age and aerobic power variables. Since the interpretation of aerobic power in young people is confounded by the need of suitably partition out body size variation, the use of scaling techniques is needed.

CONCLUSIONS

Our study supports the reported evidences which state that aerobic power increase in direct proportion to body mass. It is also supported that maturity advanced boys attain higher absolute peak VO2($L.min^{-1}$) but, on the other hand, maturity delayed boys reach higher peak VO2 results per unit body mass ($ml.kg^{-1}.min^{-1}$). Regarding to tactical playing position, the defenders from our sample showed higher results for morphology, biological maturation and absolute peak VO2. They also attained higher values concerning to annual average game minutes. In other words, they were chose more often by coaches in their respective competitive process.

The evidence from our study seems to point that coaches tend to select young maturity advanced athletes to areas of the field nearest to the goal posts (where physical contact seems to be crucial). It seems to subsist, moreover, a hypothetical exacerbated concern about the defensive process, since the young players classified as forwards, besides less selected by coaches compared to defenders and midfielders, were also smaller, thinner and delayed in the maturity process.

Each tactical playing position seems to be related to a different functional and morphological profile that may, however, be related to the sport selection process, when using the maturity status of the young soccer player as the main criterion. Furthermore, youth soccer coaches must be aware that, besides playing position patterns and even in the same particular age group, there are significant differences regarding to morphology and aerobic fitness of youth soccer players in the same age group, so the training process itself must be carefully defined and adapted. Subsequently, more studies are needed.

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REFERENCES

Armstrong, N., Kirby, B., &McManus, A.M. (1995). Aerobic fitness of prepubescentchildren. *Annals of Human Biology*. 22(5): 427 – 441.

Armstrong, N., Welsman, J.R., &Winsley, R.J. (1996). Is Peak VO2 a Maximal Index of Children's Aerobic Fitness?. *International Journal of Sports Medicine*. Vol. 17: 356-359.

Armstrong, N., Welsman, J.R., & Kirby, B.J. (1998). Peak Oxygen Uptake and Maturation in 12-yr Olds. *Medicine & Science in Sports & Exercise*. Vol. 30 (1): 165-169.

Armstrong, N., &Welsman, J.R. (2001). Peak Oxygen Uptake in Relation to Growth and Maturation in 11- to 17-year-old Humans. *European Journal of Applied Physiology*. Vol. 85: 546-551.

Armstrong, N., &Welsman, J.R. (2005). Essay: Physiology of the Child Athlete. *Lancet*. Vol. 336 (1) (Suppl): S44-45.

Armstrong, N. (2006). Aerobic fitness of children and adolescent. *Jornal de Pediatria*, 82 (6): 406-408.

Bangsbo, J (1994). *Fitness Training in Football – A Scientific Approach*. Bagsvaerd: HO & Storm.

Bangsbo, J., Mohr, M., &Krustrup, P. (2006). Physical and metabolic demands of training and match play in the elite football player. *Journal of Sport Sciences 24 (7): 665 – 674*.

Beunen, G., Baxter-Jones, A., Mirwald, R., Thomis, M., Lefevre, J., Malina, R.M., & Bailey, D. (2002). Intraindividualallometric development of aerobic power in 8-to 16-year-old boys. *Medicine & Science in Sports & Exercise,* 33(3), 503-510.

Carter, J.E.L., & Heath B.H., (1990). *Somatotyping: Development and Applications*. Cambridge University Press.

Castagna, C., Impellizzeri, F.M., Rampinini, E., D'Ottavio, S., &Manzi, V. (2008). The Yo-Yo intermittent recovery test in basketball players. *Journal of Science and Medicine in Sport*. Vol. 11: 202-208.

Centers for Disease Control and Prevention (2000). National Center for Health Statistics. CDC growth charts: United States. http://www.cdc.gov/growthcharts.htm.

Chamari, K., Moussa – Chamari, I., &Boussaidi, L. (2005). Appropriate interpretation of aerobic capacity: allometric scaling in adult and young soccer players. *British Journal of Sports Medicine*. Vol. 39 (2): 97-101.

Eisenman, J.C., Pivarnik, J.M., &Malina, R.M. (2001). Scaling peak VO2 to body mass in young male and female distance runners. *Journal of Applied Physiology*. 90: 2172 – 2180.

Figueiredo, A. J. (2007). Growth, Maturation and Training – A study of youth soccer players 11-15 years of age. (Englishversion for defencepurpose). Faculdade de Ciências do Desporto e Educação Física. Universidade de Coimbra. July, 2007.

Figueiredo, A. J., Carlos E. Gonçalves, Manuel J. Coelho e Silva, & Malina, R.M. (2009). Youth soccer players, 11-14 years: Maturity, size, function, skill and goal orientation. *AnnalsofHumanBiology*, 36(1): 60-73.

Fragoso, .I, Vieira, F., Canto e Castro, L., Oliveira Júnior, A., Capela, C., Oliveira, N., & Barroso, A. (2004). Maturation and strength of adolescent soccer players. *In* M. Coelho e Silva, & R.M. Malina (Eds). *Children and Youth inOrganized Sports*. Coimbra. Imprensa da Universidade.

Geithner, C.A., Thomis, M.A., Eynde, B.V., Mães, H.H.M., Loos, R.J.F., Peeters, M., Claessens, A., Vlietinck, R., Malina, R.M., &Beunen, G.P. (2004). Growth in Peak Aerobic Power during Adolescence. Medicine & Science in Sports & Exercise. Vol. 36 (9): 1616-1624.

Gil, S. M., Gil, J., Ruiz, F., Irazusta, A., &Irazusta, J. (2007). Physiological and Anthropometric characteristics of young soccer players according to their playing position: relevance for the selection process. *Journal of Strength and Conditioning Research*. 2007, 21(2), 438-445.

Gursel, Y., Sonel, B., Gok, H., Yalçin, P. (2004). The peak oxygen uptake of healthy Turkish children with reference to age and sex: a pilot study. *The Turkish Journal of Pediatrics*. 46: 38 - 43.

Helmantel, A., Elferink-Gemser, M., Visscher, C. (2009). Trainability of VO2max during childhood and adolescence. *In* Coelho e Silva M, Figueiredo A, Elferink-Gemser M & Malina R (Eds.). *Youth Sports: Participation, Trainability and Readiness.* Imprensa da Universidade de Coimbra.

Impellizzeri, E., Mognoni, P., Sassi, A., &Rampinini, E. (2005). Validity of a submaximal running test to evaluate aerobic fitness changes in soccer players. *In* Reilly, T., Cabri, J. &Araújo, D. (Eds). *Science and Football V – The Proceedings of the Fifth World Congress on Science and Football.* 105 - 111.

Khamis, H. J., & Roche, A. F. (1994). Predicting adult stature without using skeletal age: the Khamis – Roche method. *Pediatrics*, 94 (4), 504-507.

Khamis, H. J., & Roche, A. F. (1995). Predicting adult stature without using skeletal age: the Khamis-Roche method. *Pediatrics – erratum*, 95(3), 457.

Le Gall, F., Carling, C., & Reilly, T. (2007). Biological maturity and injury in elite youth football. *Scandinavian Journal of Medicine and Science in Sports*. 17: 564 – 572.

Malina, R.M., & Bouchard, C. (1991). *Growth, Maturation and Physical Activity. Champaign, Illinois.*: Human Kinetics Publishers.

Malina, R.M. (1995). Anthropometry. In Physiological Assessment of Human Fitness, edited by P.J. Maud and C. Foster (Champaign, IL: Human Kinetics), pp. 205-219.

Malina, R.M., PeñaReyes, M.E., Eisenmann, J.C., Horta, L., Rodrigues, J., & Miller, R. (2000). Height, mass and skeletal maturity of elite Portuguese soccer players aged 11± 16 years. *Journal of Sports Sciences*, 2000, 18, 685-693.

Malina, R. M., (2004a). Growth and Maturation: basic principles and effects of training. *In* M Coelho e Silva, RM Malina (Eds). *Children and Youth in Organized Sports.* Imprensa da Universidade de Coimbra / Coimbra UniversityPress.

Malina, R.M., Bouchard, C., & Bar-Or, O. (2004b). *Growth, maturation and physical activity*, 2nd Edition. Champaign, IL: Human Kinetics.

Malina, R.M., Cumming, S. P., Kontos, A.P., Eisenmann, J.C., Ribeiro, B., &Aroso, J. (2005). Maturity-asociated variation in sport-specific skills of youth soccer players aged 13-15 years. *Journal of Sports Sciences,* May 2005; 23(5): 515-522.

Malina, R.M., Claessens, A.L., Van Aken, K., Thomis, M., Lefevre, J., Philipparts, R., &Beunen, G. (2006). Maturity offset in gymnasts: application of a prediction equation. *Medicine and Science in Sports and Exercise*, Vol. 38 (7): 1342-1347.

Malina, R.M., Hamill, P.V.V., and Lemeshow, S. (1973). Selected measurements of children 6-11 years, United States. Vital and Health Statistics, Series 11, No. 123 (Washington, DC: Department of Health and Human Services, U.S. Government Printing Office).

Malina, R.M., Ribeiro, B., Aroso, J., &Cumming, S.P. (2007). Characteristics of youth players aged 13-15 years classified by skill level. *Br J Sports Med 2007*; 41: 209-295.

Mamen, A., Resaland, G.K., Mo, D.A., & Anderson, L.B. (2009). Comparison of Peak Oxygen Uptake in Boys Exercising on Treadmill and Cycle Ergometers. *In* T Jurimae, N Armstrong, J Jurimae (Eds). *Children and Exercice XXIV.* Oxfordshire, Routledge, pp: 223 – 226.

Metaxas, T., Koutlianos, N., Kouidi, E., &Deligiannis, A. (2005). Comparative study of field and laboratory tests for the evaluation of aerobic capacity in soccer players. *Journal of Strength and Conditioning Association*. Vol. 19 (1): 79-84.

Mirwald, R.L., Baxter-Jones, A.D.G., Bailey, D.A., & Beunen, G.P. (2002). An assessment of maturity from anthropometric measurements. *Medicine and Science in Sports and Exercise*, 34 (4), 689-694.

Montfort-Steiger, V., Williams, C., & Armstrong, N. (2005). The reproducibility of an endurance performance test in adolescent cyclists. *European Journal of Applied Physiology*, 94: 618-625.

Morris, T. (2000). Psychological characteristics and talent identification in soccer. *Journal of Sport Sciences,* 18, 715-726.

Mueller, W.H., and Martorell, R. (1988). Reliability and accuracy of measurement. In Anthropometric Standardization Reference Manual, edited by T.G. Lohman, A.F. Roche and R. Martorell (Champaign, IL: Human Kinetics), pp. 83-86.

Nourry, C., Fabre, C., Bart, F., Grosbois, J.M., Berthoin, S., &Mucci, P. (2004). Evidence of exercise-induced arterial hypoxemia in prepubescent trained children. *Pediatric Research.* 55: 647 – 681.

Peña Reyes, M.E., Cardenas-Barahona, E., &Malina, R.M. (1994). Growth, physique, and skeletal maturation of soccer players 7-17 years of age. *HumanbiologiaBudapestinensis*, 5, 453-458.

Peña Reyes, M.E., &Malina, R.M. (2004). Growth and Maturity Profile of Youth Swimmers in México. *In* M Coelho e Silva, R Malina (Eds). *Children and Youth in Organized Sports*. Coimbra: Imprensa da Universidade.

Philippaerts, R.M., Vaeyens, R., Janssens, M., Van Renterghem, B., Matthys, D., Craen, R., Bourgois, J., Vrijens, J., Beunen, G. & Malina, R.M. (2006). The relationship between peak height velocity and physical performance in youth soccer players. *Journalof Sports Sciences,*March 2006; 24(3): 221 – 230.

Ramos, F. (2002). *Futebol – Da "Rua" à Competição*. Centro de Estudos e Formação Desportiva, Lisboa.

Reilly, T., Bangsbo, J., & Franks, A. (2000). Anthropometric and physiological predispositions for elite soccer. *Journal of sports Sciences*. Vol. 18: 669-683.

Reilly, T. (2004). The physiological demands of soccer: implications for youth training. *In* M Coelho e Silva, RM Malina (Eds). *Children and Youth in Organized Sports.* Imprensa da Universidade de Coimbra / Coimbra UniversityPress.

Roche, A., Chumlea, W., &Thissen, D. (1988). Assessing the skeletal maturity of the hand wrist – FELS method. Springfield, Illinois: CC Thomas.

Rowland, T., Goff, D., Martel, L., &Ferrone, L. (2000). Influence of cardiac functional capacity on gender differences in maximal oxygen uptake in children. *Chest*. 117: 629 – 635.

Rowland, T. (2004). *Children's Exercise Physiology.* 2nd Edition. Champaign Illinois: Human Kinetics.

Seabra, A., Maia, J. A., & Garganta, R. (2001). Crescimento, maturação, aptidão física, força explosiva e habilidades motoras específicas. Estudo em jovens futebolistas e não futebolistas do sexo masculino dos 12 aos 16 anos de idade. *Revista Portuguesa de Ciências do Desporto*. 2001, vol. 1, nº 2 [22-35].

Stølen T., Chamari, K., Castagna, C., &Wisløff, U. (2005). Physiology of soccer: an update. *Sports Medicine*, 35 (6): 501 – 536.

Svensson, M., &Drust, B. (2005). Testing soccer players. *Journal of Sport Sciences*. 23(6):601-618

Vaeyens, R., Malina, R., Jansses, M., Van Renterghem, B., Bourgois, J., Vrijens, J., &Philippaerts, R.M. (2006). A multidisciplinary selection model for youth soccer: the Ghent Youth Soccer Project. *Br J Sports Med* 2006; 40:928-934.

Vinet, A., Mandigout, W., Nottin, W., N´Guyen, L.D., Lecoq, A.M., Courteix, D., &Obert, P. (2003). Influence of body composition, haemoglobin concentration, and cardiac size and function of gender differences in maximal oxygen uptake in prepubertal children. *Chest*. 124: 1494 – 1499.

Welsman, J.R., Bywater, K., Farr, C., Welford, D., & Armstrong, N. (2005). Reliability of peak VO2 and maximal cardiac output assessed using thoracic bioimpedance in children. *European Journal of Applied Physiology*, 94: 228 – 234.

Wisløff, U., Helgerud, J., & Hoff, J. (1998). Strength and endurance of elite soccer players. *Medicine and Science in Sports and Exercice*, 30, 462 – 467.

2 • SPORT TRAINING

OPTIMIZATION OF THE METHOD FOR THE DETERMINATION OF THE INDIVIDUAL OPTIMAL FREQUENCY IN WHOLE BODY VIBRATIONS

F. Carlucci[1], F. Felici., M. Sacchetti

PURPOSE

Studies have shown the importance of individualizing the vibration intervention in order to produce greater effects on the neuromuscular system in less time, thereby limiting the possible side effects generated by prolonged vibration exposure.

The purpose of this study was to find the shortest protocol that allows assessment of the individual optimal vibration frequency (O.V.F.), corresponding to the highest muscle activation recorded during vibration at different frequencies.

METHODS

Twenty-nine university students underwent three different vibrating experimental protocols, maintaining a squat position.

The *C* protocol lasted 45 seconds and involved the succession of ascending frequencies from 20 to 55Hz. The vibration time for each frequency was 5 sec, with no pauses in between.

In the *R-2min* and *R-4min* protocols, frequencies were applied in random order. Vibration time was 20 seconds with a 2-minute and a 4-minute pause in the *R-2min* (20 min total) and in the *R-4min* (36 min total), respectively.

The ANOVA analysis, showed no significant differences in EMG parameters for all protocols.

RESULTS

The results suggest that the shortest protocol, like the other two, produce similar electrical activity and muscle fatigue indexes in muscle.

CONCLUSION

In conclusion, the C protocol could be equally valid in identifying the O.V.F with considerable time efficiency.

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2 • SPORT TRAINING

GOING BEYOND THE QUANTITATIVE APPROACH: A CROSS-SECTIONAL STUDY OF THE LINKAGE BETWEEN PHYSICAL ACTIVITY LEVELS, ENJOYMENT, MOTOR AND COGNITIVE DEVELOPMENT

C. Crova[1], A. Bufo, C. Pesce

PURPOSE

This study represents the first, cross-sectional step within the broader framework of an intervention study targeted to identify quality physical activity (PA) guidelines for promoting children's motor and cognitive development jointly.

We verified whether (1) the quantity and characteristics of PA practiced by children and their enjoyment in PA predict the quality of their motor development and (2) if this last, in turn, is predictive for cognitive development.

METHODS

Hundred and twenty-four primary school children, aged 6-8, from the municipality of Rome, were administered questionnaires to evaluate their PA levels (PAQ-C) and enjoyment in PA (PACES), as well as tests to assess motor (M-ABC and TGMD) and cognitive development (CAS and RNG). In addition, children's spontaneous outdoor play was evaluated by means of a questionnaire completed by parents.

RESULTS AND CONCLUSION

The results show a complex relationship, different in males and females, among the amount of structured PA, enjoyment in PA, and the development of specific motor skills. Developmental levels in different motor skill classes were predictive for the development of specific higher-level cognitive functions. This specificity supports the intent to evaluate, in the following intervention study, whether qualitatively different types of PA may selectively impact different motor skills and promote the development of high-level cognitive functions in their unity and diversity.

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2 • SPORT TRAINING

GROWTH HORMONE RESPONSE TO ACUTE EXERCISE: EFFECTS OF CHRONIC TRAINING AND ACID-BASE STATUS

D. Hammarström.[1]

PURPOSE

The study investigated whether [H^+]-dependent growth hormone (GH) response to exercise is affected by chronic alteration of acid-base status during training. The study also investigated GH secretion during acute exercise in relation to adaptation to endurance training.

METHODS

21 healthy subjects (age, 24.4 ± 2.5 yr; height, 180.9 ± 5.8 cm; weight, 78.8 ± 11.6 kg; VO_{2peak}, 48.5± 1.7 ml·kg^{-1}·min^{-1}) underwent a six week leg-cycle training. During training subjects were supplemented with either $NaHCO_3^-$, (0.4 mg·kg^{-1}) or placebo. GH response to high-intensity exercise (8 x 2-min, 1-min rest at 90% of PPO) was evaluated before and after the training during leg-cycling (under influence of $NaHCO_3^-$) and arm-cycling.

RESULTS

Exercise increased GH levels in both groups ($P < 0.05$) with no effects from $NaHCO_3^-$. Pre-training GH response to leg-cycle exercise was inversely related to the improvement in LT ($r = -0.580$, $P < 0.05$). GH response to exercise was positively correlated to relative exercise intensity and increase in [H^+] pre-training ($r = 0.477$ and 0.560, respectively, $P < 0.05$) but not post-training.

CONCLUSION

Thus, this novel finding suggests a potential role of the GH-IGF axis in the adaptive response to endurance training.

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2 • SPORT TRAINING

NEUROMUSCULAR FUNCTION IN DIABETIC PATIENTS WITH DIFFERENT DEGREES OF NEUROPATHY

J. Haxhi.[1], S. Balducci, F. Carlucci, A. Scotto di Palumbo, I. Bazzucchi, M. Sacchetti

PURPOSE

Diabetic neuropathies are a common debilitating complication of diabetes mellitus. They affect the peripheral nervous system, with a characteristic axonal loss. We tested the hypothesis that the severity of motor neural impairment would be reflected in the electrophysiological characteristics of the muscle fiber.

METHODS

18 male diabetic patients with neuropathy were divided in quartiles of motor nerve conduction velocities (group 1- patients belonging to the 1st quartile; group 2- those belonging to the 4th quartile). Their evaluation consisted in mechanical and electrophysiological assessment of the muscles involved in dorsi-flexion, knee-extension, elbow-flexion. Subjects performed the following tasks: Maximal voluntary isometric contractions (MVC); Isokinetic contractions at different angular velocities; Maximal twitch; and Time to exhaustion at 80% MVC.

RESULTS

Isometric and isokinetic strength parameters did not differ significantly between the two groups. Torque-velocity curves and MFCV were similar between groups for the tested muscles. Twitch characteristics did not vary importantly between groups. Endurance test was also non significantly different in group 1 and 2.

DISCUSSION

Voluntary and evoked contraction capacity in arm and leg muscles in diabetic patients do not follow the same impairment as neural function. MFCV is fairly well preserved in different degrees of neuropathy which do not seem to increase the impairment of neuromuscular function.

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2 • SPORT TRAINING

CARDIOVASCULAR RESPONSES TO A SHORT DURATION VIGOROUS EXERCISE TRAINING PROGRAMME IN MIDDLE AGED ADULTS

J. Mair[1]

PURPOSE

The aim of the present study was to investigate the physiological response to a 4 week progressive step exercise training protocol in a middle aged population. This protocol was designed to be time efficient, simple to perform and stimulate vigorous exercise in short amounts throughout the day. We hypothesised that cardiovascular fitness would be improved following 4 weeks of exercise training compared with a 4 week control period of no exercise.

METHODS

Thirty three sedentary but apparently healthy middle aged adults (age 59.8: ± 2.71yrs (mean ± SD), height: 167.2 ± 7.53cm, weight: 74.3 ± 13.63kg) took part in the step exercise training programme. Participants accumulated up to 9 minutes of exercise on 3 days of the week for 4 weeks at their own convenience. Exercise was individually prescribed using a linear regression prediction model, and at a target intensity relating to 80%HRr.

A repeated measures ANOVA indicated that the main effects for training (pre-test vs post-test) were statistically significant as submaximal decreases were observed in VO_2, RPE and HR ($p<0.05$).

RESULTS AND DISCUSSION

Results suggest that short bouts of stepping exercise (1) are sufficient in stimulating a vigorous exercise response in middle aged adults and (2) improve cardiovascular fitness following only 4 weeks (totalling 84mins) of training.

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2 • SPORT TRAINING

EVALUATION OF THE THREE MINUTE EXERCISE STAGE FOR MEASUREMENT OF LIPID OXIDATION IN TREADMILL WALKING IN SEDENTARY ADULTS

C. O'Hagan[1]

PURPOSE

A protocol of 3 minute cycling stages has been validated for measurements of steady-state lipid oxidation in young, trained subjects but is not valid in older, sedentary individuals, who take longer to reach steady state conditions. The shorter stage protocol has not been tested in older individuals in walking exercise, which is known to elicit higher rates of lipid oxidation than cycling.

METHODS

11 sedentary males (age 54 ±9 years, BMI 31±4 kg/m^2) performed four 6-minute bouts of treadmill walking, at intensities corresponding to 20%, 30%, 40% and 50% of their estimated VO_{2max}.

RESULTS

Data from the 2nd and 3rd minute (SHORT) and 5th and 6th minute (LONG) of each bout showed strong correlations for VO2 (r = 0.98) and lipid oxidation (r = 0.74), and moderate correlation for RER (r = 0.69). However, agreement between SHORT and LONG was tested with Bland-Altman analysis; SHORT underestimated VO_2 (mean underestimation of 47 ml/min) and RER (a mean underestimation of 0.06) and overestimated lipid oxidation (mean overestimation of 120 mg/min). There was a significant effect of exercise intensity on the magnitude of the discrepancy, with discrepancy increasing with exercise intensity for all three variables (one way ANOVA, $p < 0.05$).

CONCLUSION

3 minute exercise stages are not sufficient to establish steady state in walking exercise in sedentary, middle aged males.

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2 • SPORT TRAINING

FAT OXIDATION IN AGEING: EFFECT OF EXERCISE TRAINING

A. Scotto di Palumb[1], M. Sacchetti

INTRODUCTION

Ageing is associated with deleterious changes of energy metabolism, whereas exercise training has the potential to counteract this phenomenon. The aim of the present study was to investigate the effect of ageing, endurance training and their interaction on the oxidative capacity during exercise.

METHODS

Eight elderly master cyclists (ET) and eight age-matched sedentary controls (EU), ten young elite cyclists (YT) and nine age-matched sedentary controls (YU) underwent an incremental cycling test (35%, 45%, 55%, 65%, 75%, and 85% of VO_2max previously determined) to assess maximal lipid oxidation capacity (fat max), measured by indirect calorimetry.

RESULTS

YT showed the highest maximal fat oxidation (0.85 ± 0.14 g*min^{-1}), which was occurring between 65% and 75% of VO_2max. Differently, fat max was lower (0.26 ± 0.8 g*min^{-1}) and peaked quite early in EU. ET showed a relatively high fat oxidation capacity (0.49 ± 0.12 g*min^{-1}), which was superior and was peaking at higher intensities than in YU, who, on the other hand, had a comparable VO_2max.

DISCUSSION

The analysis of the contribution to total energy expenditure (CTEE) revealed that the intensity at which fat CTEE was equivalent to CHO. CTEE was shifted towards higher values in the trained groups. Such results indicate that chronic endurance training contrast the decay in oxidative capacity, in particular lipid oxidation capacity during exercise.

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2 • SPORT TRAINING

MOTIVATION FOR SPORT IN ITALIAN COMPETITIVE SWIMMERS: DIFFERENCES IN YOUNG COMPETITIVE AND MASTER ATHLETES

S. Amici [1], R. De Pero, L. Capranica

PURPOSE

The study aimed to investigate the motivation to sport participation in Italian competitive swimmers in relation to gender and class participation.

METHODS

To verify differences ($p<.05$) in Intrinsic Motivation (IM-toKnow, IM-toStimulation, IM-toAccomplishment) Extrinsic Motivation (EM-Identified Regulation, EM-Introjected Regulation, EM-External Regulation) and Amotivation, 737 competitive swimmers. Regional and national level, divided into two class participation (363 young 8-24yrs.374 master 25-44yrs) subgroups, were administered Sport Motivation Scale questionnaire (Pelletier et al.,1995).

RESULTS

No effect emerged for gender. Differences emerged for class participation ($Wilk'sLambda_{(7,727)}=41.063$ $p=.00;\eta p^2=.283$) with young swimmers subgroup showing highest values, with respect to master swimmers, for IM-toKnow (17.5±5.6 vs.16.1±5.9) IM-toStimulation (20.8±4.7 vs.18.9±5.4) EM-Identified Regulation (17.8±5.0 vs.15.5±4.9) EM-External Regulation (14.5±5.6 vs.9.3±4.9) Amotivation (9.2±5.0 vs. 6.6±3.7) and lower values of EM-Introjected Regulation (19.4±4.8 vs.20.1±5.4). No significant effect. Emerged for gender x class participation interaction.

DISCUSSION

According with literature (Vealey 1988).Gender differences seemed to be reduced or eliminated in elite athletes. Young competitive swimmers seem to be motivated by external incentives (Chantal et al., 1996) with an increase in anxiety (Ryan &Deci, 2000) an increased dropout risk (Pelletier et al.,2001); their higher levels of Amotivation, with respect to master swimmers, confirm these increases. Master swimmers showed less need for external approval.

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REFERENCES

Chantal, Y et al., (1996).*Inter J Sport Psychol*, 27,173-182.

Pelletier LG et al., (1995).*J Sport Ex Psychol*, 17, 35-53.

Pelletier, L G. et al.,(2001).*Motivation and Emotion*, 25, 4, 279-306.

Ryan RM &Deci EL (2000).*American Psychologist*, 55, 68-78.

Vealey, R. (1988).*Journal of Sport and ExercisePsychology*, 10, 471-478.

THE USE OF SESSION-RPE METHOD FOR QUANTIFYING A SPECIFIC TAEKWONDO TRAINING SESSION

E. Casolino[1], C. Cortis, C. Lupo, L. Capranica

PURPOSE

This study aimed to analyse the relationship between subjective (Session-RPE, Foster, 1998) and heart-rate based (Summated-HR-Zone, Edwards, 1993) measures of exercise intensity during a taekwondo training session.

METHODS

Twelve elite taekwondo athletes (F=5, M=7) performed a training session (51±14min) consisting of a specific circuit-training, which included squat jumps and kicks to the pad. During training, heart rate (HR) was continuously monitored, whereas rating of perceived exertion (RPE) was recorded at 30-min of the recovery phase. Blood lactate concentration [La] was measured at rest and 3, 6 and 9 min after the circuit-training. Pearson's correlation coefficients (r) were used to ascertain the relationship ($p<0.05$) between subjective and objective measures of internal training load.

RESULTS

A significant correlation ($r=0.762, p<0.01$) emerged between Session-RPE and Summated-HR-Zone scores. Furthermore, Session-RPE scores resulted also significantly correlated ($r=0.603, p=0.038$) to [La]peak values.

DISCUSSION

The present findings support the use of Session-RPE as a valid tool for quantifying the internal training load of elite taekwondo athletes during a specific training session. Being inexpensive and easy to administer, coaches could make use of the Session-RPE method to monitor and control their training plan.

REFERENCES

Edwards S. (1993).*The Heart Rate Monitor Book*.

Foster C. (1998).*Med Sci Sports Exerc*.

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2 • SPORT TRAINING

ANALYSIS OF RUNNING PHASE DURING TRIATHLON AND AQUATHLON COMPETITION IN YOUNG ATHLETES

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PURPOSE

This study evaluated the last running-phase during triathlon and aquathlon competitions in young athletes.

METHODS

Four Youth athletes (M=2; F=2; 16±1yrs) participating in both triathlon (running-phase 1600m) and aquathlon (running-phase 2000m) Italian championships took part in the present study. A wearable GPS (SPY-ProX, GPSSport, 15hrz) was used to record individual velocities and distance covered. To evaluate pacing-strategy, fractions of 200m mean distance were considered. ANOVA for repeated measures was used to evaluate pacing-strategy, and a student paired T-test was used to verify speed differences between triathlon and aquathlon ($P<0.05$).

RESULTS

Running during triathlon showed a 19% non significant decrement during the last 200m. Conversely, during aquathlon, athletes adopted a negative pacing-strategy with an increase of 15% in velocity between the first and the last 200m.

Differences between races emerged only at 1200m (3.6±0.6m/s for triathlon and 4.1±0.6m/s for aquathlon) and 1400m (3.6±0.7m/s and 4.1±0.8m/s, respectively).

DISCUSSION

To our knowledge, this is the first study to evaluate differences in triathlon and aquathlon running-phase. Athletes adopted a different pacing-strategy in the two races, with a trend of higher running velocities in aquathlon compared to triathlon. Further research is needed to investigate the effects of cycling or swimming on the last running phase.

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2 • SPORT TRAINING

ACTIVITY PROFILE OF A NO-PROFESSIONAL GOALKEEPER DURING OFFICIAL MATCHES

G. Condello[1], C. Lupo, A. Cipriani, A. Tessitore

PURPOSE

This study aimed to identify the activity profile of the soccer goalkeeper performance.

METHODS

A time motion analysis of a goalkeeper (age: 23 yrs) was performed during three official matches using six classes of activities (*standing*, *walking*, *jogging*, *high-speedrunning*, *sprinting*, *sliding*) and five of durations (0-5sec, 6-10sec, 11-15sec, 16-20sec, >20sec) and distances covered (0-5m, 6-10m, 11-15m, 16-20m, >20m).

Chi square was applied to verify the differences between matches and halves.

RESULTS

No significant difference between matches emerged for activities and durations, while a tidy difference for distances covered was found between first and second match (p=0.04). Furthermore, the third match showed a difference between first and second half for distances covered. The descriptive analysis indicated a high frequency of occurrence for standing (28±2%) and walking (35.2±1.2%) activities, 0-5sec (53.2±1.9%) and 6-10sec (20.7±1.6%) durations, and 0-5m (56.6±3.4%) and 6-10m (20.5±4.1%) distances covered.

DISCUSSION

This study showed as the goalkeeper's activity profile was characterized by low intensity, despite the high intensity could be very decisive in the final result of match (Di Salvo *et al.*, 2008). Moreover, the intermittent nature of the goalkeeper's performance was demonstrated by the short durations and distances performed and the continuous changing of activity.

REFERENCES

Di Salvo V, Benito PJ, Calderón FJ, Di Salvo M, Pigozzi F (2008). *Activity profile of elite goalkeepers during football match-play.*J Sports Med Phys Fitness, 48:443-446.

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2 • SPORT TRAINING

SELF-PERCEPTION OF MENTAL TOUGHNESS IN TRIATHLON, COMPARISON BETWEEN ATHLETES AND TRAINERS

G. De Ioannon[1], A. Bottoni[2]., L. Capranica, M.F.Piacentini

PURPOSE

The purpose of the present study was to analyse the complex process of talent selection in triathlon administering the mental toughness questionnaire (MTQ48).

METHODS

16 elite Italian triathletes (8 female,8 male) between 15-18 years of age and 7 national coaches agreed toparticipate in the present study.

They were requested to fill in the MTQ48 *Mental toughness questionnaire* (Clough et al 2002) during a pre-season training camp (October 2010).

Data collected from athletes were correlated ($p<0.05$) to the questionnaire completed by the trainers that were requested to evaluate their own athletes mental toughness.

RESULTS

Higher levels of mental toughness were significantly correlated to higher pressure tolerance during the training camp for male (R= 0,285) but not for females.

Athletes that had higher scores of mental toughness were selected by the national team.

We assessed that trainers overestimate some psychological features such as mental toughness, challenge's behaviour, control and confidence in abilities of their athletes.

CONCLUSION

The results demonstrate that mental toughness can be useful in talent selection. Moreover the MTQ48 has been shown to have a good reliability to monitor stressful situations. Further research is necessary to understand why the coaches' evaluation does not correspond to their athletes'.

REFERENCES

Clough, P. J., Earle, K., & Sewell, D. (2002).Mental toughness: The concept and its measurement. In I. Cockerill (Ed.), *Solutions in sport psychology* (pp. 32-43)

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2 • SPORT TRAINING

FOOTBALL INJURIES DURING SERIE A SEASON 2009/2010

F.M. Francioni[1], A. Tessitore.

PURPOSE

The present study aimed to analyze the incidence of football injuries in the most important Italian championship.

METHODS

Injuries were considered when causing an absence from a match during 380 football matches of Serie A during 2009/2010. All 736 players selected by the team to participate in the tournament were included in the study. Players were divided in three group based on the transfer's date: players in the same club during the season 2008/09 (SC), players that changed club before the first training of new team (NCB) and players moved in the new team after the first training (FNT). Players were divided in five age categories: <18years (IA, n=4;1 injury),19-21 (IIA, n=144; 3 injuries), 22-25years (IIIA, n=149; 84 injuries), 26-29years (IVA, n=204, 131 injuries), >30years (VA, n=235; 168 injuries).

RESULTS

More absences for injury were found in FNT group (474 incidence = 45788 minutes) while SC was the group with less injury (1737 incidence =167505 minute). More absences for injury were found in the VA group while IIA was the group with less injury

CONCLUSIONS

Transfer date is a factor influencing the incidence of injuries in Football. However, the football club continues the recruitment after the beginning of preseason.

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2 • SPORT TRAINING

MATURITY, ANTHROPOMETRIC AND FUNCTIONAL CHARACTERISTICS OF NON-ELITE AND SUB-ELITE YOUNG SOCCER GOALKEEPERS UNDER-15

R. Gonçalves[1]

PURPOSE

The aim of this study was to describe the maturity, anthropometric and functional characteristics in young soccer goalkeepers according to their competitive level.

METHODS

The sample included 12 young male soccer goalkeepers under-15, from the midlands of Portugal, classified as non-elite (n = 7) and sub-elite (n = 5). Height, weight, arm span, body mass index, sitting height/height ratio, four skinfolds were measured. Maturation was assed by somatic indicators. Participants performed the following tests: PACER, 7 sprints, squat jump and counter movement jump, throwing of the 2 kg medicine ball, sit-ups and 10x5 shuttle run. A non-parametric analysis was conducted.

RESULTS

Non-elite and sub-elite goalkeepers differed significantly in chronological age, maturity offset and percentage of predicted adult height (p <0.01) where sub-elite goalkeepers have already experienced peak height velocity (0.77; 95% CI: 0.26-1.29) while the non-elite haven't yet reached this event (-0.58; 95% CI: - 1.10-(-0.05)). No significant differences were found for anthropometric characteristics. For functional characteristics, differences were found for the fastest sprint, mean of 7 sprints, 2kg ball throwing (p <0.05) and 10x5-meter agility (p <0.01).

DISCUSSION

Our results suggests anaerobic performance, upper limbs muscle power and agility as discriminant characteristics for competitive level in soccer goalkeepers and supports previous evidences for soccer to privilege early maturing boys.

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2 • SPORT TRAINING

CONFIRMATORY FACTOR ANALYSIS OF THE STRUCTURE OF ITALIAN SAMSAQ

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PURPOSE

This study aimed to evaluate the factor structure of the Italian version of the Student Athletes' Motivation Toward Sports and Academics Questionnaire (Gaston-Gayles, 2005) for the assessment of academic, athletic and sport career motivations of student-athletes.

METHODS

323 Italian student-athletes (age: 19.4±3.1yrs; 48.3% high school; 51.7% college) participated in this study. The SAMSAQ was administered and responses were used to confirm a two-factor model (Academic Motivation, AM; Student Athletic Motivation, SAM). A maximum-likelihood confirmatory factor analysis (CFA) was conducted using AMOS™ 16.0 (Arbuckle, 2007), taking into account the following indices (Bishop et al., 2004): chi-square goodness-of-fit statistic (χ^2); ratio (χ^2/df); normed fit index (NFI); comparative fit index (CFI); Tucker-Lewis index (TLI); root mean square error of approximation (RMSEA).

RESULTS

CFA confirmed the two-factors model of the SAMSAQ, with 12-items loaded for SAM and 12-items for AM (7 items unrelated both with SAM and AM). For the considered indices, a good fit emerged (χ^2= 426.524; ratio= 2.2; NFI= 0.828; CFI= 0.903; TLI= 0.883; RMSEA= 0.057, 90% confidence interval).

DISCUSSION

According to the literature (Bishop et al., 2004), the two-factor model was considered appropriate for further studies aiming to evaluate the motivation toward sport and educational careers in Italian student-athletes.

REFERENCES

Arbuckle, J. L. (2007). Chicago, IL: SPSS Inc.

Bishop, D.I., Hertenstein, M.J. (2004). *Educational and Psychological Measurement*, 64(6), 1-11.

Gaston-Gayles J. (2005). *J College Student Development*, 46(3), 317-327.

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2 • SPORT TRAINING

EFFECTS OF MOTOR TASK DIFFICULTY IN RHYTHMIC ABILITY OF ARTISTIC GYMNASTS

F. Iannarilli[1], G. Vannozzi, L. Capranica

PURPOSE

Rhythmic ability is a relevant skill in sports (Zachopoulou, 2000), especially when movement executions are dictated by rhythmic constrains. Because there is scarce information on the relationship between rhythmic ability and the complexity of movement in trained subjects, this study aimed to evaluate rhythmic ability of gymnasts in relation to task complexity.

METHODS

Fourteen (M=4, F=10; age:23.4±4.3yrs) gymnasts were administered three rhythmic patterns (R1, R2, R3; Persichini&Capranica, 2004) during Finger-tapping (F), Stepping (S) and Walking (W). ANOVA for repeated measures ascertained differences ($p<0.05$) for patterns and tasks in Number of Beats (NB), Total-Duration (TD), and Rhythmic-Ratio-among-beats (RR) reproductions.

RESULTS

Only one athlete failed in reproductions NB. For TD and RR, differences emerged for patterns ($p<0.0001$), tasks ($p<0.001$), and their interaction ($p<0.01$). Worst values always emerged for R2. Walking resulted the most difficult task For RR reproduction, whereas different trends between tasks were found for TD.

CONCLUSION

Although gymnasts showed a good rhythmic ability, their performance resulted affected by both rhythmic pattern and task complexity. In particular, differences with respect to the standard were more evident in walking reproductions of the most difficult R2 pattern (Persichini&Capranica, 2004).

REFERENCES

Zachopoulou E. et al. (2000) Eur J Phys Educ,5, 220-230

Persichini C &Capranica L (2004) Int J Sport Psychol, 35, 246-265

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2 • SPORT TRAINING

TAKE-OFF ANALYSIS IN YOUNG MALE LONG JUMPERS

L. Mampieri[1], M.F. Piacentini

PURPOSE

Results from previous studies showed that long jump take-off execution can discriminate between different performance levels (Chen-Fu, 2007). The purpose of the present study was to analyze long jump technical parameters that can give useful indications to coaches.

METHODS

Twelve male athletes (age 16.4 ± 2.3 years) performed a total of 60 jumps and were analyzed during a training session. The following parameters were obtained by video analysis (DartfishTeamPro): last-step-length; touchdown-velocity; braking-ankle-speed; braking-knee-speed and propulsive-knee-speed; braking-ankle-duration and propulsive-ankle-duration; long-jump-training-distance; projection-angle and thrust-angle. A Pearson correlation was performed among all parameters and long-jump-training-distance ($P< 0.05$).

RESULTS

The following long jump parameters were significantly correlated with performance ($P < 0.05$): last-step-length ($r = -0.31$); touchdown-velocity ($r = 0.36$); projection-angle and thrust-angle ($r = 0.52$ and $r = 0.33$); braking-ankle-duration and propulsive-ankle-duration ($r = 0.35$ and $r = -0.3$); braking-ankle-speed ($r = 0.36$); braking-knee-speed and propulsive-knee-speed ($r = 0.32$ and $r = 0.48$)

DISCUSSION

The results demonstrated that angular joint speed is an important parameter to evaluate in jumpers because associated with muscular activation patterns.

REFERENCES

Bouchouras G., Moscha D., Papaiakovou G., Nikodelis T., Kollias I. EJSS, January 2009; 9(1): 53-59.

Chen-Fu H., Chen-Shou K. (2007), J. Biomech XXI ISB Congress, 2007.

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2 • SPORT TRAINING

ANALYSIS OF MENTALLY CHALLENGED PEOPLE'S MOTOR ABILITIES AND KNOWLEDGE OF MARTIAL ARTS AND THEIR CORRELATION BEFORE AND AFTER EIGHT WEEKS OF TRAINING

S. Maslesa.[1]

PURPOSE

The study aimed to establish a correlation between selected motor abilities and knowledge of martial arts as well as how and to what extent mentally challenged people who regularly practice Gan (inclusive) judo can achieve progress in their knowledge of selected technical elements of the martial arts (judo, karate, boxing and fencing) after an eight-week training programme. We were also interested in whether there were any changes in selected motor abilities.

METHODS

The training programme lasted for two months, with two sessions per week. The sample of subjects comprised five women and 18 men aged between 16 and 36, with intellectual disability.

The study was conducted using eight motor tests and nine tests of martial arts knowledge.

RESULTS AND DISCUSSION

The results of a t-test for dependent samples showed statistically significant differences between the initial and final states in seven tests of motor abilities and eight tests of knowledge. Regression analysis showed a statistically significant correlation between motor abilities and the average score in the tests of knowledge of martial arts before and after the eight-week training programme.

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2 • SPORT TRAINING

FACTORS LIMITING THE KICKING PERFORMANCE IN KARATE: ELITE VS AMATEUR KARATEKA

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PURPOSE

This study aimed to evaluate differences in the execution the Roundhouse Kick (RK) between Elite and Amateur karateka. The RK was performed with two different techniques: Low Roundhouse Kick (LRK) and High Roundhouse Kick (HRK).

METHODS

Six Elite and six Amateur karateka performed 3 LRK and 3 HRK with the dominant leg. A stereophotogrammetric system was used to acquire Kinematics data.

After data processing the angular excursion relative to: Knee Flexion-Extension (KFE), Hip Flexion-extension (HFE), Hip Ab-Adduction (HAA) and Hip Internal-external rotation (HIE) were calculated.

Peak linear velocity (PLV) of the marker placed on the Superior Anterior Iliac Spinae (RASI), Lateral Epycondil of the Femur (LE) and Lateral Malleoli (LM) were computed.

The effect of Group and Kick on angular excursion and linear velocity were tested with a two way ANOVA ($p<0.05$).

RESULTS

No effect of Group or Kick was present for the angular excursion.

Conversely, Elite karateka showed higher PLV respectively for RASI, LE, LM ($p<0.001$) in both kicks.

DISCUSSION

The higher PLV shown by Elite karateka was not paralleled by differences in technical execution. Therefore, it is likely that the higher PLV depends on an enhanced muscular performance. This aspect needs to be further investigated.

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2 • SPORT TRAINING

A FIELD TEST BATTERY TO ASSESS SPECIFIC MOVEMENTS IN YOUNG SOCCER PLAYERS

A. Scalzo[1], G. Condello, C. Minganti[2], A. Tessitore

INTRODUCTION

This study aimed to investigate the ability of young soccer players to perform movements combining accelerations, decelerations and breaking.

METHODS

Twenty-five male players (age: 14-15 years) were administered a field battery composed by four straight sprint tests [10m with arrival flight (10mF); 10m with stop on the finish line (10mSt); 15m with arrival flight (15mF); 15m with two intermediate and finishing line stops (15mISt)]; and two change of direction sprint tests [15m with arrival flight (15mCOD); 15m with arrival flight and an intermediate stop (15mCODISt)]. Individual time of performance (TP) and position on a scale (ranking) were registered for each test.

RESULTS

Distance and motor task criteria were used to pair up the mean values of tests: a) 10 m straight (10mF: 2.09±0.10sec; 10mSt: 2.46±0.14sec); b) 15 m straight (15mF: 2.88±0.16sec; 15mISt: 3.78±0.25sec); c) change of direction (15mCOD: 2.97±0.17sec; 15mCODISt: 3.20±0.17sec.).

DISCUSSION

The descriptive analysis of individual TP and ranking, for each test and between the three pairs of tests, showed that players with better score in the linear straight tests obtained often not same relevant performances and rankings in those with higher complexity, suggesting as a youth soccer players evaluation based mainly on straight tasks could be misleading.

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2 • SPORT TRAINING

INCIDENCE, RISK FACTORS AND PREVENTION OF RUNNING RELATED INJURIES IN LONG DISTANCE RUNNING: A SYSTEMATIC REVIEW

C. Tonoli[1]

INTRODUCTION

Until today, no systematic review exists on the epidemiology, etiology and prevention of running related injuries, in which a distinction is made between each running level.

METHODS

The purpose of this study was to perform a systematic review using 3 electronic databases.

RESULTS

Data were pooled to become overall injury incidences and injury localizations. Injury incidence varies between 0.1% and 2.6% ($p < 0.05$). Most common injuries sustained by long distance runners were found to be Achillestendinopathy, Iliotibial Friction Syndrome (ITBS) and Medial Tibial Stress Syndrome (MTSS). Most common risk factors are age, running history and injury history. The only significant measure for runners was the use of orthoses in the prevention of MTSS and stress fractures.

DISCUSSION

Most of the suggested preventing strategies in running lack convincing evidence of (non) randomized clinical trials or have not yet been investigated. Therefore, suggestions for prevention and future research were made.

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2 • SPORT TRAINING

TIME MOTION ANALYSIS OF YOUTH TAEKWONDO COMBATS

F. Tornello[1], C. Minganti, S. Chiodo, A. Tessitore

PURPOSE

The purpose of this study was to determine the activity profiles of youth Taekwondo competitions.

METHODS

Thirty combats, equally distributed in *light* (LW, -33, -37,-41 kg), *middle* (MW, -47, -49, -53, -57 kg) and *heavy* (HW, -61, -65, +65 kg) weight-categories, were studied during semi-finals and finals of the Italian Championship "Cadetti- A" (age: 13-14 years). Combats included three rounds (1'30" min) during which duration and number of activities were collected in relation to *fighting* (F) and *non-fighting* (NF) phases. A descriptive analysis was applied to the study.

RESULTS

The analysis of durations showed that independently from the weight-categories, F actions (LW: 2.7±1.7s; MW: 2.6±1.8s; HW: 2.6±1.8s) always lasted about one third less than those of NF (LW:6.6±4.5s; MW:6.6±4.4s; HW: 6.1±3.9s). Moreover, the F actions were longer during semifinals (2.7±1.8s) than finals (2.4±1.6s), while no difference emerged between NF actions (semifinals: 6.3±4.3s; finals: 6.3±4.2s). The analysis of events showed a slight increase corresponding to the weight categories for both F (LW:8.3±1.8; MW:8.8±2.3; HW: 9.3±2.6) and NF (LW:8.8±1.9; MW:9.3±2.4; HW: 10.0±2.4) phases.

DISCUSSION

The elevated number of events in relation to the duration of both the F and NF phases demonstrated the high intensity of combats even at this age.

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REVISION ARTICLE 3

3 • SPORT TRAINING

WHAT DISCRIMINATES ELITE AND SUB-ELITE YOUTH FIELD HOCKEY PLAYERS?

Artur Santos[1], Márcio Domingues[1], Carlos Eduardo Gonçalves[1]

KEYWORDS: youth, sport, context

INTRODUCTION

Sport influences the youth athlete development in several dimensions beyond technical and tactical skills, being source of satisfaction but at the same time acting as a promoter of attitudes and values regarded as socially positive (Kavussanu& Spray, 2006). In the last years it has been verified an increase in the number of people involved in youth sport, as athletes and their families, coaches, managers or supporters.

The youngsters involvement in sports it's related to several positive outcomes (e.g., skills development, positive relationship with peers, satisfaction, pro-social values) (Fraser-Thomas, Côté&Deakin, 2005). However, sport can pervert some values, as the case of behaviors that doesn't explicit violate the rules, but aren't socially correct. The behaviors called "useful or tactic fouls" are accepted and expected by sport managers, coaches and supporters (Cruz, Torregrosa, &Boixadós, 2007).

The established relationships between the athletes and other persons in sport context (e.g., coaches and peers), as well with the institution in which they practice sport, have an important role in sportive experiences, influencing the athletes development. According to Bronfenbrenner (1999), who proposed the Bio-ecological Modelapproach in human development, despite the various sources of influences that the young athlete is subjected, he still has an important role in his own development process.

The use of the ecological theory in youth sport studies is more and more accepted among scholars in recent years (Bengoechea&Jonhson, 2001; Strachan, 2008; Holt, 2008; Araujo, 2009).Bengoechea and Jonhson (2001) specifically refer that this is an appropriated model to examine the youngsters' involvement in sport as a developmental process.

Bronfenbrenner (1999) improved his initial theory of the Ecological Model, developing the PPCT model: "person, process, context and time". This model states that there exist particulars ways of interaction between person and context, which operate through life and relate to the primary mechanisms that produce human development. (Bronfenbrenner, 1999). The personal characteristics influence the way the subject lives, experiences and perceives the contexts in which he/her is involved. It is throughout complex and dynamic processes that

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the subject establishes active (progressively more complex and reciprocal) relationships with other individuals, objects and symbols on the immediate environment.

Two specific propositions were defined on the original Ecological model conception. To be effective this interaction has to occur on a fairly basis and through a long period. These ways of interaction with the environment are referred as *proximalprocesses* (e.g., parent(s)-child, child-child, teacher-child, coach-athlete activities).

"The form, power, content, and direction of the proximal processes effecting development vary systematically as a joint function of the characteristics of the developing person; of the environment – both immediate and more remote – in which the processes are taking place; and the nature of development outcomes under consideration." (Bronfenbrenner, 1994)

The global context, where the individual is living and where the interactive processes occur is denominated as *developmental context*, which is a complex unity, embracing both the immediate environment, where the person in development lives, and the more remote one, where the person had never been, but being strong related and having power to influence the human development. Those context sub-components are denominated:

MICROSYSTEM: here are inserted a number of activities, roles and interpersonal relationshipsthat the individual experiences in his locals of residence and activity. In school context, for example, this level concerns the relationships between peers and adults in school, child capacity to confront problems in this context. But if we refer to home context this level is referent to parents and child relationships, or between siblings. In sport case, this is related to relationships between peers, coaches, families, sport managers, through the practice and competition processes.

MESOSSYSTEM: in this level fit the interactions between two or more contexts, in which the individual has an active role. For example, interaction between home and a sport or social program, home and community services, relationships parents/educators, parents/coaches, family/community, etc. The subsystems interactions have an immediate reflex on youth development outcomes.

EXOSSYSTEM: it refers to contexts in which the subject isn't directly involved but the events in this system affect it or are affected by what happens in others contexts. The parental workplace is a place where the children don't participate directly but, it can influence and be influenced by that. For example, the mother abdication of a successful career to spend more time with her children can have consequences on the mother well-being and consequently, on the child's as well; the same is true to the fact that the relegation, discharge or workload augmentation can reflect on financial- and/or time- expenditure with the child.

MACROSYSTEM: this level concerns the sociocultural values and beliefs where all systems are set in. This is a set of social factors that inflow in a less visible manner on systems and

subsystems. As an example, the perspective through which society sees the services provided to children and families, how society deals with poverty and provide support to it can influence the childrens' education. The same is true regarding the way families solve their problems, the quality of sport programs and of the sport organizations (e.g., clubs, federations), and their sport philosophy.

CRONOSYSTEM: it appears as a final system that extends the context to a third dimension. Traditionally, when studying human development, the time passage was treated in a synonymous way with chronological age. This system embraces the consistence or the changes of the subject characteristics and of the environment where he lives, throughout time (e.g., changes in family or organizational structure, socio-economical status, job, local of residence).

Therefore, the bio-ecological approach of youth sport practice allows the researcher to analyze the context characteristics, beyond the power to assess the individual characteristics - developmental assets, values, attitudes, motivation. The context can be related to other constructs that are able to clarify the complexity of interactions that foster a positive sport experience. The practice climate has been studied mostly inside the team, reducing the analysis to the dynamics of a small group of teammates that represent the sport microsystem. The multiple and sometimes contradictory influences arising from other relevant sources in the life of the young athletes must be considered and researched, comparing contexts and assessing the potential benefits of each one of the ecological settings.

METHODS

The study of the context rises important methodological problems, making impossible the use of a single method. The procedures emphasized in this type of research are mixed, blending quantitative and qualitative methods. In this part of the text we suggest a methodological path to study two different contexts of sport practice, strongly marked by social status diversity, and the type of sport organization.

The qualitative analysis consists of a semi-structured inquiry interview as well as a descriptive exploratory analysis. The first represents a type of interview that provides more information. It consists on developing ideas using a guide orientation approach and having the interviewed introducing new reflexions and new directions. The second is justifiable to describe components of a determined social situation (micro-), trough active participation. The observed behaviours are registered and codified according the categories described in the theoretical model.

A documental search technique suitable to case studies is performed. It will enable an exhaustive and in-deep analysis of few sources of information, gathering a vast and detailed knowledge about the object, in order to describe the settings where the research is being held and, to explain the causal variables of youth sport participation in complex situations. The potential lack of methodology accuracy will be sustained by the use of triangulation, a technique described by Denzin (2007).

PARTICIPANTS AND MEASURES

Two diverse ecological settings in youth sport are studied. The sample comprehends 200 athletes from 14 through 16 years of age in two soccer clubs, one professional club and a club from a poor social and economic neighbourhood.

Three studies are performed:

STUDY 1A (PERSONS AND CONTEXT): coaches and parents from the two clubs in question are interviewed. The scope of the interview is to determine youth behaviour susceptible to be influenced by competitive sport practice. The interviews are performed in a semi-structured manner allowing the subjects to determine and dictate their own answers.

STUDY 1B (CONTEXT): the two sport microsystems, the professional club with its academy and the small amateur club are characterized. This analysis is connected to the previous one. Significant others (directors, managers, coaches, families) and their relationships with the club context, the community, the school, are interviewed, in order to reveal potential peer and adult social networks that can frame the environment.

STUDY 2 (PROCESS): the interactions among subjects are studied, in order to define an ecological paradigm. Demographic information is also collected, in order to obtain data about age, years of experience in football, scholar year, ethnic origin of the youngster and the families' socio-economic status. In this phase the instruments are quantitative: three questionnaires adapted to youth sport settings with different background practice are fulfilled. The questionnaires aim to measure the attitudes towards sportspersonship, that can be positive or negative, and the perceived motivational climate, if oriented to mastery or performance.

STUDY 3 (ANALYSIS): an inferential and predictive study, in order to relate the constructs implicit in the quantitative studies with the results of the application of Bronfenbrenner's theory to two diverse ecological settings. The teams' perceived motivational climate and sports-

manship and its effects on personal dispositions of youth athlete, and the possible emergence of a predictive model, are analyzed through structural equation modelling.

FINAL THOUGHTS

The research project presented above aims to deal with the complexity of sport participation, regarded as an interactive and dynamic process where the ecological context shows multiple levels of influences, sometimes contradictory and potential confusing to the young athletes. The study of the contexts, although with strong theoretical support, has been scarcely used in sport contexts. Furthermore the study of sport motivation has been performed mostly inside the team, limiting the influences to coaches or peers. From this point of view, Vallerand's hierarchical model (2001) has never been full exploited.

The narrative about children and adolescents' participation in sport has been scarcely approached from an ecological perspective, dealing with all the complexity of multilevel social and personal influences that frame sport experiences in a positive or negative way. As Araújo and Davis (2009) state, useful scientific knowledge is needed in order to clarify and guide the tasks of those who work on the field.

REFERENCES

Araújo, D., & Davis, K. (2009). Ecological approaches to cognition and action in sport and exercise: ask not only what you do, but where you do it. *International Journal of Sport Psychology*, 40, 1, 5-37.

Bengoechea, E. G., & Johnson, G. M. (2001). Ecological systems theory and children's development in sport: Toward a process-person-context-time research paradigm. *Avante*, 7, 1, 20-31.

Benson, P. (2002). Adolescent Development in social and community context: A program of research. In R. M. Lerner, C. S. Taylor, & A. von Eye (Eds.), *Pathways to positive development among diverse youth* (pp. 123-147). San Francisco, Ca, Jossey-Bass.

Bronfenbrenner, U. (1994). Ecological Models of Human Development. In U. Bronfenbrenner, *Readings on the Development of Children* (2nd ed.), (pp. 37-43). New York, Freeman.

Bronfenbrenner, U. (1999). Environments in developmental perspective: theoretical and operational models. In U. Bronfenbrenner, S. L. Friedman, & T. D. Wachs (Eds.), *Measuring environments across the life span: Emerging methods and concepts* (pp. 3-28). Washington. DC: American Psychological Association Press.

Chambel, M. J., &Curral, L. (1995). Psicossologia das Organizações. Lisboa, Texto Editora.

Cruz, J., Torregrosa, M., &Boixadós, M. (2007). Behaviours related to fair-play in english and spanish professional football players. In C. E. Gonçalves, S. P. Cumming, M. J. Coelho e Silva, & R. M. Malina (Eds.), *Sport and Education: Tribute toMartin Lee* (pp. 155-164). Coimbra, Coimbra University Press.

Denzin, N. (2007). Strategies of Qualitative Inquiry (3rd ed.). New York, Sage.

Fraser-Thomas, J. L., Côté, J., &Deakin, J. (2005). Youth sport programs: an avenue to foster positive youth development. Physical Education & Sport Pedagogy , 1, 19-40.

Holt, N. L. (2008). Positive youth development through sport. New York: Routledge.

Kavussanu, M., &Spray, C. (2006). Contextual influences on moral functioning of male youth footballers. *The Sport Psychologist*, 20, 1-23.

Scales, P. C., Benson, P. L., Roehlkepartain, E. C., & van Dulmen, M. (2006). The role of developmental assets in predicting academic achievement: A longitudinal study. *Journal of Adolescence* , 29, 691-708.

Slack, T. (1997). Understanding Sport Organizations: The Application of Organization Theory. Champaign, Ill, Human Kinetics.

Strachan, L. (2008). *An Ecological Approach to Examing Positive Youth Development in Competitive Youth Sport*. Ph. D. Thesis. Queen's University, School of Kinesiology and Health Studies, Kingston, Ontario, Canada.

Vallerand, R. (2001). A hierarchical model of intrinsic and extrinsic motivation in sport and exercise. In G. Roberts (Ed.), *Advances in Motivation in Sport and Exercise* (pp. 263-320). Champaign, Ill, Human Kinetics.