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TOIMETISED
CTA ET COMMENTATIONES UNIVERSITATIS TARTUENSIS

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BIOLOGICAL AND PEDAGOGICAL PROBLEMS OF PHYSICAL EDUCATION AND SPORT

III

Tõid kehakultuuri alalt

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CONTENTS

LACTATE VS RUNNING VELOCITY CURVES OF THE BRASILIAN NATIONAL SOCCER TEAM FOR THE WORLD CUP–90

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Introduction

The purpose of the study

The aim of this data collection was to obtain the physical characteristics and fitness parameters of the Brasilian soccer players selected for the World Cup-90 games in Italy and devise a conditioning programme in reliance on certain selected data. The obtained lactate/velocity curves allowed an individualization of the training procedure.

Demands and problems

At the present state of affairs, the prediction of training intensities associated with lactate threshold, fixed blood lactate concentrations using field collected data as well as the development of suitable predictive equations still need improvement. Exercise physiology laboratories are everywhere expected to develop easier and more practical tools based on advanced concepts for the coaches' daily use.

The nations interested in association football often have to face the problem of having a soccer squad of considerable heterogeneity. National teams are expected to possess the best available players in top physical condition. However, to have the talented ones in their best shape at the desired time is not so simple. Actually, the more skilled ones are playing abroad. Differences in the climate of the respective countries, the players' nutrition, training methods, social environment and seasonal readiness are some of the reasons explaining heterogeneity.

In a team sport like soccer, a lot of negative consequences may arise if the head coach is left unaware of these individual differences. Such dangers include the injuries and physical weaknesses deteriorating the performance of the skilled players, and also the employed training procedures that may be effective for some and ineffective for others.

In the high-level professional soccer of today the players have not enough time for a well-designed physical conditioning programme because of the too many games they have to play. The little time they have for conditioning must be efficiently used. The present ways of working capacity determination are not meaningful without knowing how much stress has actually been imposed on the metabolic system or how the production and removal of lactate proceeds [Jordfeldt 1970, Issekutz 1976, Essen 1975, Hermansen 1975].

The intermittent nature of soccer requires an adaptation to processing oxygen debt (acidosis) accumulated during the short dashes, despite that the intermittent effort in soccer is often apparent considering the 90 minutes of a game. The player must be adapted to get rid of excess lactate between the dashes [Donovan 1983]. Tanaka and associates' [1984] report and data suggest that the best determinant for the assessment of both peripheral and central adaptation to the respective forms of endurance is a programme of running at speeds based on lactate concentrations. So for selecting an effective individual running velocity subserving metabolic adaptation to endurance work and acidosis it is much recommendable to obtain individual lactate/velocity curves combining several lactate concentrations since low-intensity training affects the capacity of lactate removal. Dashes favour adaptation to acidosis, because VO_2max is related to central factors while lactate threshold training improves on performance by involving peripheral factors.

Methods and Procedures

A three-stage running test was employed to obtain lactate/velocity curves under field conditions. The first stage was so designed that running speed should produce about 2.2 $mM.l^{-1}$ lactate. Blood lactate concentrations of 2.2 $mM.l^{-1}$ after two treadmill runs of 10 minutes duration was found a good predictor of maximal steady state by LaFontain (1981). Farrell [1979] used a series of eight steady-state runs of 10 min duration and defined the level of 1.0 $mM.l^{-1}$ as being the onset of plasma lactate accumulation.

Several investigations [Coyle et al. 1983, Hagberg 1983] recommend a running intensity producing about 2.0 $mM.l^{-1}$ of lactate for the first point of the lactate/velocity curve as well as for a later pace of endurance training.

The choice of the 4 $mM.l^{-1}$ for the second point of the curve to be used for an individual training intensity, is based mainly on researches of the Scandinavian groups [Heck et al. 1983, Komi et al. 1981, Sjodin 1981 and 1982, Jacobs et al. 1983]. Also other investigations have shown the physiological and practical importance of this point [Wasserman et al. 1984, Davies 1985, Brooks 1985, Weltman et al. 1978, Tanaka et al. 1985, Aunola and Rusko 1986, Rusko et al. 1986].

To obtain the third point an all-out effort in a 800 m run was requested. From among a number of running distances it was the 800 m dash that correlated best with anaerobic work capacity predictions [Shaver 1975].

The ideal velocities for the running steps were based on the Brasilian soccer player's average maximal oxygen consumption per body weight. Because of the local conditions in the soccer players' training centre in Teresopolis (about 1200 metre above sea level), maximum oxygen uptake was measured on the bicycle. Though the players complained about local stiffness, the observed mean relative aerobic power ($53.4\ ml.min^{-1}.kg^{-1}$) was poorer than that predicted by the formula based on the 12-min running test ($60.2\ ml.min^{-1}.kg^{-1}$).

After considering the existing (field) conditions, however, the mean of 60.2 obtained in the 12-min running test was thought preferable for setting the ideal velocity for the running steps. Yoshida and associates (1982) examined the relationship between VO_2 and certain fixed blood lactate concentrations (1.0, 2.0 and $4.0\ mM.l^{-1}$) and found that the correlation coefficient to predict a 12-min running performance was at least 0.87.

In order to obtain the target velocity for the first stage to approximate $2.2\ mM.l^{-1}$, the 70 % point of maximal oxygen consumption was taken from the predictive equation: $VO_2max = (Distance - 504.9)/44.78$ [Cooper 1968]. By applying the regression equation suggested by the American College of Sports Medicine (1980): $VO_2 = 0.2 \times Velocity + 3.5$, the target velocity was estimated as being $192\ m.min^{-1}$.

The 90 % level of VO_2max was chosen to obtain the target velocity for the second stage (approximately $4.0\ mM.l^{-1}$). Coyle and associates (1983) pointed out that trained normal subjects ($45.0\ ml.kg^{-1}.min^{-1}$) reached lactate threshold at 83.3 % of aerobic power. The increment from 70 to 90 % of VO_2max between the first and second running steps seemed feasible. Proceeding the same way as in step one, but using 90 % of predicted VO_2max (60.2 ml), the estimated velocity for the second running step was $265\ m.min^{-1}$.

Distances to be run for the three stages were determined by a pilot experiment performed in the players from the Vasco da Gama (national champion) club. Also the timing then used (between the

3rd and 4th postexercise min) for blood sampling was shown to be ideal.

In the first running step 1600 metres had to be completed in 8 minutes and 20 seconds. The mean lap time of 2:05 was required and controlled for each 400 m. The distance of 1200 metres for the second running step had to be covered in 4 min and 30 sec, i.e. 1:30 for each 400 m lap. The third running step of 800 m required an all-out effort, however, a reference time of 1:10 was set for the first lap.

Groups of four players of approximately similar performance in Cooper's 12-minute test ran together. Chairs, stop watches, gloves and four mats were previously prepared. Blood was taken from the pre-warmed ear-lobe. The marked micro tubes were kept in freeze box until the group completed the third running step. Blood lactate was determined by using a computerized Yellow Springs (Ohio) lactate analyzer and kits.

The protocol after each running step was

a. first minute: walking;

b. second minute: laying down on the mat;

c. third minute: blood sampling;

d. fourth minute: heart rate by palpation;

e. fifth minute: start second-step running, but before the third (all-out) step 10 min of recovery time was allowed.

A battery of tests including estimation of fitness, body composition and somatotype were also performed previously. The physical performance tests included assessment of peak oxygen consumption on the bicycle and aerobic power estimated indirectly by the Cooper 12-minute running test. In order to obtain anaerobic (alactic) power and assess relative anaerobic (alactic) power per body weight indirectly, the Flegner Power Test (FPT) was used. Dynamic leg power was measured in a Sargent Vertical Jump Test. A regression equation including LBM based on FPT was used to estimate relative predominance in fibre composition.

Results and Discussion

To inform on the Brasilian elite soccer player, descriptive statistics including anthropometry (height, weight, fat percentage estimated by a four skinfolds technique, lean body mass LBM, total fat in kg as well as Heath-Carter somatotype means are also presented (Table 1).

Table 1

Anthropometric measures of selected Brasilian soccer players World Cup – 1990

Variable	Mean	SD	Max.	Min.	Range	N
Height cm	177.9	5.3	189.0	168.0	21.0	23
Weight kg	76.5	8.4	95.7	64.4	34.3	23
Fat %	12.2	4.4	21.3	5.0	16.7	23
Total fat kg	9.4	3.8	20.7	3.4	17.3	23
LBM kg	67.0	6.9	78.3	53.6	24.7	23
			Somatotype			
Endomorphy	1.8	0.4	2.7	1.2	1.5	23
Mesomorphy	5.7	1.0	8.4	3.6	4.5	23
Ectomorphy	2.2	1.0	6.2	0.9	5.3	23

The players' average height was 177.9 cm, the maximum of 189.0 cm was that of a goalkeeper (one of the two reserve goalkeepers) who had maximum values for fat %, total fat, LBM and body weight as well.

As shown, mesomorphy was the dominant component (5.7); its highest value (8.4) belonged to a field player. The maxima in ectomorphy were those of the goalkeepers.

To test star soccer players for VO_2max on the bicycle is not recommended in a training camp (Table 2). They care much more about good field practice and try to avoid whatever they judge, often without adequate reasons, unfavourable for ball training. They worried about cramps, stiffness and local burning. They interrupted the test too early and this resulted in lower than expected values compared to the running test. The competitive aspect of the running test might also contribute to a better performance.

The absolute and relative power units (AAPU and AAPU/W) evaluated by the Flegner Power Test (FPT) agreed well with the good average of the vertical jump test. In respect of the physical fitness parameters, the strong point of the Brasilian soccer players was anaerobic alactic power (explosive dynamics). The Flegner Power Test (±10 sec) is extensively used in Brasilian soccer and volleyball for power assessment. AAPU/W values higher than 4.0 represent the outstanding mark of record-holder athletes (in this team two higher than 4.0, one 3.9 and four 3.8 marks were measured).

Of the 19 measured players, 10 showed a predominance of the FT fibre type; in 7 cases it was type ST and in 2 others the intermediate fibre type that predominated. The player with the

Table 2

Physical performance test of the Brasilian National Soccer Team for World Cup – 1990

Variable	Mean	SD	Max.	Min.	Range	N
VO_2 (bike) $ml.kg^{-1}.min^{-1}$	53.4	4.6	62.4	41.8	20.6	20
VO_2 (Cooper) $ml.kg^{-1}.min^{-1}$	60.2	5.8	70.5	49.2	21.3	22
FPT (absolute)	283.5	34.6	359.0	225.7	133.3	19
FPT (relative)	3.68	0.25	4.3	3.2	1.1	19
Vertical jump cm	57.9	8.0	76.0	44.0	32.0	20

maximum value of 4.3 in (relative) FPT was the same as reached 76 cm in vertical jump. He was convoked despite recent surgery.

In comparing target lactate concentrations and running times on Table 3, the mean time of 486 seconds for the first running step was 14 seconds less than the target time of 8 minutes and 20 seconds (500 sec) (set to 70 % of VO_2max). The related actual lactate concentration of 2.52 $mM.l^{-1}$ agreed well with the target concentration of 2.2 mM. Observe that there were two values above 4.0 mM (4.2 and 4.7), both belonging to players from abroad.

Table 3

Running steps and lactate/velocity values

Subj.	1600m	1200m	800m	Time 1	Time 2	Time 3	Vel 1	Vel 2	Vel 3
1	1.8	5.6	11.0	7:53	4:09	2:26	202.8	271.8	328.7
2	1.6	6.0	9.9	7:53	4:09	2:40	202.8	271.8	300.0
3	2.4	5.9	7.5	7:53	4:11	2:38	202.8	270.1	302.7
4	1.4	3.8	8.5	7:52	4:10	2:26	203.3	271.2	328.7
5	2.4	7.0	11.5	8:16	4:17	2:36	193.5	263.8	307.6
6	2.3	6.5	12.9	8:12	4:13	2:28	195.1	267.9	324.3
7	2.3	7.8	9.6	8:12	4:12	2:57	195.1	269.0	271.1
8	2.2	4.7	9.5	8:16	4:17	2:28	197.5	263.8	324.3
9	2.9	4.4	10.0	8:12	4:24	2:19	195.1	256.8	345.3
10	2.1	4.1	8.4	8:16	4:24	2:24	197.5	256.8	333.3
11	4.7	8.8	10.5	8:14	4:23	2:38	194.3	257.7	303.7
12	4.2	7.6	10.8	8:17	4:30	2:54	193.1	251.1	275.8
13	2.4	6.5	9.8	7:53	4:09	2:31	202.8	271.8	317.8
Mean	2.52	6.05	9.99	8:10.0	4:26.7	2:53.2	198.10	264.89	312.60
SD	0.95	1.53	1.42	0:11.0	0:07.1	0:13.3	4.10	7.14	21.90

At the second running step intended to be 90 % of VO_2max, the difference between the target time of 4:30 (270 sec) in 1200 meters was again 4 sec less, 256 sec, despite of control. The observers again felt the players were more motivated in doing a field test than laboratory exercise. The target lactate concentration of 4.0 mM was lower than the average of 6.0 mM actually produced which could not be accounted in view of the 4 s faster than target running time. It is noted that best performances in the 12-min running test as well as the ones on the cycle ergometer gave such values as 4.7, 4.4 and 4.1 mM.

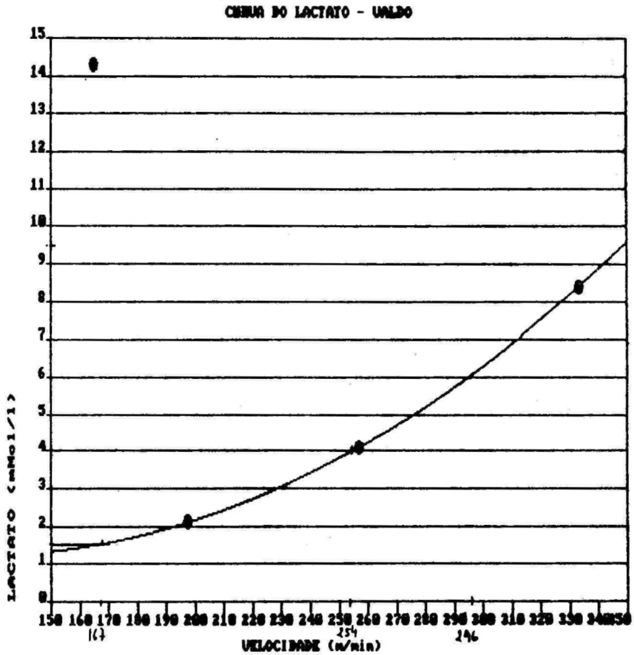
The author is inclined to believe that the 12-min running test was actually carried out under very competitive and strongly motivated conditions. A weak point was detected, however, in the physical condition of the players at and above the level of the anaerobic threshold (4.0 mM).

In the third running step the average time to cover 800 m was 2:31. Considering the achievements in the power tests (absolute and relative FPT, vertical jump), a faster pace as well as a higher maximal lactate level was expected than the obtained 10 mM.

The points obtained by a player of about average results are shown in Fig. 1. He ran 3200 m in the 12-min running test. The obtained running velocities and lactate levels (2.2 and 4.0 mM) at speeds 1 and 2 coincided fine with the expected values. His "maximum" effort resulted, however, in a lower than expected lactate level. The lower lactate concentration could be explained in this case by a fibre composition of predominantly oxydative type as predicted by Flegner's equation and confirmed also by the player's negative Z-scores in AAPU, AAPU/W and vertical jump.

On the other hand, the lactate/velocity curve for another player (an international goal star) who performed 3100 meters on the 12-min run, the estimated velocity for the first stage (lactate threshold) coincided with the expected lactate level (Fig. 2). At the second step the production of lactate was higher (4.5 mM) for a lower-than-preset pace, ie. 250 rather than 265 $m.min^{-1}$.

His pace in the third stage was too conservative so instead of a marked acidosis, expected in the presence of a genuine "readiness to suffer", a slower pace of 300 $m.min^{-1}$ was observed which brought his lactate to 9.0 $mM.l^{-1}$, a level far from causing unbearable acidosis discomfort. This was in contrast to his performance in the anaerobic tests, in which his Z-scores were all high and positive, as well as to his predicted anaerobic fibre type dominance.



THE REGRESSION POLYNOMIAL OF LINE 1 -

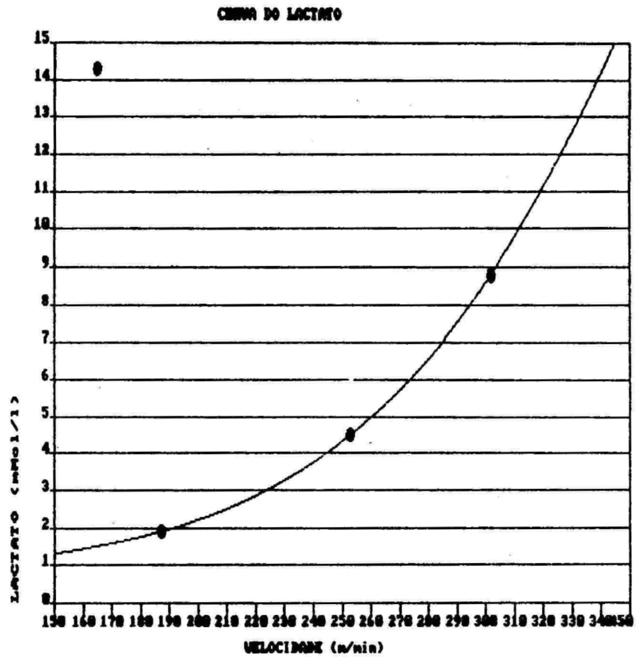
(1.338E+00) + (1.636E+00)*X + (6.622E+00)*X^ 2
THE VARIANCE - 5.273E-12

Fig. 1. Lactate/velocity curve of a player of average VO_2max and below average scores in the anaerobic alactic tests. Reference points for the three-stage field protocol were 192, 265 and ca 280 $m.min^{-1}$. The polynomial regression fit to the individual curve was $6.622 \times speed^2 + 1.636 \times speed + 1.338$ with a variance of 5.273×10^{-12}.

Conclusions and Recommendations

High-level professional soccer players have a strong self-protecting mechanism to avoid any higher levels of exhaustion. This protecting reaction affects physical conditioning performed in the critical lactate zone of about 4.0 $mM.l^{-1}$ so psychological preparation to compensate for this seems to be necessary.

Peripheral adaptation due to training around and above the lactate threshold tends to build up a zone of "reserve of quality"



THE REGRESSION POLYNOMIAL OF LINE 1 -

(1.313E+00) + (2.420E+00)*X + (2.133E+00)*X^ 2 + (1.011E+01)*X^ 3
THE VARIANCE - 1.042E-12

Fig. 2. Lactate/velocity curve of another player of average VO_2max and above average scores in the anaerobic alactic tests. The polynomial regression fit to the individual curve was $10.110\times speed^3+2.133\times speed^2+2.420\times speed+1.313$ with a variance of 5.273×10^{-12}.

rather than deplenish reserves.

A high-quality programme to develop specific abilities and avoid unproductive "choreography" must be introduced, considering the limited time for a full recovery between games and the long strategic training sections.

In the physical preparation of a group of soccer players heterogeneous in several respectsas well as in the position-specific requirements, a knowledge of the individual lactate/velocity curves is of great help. The implementation of the "bottom line" idea in terms of lactate level results in a better peripheral and central (VO_2max) adaptation than relying merely on heart rate check-ups. Poor clearance of lactate is bound to result in accumulating fatigue, loss of speed and slow recovery to a favourable level of potential energy.

The conscious professional soccer player must keep being a useful part of the team and take care of his own competitive shape.

Acknowledgement

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LACK OF STIMULATION OF PROTEIN SYNTHESIS IN SKELETAL MUSCLES BY CREATINE ADMINISTRATION IN RATS

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Introduction

It was hypothezised that the metabolites accumulating during training exercises specifically induce the adaptive protein synthesis. The metabolites determine the choice of proteins that will be synthezised during postexercise recovery period in skeletal muscles and other cells. The role of the hormones intensively secreted during and after exercise session is to amplify the adaptive synthesis of proteins [10]. For the confirmation of the hypothesis it is necessary to establish what are the metabolites connecting various exercises and their specific action on the genome. Among various candidates for this role the accumulation of creatine may have essential function. In a number of studies the induction of protein synthesis in skeletal muscles by creatine was found in conditions of in vitro [4–9]. During muscular activity creatine is released both due to breakdown of phosphocreatine and protein degradation.

The aim of the study is to check up the creatine action on the muscle protein synthesis in vivo in conditions of muscular activity.

Methods

The experiment was performed on male Wistar rats (body weight 260±4 g). The animals were kept on standard conditions of vivarium (nutrition, temperature, lighting schedule). The animals were divided into four groups:

CR injected with creatine 40 mg/kg b.w. daily for 7 days. Creatine was injected in physiological saline by subcutaneous routine twice daily,

CR-E injected with creatine and performed on the 7th day of injection a 90-min swimming in water of 33±1°C (mean water surface per rat 100 cm^2), F injected with physiological saline,

F-E injected with physiological saline and performed on the 7th day of injection a 90-min swimming.

All animals were sacrificed by bleeding under a light ether anesthesia on the 8th day, 12 h after the last injection.

During 2 h before the sacrifice all animals received L-^{3}H-tyrosine (100 uCi per 100 g b.w.) by intraperitoneal injection.

The gastrocnemius, quadriceps and soleus muscles as well as heart and brain were immediately separated, weighed and divided into two samples: (1) for determination of the dry weight (14 h on 80°C + 14 h on 100°C). In other tissue samples the following determinations were performed:

(1) creatine concentration by Eggleton [2],

(2) rate of synthesis of sarcoplasmic and myofibrillar proteins by Deuster et al. [1],

(3) concentration of free tyrosine by Waalkes and Udenfriend [12].

In addition to that the urea concentration in blood serum was determined with the help of the Lachema kit (Czechoslovakia).

Standard statistical calculus (means±S.E) was applied, and student's t-test was used to evaluate the differences.

Results

The creatine administration resulted in an increase of creatine content in skeletal muscles, most of all in soleus muscle – by 20 % (Table 1). The creatine concentration increased also in myocardium (by 14 %) and brain (by 6 %). Swimming after creatine administration did not result in further changes in the creatine content in tissues, in comparison with contents observed after creatine administration in sedentary rats. Only in brain tissue swimming inhibited the increase in creatine content. Swimming after saline administration did not cause any change in creatine contents.

Creatine administration to sedentary rats did not change the rate of synthesis of myofibrillar or sarcoplasmic proteins (Table 2). 24 h after swimming the rate of sarcoplasmic protein synthesis was increased in gastrocnemius muscle but not in the white part of quadriceps muscle. Previous creatine administration inhibited this response in gastrocnemius muscle.

The tissue water content as well as relative weight did not change by creatine administration (Tables 3 and 4).

Table 1

Concentration of creatine in various organs (umol/g of wet weight; $\overline{x}\pm$S.E., n=5)

Group	M. soleus	M. quadriceps femoris (red portion)	M. gast-rocnemius	M. quadriceps femoris (white portion)	Heart	Brain
CR	104.6±2.7*	169.3±1.8*	184.3±6.1	204.1±4.6*	57.6±1.0*	38.0±0.8*
F	87.2±5.1	153.3±5.2	171.5±2.5	185.0±5.9	50.7±2.5	35.9±0.8
CR–E	108.6±5.2*	162.1±3.3	180.7±1.4	199.8±2.8*	61.6±0.8*	36.6±0.5
F–E	82.0±7.7	148.8±3.9	169.1±2.8	173.0±6.4	50.7±1.9	35.1±0.8

* – significantly different at P≤0.05 from F group

Table 2

The rate of synthesis of sarcoplasmic and myofibrillar proteins in various skeletal muscles (nmole of ^{3}H-tyrosine incorporated into 1 mg of protein during two hours; $\bar{x}\pm$S.E., n=5)

Group	M. gastrocnemius, sarcoplasmic p proteins	M. gastrocnemius, myofibrillar proteins	M. quadriceps femoris, white portion, sarcoplasmic proteins	M. quadriceps femoris, white portion, myofibrillar proteins
CR	0.626±0.04	0.303±0.04	0.469±0.09	0.176±0.01
F	0.583±0.06	0.316±0.02	0.352±0.02	0.182±0.03
CR–E	0.639±0.06	0.155±0.02	0.397±0.03	0.185±0.02
F–E	0.788±0.09*	0.176±0.02*	0.402±0.04	0.140±0.02

* – significantly different at P≤0.05 from F group

Table 3

Water content of various tissues (%, $\bar{x}\pm$S.E., n=5)

Group	M. soleus	M. quadriceps femoris, red portion	M. quadriceps femoris, white portion	M. gastrocnemius	Heart
CR	77.23±0.64	78.20±0.19	77.30±0.43	77.54±0.35	80.05±0.39
F	77.09±0.68	77.78±0.45	77.67±0.37	77.43±0.61	79.32±0.52
CR-E	76.73±0.48	77.59±0.23	77.13±0.27	77.18±0.20	79.35±0.25
F–E	75.26±1.15	76.52±0.44	76.92±0.29	76.98±0.31	78.72±0.22

Table 4

The relative wet weight of various organs (organ's weight –mg/body weight –g; $\bar{x}\pm$S.E., n=5)

Group	M. gastrocnemius	M. quadriceps femoris	M. soleus	Heart
CR	5.187±0.116	7.270±0.232	0.333±0.007	3.168±0.048
F	5.299±0.078	7.053±0.206	0.353±0.014	3.397±0.091
CR–E	4.939±0.173	6.462±0.171	0.339±0.012	3.208±0.136
F–E	4.981±0.169	6.978±0.117	0.343±0.007	3.241±0.077

Creatine administration elevated blood urea concentration both in sedentary and exercised rats. The content of free tyrosine increased in gastrocnemius muscle when creatine was administered to sedentary rats, but not to exercised rats. In other muscles no significant changes in tyrosine content were found (Table 5).

Table 5

The concentration of free tyrosine in muscle (nmol/g of wet weight) and that of urea in blood serum (mmol/L) ($\bar{x}$±S.E., n=5)

Group	Free tyrosine in the muscle, nmol/g: m. gastrocnemius	Free tyrosine in the muscle, nmol/g: m. quadriceps femoris, white portion	Urea in blood serum (mmol/l)
CR	152.1± 8.0*	121.5±12.7	3.47±0.28*
F	115.8± 7.8	116.7± 0.2	2.47±0.32
CR–E	110.6±11.2	119.4±17.3	4.14±0.32*
F–E	125.8± 8.2	120.3± 8.0	3.29±0.17

* – significantly differen at $P \leq 0.05$ from the F group

Discussion

In vitro creatine was found to stimulate the myosin synthesis [4, 5]. In experiments on the rat myocardium the stimulation of the synthesis of myosin heavy chain was detected [6]. The incubation of the growing myoblast culture of chickens embryon with creatine resulted in 1.5-fold increase in ^{14}C-orotic acid incorporation into RNA, 1.9-fold increase in the activity of nuclear RNA-polymerase and 29 % increase in the incorporation of ^{14}C-leucine into myosin [7, 9]. A study on muscle tissue culture failed to confirm the effect of creatine on myosin synthesis [3].

Our experiment with creatine administration in vivo did not demonstrate increased synthesis of neither myofibrillar nor sarcoplasmic proteins in skeletal muscle, despite the increase of creatine content in tissues by 14–20 %. In accordance with previous results [11], 12 h after swimming the rate of protein synthesis was increased in the gastrocnemius muscle but not in the white part of quadriceps muscle. Creatine administration did not enhance but even reduced this response in gastrocnemius muscle.

In sedentary rats creatine administration increased the content of free tyrosine in gastrocnemius muscle, suggesting an increase in protein degradation rate. When creatine was administered in combination with exercise no signs of stimulation of protein degradation were found.

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THE ORIGINAL CONCONI TEST FOR CYCLISTS IN LABORATORY

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Abstract

Heart rate (HR) and pace relationship was studied in 12 professional cyclists in laboratory and field conditions in order to evaluate the original Conconi test (CT) in cycling treadmill. Student's t-test did not indicate any statistically significant difference ($p<.001$) between the two tests. Anaerobic threshold (AnT) was determined separately by the laboratory CT and ventilatory responses; Student's t-test did not show any statistically significant difference ($p<.001$) between the two methods. Simultaneous combination of CT with the gas analysis allowed to study the metabolic background (economy) of the cycling. It has been concluded that the laboratory CT in cycling treadmill with synchronous gas analysis is a useful tool for studying the physical fitness of professional cyclists due to the good resemblance with the field conditions and high informatibility.

Key words: Conconi test, cycling treadmill, economy, gas analysis, professional cyclists.

Introduction

The original Conconi test (CT) is a relatively simple field test for noninvasive determination of the anaerobic threshold (AnT) and based on a sharp loss of linearity of the heart rate (HR)-pace relationship (5–10). This so-called deflection point in HR-pace curve has found to be closely related to the AT determined by blood lactate or ventilatory parameters [1, 10, 14].

While CT for runners has been easily performed in laboratory, the original test procedure can not be applied easily to the professional cyclists for the laboratory conditions. Usually CT has been modified in a way where the power-HR relationship has been studied using bicycle ergometer [7–9]. Results obtained in such a way contained too little useful for the professional cyclists information.

Probably therefore CT for cyclists has been still less spread than CT for runners.

The aim of the present study was an evaluation of the original CT method for cyclists in laboratory conditions. Subjects cycled on the usual road-race bike whereas the specially designed cycling treadmill was used for loading. CT was combined with the gas analysis.

Subjects and Methods

12 professional cyclists, members of the Estonian road-race team, volunteered on their informed consent to take part in study. Selected characteristics of the subjects are presented in Table 1.

Table 1

Selected parameters of the subjects (mean ± SE)

n	Age (years)	Weight (kg)	Height (cm)
12	21±1.01	72±1.30	178±1.02

Test design

CT was carried out on the professional road-race bike. The specially designed cycling treadmill (Fig. 1) was used for loading. The test was preceded by a warm-up during 15 min at the HR 125±5 beats per minute. The starting speed was 15 km/h and it was increased by 5 km/h after each kilometre passed until the volitional exhaustion.

The found HR-pace relationship was verified in field CT, performed in a similar way.

HR was recorded continuously using sport tester PE 3000 (Polar Electro, Kempele, Finland).

Gas analysis

Simultaneously to the CT gas analysis was used for follow-up changes in metabolism during a test. The exhaled gas was analysed steadily using the open-circuit respiratory gas system Oxycon 2 (Mijnhardt, Holland).

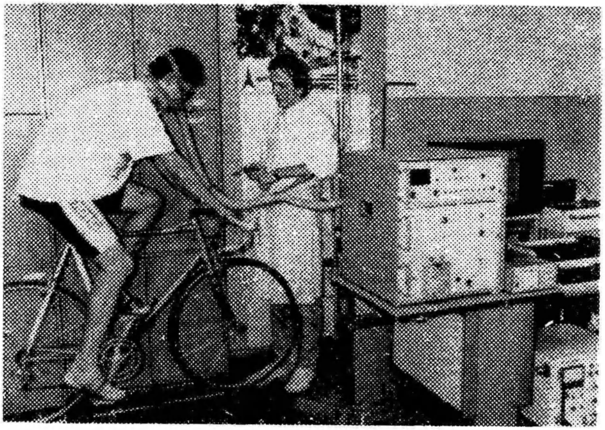

Fig. 1. The specially designed cycling treadmill.

Data analysis

AnT was determined separately from the HR-pace relationship (Conconi Test – AnT_{CT}) and from ventilatory and gas exchange responses (AnT_v).

Heart rate values were fed into PC where Polar Heart Rate Analysis Software (version 3.20A, Polar Electro, Kempele, Finland) was used to study HR-pace relationship. AnT_{CT} was estimated by a computer as the deflection point in the HR curve [5–10].

AnT_v was determined to be just below the point where ventilation and ventilatory equivalent for CO_2 ($EqCO_2$) rapidly increased [1, 2, 11].

Aerobic threshold (AerT) was determined as the optimum level of the aerobic metabolism and it coincided with the work rate at which the lowest amount of O_2 was found in the exhaled air [1, 12].

Statistical analysis

The means and standard deviations of the variables and the correlation between them were calculated. Differences between the mean values were tested for significance by Student's t-test. A significance of $p<.05$ was accepted.

Results

Oxygen consumption, heart rate, cycling velocity and oxygen cost of 100 m at different work intensities, found in laboratory test, have been presented in Table 2.

Table 2

Oxygen consumption (VO_2), oxygen consumption per body weight (VO_2/kg), heart rate (HR), cycling velocity (Pace) and oxygen cost of 100 m (O_2 cost) at aerobic threshold (AerT), anaerobic threshold (AnT) and maximal level (Max) (mean ± SE)

	AerT	AnT	Max
VO_2 (l/min)	3.14 ± .13	4.10 ± .14	5.40 ± .10
VO_2/kg (ml/kg/min)	43.38 ± 1.50	56.69 ± 1.47	74.72 ± 1.21
HR (beats/min)	152 ± 1.50	175 ± 1.89	
Pace (km/h)	37.08 ± .80	46.67 ± 1.32	57.74 ± 1.61
O_2 cost (ml/kg/100m)	6.92 ± .29	7.20 ± .28	7.82 ± .27

Heart rate values at AnT, estimated by two different methods, have been presented for each subject in Table 3. In Student's t-test it was found that no difference ($p<.001$) existed between the mean values (175 vs. 174 beats per minute). Thus there was no significant difference between the two methods used for the AnT determination.

Table 3

Heart rate values at AnT determined by laboratory Conconi test (HR_{CT}) and by gas exchange responses (HR_v) for each subject

	T.R.	M.R.	E.P.	P.M.	M.M.	M.K.	A.L.	U.K.	J.K.	J.E.	L.A.	A.A.
HR_{CT}	167	163	175	183	177	176	181	175	184	169	173	170
HR_v	170	164	173	181	179	176	180	176	182	170	172	170
±	–3	+1	+2	+2	–2	±	+1	–1	+2	–1	+1	±

Cycling speed at AnT, found in laboratory CT was verified in field test. Results for each subject have been presented in Table 4. The mean pace at AnT in laboratory CT was found to be 46.67 km/h and in field test 46.85 km/h. The mean velocity at VO_{2max} has been 57.48 km/h in laboratory test; at the same HR in field test it was found to be 57.42 km/h. At AerT estimated mean pace in laboratory was 37.08 km/h vs. 36.89 km/h at the same HR values in field test.

Table 4

Cycling speed at AnT in laboratory Conconi test (CT_L) and in field Conconi test (CT_F) for each subject

	T.R.	M.R.	E.P.	P.M.	M.M.	M.K.	A.L.	U.K.	J.K.	J.E.	L.A.	A.A.
CT_L	51.5	43.4	40.0	50.2	38.0	49.7	50.2	42.8	50.1	47.3	50.1	46.4
CT_F	50.4	44.2	40.1	49.8	38.7	50.2	50.2	43.3	51.0	47.6	50.2	46.6
±	+1.1	–.8	–.1	+.4	–.7	–.5	±	–.5	–.9	–.3	–.1	–.2

Student's t-test did not indicate any significant differences ($p<.001$) between the mean values in all the three studied levels.

A correlation was found between oxygen consumption values at different work intensities (correlation coefficient $r = .59 - .87$; $r>.58 = p<.05$; $r>.71 = p<.01$; $r>.81 = p<.001$). Heart rate at VO_{2max} correlated with the heart rate at AnT ($r = .77$); heart rate at AnT correlated with the heart rate at AerT ($r = .76$); but a weak correlation was found between HR at VO_{2max} and HR at AerT ($r = .34$).

Age and body weight correlated with the speed at VO_{2max}, AnT and AerT ($r = .60$–$.71$); except the correlation (ns) between age and velocity at AerT ($r = .41$). Both variables correlated negatively with the oxygen cost of 100 m at maximal speed ($r = -.61 - -.73$). One could speculate that relatively higher body weight has some advantages in cycling.

A strong correlation was found between speed values at different work intensities ($r = .70 - .88$). A strong negative correlation was always found between speed and oxygen cost of 100 m at the same work intensity ($r = -.71 - -.87$). Speed at higher, work intensity correlated negatively with the oxygen cost of 100 m in lower work intensities ($r = -.65 - -.87$); correlation between maximal speed (i.e. a speed at VO_{2max}) and the oxygen cost of 100 m at AerT ($r = .55$ at $p<.06$).

A correlation was always found between oxygen cost of 100 m at different work intensities ($r = .60 - .94$). Oxygen cost of 100 m at higher work intensity correlated always with the cycling velocities at lower studied work intensities ($r = -.73 - -.87$). Some stronger correlation between different variables at AnT and AerT might indicate an important role of the aerobic training to the metabolism and mechanical output (i.e. velocity) at AnT.

In Table 5 correlation matrix for the pace and O_2 cost of 100 m in relation to other variables has been presented.

Comparison of the correlation coefficients between pace ($Pace_L$ – pace in laboratory test; $Pace_F$ – pace in field test) and O_2 cost of 100 m and other variables related to physical fitness

	AerT		AnT		VO_{2max}	
	$Pace_L$	O_2cost	$Pace_L$	O_2cost	$Pace_L$	O_2cost
Age	.41	–.20	.61	–.32	.71	–.65
Weight	.65	–.32	.65	–.42	.60	–.73
Height	.42	–.31	.41	–.41	.51	–.52
VO_{2max}						
VO_2	.43	–.12	.50	–.12	.66	–.35
$VO_{2/kg}$	–.24	.22	–.15	.33	.10	.40
HR	.21	.03	.12	–.10	.10	–.26
$Pace_L$	.70	–.55	.88	–.65		–.87
$Pace_F$	.76	–.59	.92	–.68	.99	–.87
O_2cost of 100 m	–.73	.60	–.87	.77	–.87	
Anaerobic threshold						
VO_2	.44	.10	.58	.06	.58	–.44
$VO_{2/kg}$	.11	.36	.29	.38	.33	–.06
HR	.13	.32	.18	.12	.19	–.26
$Pace_L$	.86	–.70		–.76	.88	–.87
$Pace_F$	.87	–.71	.99	–.79	.86	–.88
O_2 cost of 100 m	–.72	.94	–.76		–.65	.77
Aerobic threshold						
VO_2	.24	.41	.27	.31	.32	–.22
$VO_{2/kg}$	–.06	.64	–.03	.59	.05	.13
HR	–.20	.74	–.17	.53	–.14	.05
$Pace_L$		–.71	.86	–.72	.70	–.73
$Pace_F$	.97	–.78	.88	–.78	.74	–.74
O_2 cost of 100 m	–.71		–.70	.94	–.55	.60

$r>.58 = p<.05$
$r>.71 = p<.01$
$r>.81 = p<.001$

Discussion

The found negligible differences in AnT determination between the two methods (<3 heartbeats per minute) indicated the usefulness of the CT as a simple test of the AnT determination. In the other hand, the found HR-pace relationship in laboratory test was verified to be valid also in field test. Thus the used laboratory CT may be recommended as a useful tool for testing professional cyclists.

The advantage of the used test might be connected with the high resemblance between laboratory test and natural field conditions. Several factors might be noticed. Subjects have not been fixed stiffly neither to the bike nor to the treadmill; i.e. subjects had to keep balance themselves. Subjects were able to choose the best posture and change it during the test; the seat position was exactly measured off for each subject. Thus, biomechanically the laboratory test tallied exactly with the field conditions. No one commercial bicycle ergometer could correspond to the conditions described above.

All the subjects have been investigated several times before the present. Maximally comfortable test conditions and velocity loading in the last test allowed to increase the maximal HR by 2–9 beats per minute. The main complaint in previous studies was the acute feeling of fatigue in leg muscles. One could speculate that in previous studies the work was stopped before the cardio-respiratory function realized all the potentialities [3]. Bikes used in sports are fit with a transmission that allows to choose the most rational pedalling frequency in relation to the resistance. One may speculate that during bicycle ergometry pedalling frequency does not correspond to the resistance; at least at the last steps. In such a condition an acute feeling of fatique in leg muscles and a common discomfort might stop the work prematurely [3].

The effect of the training, expressed as some changes in (real) speed might be better understood by the coaches and sportsmen than changes in VO_{2max} or load. On the other hand, CT in combination with the gas analysis allowed to study the metabolic background of the velocity at each work level. Metabolic background of the velocity might be taken as the economy. Economy could be divided into different sides; i.e. metabolic economy and oxygen efficiency. The first mentioned indicated how much air has been needed for the unit of the consumed oxygen; usually it has been expressed as EqO_2 [1, 14]. The second variable determined the amount of work done in relation to the consumed O_2; in the present work the oxygen cost of 100 m was used to estimate oxygen efficiency.

Economy in cycling might have the greatest importance in team-race. Nearly 95 % of the race a team tried to keep constant speed and increase it only in the last kilometres. Therefore the starting speed might be chosen carefully. Theoretically a speed near to the AnT might be chosen because the speed at AnT is the highest velocity without uninhibited lactate accumulation and therefore might be kept continuously [1, 12, 14]. For that reason a speed at AnT has been the most substantial (often the single) factor for the team formation. On the other hand it has been known that during prolonged work at a constant level the energy consumption/work ratio increases at least due to the increased body temperature [13]; i.e. at the beginning of the work, energy needs for the unit of work are lower than at the end of the work period. During continuous work without unrestrained increase in blood lactate the depletion of energy sources may act as the limiting factor. Thus it might be rational to suppose that in equal conditions a person with higher economy could work longer.

The O_2 cost of 100 m showed a clear tendency to be higher at higher speeds. Statistically significant difference ($p<.05$) was found between the O_2 cost of 100 m at VO_{2max} (7.82 ml O_2 per kg/100 m) and at AerT (6.92 ml O_2 per kg/100 m). At AnT the group average O_2 cost of 100 m was found to be 7.20 ml O_2 per kg/100 m; it was more close to the value measured at AerT than at VO_{2max}. At the same time pace at AerT was 37.08 km/h, at AnT 46.67 km/h and at VO_{2max} 57.47 km/h. Thus increase in speed from AerT to AnT (9.59 units) was not accompanied with a particular decrease in economy whereas increase from AnT to VO_{2max} (10.80 units) was followed by a remarkable decrease in economy.

When subjects were divided into elder (24 years) and younger (18 years) statistically significant ($p<.05$) difference between the two groups appeared at all three studied work levels; 6.55, 6.79, 7.11 for elder subjects and 7.54, 7.63, 8.29 ml O_2 per kg/100 m at AerT, AnT and VO_{2max} respectively. The elder group has higher velocity at all steps, but in oxygen uptake per body mass there was only a tendency to be higher at AerT and AnT in the elder group whereas at maximal level both groups have practically the same values. Since the age-related analysis was not the purpose of the present study it might be only noted that in young cyclists first the oxygen consumption increased to the high level and thereafter the speed. Only together with the increased speed the economy (oxygen efficiency) increased. At the same time relatively big intra-individual differences in both group appeared.

In correlation analysis it was found that the used economy index correlated better with the velocity; it might be due to the formula used for calculations. On the other hand it might indicate that the mechanical output is more important determinant of the economy than VO_2.

The results of this study suggest:

i) CT in cycling treadmill is a useful tool for the physical fitness testing in professional cyclists due to the good resemblance with the field conditions;

ii) CT with simultaneous gas analysis allowed to study the metabolic background (economy) of cycling.

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ACTION OF CREATINE INTAKE ON PERFORMANCE CAPACITY OF MIDDLE-DISTANCE RUNNERS

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Abstract

10 middle-distance runners were divided into two, experimental and placebo groups. The experimental group consumed 30 g of creatine with glucose daily for 6 days. The performance capacity was tested before and after a 6-day period with the aid of 4×1000 m and 4×300 m runs (rest intervals 3–4 min). Creatine administration resulted in the improvement of running time for both 1000 and 300 m, as well as of total time 4×1000 and 4×300 m, creatine intake induced also an increase in body weight by 1.8±0.51 kg. In placebo group the improved performance was less pronounced. No gain of weight was found.

Key words: creatine, running performance, middle-distance runners.

Introduction

Creatine has an essential role in energy metabolism of muscles. On the one hand, it is the product of phosphocreatine breakdown as well as the substrate for phosphocreatine resynthesis [6]. On the other hand an important function belongs to phosphocreatine/creatine metabolism in transport of energy from mitochondria to myofibrils [1, 6, 8, 9]. It was found that the intake of creatine promotes training effects in sprinters [10]. In this study the action of creatine intake on performance capacity was checked in middle-distance runners.

Methods

Experiments were conducted on 10 runners of middle distances of the university level. The age of a person was 24±3.0 (mean ± S.E.), weight 71.6±5.02 kg, height 183±2.1 cm. The persons were randomly divided into experimental and placebo groups. The experimental group consumed 30 g of creatine with glucose for 6 days. During the same period the placebo group received the same amount of a similar powder (glucose without creatine). The persons were not informed whether they consumed creatine or placebo. Before and after the period of the administration in different training sessions, the runners performed 4×1000 m and 4×300 m runs over 3–4 min rest intervals between the running sets. The sportsmen were asked to run at the velocity of 90–95 % of their best and maintain this velocity during the 4 repetitions. The time of each running set was recorded with the help of a stop watch. During the whole session the heart rate was monitored with the help of the Sporttester (PE-3000). During the experimental period the sportsmen continued their regular training without any significant change in the choice of exercises neither in training volume nor intensity. The regimen of nutrition remained unchanged.

The obtained results were statistically analyzed by the paired t-test, comparing the individual values recorded before and after the experimental period.

Results

Typical for the person of the experimental group was a gain in body weight (by 1.8±0.51 kg). In the placebo group the body weight before the experiment was 69.4±1.89 kg and after the experiment 69.3±2.02 kg.

Table 1 indicates that after creatine administration the best recorded time for 1000 m or 300 m running was improved. A more pronounced improvement occurred when the time before and after creatine intake was compared. The total time of 4×1000 or 4×300 m running improved significantly as well. Before the creatine intake the running time increased from the first up to the last repetition. After the creatine administration the running time was maintained approximately on the same level. Despite the increase in the running velocity the heart rate was lower during the training sessions performed after the administration of creatine (Fig. 1).

The changes obtained in the experimental group were not found in the placebo group, except a little improvement in the time of the last 1000 m run and the total time of 4×300 m running. However, in these cases the positive changes were significantly lower than in the experimental group.

Table 1

	Placebo					Creatine				
	Before	After	Ind.	Paired t-test	P	Before	After	Ind.	Paired t-test	P
Best 1000 m	3 min 12.0 s	3 min 12.1 s	+0.1±0.68s	0.15	0.9	3 min 10.0 s	3 min 7.9 s	−2.1±0.62 s	3.38	0.01
Total 4×1000 m	12 min 54.1 s	12 min 55.3 s	+1.2±2.05 s	0.58	0.6	12 min 49.8 s	12 min 36.8 s	−13.0±2.70 s	4.81	0.01
Last 1000 m	3 min 17.2 s	3 min 15.6 s	−1.6±0.67 s	2.39	0.05	3 min 14.1 s	3 min 14.1 s	−5.5±1.55	3.55	0.01
Difference of first-last 100 m	+3.5 s	+3.1 s	−0.4±0.96	0.42	0.6	+3.0 s	−0.8	−3.8±1.69 s	2.24	0.05
Best 300 m	40.4 s	40.6 s	+0.2±0.21	0.95	0.4	37.8 s	37.5 s	−0.3±0.09 s	3.33	0.02
Total 4×300 m	2 min 45.0 s	2 min 44.4 s	−0.6±0.19	3.15	0.02	152.6 s	151.1 s	−1.5±0.35 s	4.29	0.01
Last 300 m	41.7 s	41.5 s	−0.3±0.15	2.00	0.1	38.4 s	37.7 s	−0.7±0.03 s	23.33	0.01
Difference of first-last 300 m	+0.6 s	+0.8 s	+0.2±0.2	1.00	0.4	+0.4 s	−0.2 s	−0.6±0.22 s	2.73	0.05

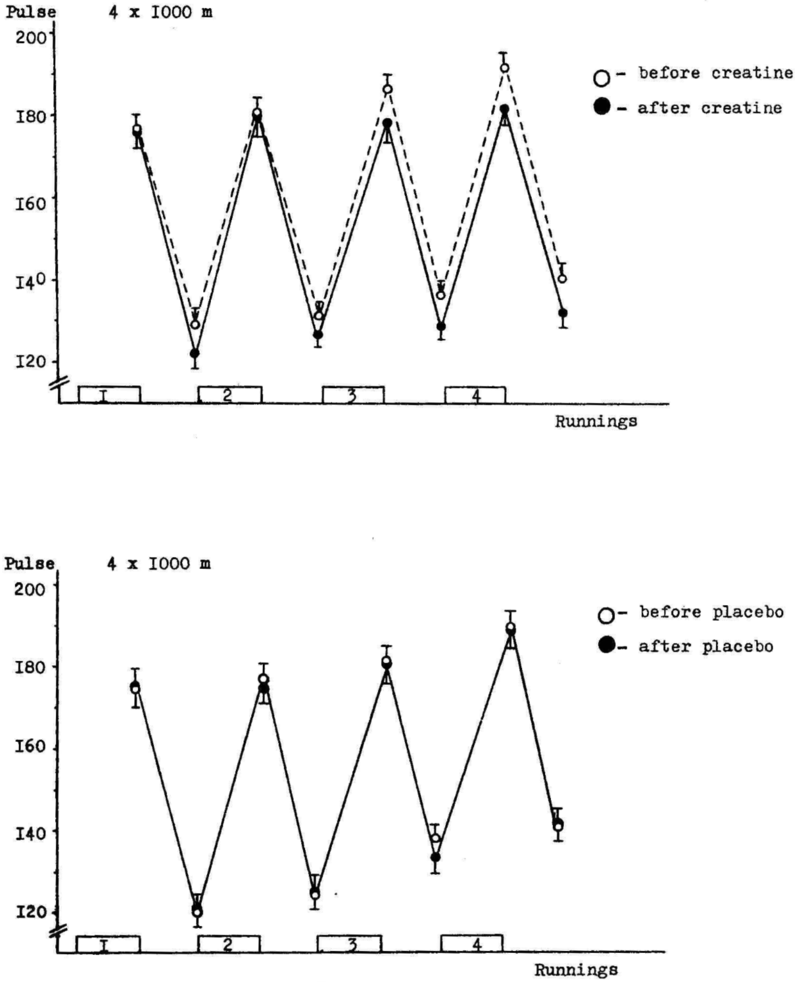

Fig. 1. The changes on the heart rate during different runnings.

Discussion

The obtained results indicate on the improved endurance in middle distance runners after a short-term period of creatine intake. The increased running velocity was maintained better during 4 repetitions of both 300 and 1000 m. As it occurred at the level of reduced heart rate throughout the training session it is difficult to believe that the increased anaerobic working capacity was responsible for the improved endurance. It is more reasonable to suggest that exogenous creatine favoured oxidation processes in skeletal muscles as well as in the myocardium. A more effective oxidation during the rest periods between the running sets promoted lactate elimination/oxidation in exercised muscles and thereby promoted the maintaining of the running velocity. However, anyway the increased creatine content favours the resynthesis of phosphocreatine.

The action of the exogenous creatine on the oxidation processes is probably related to the transport functions of the phosphocreatine between mitochondria and myofibrils [1, 6, 8, 9]. One may be suggested that the excess of cellular creatine favours the mitochondrial formation of phosphocreatine and thereby to the intracellular energy transport. In the myocardium, creatine specifically increases the activity of phosphocreatine kinase [5].

It is rather difficult to explain the gain of body weight during a short-term creatine administration. First, it is difficult to believe that an increased amount of body fat associates with improved endurance in runners. The experiments on rats did not show any water accumulation due to creatine administration [7]. In vitro experiments indicated the possibility of induction of the synthesis of myofibrillar proteins by creatine [3, 4]. However, this phenomenon was not confirmed when creatine was administered neither to muscle tissue culture [2] nor in vivo to rats [7]. Nevertheless, the weight gain existed and it seems the best way to find the explanation in the increased protein synthesis in some of the human tissues. The gain in body weight associated with a subjective feeling of increased muscular power.

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SERUM APOLIPOPROTEINS A-I AND B IN RELATION TO DIETARY PATTERN AND LEVEL OF PHYSICAL ACTIVITY IN SCHOOLCHILDREN OF TALLINN

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Dyslipoproteinemia with enhanced content of atherogenic lipoproteins (low density lipoproteins – LDL, very low density lipoproteins – VLDL) and reduced content of antiatherogenic lipoproteins (high density lipoproteins – HDL) is a required precondition in pathogenesis of atherosclerosis. The recent 10–15 years have placed in the forefront the relevance of protein part of lipoproteins (LP) – the apolipoproteins, in atherogenesis. The particles of atherogenic lipoproteins include apoprotein B (apo B), that is responsible for the binding of LDL-particles with specific LDL-receptors in body cells. The major protein constituent of HDL is apo A-I, which is activator of enzyme, that is favourable to transmission of cholesterol (CH) from LDL or body cells to HDL. HDL serves as acceptor for cellular CH and transports it into the liver.

The serum lipids and lipoproteins spectrum (as well as apo LP) depends on:

1) individual nutrition patterns: diet containing lot of CH and saturated fatty acids increases the content of atherogenic LP in the blood, polyunsaturated fatty acids reveal antiatherogenic effect [1];

2) the level of physical activity: physical training enhances the concentration of antiatherogenic LP and reduces the level of atherogenic LP [2].

The process of atherogenesis depends on the relationship between apo B and apo A-I concentrations in the blood plasma. The serum apo B level and $\frac{apo\ B}{apo\ A\text{-}I}$ ratio are supposed to be better predictors of developing premature coronary atherosclerosis later in life than blood lipids [3].

The aim of this study was to determine epidemiological criteria for apolipoproteins A-I and B in schoolchildren of Estonia (for the first time in Estonia) and to analyse the relation between the blood apo LP content, the child's dietary habits and level of physical activity.

In this study 220 14–15 year schoolchildren from 4 schools of Tallinn (2 Estonian and 2 Russian schools) were examined on:

1) serum lipids (total CH, triglycerides, HDL-CH) and apo A-I and B. Apo LP were determined with rocket immunoelectrophoresis by Laurell [4];

2) nutrition pattern by the 24-hour dietary recall method (in 81 pupils);

3) the level of physical activity was assayed by interview;

4) index of Quetelet (QI; kg/m^2).

The obtained results were analyzed from the aspects of nationality and the level of $\frac{apo\ B}{apo\ A\text{-}I}$ ratio.

Results and discussion

1. We found national differences in the blood content of apo B (Table 1). The serum apo B level was lower in Russian children than in Estonian ones. These results were in accordance with the national peculiarities in their nutrition pattern.

Table 1

Serum apolipoprotein concentrations (mg/dl) in 14 year-old schoolchildren of Tallinn ($\bar{x}\pm m$)

Group	n	Apo A–I	Apo B	$\frac{Apo\ B}{Apo\ A\text{-}I}$
Boys	92	130.5±1.76	84.7±1.58	0.65±0.01
Girls	128	129.9±1.29	85.9±1.41	0.67±0.02
p		>0.05	>0.05	>0.05
Estonians	127	131.3±1.35	87.2±1.44	0.67±0.02
Russians	93	128.5±1.69	82.6±1.45	0.65±0.02
p		>0.05	<0.05	>0.05
Estonian boys	54	130.9±1.93	87.4±1.98	0.68±0.02
Russian boys	38	130.6±3.24	80.6±2.43	0.63±0.02
p		>0.05	<0.05	<0.1
Estonian girls	73	131.9±1.77	88.1±1.71	0.67±0.01
Russian girls	55	127.1±1.77	84.1±1.76	0.67±0.02
p		>0.05	<0.1	>0.05

Estonian children derived more energy from dairy and cereal products ($p<0.05$) and from margarine and vegetable fats ($p<0.01$). The diet of Russians includes more pectins ($p<0.01$) and ascorbic acid ($p<0.05$) per 1000 kcal. The ratio of polyunsaturated fats to saturated ones (P/S) was higher in Russians (0.42) than in Estonians (0.29; $p<0.05$). In literature data there is evidence of the atherogenic effect of dairy products and antiatherogenicity of pectins and C-vitamine in the dietary pattern [1]. In an epidemiological study Olsson et.al. (1988) have established a higher serum apo B, lower P/S ratio in diet and more frequent occurence of ischaemic heart diseases in Stockholm males in comparison with Naples men. From our data and literature data we conclude that Estonian children are more predisposed to the atherosclerotic process than Russian ones.

2. From the 220 pupils studied, we selected pupils with $\frac{apo\ B}{apo\ A\text{-}I}$ ratio higher or lower than $\bar{x} \pm \sigma$: 1) $\frac{apo\ B}{apo\ A\text{-}I}>0.8$. This group was conventionally called the group with "atherogenic plasma" (n=41 pupils); 2) $\frac{apo\ B}{apo\ A\text{-}I}<0.56$. That group was called the one of "nonatherogenic plasma" (n=40 pupils).

We have nutrition data on 13 pupils from the first and only 3 from the second group. There were substantial differences in the nutrition pattern of these groups. We found that in the group with "atherogenic plasma", consumption of dairy products and eggs was considerably higher than in the other group. By the way, consumption of meat products and total fat intake were lower in this group. Fat intake was lower first of all on account of vegetable fat, that was consumed by 43 % less than in the other group. Monounsaturated fatty acids were considerably consumed ($p<0.001$), the difference in consumption of polyunsaturated fats between the two groups was less plausible ($p<0.2$). It is noteworthy that this dietary pattern is very close to lacto-ovo-vegetarian diet. This makes us think that lacto-ovo-vegetarian diet may cause unanticipated adverse sideeffects.

The level of physical activity was higher in the group of children of $\frac{apo\ B}{apo\ A\text{-}I}<0.56$ (Table 2). More pupils of this group went to regular training at various sport clubs, the mean number of sport hours in a week was higher. The mean value of QI was somewhat lower in this group. Our results are in accordance with literature data, which suggest that $\frac{apo\ B}{apo\ A\text{-}I}$ ratio decreases as an effect of swimming training [2].

Table 2

Data of physical activity in groups of schoolchildren with different level of $\frac{apo\ B}{apo\ A\text{-}I}$ ratio

Group / Data	$\frac{Apo\ B}{Apo\ A\text{-}I}$<0.56 (n = 39)	$\frac{Apo\ B}{Apo\ A\text{-}I}$>0.8	p
Number of sport hours in a week ($\bar{x}\pm m$)	4.74±0.91	2.92±0.54	<0.1
Number of children, going in for sports (%)	54	38	<0.05
QI ($\bar{x}\pm m$)	20.0±0.44	21.4±0.46	<0.001

Conclusions:

1. Serum apo B level is higher in children consuming more dairy products.

2. Estonian children are in their school years more predisposed to atherosclerotic alterations than Russian ones.

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THE COMPONENTS OF THE AEROBIC WORKING CAPACITY AND THEIR INFLUENCE ON THE RESULTS OF 10–KM RACE

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Abstract

The purpose of this study was to find connections between the more essential single components of the aerobic working capacity and to elucidate which functional indices are informative in prognosticating the results of the 10-km race. Twelve well-trained middle and long distance runners were examined in laboratory conditions. The subjects performed a maximal treadmill test during which the indices of the aerobic working capacity were registered. The results indicated that the basis of aerobic working capacity and corresponding morphofunctional adaptation of runners is the dominating muscle work regime. The energetical granting of the latter occurs on the basis of the co-ordinated connection of four main factors: VO_{2max}, submaximal endurance, central hemodynamics and metabolic profile of the organism. The result in the 10-km race depends on the functional economy (0_2 utilization at AnT and AerT, economy of the use of the energy substrates) and capacity (VO_{2max}, capacity of the use of the energy substrates, level of the anaerobic working capacity) of the energy processes of the organism.

Keywords: VO_{2max}, anaerobic threshold, submaximal endurance, functional economy and capacity, distance running performance.

Introduction

The integral index of the aerobic working capacity of the runner, VO_{2max}, is conditioned by the transportation of oxygen to the working muscles and O_2 utilization in the muscle cell. VO_{2max} is in a high correlation with the results in endurance events [30, 31].

It is possible to maintain the maximal level of the O_2 uptake for 10 minutes. Consequently, in distances temporily exceeding this time, it is possible to use a certain percentage of the VO_{2max}. Therefore, during the last decades the attention of the investigations has been concentrated on the running speeds and the corresponding O_2 uptake levels at submaximal loads. They are the anaerobic [36, 37] and aerobic [21] thresholds. In case of top runners the O_2 uptake at the anaerobic threshold can reach 85–90 % of the VO_{2max} [10, 29].

It has been found that the increase of both anaerobic (AnT) and aerobic (AerT) thresholds occurs independently from the VO_{2max} [8] and that they reflect the submaximal endurance better than the VO_{2max} [38]. Possibilities for raising the AnT by training are also much greater than for the improvement of the VO_{2max}. Shifts in the levels of the AnT and AerT are connected with specific changes in the volume and number of the mitochondria of the muscle cell [9, 26], mitochondrial enzymes [11, 13], better elimination of lactate during work [16, 19], more extensive oxydation of fatty acids [7, 20].

Essential components for guaranteeing the aerobic working capacity are the mechanical economy [27] and functional efficiency of the energetical processes of the organism [24]. The latter is directly connected with the preserving influence on the reserves of the relatively limited substrates – glycogene and creatine – phosphate [15, 32] and with changes in the values of the respiratory quotient.

The rise of the respiratory quotient (RQ) in connection with the increase of the work intensity reflects a "substrate shift" – from fats to carbo-hydrates [25]. In case of high intensity work accompanied by an extensive rise in the blood lactate and "excess CO_2" the RQ exceeds both during work and during the recovery period the level of 1.0. Consequently, on the basis of the RQ dynamics it is possible to assess in percentage the ratio of lipids and carbo-hydrates in the energy consumption [6] and through it both the metabolic economy and range of the use of the reserve of the anaerobic mechanisms, their power.

The aerobic working capacity is also influenced by the speed-strength qualities of the metabolically active muscles [23, 33]. As the 10-km distance belongs to the zone of high intensity it is necessary to take into account also the level of the anaerobic working capacity.

In the factor model of the aerobic working capacity presented by Aunola et al. [1] and based on the data of the middle-aged men going actively in for sports as a source of health four factors were used: VO_{2max}, submaximal endurance, metabolic profile of muscles and capacity of O_2 transport. In this model the submaximal endurance correlated most strongly with the VO_{2max} (r = 0.92). The correlation of the same index was also high with the metabolic profile (r = 0.83) as compared with the O_2 transport capacity.

A question arises: is the mentioned model also valid in the case of well-trained middle and long distance runners and how do the single components of the aerobic working capacity correlate with the results of the 10-km race? Proceeding from the above said, the tasks of the present study were set as follows:

1) to find connections between the more essential single components of the aerobic working capacity;

2) to elucidate which functional indices are informative in the prognostication of the results of the 10-km race.

Material and methods

12 well-trained middle and long distance runners participated in the study. Their age, anthropometrical indices, VO_{2max} and the average speed of running 10 km are presented in Table 1.

Table 1

Means and standard deviations of the variables

	$\bar{x}$	SD	Min	Max
Age (years)	20.6	3.6	17	29
Height (cm)	179.8	4.5	170	187
Weight (kg)	66.4	6.2	57	79
VO_{2max} ($ml/kg^{-1}/min^{-1}$)	70.05	5.0	63.1	77.9
Running speed of the 10-km race (m/sec)	4.95	0.23	4.7	5.5

The examinations were carried out in the Laboratory of the Investigation of the Training Process and in the Department of Sports Medicine of Tartu University. Running loads were exerted on the treadmill Burdick T 500 ("Siemens", Germany). The work was begun at the speed of 10 km/h. The athlete ran so for 3 minutes, after which the speed was increased by 1 km/h after each 2 minutes up to the speed of 13 km/h. The latter remained the last speed at which the work was being done. Futher the work intensity was increased by 2 per cent after each 2 minutes by means of raising the inclined angle of the treadmill. For the gas analysis the gas analyzer "Oxyconbeta" (Mijnhardt, Holland) and the IBM system were used which registered the following indices of gas exchange:

VO_2 (ml/min) – volume of oxygen in expired air,
Ve (l/min) – ventilation of lungs,
RQ – respiratory quotient,
VO_{2max} (ml/kg/min) – maximal oxygen uptake,

$EgCO_2 = \frac{Ve}{VCO_2}$ – ventilatory CO_2 production equivalent,

$EgO_2 = \frac{Ve}{VO_2}$ – ventilatory O_2 uptake equivalent.

The samples of the expired air were constantly analyzed after each 30 sec. The O_2 uptake was also fixed after every 30 sec and the highest value considered as the VO_{2max}. The treadmill speed at which the anaerobic threshold occurred was assessed by examination of excess CO_2 elimination [34] employing the Wasserman et al [36] definition of the anaerobic threshold. The workload just prior to the initial jump in CO_2 elimination, out of proportion to VO_2, was assumed to indicate the anaerobic threshold, marking the onset of anaerobic metabolism. To determine the aerobic threshold the principle described by Kindermann et al [22] was applied. The AerT was taken as a point where the linearity in the pulmonary minute ventilation against the corresponding power output and oxygen consumption values changed the first time (a slight change) and the blood lactate concentration increased above the level observed at rest or at low power outputs. The O_2 uptake at the level of anaerobic and aerobic thresholds as well as the submaximal loads were fixed. The index got in the 13th work minute (speed – 13 km/h and inclination angle 4 per cent) was taken as the value of the latter. The RQ value of this load was considered as the RQ index of the submaximal load. As the basis for the highest RQ value the RQ in the 2nd minute of recovery was taken. The heart frequency was constantly registered by SPORT TESTER PE 3000. The heart rate at the level of the AnT was also measured. The pulse frequency 20 beats below the pulse frequency of the AnT was regarded as that of the aerobic threshold [35].

The means and standard deviations of the variables and the correlations between them were calculated. On the basis of the obtained correlations a model of the aerobic working capacity was constructed the basis of which are the changes in the level of O_2 uptake at different intensities of work and in the recovery period. The main physiological characteristics of the aerobic working capacity influencing the result in the 10-km race were also found.

Results

The means and the standard deviations of the analyzed indices are given in Table 2.

On the basis of the above indices 4 main factors of the aerobic working capacity were differentiated: maximal aerobic power (VO_{2max}), submaximal endurance (AnT and AerT), central hemodynamics (O_2 pulse) and the metabolic profile of the organism (the economy and capacity of the use of the energy substrates on the

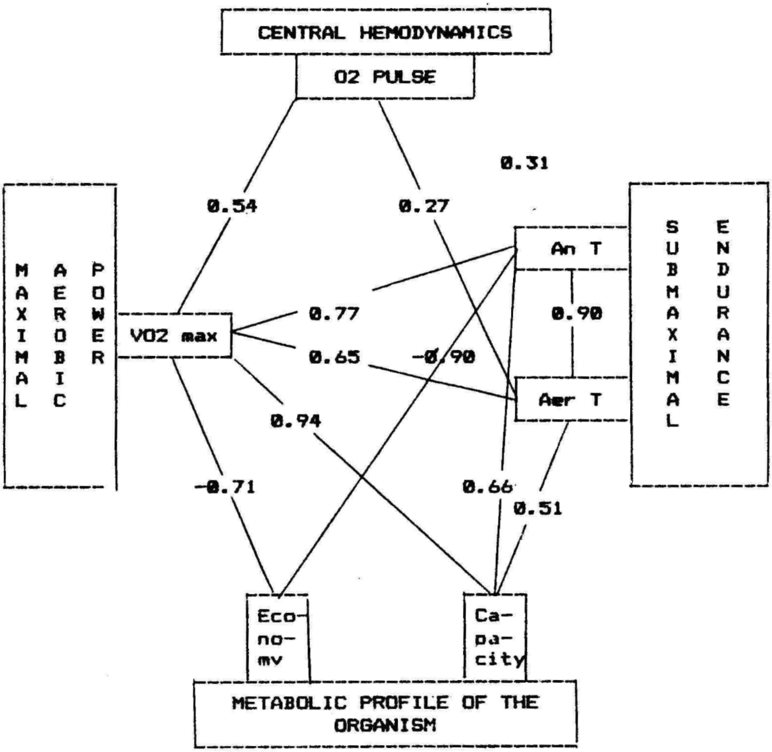
Table 2

Means and standard deviations of the main indices of the aerobic working capacity

Variables	$\overline{x}$	SD
VO_{2max} (O_2 ml/kg^{-1}/min^{-1})	70.05	5.0
Maximal Ve (l/min)	144.3	21.5
Maximal O_2 pulse (ml O_2/beat^{-1})	25.1	2.3
O_2 pulse at AnT (ml O_2/beat^{-1})	23.4	2.1
O_2 pulse at AerT (ml O_2/beat^{-1})	20.8	2.1
VO_2 at AnT (ml O_2/kg^{-1}/min^{-1})	62.9	4.5
VO_2 at AerT (ml O_2/kg^{-1}/min^{-1})	49.0	3.6
VO_2 at submaximal work level (ml O_2/kg^{-1}/min^{-1})	56.4	1.9
Maximal heart rate (beats/min^{-1})	185.3	7.5
Heart rate at AnT (beats/min^{-1})	176.4	7.0
Heart rate at AerT (beats/min^{-1})	156.4	7.0
Heart rate at submaximal work level (beats/min^{-1})	169.4	6.0
RQ at VO_{2max}	1.08	0.03
RQ at AnT	0.98	0.02
RQ at submaximal work level	0.95	0.05
RQ at AerT	0.83	0.03
RQ at first minute of recovery	1.08	0.04
RQ at second minute of recovery	1.13	0.07
RQ at third minute of recovery	1.08	0.07

basis of RQ, correspondingly during the 2nd minute of the submaximal load and recovery. The correlative connections between the mentioned factors are given in Fig. 1.

A very high positive correlation was revealed between the VO_{2max} and the capacity of the use of the energy substrates ($r = 0.94$). Essential positive correlations also existed between VO_{2max} and the O_2 uptake at AnT and AerT. A high negative correlation existed between AnT and the economy of the use of the energy substrates ($r = -0.90$). The index of the central hemodynamics, maximal O_2 pulse influenced more the maximal aerobic power while the correlations with the indices of submaximal endurance was relatively modest. VO_{2max} and the economy of the use of the energy substrates were in the inversely proportional correlation.



n = 12
$r > 0.57 = p < 0.05$
$r > 0.69 = p < 0.01$

Fig. 1. Correlative connections between the main components of the aerobic working capacity.

Table 3

Correlation coefficients between the variables of the aerobic working capacity and the 10-km race result

2	0.34					
3	0.07	0.20				
4	0.65	0.23	0.90			
5	0.94	0.25	0.66	0.51		
6	-0.71	-0.15	-0.90	-0.80	-0.59	
7	0.87	0.21	0.96	0.84	0.76	-0.90
	1	2	3	4	5	6

Variables:

1. VO_{2max}
2. Maximal O_2 pulse
3. AnT
4. AerT
5. RQ at second minute of recovery
6. RQ at submaximal work load
7. 10-km race result

The influence of the factors of the aerobic working capacity on the results of the 10-km race is shown in Table 3. A high positive correlation was revealed between the 10-km race results and AnT ($r = 0.96$), AerT ($r = 0.84$) and VO_{2max} ($r = 0.87$). A high negative correlation occurred with the RQ at the submaximal load and a positive correlation with the RQ in the 2nd minute of recovery.

Discussion

Authentic correlations between the main components of the aerobic working capacity reveal that in the course of the endurance training extensive morphological-functional rearrangements occur in the organism and a corresponding functional system is formed. The muscle work regime used preferably determines the direction of the morphofunctional adaptation, first and foremost the peculiarities of the O_2 uptake. The kinetics of the O_2 uptake depends on the biochemical processes of the O_2 utilization and O_2 transport [18]. The points of view of different authors on the dominating role of one or the other process are contradicting. Apparently, it is determined by the dominating regime of the muscle work, demands of the specific event and individual peculiarities of the athlete's organism.

As in our investigation the assessment basis was the 10-km result belonging to the high intensity zone it was more strongly influenced by AnT than by VO_{2max}. The correlation between the result and AerT was also relatively high. This is in accordance with the earlier study results [3]. Consequently, the 10-km result is mostly influenced by the processes of the O_2 utilization. Taking the maximal O_2 pulse as the criterion of O_2 transport or central hemodynamics we find that the influence of this factor on the result of the 10-km race is relatively small ($r = 0.21$). Obviously, with the increase of the length of the distance the role of O_2 utilization also increases. It is also proved by the high negative correlation with the RQ at submaximal load ($r = 0.90$). The above said shows an essential role of the submaximal endurance in granting the result of the 10-km race of well-trained runners and is in accordance with Aunola et al [1] study results.

The submaximal endurance can directly be connected with the economy of running [4]. In our study the criterion of economy was the RQ value at submaximal load. The correlation analysis revealed that the athletes who had on the basis of RQ a higher level of utilization of free fatty acids gained a greater speed in the 10-km distance ($r = -.90$). While the economy of the energy exchange influenced AnT more ($r = -0.90$) than VO_{2max} ($r = -0.71$). Simultaneously, one has to take into account the fact that at high intensity muscle work an essential role in the energy production is played by the range of glycogen decomposition, capacity of the use of energetical resources. Essentially it means the range of the application of the anaerobic-glycolytic mechanisms. A rather high correlation between the result in the 10-km race and the RQ of the 2nd minute ($r = 0.76$) shows the contribution of the anaerobic energy resources to the achievement of the result. The mentioned mechanism has the greatest influence on VO_{2max} ($r = 0.94$), much less on AnT ($r = 0.66$) and AerT ($r = 0.51$). The obtained data confirm the results of the earlier investigations [12, 14, 17] on the expediency of the anaerobic and strength training for the achievement of middle and long distance runners' high aerobic capacity. Our study results reveal a rather high prognosticative value of RQ values in the assessment of the result at competitions and different aspects of the aerobic working capacity.

The functional economy and capacity of the energy processes of the organism are contradictory categories but an expedient order of their development and connection are a basis for the functional stability [28], while the latter – for the special endurance as a most essential endurance factor determining the result at competitions [2, 5].

In the direction of the aerobic training of middle and long distance runners and in the determination of the optimum training speeds it is expedient to proceed from the values of the heart rate at the level of AerT and AnT. For the assessment of runners fitness VO_{2max}, AnT and AerT speeds, maximal value of the O_2 pulse as well as its values at the level of AnT and AerT can be used. Our experiments also proved the validity of the used scheme of the test and the apparatus (gas analyzer "Oxyconbeta", tredmill Burdick T 500) to estimate aerobic working capacity of runners.

Conclusions

1. The basis of aerobic working capacity and corresponding morphofunctional adaptation of well-trained middle and long distance runners is the dominating muscle work regime. The energetical granting of the latter occurs in the basis of the co-ordinated con-

nection of four main factors: maximal aerobic capacity, submaximal endurance, central hemodynamics and metabolic profile of the organism.

2. The result in the 10-km race depends, first and foremost, on the functional economy of the energy processes and the maximal aerobic capacity of the organism. The economy and power of the energy processes of the organism form a basis for the functional stability, the latter – for special endurance.

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THE EFFECT OF SLEEP DEPRIVATION ON THE LOCOMOTOR ACTIVITY AND BEHAVIOUR OF MICE

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Introduction

Sleep deprivation produces in laboratory animals a severe stress. The platform technique, which consists of keeping the animals on a small platform surrounded by water (7 cm diameter for rats and 3.5 cm diameter for mice) involves besides its specific action on sleep several factors of stress – isolation, immobilization, falling into the water, soaking and others which produce a heavy stress in the animals. This experimental model must therefore be considered mainly as a stress model of which sleep deprivation is one factor. (FRATTA et al 1990)

In contrast to other stressful situations sleep deprivation induces in rats and mice the state of behavioural activation. A peculiar feature of this model is that following the period of sleep deprivation, the animal does not fall asleep once returned to its home cage as could be expected but shows a constant period of wakefulness. (FRATTA et al 1990)

The goal of this work was to study the influence of sleep deprivation on the emotional status of mice and the influence of anxiolytic diazepam on the changes caused by sleep deprivation.

Materials and methods

ANIMALS. Male albino mice weighting 25–35 g were used in all experiments. Mice were kept with free access to water and food. Mice were deprived of sleep for 24hrs using the platform technique.

THE MEASUREMENT OF LOCOMOTOR ACTIVITY was carried out in actometer. Counts were registered after every 15 minutes during 75 minutes.

THE HOLE-BOARD TEST was performed according to FILE and WARDWILL (1975) and DURCAN and LISTER (1989). The hole-board apparatus was a plexiglass box 30+30 cm. In the floor were 16 equally spaced holes (2 cm diameter).

During 5 minutes

1. the number of head-dips into the holes and
2. the number of rearings were recorded.

THE STAIR-CASE TEST was carried out by the method adapted by SIMIAND (1984). The stair-case consisted of 6 steps.

During 3 minutes

1. the latency period of the first step climbed and
2. the number of steps were recorded.

THE PLUS-MAZE TEST was performed according to the method described by PELLOW and FILE (1986) and LISTER (1987).

The plus-maze consisted of two open arms 18+4 cm and two closed arms 18+6+14 cm with an open roof, arranged so that the two arms of the same kind were opposite to each other. The central compartment of the plus-maze was an open square 5+5 cm. The maze was elevated to the height of 20 cm.

During a 5-minute test period the following measures were taken

1. the total number of entries,
2. the number of open arm entries,
3. time spent in open arms,
4. time spent in closed arms.

In successive experiments the effect of anxiolytic diazepam on the changes in the emotional status of mice caused by sleep deprivation was studied.

30 minutes before the measurement of locomotor activity or behavioural experiments saline or diazepam was administered intraperitoneally.

Diazepam was used in doses 0.25, 0.5 and 1.0 mg/kg.

Statistical analysis

Results were analysed by ANOVA one-way analysis of variance. Further statistical analysis was done by the NEWMAN-KEULS test. The criterion for statistical significance was $P<0.05$.

Results

CHANGES OF LOCOMOTOR ACTIVITY. Sleep deprivation caused significant rise of locomotor activity. (Fig. 1.)

The inhibitory effect of diazepam on the locomotor activity was more pronounced in sleep deprived mice. (Fig. 2.)

THE HOLE-BOARD TEST. Sleep deprivation decreased the number of head-dippings and rearings in the hole-board test. (Fig. 3.)

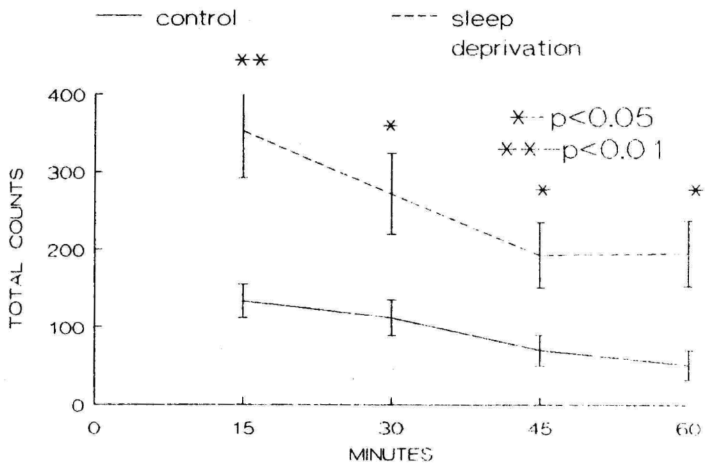

Fig. 1. The effect of sleep deprivation on the locomotor activity

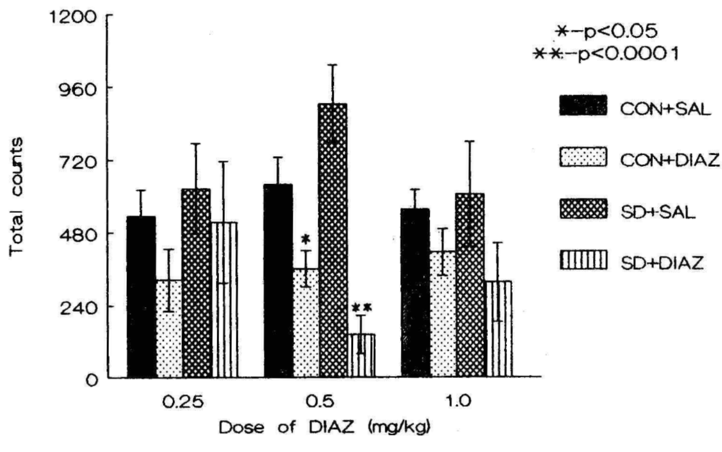

Fig. 2. The effect of diazepam on the locomotor activity of mice

Diazepam decreased the number of rearings in control group and in sleep deprivation group. (Fig. 3.)

Diazepam decreased the number of head-dippings in control group and increased in sleep deprivation group. (Fig. 3.)

THE STAIR-CASE TEST. Sleep deprivation increased the number of steps without changes in the latency time. (Fig. 4.)

Diazepam lenghtened the latency time and decreased the number of steps climbed both in control group and in sleep deprivation

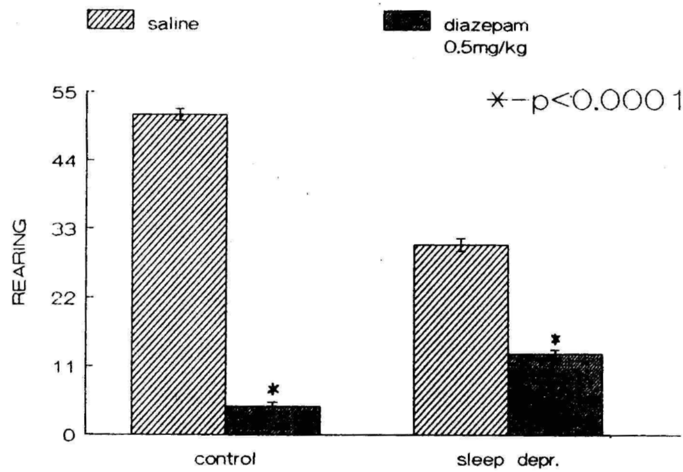

Fig. 3. The effect of diazepam in the hole-board test

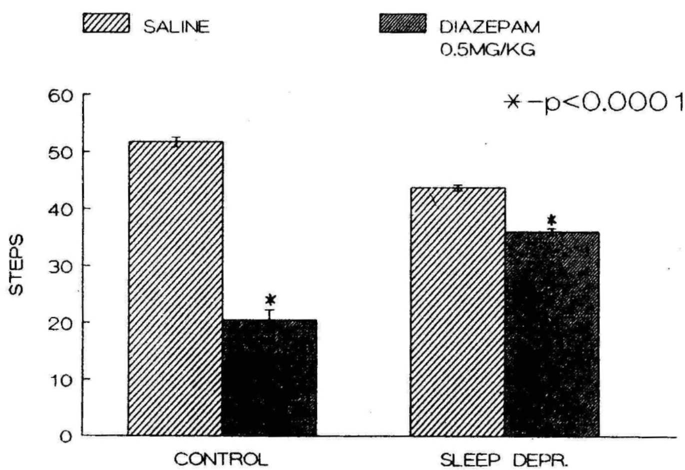

Fig. 4. The effect of diazepam in the strair-case test

group. (Fig. 4.)

THE PLUS-MAZE TEST. Sleep deprivation increased the total number of entries, the % of entries into the open arms and the % of time spent in the open arms. (Fig. 5.)

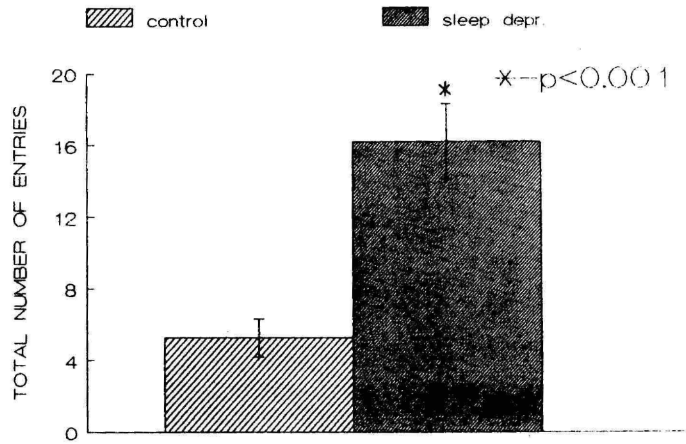

Fig. 5. The effect of sleep deprivation on the behaviour of mice in the plus-maze test

Diazepam raised the % of entries into the open arms in control group and decreased in sleep deprivation group. (Fig. 6.)

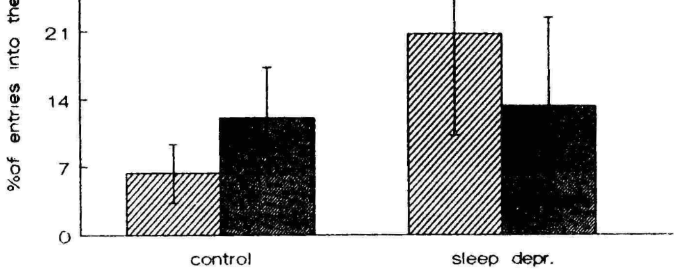

Fig. 6. The effect of diazepam in the plus-maze test

Conclusions

1. Sleep deprivation for 24 hours induced behavioural changes in mice which might be described as behavioural activation with a slight increase in the endogenous level of anxiety. This suggestion is suppourted by the following behavioural changes found in sleep deprived mice:

- increase in locomotor activity,
- decrease in exploratory activity in the hole-board test,
- increase in the number of steps climbed without changes in latency time in the stair-case test,
- increase in the total number of entries in the plus-maze test. Increase in % of time spent in the open arms and % of entries into the open arms is probably due to the increase in the total number of entries.

2. The inhibitory effect of diazepam on the behaviour of sleep deprived animals was considerably more pronounced as compared to control group.

These data indicate that sleep deprivation induces a sensibilisation of mice to the sedative and probably anxiolytic effect of diazepam.

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EFFECT OF COMPETITION SITUATION ON CATECHOLAMINE, CORTISOL, INSULIN AND LACTATE RESPONSES TO SUPRAMAXIMAL EXERCISE

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Introduction

There are comparatively old evidences that exercise-induced hormonal changes are modified in competition situation. The adrenocortical [4, 5, 18] and sympatho-adrenal responses (both changes of blood level [15] and of urinary excretion [1, 2, 8, 13, 14] of catecholamines) are usually exaggerated. Emotional strain may alter also the insulin response. Mild hyperglycemia has been found in association with unchanged insulin level after basketball competition [17]. However, in boxers after a highly emotional match a reduced insulin level was observed [6]. In accordance with exaggerated activation of sympatho-adrenal system enhanced rises in lactate concentration [9, 10, 20] together with fascilitated shift to acidosis [11] as well as hyperglycemia [19, 20] was established after competition exercises.

This study was performed to reexamin the action of competition situation on catecholamine, cortisol, insulin, lactate and urea response to supramaximal exercise. A laboratory model of competition situation was used.

Methods

5 physical education students performed within a week twice a 5-min exercise on a bicycle ergometer at the maximal possible rate. In the first time the exercise was performed in "training situation": in the laboratory there were only experimentators and the person. On another day the exercise was repeated in "competition situation": there was a competition between persons for the best performance, visitors were in the laboratory who cheered the persons, there were prizes for winners. Experiments were performed between 10.00 and

12.00 a.m. The participants had a light breakfast at least 3 hrs before the withdrawal of the first blood sample. Blood samples were taken before exercise, immediately and 30 min after it. Venous samples were taken by punctuation of the antecubital vein. The plasma was separated immediately through centrifugation. The plasma was stored at −20°C.

Cortisol and insulin were detected by radioimmunoassays [7] using the commercial kits of the Institute of Bioorganic Chemistry of the Academy of Science of the Byelorussian SSR.

Simultaneously with sampling venous blood, aliquots of capillary blood were taken from finger tips for determination of lactate and urea. Both metabolites were detected with the aid of the kits of Lachema (Czechoslovakia).

Urine was collected in three samples: (1) two hours before exercise, (2) during a period including 30 min before exercise, exercise performance and 30 min after exercise, (3) 2-h postexercise period (from the 30th min after exercise until 2.5 hrs had passed from the end of exercise. In the urine samples, adrenaline and noradrenaline concentrations were measured [12] and their excretion rate was calculated.

For statistical analysis of the obtained data the comparison of group mean values was performed with the aid of a t-test.

Results

The most pronounced changes induced by competition situation were in catecholamine excretion. Already in anticipatory state the adrenaline excretion was elevated by 78 % and noradrenaline excretion by 83 % in comparison with the levels observed before exercise in training situation. In ordinary conditions the exercise resulted in increases in adrenaline and noradrenaline excretion by 3.6 and 2.3 times. During the first two hours of recovery period the same level peristed in adrenaline excretion, but further increase was revealed in noradrenaline excretion. During exercise in competition situation adrenaline excretion rised to values 46 % and noradrenaline excretion to values 122 % higher than in training conditions. During the first postexercise hours the rise in catecholamine excretion continued and the obtained values were 1.63 and 2.24 times higher, respective to adrenaline and noradrenaline, than in postexercise recovery after exercise in training conditions.

Exaggerated catecholamine responses associated with more pronounced increase in blood lactate levels during exercise in competition situation. While in ordinary conditions during first 30 min blood lactate level was reduced, in competition situation the high lactate level persisted at least 30 min (Table 1).

Table 1

Changes in blood constituents induced by 5-min exercise in "training" and "competition" situation (mean ± S.E.)

	Before exercise	Immediately after exercise	30 min after exercise
Cortisol $nM.L^{-1}$			
Training situation	543±40	643±47*	652±51*
Competition situation	545±24	630±52*	640±74*
Insulin $.uU.ml^{-1}$			
Training situation	9.1±0.9	10.2±4.1	8.8±1.1
Competition situation	18.8±2.9	7.6±1.6*	10.4±1.4*
Lactate $mM.L^{-1}$			
Training situation	2.4±0.3	8.6±0.6*	6.5±0.9*
Competition situation	2.6±0.5	15.1±0.8*+	14.3±0.7*+
Urea $mM.L^{-1}$			
Training situation	4.7±0.5	5.7±0.7	4.3±0.3
Competition situation	4.5±0.5	5.3±0.8	4.8±0.8

* denotes statistically significant difference from pre-exercise values ($P < 0.05$);

\+ denotes statistically significant difference between values in training and competition situation ($P < 0.05$)

Cortisol level increased to the same extent in both situations. While the insulin level did not change during and after exercise in ordinary condition, in competition situation a drop of insulin concentration was found. Urea concentration changed neither in training nor competition situation.

During 5-min exercise the total work output was in competition situation 112 to 140 % of that in ordinary conditions.

Discussion

The obtained results confirmed an increased activation of the sympatho-adrenal system during exercises performed in competition situation. Taking into account the essential role of adrenaline in stimulation of muscle glycogenolysis [16], the observed high lactate level in competition situation might be the result of exaggerated sympatho-adrenal response. It is suggestive that the high degree of mobilization of glycogenolysis by adrenaline is causally related to increased performance in competition situation.

In competition situation the high activity of sympatho-adrenal system seems to impair the postexercise elimination of the blood lactate as it was indicated by the persisting high level.

Insulin concentration dropped only when exercising in competition situation. The exercise-induced inhibition of insulin secretion is attributed to the increased sympatho-adrenal activity [3]. The obtained results confirm this suggestion. On the other hand hypoglycemia stimulates insulin production. Obviously the ratio between the opposite actions of hyperadrenalinemia and hyperglycemia determine the actual response of insulin secretion in exercise. This may be the reason of various results in insulin response to exercise in competition obtained in earlier studies [6, 17].

Our results did not confirm the exaggerated adrenocortical response to exercise in competition situation [4, 5, 18]. One must take into account the methodological shortcomings of the previous studies mentioned. Nevertheless, most likely the differences in results are caused by possible peculiarities in the emotional state, those may vary to a great extent.

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LOWER LIMB VOLUME, SEGMENTAL AND SEGMENTAL TISSUE MASSES AND RECOVERY HEART RATES IN ADULT FEMALES

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Abstract

This study examined the relationships amongst lower limb volume, segmental and segmental tissue masses and recovery heart rates in adult females. Fourteen female students were studied.

Ten anthropometric variables were measured using ISAK procedure. Eleven segmental and segmental tissue masses were estimated using Clarys and Marfell-Jones equations. Leg volume was predicted with Katch et al equation. A five minute maximum step test, at the rate of 30 steps per minute was the exercise mode employed. Exercise was terminated at the end of the fifth minute or before the 5th minute either voluntarily as a result of fatigue or inability to maintain the stepping pace. Recovery heart rate was measured from the brachial artery for 30 seconds, first, second, third and fifth minute postexercise from the sitting position. The cuff and stethoscope were used in heart rate measurement. Means, standard deviations, t-test and Pearson product-moment correlation were employed in the treatment of data.

One-half of the subjects completed the five minute maximum test. Non-definite relationships were observed with varying performance time. Thigh weight and the weights of thigh bone, thigh

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and leg soft tissues consistently revealed inverse relationships with recovery heart rates.

With performance time held constant at 5 minutes, weights of leg, foot and their bones consistently revealed positive relationships with recovery heart rates. Weights of thigh, lower limb and their soft tissues revealed inverse relationships with recovery heart rates first, second and third minute post-exercise. Weight of thigh bone revealed increasing inverse relationships with recovery heart rates for all the minutes. It was concluded that heavy legs and feet will probably delay recovery while heavy thigh and thigh bone will hasten recovery after stepping exercise.

Introduction

There is surfeit of data on cardiac responses to submaximal and maximal exercises in patients, fit (athletes) and sedentary individuals. The mechanisms and factors responsible for cardioacceleration and cardiodeceleration before, during and after exercise have also been identified and elucidated. One of the several factors, and the most important for exercise cardioacceleration is increased venous return to the right atrium [Bevegard et al, 1963; Shephard et al, 1968a; Skranch et al, 1970; Guyton, 1981]. A little increase in venous return that moderately stretch the right atrium is reported to increase heart rate by as much as 10 to 30 percent (Bainbridge mechanism) while large venous return resulting in excessive increase in right atrial intraluminar pressure decelerates the heart [Pathak, 1959].

Several inverse relationships have been reported between exercise cardiac frequency and indices of body muscle (lean body mass, thigh muscle width, total body potassium) and heart volume [Jones et al, 1970; Cotes et al, 1973; 1980]. Heart volume and maximum oxygen consumption were reported to correlate positively with these indices [Cotes et al, 1980]. Jones et al, (1970) reported a positive proportional correlation between VO_{2max} and thigh muscle width during leg exercise. Duncan and Chan (1974) also reported highly positive correlations between maximal stroke volume and VO_{2max}, and between maximal cardiac output and VO_{2max} in Asian women, 12 to 19 years old. The works of these authors concluded that venous return and consequently exercise cardiac output is determined by individuals' cardiac and skeletal muscularity [Patrick and Cotes, 1978]. It is reasonable to therefore hypothesize an inverse relationship between lower limb lean tissue and recovery heart rate consequent to a standard leg exercise. Our primary objective was therefore to examine the relationships amongst lower limb segmental and segmental tissue masses and recovery heart rates.

Method and procedure

Subject – Fourteen female students from Lagos State University (LASU) were studied; 13 were from the Department of Physical and Health Education, 1 from Mathematics and Physical Sciences Department. The mean ± SD age for the group was 21.34±2.41 (range 19 to 25). The subjects were of various recreational and physical activity levels. They were medically certified fit for stress testing and test protocols were thoroughly explained to them before they voluntarily consented to take part in the study. All the subjects were highly intrinsically motivated because they were interested in knowing, in a quantitative manner, their fitness status.

Anthropometry – Two general and eight regional anthropometric variables were quantified using the procedure of the International Society for the Advancement of Kinanthropometry (ISAK). This procedure is endorsed by the Research Committee of International Council in Sports and Physical Education. All anthropometric variables were measured in the morning before noon for two days. A beam scale was used in quantifying body weight in the basal state after voiding with a light swim suit on. Stretched stature was measured from the Frankfort plane. Two girths (maximum calf, upper thigh), three skeletal lengths (trochanterion-tibiale, tibiale-malleolare, akropodion-pternion), and three skeletal breadths (femur biepicondylar, bimalleolare and metatarsals) were measured thrice and the mean computed. Lufkin metal tapes were used in measuring body girths and skeletal lengths. One of the tapes was adapted as suggested by Spenst-Blade (personal communication) for measuring skeletal length – two pin points, one stationary and the other moveable, were fixed to a Lufkin metal tape. This was employed in measuring skeletal length. Skeletal breadths were measured with a broad blade Bayer-Rue anthropometer. The anatomical sites were as described by Ross and Marfell-Jones (1983).

Twelve lower limb variables were estimated from the anthropometric measures. Eleven segmental and segmental tissue masses were estimated using the equations of Clarys and Marfell-Jones (1986a; 1986b):

i) Thigh Wt. (W_T), gm = 0.0851 (Body wt, kg) + 130 (Upper thigh, cm).

ii) Leg Wt. (W_L), gm = 115 (max calf girth) + 114 (Tibiale-Malleolare length) – 5599.

iii) Foot Wt. (W_F), gm = 65.9 (Akropodion-Pternion length) – 671.

iv) Wt. thigh bone (W_{TB}, gm = Tronchanterion-Tibiale length 25.46116 + Biepicondylar femur breadth 75.53176 – 1077.3.

v) Wt. leg bones (W_{LB}), gm = Tibiale-Malleolare length 20.88237 + Bimalleolare breadth 106.40592 − 1052.3.

vi) Wt. foot bones (W_{FB}, gm = Akropodion-Pternion length 20.60688 + Metatarsal breadth 37.74407 − 519.6.

Weight of thigh soft tissues (T_{ST}) was calculated by subtracting W_{TB} from W_T. The weights of leg soft tissues (L_{ST}) and foot soft tissues (F_{ST}) were derived in the same manner.

Total lower limb weight (LL_{Wt}) was calculated by summing together W_T, W_L and W_F. Total lower limb soft tissues weight (LL_{ST}) was also derived in like manner.

Leg (lower limb) volume (LV) was calculated from the equation of Katch et al (1973):

LV, mls = 142.11 (Body Wt., kg) + 181.2 (max calf girth, cm).

Exercise Mode − For obvious reason, the step test was the exercise mode employed. Several authors [Skranc et al, 1970; Maritz et al, 1961; Shephard et al, 1968a; 1968b; Sloan, 1969; Cotes, 1969b; Ariel, 1969; Duncan, 1972; Shephard, 1970] have employed step testing for evaluative and comparative (types of exercise mode) studies. A five minute maximum single level step test on a 43.2 cm (17 inches) bench at the rate of 30 steps per minute was allowed. Stepping was paced by metronome that was constantly recaliberated. Correct stepping was emphasised and subjects were instructed to stand erect on the bench at each ascent and place both heels upon the floor at each descent. Exercise was terminated at the end of the 5th minute or before either voluntarily as a result of fatigue or inability to maintain stepping pace.

Recovery heart rate (rHR) was measured from the brachial artery using the cuff and stethoscope with the subject sitting on the bench. Standard procedure for counting rHR after stepping exercise was employed, that is, 1 to $1\frac{1}{2}$ minute, 2 to $2\frac{1}{2}$ minute, 3 to $3\frac{1}{2}$ minute. In addition, rHR was also counted from 5 to $5\frac{1}{2}$ minute post-exercise. The values obtained were multiplied by 2 to convert to beats per minute.

A week prior to exercise testing subjects were randomly allowed to practice bench stepping, using the test bench, in order to familiarise them with the test and probably reduce if not eliminate anxiety which can cause anticipatory rise in heart rate prior to exercise. Ignorance of laboratory exercise tests has resulted in under-estimation of max VO_2 [Shephard et al, 1968b; Duncan, 1972] probably because of anxiety induced increase in pulse rate; Shephard and others further observed that relatively little anxiety or learning were shown with the step test. Each subject was allowed two practice sessions on different days with a minimum of one or two days interval. Practice and test sessions were conducted in a well ventilated classroom in the morning before noon. Thompson (1977) observed a non-specific cardiovascular fatigue when testing was conducted in the afternoon. Testing time was randomised. All subjects were evaluated between the month of July and August. The mean maximum temperature and humidity for these months were 27°C and 82.5 % respectively.

Extra precautions were taken in controlling other variables that can influence heart rate. Exercise testing was conducted not less than two hours postprandially. Subjects were advised to avoid coffee, tea, smoking and exhaustive exercise a day previous to testing.

On arrival for testing, each subject was allowed to rest for five minutes on a chair after changing to gym wear without the shoes on. Heart rate was immediately taken from the radial artery after the 5 minutes rest. This was repeated a minute after. Testing was further delayed where the difference in heart rate between the 5th and 6th minute exceeded 5 beats.

Analysis – The data collected were described using means and standard deviations. These were further treated with Pearson product-moment correlation and the t-test. The level of significance was set at 0.05.

Results

Half of the subjects completed the test. The mean performance time for the whole group was 4.04±1.05 minutes.

The mean rHR values for the whole group after the 1st, 2nd, 3rd and 5th minute were 125.14±9.91 (range 112–140), 109.86±11.19 (range 94–126), 103.86±10.39 (range 92–120) and 100.71±10.74 (range 92–120) beats/min respectively. Cardiodeceleration rate was significant for all the minutes. The magnitude of cardiodeceleration was 15.28 beats (62.55 %) between 1st and 2nd minute of recovery, 6 beats (24.56 %) between 2nd and 3rd minute, and 3.15 beats (12.89 %) between the 3rd and 5th minute. Decrease in rHR was gradual after the 2nd minute.

The subjects physical characteristics are shown in Table 1. Except for body weight, upper thigh girth, max. calf girth and trochanterion-tibiale length that were consistently lesser, other physical characteristics are comparable to those previously reported [Agbonjinmi, 1991]. The means of height and weight are similar to Sloan's (1969) values for Cape Town women.

The values for lower limb tissue variables are shown in Table 2. Weights of thigh, thigh bone and thigh soft tissues were consistently lower; weights of leg, leg bones and leg soft tissues are comparable to values reported for elite female judokas [Agbonjinmi, 1991].

The weights of leg and foot are higher while thigh weight is lesser than values of Clarys and Marfell-Jones (1986b). Clarys and Marfell-Jones (1986a) values for thigh bone, leg bones and foot soft

Table 1

Means, standard deviations and range of physical characteristics (n = 14)

Variable	Mean	SD	Range
Weight, kg	59.54	6.71	49.0 – 73.5
Height, cm	163.44	7.61	155.4 – 177.9
Calf girth (max), cm	34.31	1.67	31.6 – 37.8
Thigh girth (upper), cm	56.11	3.94	51.6 – 63.0
Trochanterion-Tibiale length, cm	39.85	3.13	36.4 – 46.7
Tibiale-Malleolare length, cm	38.34	2.35	34.2 – 43.9
Akropodion-Pternion length, cm	24.34	1.36	22.3 – 27.4
Biepicondylar femur breadth, cm	9.02	0.58	8.1 – 9.9
Bimalleolare beadth, cm	6.33	0.36	5.6 – 6.9
Metatarsal breadth, cm	11.6	0.57	10.9 – 12.85

tissues are comparable to our values; their value for leg soft tissues is lesser and thigh soft tissues higher than those obtained in this study. The value for leg volume is higher than that reported by Katch et al (1973) but similar to Jones and Pearsons (1969) value for females.

Table 2

Means, standard deviations and range of lower limb tissues variables (n = 14)

Variable	Mean	SD	Range
LV., Liters	14.68	1.20	12.69 – 16.97
W_T, gm	4330.92	512.86	3743.17 – 5227.25
W_L, gm	2717.6	412.55	1933.8 – 3545.6
W_F, gm	932.72	89.45	798.57 – 1134.66
W_{TB}, gm	618.73	102.43	514.25 – 859.50
W_{LB}, gm	421.79	73.73	310.96 – 598.64
W_{FB}, gm	420.25	41.4	351.34 – 490.89
T_{ST}, gm	3712.19	445.30	3122.7 – 4367.75
L_{ST}, gm	2295.81	348.02	1622.85 – 2946.96
F_{ST}, gm	512.47	56.76	447.23 – 665.01
LL_{WT}, gm	7981.24	953.32	6475.54 – 9907.51
LL_{ST}, gm	6520.48	785.23	5268.87 – 7979.72

Table 3 contains a plethora of r values depicting the relationships amongst lower limb variables and rHRs with varying performance time.

Table 3

Relationships amongst lower limb tissue variables and rHRs with varying performance time (n = 14)

Lower limb tissue variables	rHRs 1st min	2nd min	3rd min	5th min
Leg volume	-.08	-.264	-.235	-.242
Thigh weight	-.069	-.263	-.257	-.211
Leg weight	.00076	-.016	-.0072	-.0066
Foot weight	.082	-.085	-.122	-.196
Weight of thigh bone	-.168	-.356	-.413	-.47
Weight of leg bones	-.079	-.060	-.067	-.145
Weight of foot bones	.131	-.055	-.105	-.369
Thigh soft tissues	-.041	-.22	-.201	-.135
Leg soft tissues	-.011	-.112	-.043	-.02
Foot soft tissues	.177	-.094	-.115	-.166
Weight of lower limb	-.04	.212	.118	-.167
Lower limb soft tissues	-.044	-.18	-.141	-.098

Some of the relationships in Table 3 are contrary to expectation. Positive relationships were observed for five tissue variables and 1st minute rHR. These tissue variables were weights of leg, foot, leg bone and foot soft tissues. Only total lower limb weight revealed positive correlations with 2nd and 3rd minute rHRs. All tissue variables inversely correlated with 5th minute rHR. The pattern of relationships was not definite.

In search for a consistent pattern, the subjects were divided into two groups: finishers and non-finishers, and the whole data were re-examined. The mean performance time of 3.07±0.45 minutes for non-finishers was significantly different. There was no significant difference in rHRs between the two groups. Also, there was no significant decrease in rHR between the 3rd and 5th minute in finishers, the decrease was significant in non-finishers.

Examination of the relationships amongst tissue variables and rHRs for the finishers revealed a definite pattern for five of the limb variables (Table 4). Weights of leg, foot, leg bone and foot bone consistently revealed positive correlations with rHRs. Weight of thigh bone revealed increasing inverse relationships with rHRs. No definite pattern was revealed by other tissue variables. Cotes (1972) suggested cardiac frequency at a standard VO_2 as and index of cardiac response to exercise. An inverse relationship between fat free-mass and cardiac frequency has been reported [Cotes et al, 1973].

Table 4

Relationships amongst lower limb tissue variables and rHRs after 5 minutes of bench stepping (n = 7)

Lower limb tissue variables	rHRs 1st min	2nd min	3rd min	5th min
Leg volume	.058	–.015	.102	.125
Thigh weight	–.157	–.229	–.106	.089
Leg weight	.051	.0052	.090	.328
Foot weight	.476	.313	.122	.036
Weight of thigh bone	–.195	–.456	–.630	–.673
Weight of leg bones	.358	.331	.24	.128
Weight of foot bones	.646	.587	.458	.255
Thigh soft tissues	–.118	–.145	–.001	.191
Leg soft tissues	–.033	–.072	.033	.291
Foot soft tissues	.268	.062	–.14	–.126
Weight of lower limb	.617	–.124	–.032	.177
Lower limb soft tissues	–.074	–.122	–.0019	.219

Discussion

The findings of this study in respect of post-exercise cardiodeceleration and rHR responses in finishers and non-finishers are supported by existing literature [Macpherson, 1949; Skranc et al, 1970; Lamb, 1978; Devries, 1974]. The rapid fall in rHR was followed by a more steady fall representing a two phase curve. Rapid and reflexive response to macro and or micro-environmental changes is a function of the nervous system. Petro et al (1970) reported a latent period of 0.5 sec for exercise cardioacceleration, this was attributed to reduction in vagus tone. Steady rise in exercise HR is due to metabolically related factors [Shephard, 1970]. The rapid post-exercise cardiodeceleration is due to the loss of cortical and proprioceptive (muscle and joint receptors) stimulation [Shephard, 1982].

The steady phase of cardiodeceleration which was observed to start at about the 2nd minute in this study may be due to slower removal of metabolites, especially lactic acid, from tissues and blood. Cotes et al (1969c) observed that respiratory adjustment to increase in work is in excess of 3 minutes. Astrand and Saltin (1961a) observed increased in lactic acid after 2 minutes of exercise, therefore, anaerobic metabolism could result in lactacidemia which is found to be higher in muscles [Astrand and Saltin, 1961b] when only legs were exercised. Increased in body temperature could possibly have contributed to the steady state of rHR [Shephard, 1970; Robinson, 1963]; however, this is controversial in exercise of less than 6 minutes [Davies, 1970].

Differences in rHR between the finishers and non-finishers confirmed that our subjects were of varied recreational and physical activity levels. The results show that finishers were more fit [Hall, 1963; Bevegard et al, 1963; Davis and Harris, 1964; Cotes et al, 1973; Edwards et al, 1969]. Other factors that could have resulted in poor performance were body weight and height of subjects. Bench height and stepping pace were not corrected for weights of subjects, hence the work performed varied amongst the subjects [Ariel, 1969; Cotes, 1969b; Cotes et al, 1969a; Kappagoda et al, 1979; Duncan and Chan, 1974]. Extreme bending of the knee joint resulted in poor fitness index [Ariel, 1969].

The low correlations (Tables 3 and 4) of the 1st minute postexercise probably shows that body composition has little or no role to play in rapid rHR during the 1st minute. The increasing inverse correlation (Table 4) revealed by thigh bone from the 2nd minute probably shows that lean tissues contribute to speedy cardiodeceleration probably through rapid oxidation of lactate and or conversion of it to glycogen.

The decreasing positive correlation of weights of leg and foot would probably delay recovery from exercise. Considering the kinesiological principles [Rasch and Burke, 1978] involved in stepping, the low correlations revealed by the weights of foot, foot bone and foot soft tissues should be expected. These variables are neither involved in hip, knee and ankle actions during stair climbing. With the results of this study, it is concluded that heavy legs and feet will probably delay recovery while heavy thigh and thigh bone will hasten recovery from leg exercise.

This study has three implications: The first is for foot and sports protective wear industries and orthopaedic surgery. Second, more discriminative fitness test should employ the 1st minute pulse count only. Third, it should stimulate further research.

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THE ROLE OF AFFECT IN SPORTS TRAINING

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1. Introduction

Training was always the object of many studies of various facets and models of research. It must be noted that the most researched areas and which generate the most research and books, apart from articles, were the factors of periodicity, load, methods, individual qualities, biological and physiological factors. The least studied factors were the playing fields, the spectators and the coaches. These are the factors which directly intervene and affect the athletes, as well as those involved in their world. Training, or the notion of it, is integrated in a much wider world than that of sport.

Independent of any other position, to participate in competition it is necessary to prepare oneself. The world which revolies around sport is very varied and of complex relations among its actors. For the world of sport to work certain figures and characters are necessary: [illegible]e, coach, doctor, psychologist, spectator, masseur, the person in charge of clothes and equipment and many others who make a living from the athletic sphere.

As was highlighted, many studies were done principally of the athlete; fewer of the other figures. The factors which act in the interaction of athlete and coach were not well analysed and did not deserve the proper attention of the research to detect the change in performance and motivation of the athletes as, in the majority of case, the coach is imposed on the athletes by the managers, without consultation or asking the athletes opinion as to their acceptance or rejection of him.

It is believed that the study of different variables, involved in training must be analysed by the different factors that link the coach with the athlete in a working relationship. In all types of interaction, irrespective of the relation that links the participants, this interaction is always complex and difficult. For this reason, according SINGER (1986), studies should be aimed at studying the union of the many variables that combine to give the world of sport, and principally of training, the beauties and magnificence already established as universal.

The following questions guide this research: a) What importance do coaches attribute to affectivity? b) What is the role of affectivity in the coach-athlete relation? c) How do coaches demonstrate affect to their athletes?

2. Review of bibliography

2.1. The components of training

At present, sports training is an emotive topic, although it has been much written about, research and discussed. It is one of the most complex and controversial of the phenomena in sport, with thousands of coaches looking for new forms of knowledge, with the view to obtaining the highest returns in the innumerable sports competitions.

According to FERNANDES (1981) AND TUBINO (1979), training has reached a very advanced and complex level, that one coach alone needs to be in constant contact with training centres as well as having access to and studying publications about the matter in order to understand it deeply. But this has not occurred recently and it can be stated that concern with results and training have joined since the begining of humanity. Despite having a long history, training only recently was faced as a scientific fact and deserving of research and theorizing, attempting to glimpse the foundations that sustain it and make it a multi-faceted construction.

The bases of sports training are fixed in the athlete, with his different variables, the coach and his philosophy of training, apart from the support team or the technical team, consisting of many menbers from the doctor to the wardrobe maneger, from the maneger to the treasurer. In addition, one cannot forget the predominant role of the spectators and the ideology of the state for the benefit of the phenomena of world sport.

It is believed that it is on these bases that sport, training and sporting events are constructed.

2.2. The athlete

All would be in vain if there were no athlete in the conception and application of sports training. Whatever the type of sport and the philosophy for getting results from training. It seems that the figure of athlete as a human being and as achiever has been overshadowed by the obsession with achievement, forgetting many principles of direction, even purely biological ones, not to mention deontological and ethical conceptions.

The majority of conceptions of training do not take into account the desire of the athlete but only his possible athletic expressions. The structure of modern training was conceived in order to attend to and harness the capacities of the athlete to the maximum. The pressures applied by the different and diverse social mechanisins lead to inhuman excesses to maintain ones 'supremacy or merely to keep ones' job.

Many authors, among them DANTAS (1986), MATVEIEV (1986), WEINECK (1986), name some guiding principles of training as cornerstones of sports training. They refer to principles of structuring of training as well as of organization and biological factors. Those principles struggle with each other for supremacy with the biological factors clearly winning althout one cannot overlook the other factors and their interdependence.

The principles mencioned are the following:

a) principle of theoretical integration,

b) principle of the compacting of the training schedule,

c) principle of specificity of training,

d) principle of continuous load,

e) principle of periodic load,

f) principle of the exact succession of loads,

g) principle of the stimulation of loads which are effective for the training,

h) principle of overloading,

i) principle of specialization,

j) principle of reversibility.

There are many possibilities for a structural conception of the phenomenon of training but of FERNANDES (1981) depicts the complexity of training well. In the first place we have the levels of training (general and specific training), then aspects of training (physical, technical, tactical and psychological preparation), and finally each division has diverse subordinate aspects which complete the structure of training.

2.2.1. Analysis of the principles

The evolution on the methods of scientific research offered new courses for the concepts and methods of sport training, consolidating knowledge and taking both coaches and athletes along a conscious road to the attainment of their objectives. Understanding the changes that can occur in the body as a result of training makes the work to be done easier and more practical. Therefore, it is imperative to know what occurs in the body and what the bases of progress attained or to be attained are.

One common characteristic all the concepts of training is that it always tries to maximize the capacity of performance of the individual. There are many acts in training to achieve this stated aim. The amount of knowledge generated by research and concepts have been translated by principles that for particular individualized training systems, apart from being adapted to each objective. The following training principles will be developed:

a) biological principles,

b) principles of structuring,

c) organizational principles.

A. Biological principles – for BARBANTI (1986), there are three biological principles:

1) the principle of overloading refers to the functional changes which occur in the body when the loads applied are sufficient to cause considerable activation of energy and structural changes in cells related to the syntesis of new tissues. Overloading refers to the intensity and amount of training, with the recommendation of systematic and progressive increase of this overloading;

2) principle of specificity says that the majority of functional and morphological changes that occur during the training refer to the organs, cells and structures that are responsible for movement;

3) principle of reversibility affirms that bodily changes attained through physical training are temporary.

B. Principles of Structuring – for WEINECK (1986) these are the following:

1) the principle of increasing load resides in the progressive increase in the intensity and amount of training;

2) principle of continuous load refers to the continuous increase in the output until an individual limit is reached;

3) principle of variable load, different forms of load affect the body differently, permitting a gain in extent and intensity of training;

4) principle of exact succession of loads is of extreme importance for the work of the various components of the output;

5) principle of effective stimulation refers to the need for a stimulus to surpass a threshold so as to obtain an increase in the output;

6) principle of periodic load refers to the need for periodic and alternate loads in a year of training.

C. Organizational Principles – for TUBINO (1979) and MATVEIEV (1986) these are the instruments for effective quidance in the development of a training process for top competition. The following can be demonstrated:

1) principle of theoretical integration refers to the knowledge of all those who are part of the training process in the objectives, planning, programmes and other topics that act towards the maximum output and the prevention of conflicts inherent in the process;

2) principle of the compacting of the training schedule refers to planning and recovery and application of the loads;

3) principle of specialization of training refers the need to apply the processes and forms which are suitable for and specific to each sports type;

4) principle of maximum individual attainment emphasises the option of a sports type as an identification of the maximum output and its development through training conditions which are specific in a human being.

The depiction of theoretical concepts of trainig would not be complete without mentioning preparion in terms of the athletes' will. This is a much-used term in the literature of Eastern countries while in the others countries psychological preparation is the expression used, with many variables as components of these training units. We have a global view of what is required to achiève the preparation of an athlete, in the theoretical conception terms, with the reality being often very different and sadly incoherent with the theoretical consеption. We believe it is unnecessary to describe the concepts and different forms and methods of the different preparations, although we cannot forget that the growth of a human being is not possible without dignity in his training process.

2.3. The coach

Few have studied the coach as a person and as a professional – a professional that requires many facets and special preparation for the fulfilment of his profession. The professionals that show many types and many levels are those that toil in the complex world of sporting events.

The function of the coach can be analysed in three aspects, without there beings a dichotomy or a loss of a strong, constant and mutual interrelation: 1) the coach as a person, 2) the training of the coach, 3) the profession of the coach.

2.3.1. The coach as a person

The person of the coach continues to be a big question marke in many countries and cultures where the sports context is seen as an important activity and crucial for the development of the human being and an integral and indelible part of society. LIMA (1981) states that competition has contributed to "...the wide knowledge of the total human being." As part of the social context in which he is exposed to many demands, from the point of view of the performance of his role and of the figure, sometimes stereotyped as an exemplary person and educator besides being principally a teacher, as CHRISTINA and CORCOS (1988) comment. For these reasons, not everyone can be a coach or at least a coach who influences or educates, as, so LAWTHER (1978) notes, sport is a constituent of the patterns of social relations and represents different forms of group displays which society tests.

Of all that has been said, the most important is the coach as a person who transmits a philosophy, both of the sporting life which is coherent wich social life as well as of the person himself as a creature of the universe.

His leadership must be the motive, the satisfaction and the growth of both the trainee under his direction as well as the group he socialises with. The predominant characteristics of his way of being should be his behaviour as a person with high standards of respect, understanding and compassion. CARON (1984).

We still need to tread a long road to attain such views in all their fullness.

2.3.2. The training of the coach

Much has been said about the training of the teacher, but far less about the physical education teacher and even less about the training of the coach. We must bear in mind the fact that the profession of coach is a recent one (in many countries it does not even exist yet) in order to take into account the training of coaching staff and to stir up debate about this point.

Authors, among them, LIMA (1981), CURADO (1982), MATVEIEV (1986) consider the training of different levels of coaches to be indispensable and urgent in order to harmonize with the level of capacities of the participants, their motivies, interests, leading them to the constant and ever more demanding practice of sport. To sum up, it is understand that the training of the coach should be inclusive and specialised, in accordance with his idiosyncrasies, vocation, level and modality. As LAWTHER (1978) and CURADO (1981) summarise, the preparation of the coach must include the following points and provide the future coach with the following skills: capacities for planing, for evaluating, technical knowledge of the modalities, methodological models of training, knowledge of sports psychology, behavioural psychology and learning theory.

We dot not conceive of a coach without a baachelor's or master's degree, and it is an advantage if he has been an athlete, experienced in competition and has an understanding of the maintenance of physical form, besides being a leader in his community. The indirect but far – teaching factors affecting the athlete are his communication skills, the atmosphere surrounding his work as a coach, his constant and prior preparation and keeping up to date, both in his working methods and his technical methodology and tactics of the sports type in question. The question of the interaction between the sports participants should always deserve attention and the coach who yearns for success should always note this component with care and never overlook its action.

2.3.3. The profession of the coach

The profession of the instructor, trainer, preparer, technician, coach, sports teacher and many other connotations is recent in the social context of modern life. Despite this incipience, the profession of coach is a profession of prestige in many countries and has well-developed laws and a great views of the future. However, in other countries it is neither a profession nor prestigious and does not possess laws or legal protection for its maintenance.

A popular saying is that all the world is a bit of doctor and a coach so everyone has tips for coaching and forming teams, principally at the national level, regardless of the type or category. A new facet of the profession of the coach is this need to deal with the many opinions of and pressures on his work by thousands of people.

The inconstant of the profession and the dependence on the results of the team or the athletes under his instruction make the profession of the coach an unknown constant in the future with little or no guarantee as a profession, as he is often dismissed or his contract rescinded. It is believed that this type of situation generates emotional and even existential instability in the coach world, making medium and long-term planning difficult for his team as well as for his life, both professionally and personally.

To attain the stature of other professions which are older and more highly regarded, besides being more stable, the road will be long and arduous for the profession of the coach.

3. Methodology

3.1. Sample

The sample of the present study consists of male coaches as it was considered that gender has an effect on the coach's relations. There were 18 coaches, distributed among group contact sports (basketball and handball) and group noncontact sports (volleyball) and individual sports (athletics, judo, gym, swimming). The teams of the coaches are those that train in the cities of Porto and Lisbon, Portugal. There are different levels of teams in terms of age and divisions of championships. The number of teams by age and sports type was distributed as follows: basketball (junior 3, senior 2), volleyball (junior 1, senior 2), handball (junior 1, senior 1), judo (senior 1), gym (junior 1), swimming (junior 1), athletics (junior 2, senior 3).

3.2. Instrument

The instrument used to collect the data was direct interview with the coaches. According to RIERA (1985), the interview is a valid instrument for the collection of data to elucidate the problems linked to many sports questions. Six (6) questions were put to the coaches. The questions revolved around the importance of affectivity, the interaction and attitudes of the coaches in relation to the training and their actions. The coaches were chosen according to availability.

The questions of the questionnaire besides the personal and professional data of the coaches are the following: 1) What are the most important characteristics you think a coach should have? 2) What role do you attribute to human relations in your role as sports coach? 3) What is the role of affectivity in training in your opinion as coach? 4) Should victory be at any cost in your opinion? 5) In your view as coach, what are the most important points in order to be a high performance athlete? 6) What are the demonstrations of affect which you use most in relation to your athletes?

We took advantage of the opportunity to ask the coach for a self-evaluation on a scale of 0–5 and also to obtain succinct comments with regard to the topics broached in the interview. The interviews took place at a place and time convenient to the coaches and were taped on magnetic tape. They took place during the 1989/90 season.

4. Results and discussion

With reference to the objectives of this study, we can highlight the following results:

1) The average age of coaches interviewed was 37.6 years, with the youngest being 21 and the oldest 55.

2) The average length of degrees was 13.5 years, with only one not having a graduate degree.

3) The sports types were distributed as follows: handball 2, volleyball 3, basketball 5 (10 team sports); athletics 5, gymnastics 1,

swimming 1, judo 1 (8 individual sports).

4) The coaches were involved in juvenile and adult teams, with 9 coaches being of national level, 7 of state level and 2 of regional level.

Table 1 presents a summary of the sample which was interviewed.

Table 1

Characteristics of the sample

Age	N	Degree/years	N	Sports	Junior	Senior
21, 28, 29, 30	4	2, 5	2	basketball	3	2
33, 35, 37(4), 38	7	6(2), 9, 10	4	volleyball	1	2
41, 42, 44(3), 45	6	12, 13, 14, 15(2)	5	handball	1	1
55	1	19(3)	3	judo	–	1
		21, 22, 24	3	athletics	2	3
		N/Graduate	1	swimming	1	–
				gymnastics	1	–
Total: ave 37.5	18	average 13.5	18		9	9

Question 1: "What are the most important characteristics you think a coach should have?" was answered as follows:

1) with regard to training – technical knowledge, behavioural knowledge, research, keep up-to-date, be competent;

2) with regard to personality – leadership, perseverence, enjoyment, patience, responsability, friendliness;

3) with regard to philosophical issues – being humane, valuing the human being, philosophy of life, should be an educator.

An analysis of table 2 shows that the greates percentage of concerns of coaches is in relation to competence, technical knowledge and keeping up-to-date, which corroborates the findings of TUBINO (1979) and THOMAS (1982).

The factors of personality and the human questions were also important but less so.

Table 2 presents the main points covered by the coaches.

Question 2: "What role do you attribute to human relations in your role as sports coach?" was answered as follows:

1) very important, indispensable, basic, supreme, 13;

2) an experiential role of life itself, 14;

3) motivating, 3;

4) open relation, favourable climate, 11;

5) should know what the problems are, 9;

6) role of group relations, 7.

Table 2

Answers to question 1

Regard/training	N	Regard/personality	N	Regard/philosophy	N
Technical knowl	11	leadership	4	valuing human	6
Behavioural	7	'perseverence	4	philosophy of life	5
Be competent	4	enjoyment	4	respect	2
Research	4	patience	3	dedication	2
Keep up-up-date	4	responsability	2	should be educator	2
		friendliness	2		
Total	30		19		17

Table 3 shows that the majority of coaches (13), attribute a very important, indispensable or basic role to the role of human relations, which is extolled by RIERA (1985) and SINGER (1986).

Table 3 presents the main points covered by the interviewees.

Table 3

Answers to question 2

Points covered	N
Very important, indispensable, basic, supreme	13
An experimential role of life itself	14
Open relation, favourable climate	11
Should know what the problems are	9
Role of group relations	7
Motivating	3
Influence the performance	8
Work must be supported by good relations	9
Total	74

Question 3: "What is the role of affectivity in training in your opinion as coach?" was answered as follows:

1) each athlete is an individual and should be treated as one;

2) values of individuality, values of personality, values of relation, values of spirit.

Table 4 shows that many coaches belive that affectivity depends on the athlete, the sports type and age to have an important role in sports coaching. In understanding sport as a social enviroment, authors like THOMAS (1981) and ANTONELLI & SALVINI (1978) point to the necessary of studying the affective relation between

Table 4

Answers to question 3

Role of affectivity in training	N
Very important	7
Each athlete is an individual and should be trated as one	9
Should know to act	6
Values of individuality	8
Values of personality	5
Values of relation (gender, type, category)	4
Values of spirit	3
Does not have	1
Total	43

coach and athlete. It must be noted that one coach attributed no role to the affective component.

Table 4 presents the principal concepts extolled.

To question 4: "Should victory be at any cost in your opinion?" the following considerations were raised:

– no never, of course not, answered all 18 coaches. All coaches offered biological reasons – one should not alter nature to obtain a victory, ham or kill oneself; ethical, moral and human issues – affirming that victory is a balance of qualities and the other athletes, victory doesn't justify itself, it should be the motivation, it should be the experience, with a direct relation between victory an profit, rethinking the future and thinking about the tendencies of liberalization.

Table 5 shows that all the coaches felt that victory should not be at any cost, although illicit acts were condenned by 7 interviewees. There are few authors who have debated the problem of victory at any cost and at any price, although there is a world apart from or on the margin of traditional coaching with many secrets and new discoveries ahead of restrictions and controls.

Table 5 presents the tendencies of the coaches.

Question 5: "In your view as coach, what are the most important points in order to be a high performance athlete?" was responded to as follows:

1) motivational qualities – the individual should enjoy the sport, have motivation and willing;

2) capacities that condition – genetic predisposition;

3) psychological qualities – intelligence, responsibility, high aspirations, having an attitude of high performance;

4) motor and physical qualities, be a specialist, capacity of work;

5) have a competent coach.

Table 5

Answers to question 4

How victory at any cost is felt by the coaches	N
No, never, of course not	18
Doping, illicit acts were condenned	7
Victory must always be pretended	6
One should not alter nature	3
Victory is a balance of qualities and other athletes	5
Victory doesn't justify itself	5
It should be the motivation	5
It should be the experience	5
It should be prepared to victory and fairlure	5
Total	59

Table 6 shows that the psychological and personality factors were emphasised over genetic predispositions and conditioning capacities, which appears not make sense at first glace. Nevertheless, the performance in a certain sports type is conditioned by many factors which are complementary but not exclusive. Authors like SOBRAL (1988), CURADO (1982), MATVEIEV (1986) show several possibilities to attain top performance.

Table 6 presents the opinions of the coaches relative to their preference of athletes qualities.

Table 6

Answers to question 5

Be an athlete of top performance	N
Enjoy the sports, have motivation, willing	13
Capacities that condition	10
Genetic predisposition	6
Capacities of work	4
Having an attitude of high performance	5
Be a specialist	4
High aspirations	3
Motor and physical qualities	5
Have a competent coach	5
Total	55

Question 6: "What are the demonstrations of affect which you use most in relation to your athletes?" was answered as follows:

1) on a personal basis with the athlete – be respectful, converse, find out problems;

2) demonstrations of encouragement; feedback (verbal, bodily, gestures); incentives;

3) expressions in the form of gestures, pats, smiles, criticism, questions.

A coach does not demonstrate affect on the playing fields, it depends on the sports type, it depends on the sex, it differs from athlete to athlete.

Table 7 shows that the different attaiments of affect depends on the opinions, personality, approach and training of the coach. These points are corrobarate by results finding by MARKLAND & MARTINEK (1988), SMITH, SMOLL & CURTIS (1979), besides the suggestions from MARTENS (1988) and CARRON (1984). The most frequent factor was knowledge of the athletes problems, followed by the different types of feedback, incentives, encouragement, jokes.

Table 7 presents how coaches demonstrate affect and what they think about it.

Table 7

Answers to question 6

Demonstrations and what coaches think about affect	N
Knowledge about athletes' problems	10
Feedback verbal, bodily, gestures	9
Reforcement, incentives	4
Gestures, pats, smiles	5
Differs from athlete to athlete	4
Depends of the sport type	3
Jokes, incentives, questions	2
Respect to qualities	3
Does not demonstrate on the playing fields	1
Total	41

The open question asking for self-evaluation by the coach was answered as follows: 1 at level 5, 3 at level 4, 4 at level3, 1 between levels 2 and 3, 3 between levels 3 and 4. Two were unable to position themselves. One positioned himself at level 5 in one category and level 4 in an other. One considered himself to be level 4 in training of athletes and level 1 in the category of high performance. One divided his evaluation in different levels: interpretation 3, concern with sports type 5, view of evolution of the athlete 4 and relation

4. Finally, one did not know where to position himself but placed himself at 5 for relations.

These final placings which the coaches left as messages can be summed up as: necessity to learn even to accepting the error of the referee; be humane; questions and answers have the importance which people want to attribute to them; the answers are conditioned by the concepts of the sport and of the coach; many forget human relations when doing their technical and tactical work; human relations are decisive for the success of the technical part; the coach has many components and many tendencies; trying to do our best every day; there is a big difference between what is said and what is done; the younger elements need much support.

5. Conclusions

Concluding a project many seem like the end which is not the case here. The objective was to show some placings which coaches made in relation to the questions which were posed. To achieve the proposed objectives, it is necessary to add the other two parts, namely, the opinion of the athletes and the results of the observation of actions in training and games.

As it customary to draw conclusions, we are presenting indications of the tendencies, thoughts, actions and conceptions of the interviewees. The necessary information is lacking to judge these deeply and confidently but the gathered material is rich in possible interpretations and critical temptations. We can draw up the following considerations in this regard:

– the coaches regard technical and behavioural knowledge as the most important factors for the fulfilment of their function;

– the majority consider the role of human relations in training to be important;

– the affective part of training was considered by at least half of the interviewees as dependent on many considerations;

– all the interviewees believe that victory should not be at any cost;

– psychological and personality qualities come first with conditioning capacities and genetic predispositions next;

– the expressions of affect by the coach depend on various factors, nevertheless, the majority demonstrate it via knowlegde of their athletes' problems, feedback, incentives, conversations and jokes;

– the majority of coaches are not afraid to evaluate themselves and analyse their performance in relation to their team.

It is only by valuing competition to the extent that it is possible to place it on the path to the affirmation of the human being in his individuality, his humanity and in what is most noble about him that one can develop the fundamental aspects of the formation of young peoples' personalities and make training and sport a dignified way of life.

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AGGRESSION: ATTITUDES BY AGE AND SEX IN SCHOOL PLAYGROUNDS

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Abstract

The purpose of this study was to codify the display of aggression of school children of both sexes, during break-time. The data was collected by direct observation from 4 schools. The aggressions dimensions was Physical, Verbal and Gesture types. The aggression display between male, female and mixed sexes, were similar independently of the school. We can say that none of the aggression theories on their own can explain the complexity of the aggression act.
Keywords: Aggression, Playground, Children.

Introduction

Aggressive attitudes during human life have produced a wide range of literature, with the focus on various and different aspects. The different studies of childish aggression have given birth to works in the fields of Biology, Psychology, Ethology, Anthropology, Sociology, Neurophysiology, and, lastly, even in law, namely Criminology and International Law.

The different aspects proposed over the ages have approached questions involving transformations, intelligence, learning, social environment, evolution, races and mental and chronological age, among other topics. The great importance attributed to the mediators of the child's aggressive behaviours in her or his interpersonal relationships, cogniton-wise, has been the main point of the studies in the last years.

We can consider as characteristic of aggressive behaviours the harming and the suffering of their victims, and this behaviour causes several forms of suffering, physical as well as psychological. Sometimes the same action causes different reaction in the victim, according to the perception of the intention that caused the action in question. This way, one will react, probably, with apprehension, when she or he understands there was an intention of causing her or him evil, probably having a different reaction if the action that caused it was accidental instead of intentional. This way, it seems that the hostile intention comes together with the bad consequences, being an essential element of the definition of human aggression. In the specific case of children, studies on the aggressive process have posed very specific questions in order to elucidate the questions like time, the informations about and analysis of the aggressor's intentions, which are necessary in order to evaluate the intentions and the consequences, which must be analysed before we classify as aggressive the simple actions of playing, comparing themselves, challenging each other.

The strongest concern should be the reasons for the beginning and for the ending of the intentional and obviously aggressive acts of children, which, in the chronological and biological evolution of other animals appear in a later stage. Cathy & Abling [1970].

The interpretation for such behaviours can be seen differently, either from the adult point of view or from the child, because the source of the information, the age and the capacity for the treatment of that information are subject to variation too. We must still add that the perception and evaluation of an aggressive act demand a considerable capacity of cognition from the child, for, among other things, it needs different kinds of judgement, which implies realising, both the aggressor's action and her or his own reaction. The coordination and the integration of such complex information seem, at first sight, incompatible with the cognitive capabilities of young children, and there is thus an evolution and a change in the child's aggressive behaviour, not only in their biological evolution, but also in the social one.

The direct observation of children's behaviour, young as well as older, in institutions, has been a field of study very much explored for the study of different behaviours. Aggressive behaviours have been, and are still being, very much studied through direct observation by many hours' of dealing with children. The greater the freedom the children enjoy, the greater number of spontaneous interactions, and also of proposals of games, which appearand which makes these places good reservoirs of studies.

In this context, the direct observation method appears as an useful investigation technique, and even a complementary one, for the determination and confirmation of the data coming from scales, inventories and tests.

The information collected during the many years of research have stressed an important point: boys present a higher level of aggressive behaviour towards girls, though there is no unanimous opinion about this, as Tieger [1980] and Maccoby & Jacklin [1980], have recently shown us. The different aspects involved cannot be extrapolated from one culture to the other, not even from one environment to the other, thus there are differences in data.

We can say there are context factors, family factors and social factors, besides space, the toys and the games that children play, which must be taken into account. In the words of Jeffers & Lore [1979] and Van Rillaer [1978] cultural factors, like the understanding of society, aggression and its relation to it, are important to help the conclusion, the clarification and a further understanding of the subject.

Purpose

The present study's contribution is towards the clarification of child aggression in groups of Portuquese children of the pre-school and school levels. It compares also aggressive behaviour between sexes during break-time, in the space the school reserves for this purpose. We have mainly tried to find out:

a) if boys get more frequently involved in aggressive behaviour in games and break-time playing than girls;

b) the frequency of the use of different forms of aggression, according to sex, age, and school environment.

Procedure

The research took place in four schools in the Cascais area. They are public institutions which are called, either kindergarten or elementary schools. The children were grouped by age, in both of them, and there was a distinction with regard to the knowledge or the cognition pre-requirements needed to belong to the higher classes. Usually the children are with and assisted by some educator and assistent during their pre-schooling period. The same teacher is with the children during the whole of their elementary school period.

Two of these institutions have proper buildings for the development of the learning activities, though they do not have much material for children's playground activities. The other two have neither the place nor the right space for the activities. It cannot cope with such a great number of children, nor would it be recommended. Because of these space limitations, the smaller children spend most of their time in the classroom, instead of outdoors, as would be likely according to their age (4 to 6). There is no covered pavillion, for physical activities or other collective ones. The activities are dependent on good weather.

The sample was composed of 362 subjects thus distributed:

4/6 years old 143 Male 68 Female 75,

7/10 years old 219 Male 122 Female 97.

The social and cultural origin of the subjects is rather heterogeneous, though we found a majority from the middle-classes, or the mid-level. The salary variations had a wide range, from the minimum to 15 times over this.

The observers participated in drawing up the observation form as far as items, breaks and registers were concerned. The points contained in the file were obtained based on the work of Baron [1977], Fonseca [1982] and D'Antola [1981]. The three main types were: 1) Physical aggression with arms, legs, head, head and shoulders, the whole body. 2) Verbal aggression with insults to the person, to her/his family, to her/his body. 3) Gesture aggression with grimaces, obscene gestures and spitting, as Buss [1961] proposed.

There were specific areas in the playground for palying certain games and for specific purposes only. The remaining forms of activity were limited to the free or non-determined areas.

The time of observation each day was 15 minutes, adding up to a total of 225 minutes of observation. There was a distinction according to sex, age and school. The place for observation and picture-talking was outside the schools, in places strategically meant for the purpose.

Results

The present research has tried to detect and codify the different variables which could interfere in the aggression of the children studied as the sample. A statistical reference of the average was been used. The statistical test used to analyse the data was chisquare.

The numbers in the tables have the following meaning:

a) horizontal:

1 refers to physical display,

2 refers to gesture display,

3 refers to verbal display;

b) vertical:

1 refers to school with space to play, or to female sex,

2 refers to school without space to play, or to male sex.

The chi-square on table 1 is not statistically significant for the study, at the level of .05. One could say that both the schools with space and those without show the same number of aggressive acts in the same proportions, in early ages.

The chi-square on table 2 was statistically significant at the level of .05, which leads us to say that for the age of 7–10 years old, the space that the school has contributes to the occurrence of aggressive

Table 1

Results of the schools with and without space, between the age 4–6 years old

	Observed Frequencies			
	1	2	3	Total
1	40	7	21	76
2	64	8	25	97
Total	112	15	46	173
Chi-square = .153,		D.F. = 2,	Prob. = .9262	

Table 2

Results of the schools with and without space, between the age 7–10 years old

	Observed Frequencies			
	1	2	3	Total
1	106	18	38	162
2	73	20	54	147
Total	179	38	92	309
Chi-square = 8.263,		D.F. = 2,	Prob. = .0161	

Table 3

Results of the ages

	Observed Frequencies			
	1	2	3	Total
1	112	15	46	173
2	179	38	92	309
Total	291	53	138	482
Chi-square = 2.572,		D.F. = 2,	Prob. = .2764	

acts. The type of aggression most shown is physical there being high levels for verbal aggression, as well.

The chi-square on table 3 was not statistically significant at the level of .05. This leads us to say that the aggressive acts happen in the same intensity in ages which vary from the 4 until the 10.

The value of chi-square on the table 4 is statistically significant at the level of .05. This expected value must be noted as it confirms some authors and studies on the matter.

The data analysed on table 5 are not statistically significant at the level .05. One could say that the aggressive acts of the boys

Table 4

Results of school with and without space, between the age 4–10 years old

	Observed Frequencies			
	1	2	3	Total
1	121	27	75	223
2	170	26	63	259
Total	291	53	138	482
Chi-square = 6.662,		D.F. = 2,	Prob. = .0358	

Table 5

Results of the aggression between the mixed group and the male sex

	Observed Frequencies			
	1	2	3	Total
1	98	20	40	158
2	121	19	62	202
Total	219	39	102	360
Chi-square = 1.836,		D.F. = 2,	Prob. = .3993	

Table 6

Results of the aggression between the females group and mixed sexes group

	Observed Frequencies			
	1	2	3	Total
1	98	20	40	158
2	72	14	36	122
Total	170	34	76	280
Chi-square = .628,		D.F. = 2,	Prob. = .7307	

are not different from those practised by both sexes. The physical aggression occurs more frequently.

The data analysed on the table 6 show no difference at level .05. There were 170 displays of physical aggression compared with 110 of the others categories combined.

The data analysed on table 7 reached values which are not statistically significant at level .05. One could say that both boys and girls practise aggressive acts in similar quantities. We highlight the quantity of aggressive acts of the physical type (193), followed by

Table 7

Results of the aggression between males and females

	Observed Frequencies			
	1	2	3	Total
1	72	14	36	122
2	121	19	62	202
Total	193	33	98	324
Chi-square = .365,		D.F. = 2,	Prob. = .8331	

verbal types (98) and lastly the gesture type (33).

The figures 1, 2, 3 show us a comparison of schools, sexes and ages with regard to the research data.

Discussion

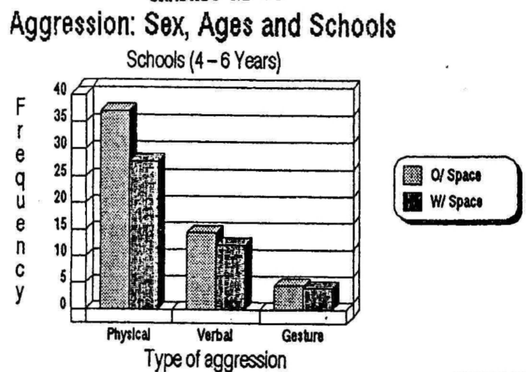
Taking into consideration the objectives of the present work, one could say that the number of aggressive acts coming from the male sex are greater compared to the female sex, but without being statistically significant, it confirms the majority of studies made until this moment. We must highlight the physical type numbers in contrast to the verbal as well as the gesture types, which appears not to be in accordance with the literature. The type of aggression against objects, initially foreseen in the study, lost its importance at the end by its non-freguent occurrence as this is a form of reaction of younger children. Fonseca et al. [1984].

The age group of 4–6 years old of the schools with and without space showed similar levels of aggressive acts, leading to the affirmation that to them space is not important in their games. The contact with their friends, acting and expressions are important, like little animals to which playing, even aggressively is not regarded as a from of hurting their companions. It is make-believen.

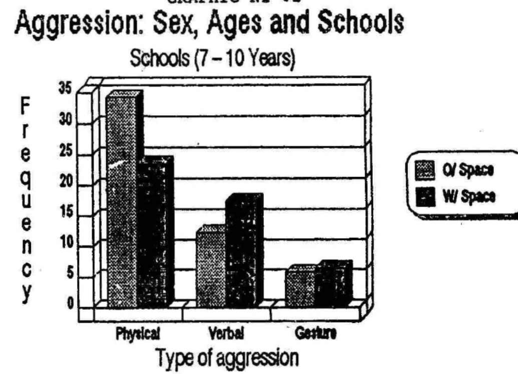
In contrast, for the ages between 7–10 years old, space must be taken into account as it is like having their own territory. Lorenz [1966], Storr [1970]. There are therefore more aggressive acts within schools which have little space to practise their games. The type of aggression most used is the physical, but also with great expression of the verbal types, regardless of the sex.

Analysing the schools with and without space and all the ages, 4–10 years, it can be observed that there is a relation between the space of the schools and the age of the children. Another curious observation the high levels, although not statistically significant, of aggression between different sexes. However, who starts the

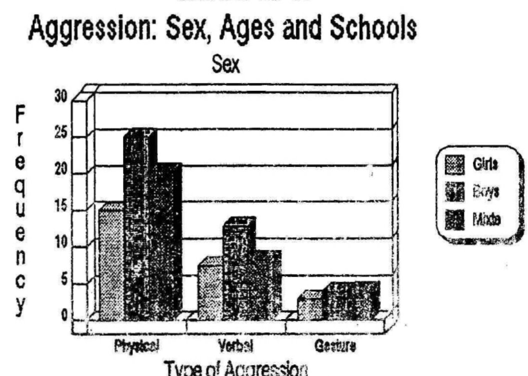
GRAPHIC Nº 01



GRAPHIC Nº 02



GRAPHIC Nº 03



aggression has not been studied yet.

It has been noticed that there are days with more frequent aggressive acts without apparent cause, like a "wave" of imitation of the behaviour. Berkowitz [1980] and Bandura [1977].

Many variables have not been controlled, and many doubts emerged throughout the study. The systematic control of each one of the possible variables may bring elucidations and explanations of so many aggressive acts practised by the children during break-time games. But still the question of the interpretation of the aggression which happens in such conditions remains. Sometimes it can be spontaneous, retaliatory, or of hyperactivity but are the psychological principles which rule each one of the types equal? To which point is the appearance of the types of aggression influenced by the enviroment in which the child lives and which is the biological influence?

Modern civilization is considered a repressive one.

The relation of infantile education to child aggression has to do with the methods of infantile education, and is our repression of the most natural and spontaneous childish aggressiveness not the cause of innumerable suicides and adult wars?

By not having enough knowledge of the needs, potentialities and also, and mainly, of the deficiencies of man, mistakes are made in education and the understanding of many actions, especially related to children.

"I am not against aggression but against violence." Hacker [1981].

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ACHIEVEMENT MOTIVATION AND MOTIVATION OF AVOIDING FAILURE: THE ROLE IN SPORT RESULTS

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Introduction

Motivation of a person to do something or to keep from doing it may be very different. In sports where the main aim of somebody is achievement, being better than the others, the relation of achievement motivation of avoiding failure is of special interest.

The concept of achievement motivation was first mentioned by J.A. Atkinson [2]. He writes that two controversial tendencies can be seen in the behaviour of a person – a wish to achieve and a wish to avoid failure. We can say that the need to be better, to get higher results is characteristic for a personality.

According to R. Martens [12, p. 327] "...success is an intrinsic factor: the reward is in the activity itself. Money and prestige are extrinsically related to the activity involved. An intrinsically motivated individual seeks the rewards inherent in the activity, e.g., the fun, thrill, or exhilaration from participation in the activity and not the rewards that come from external sources." Thereby the origin of intrinsically motivated behaviour is in a person's need for feeling competent and self-confident [6].

According to R.B. Alderman [1] the high need for achievement possessed by most outstanding athletes thus expresses itself both as a need for competition and as a need for success and pleasure. Thus, if a person consistently experiences, or actively seeks, a number of competitive situations in his career as an athlete because he has high expectations of success with its strong concomitants, then there is gradually developed in his personality makeup a strong motive for achievement.

"The need for achievement thus underlies the motive for achievement which only becomes consolidated in a person's personality if, in competitive situations, he constantly succeeds and experiences pleasure" [1, p. 206].

The paper deals with results of learning relations between achievement motivation and motivation of avoiding failure.

Methods

The best in Estonia adult sportsmen of different individual sports (swimming, cross-country skiing, track-and-field, gymnastics, rowing, shooting, sculling) were investigated. All together 440 people participated in the research program.

Several questionnaires (those of Izard, Millemann, Kisselyov and others) and measurements of characteristics of psychological qualities of sportsmen as hand tremor, variability of movement speed, features of attention were used in the study. Also data of self-assessing, interviews, pedagogic-psychologic observation before and after competition were used.

The results allowed us to estimate the urge to succeed and the urge to avoid failure of sportsmen, adequacy of self-assessing and to fix internal and external features of sportive behaviour.

Results and analysis

Firstly, three groups can be derived based on the relation of achievement motivation and motivation of avoiding failure. The first group of 282 persons (64.1 ± 5.22 %) is characterized by the dominance of achievement motivation and very weakly developed urge to avoid failure. The second group of 74 (16.8 ± 3.18 %) includes persons with dominating motivation of avoiding failure and weakly developed achievement motivation. The third group of 84 (19.1 ± 3.51 %) consists of persons with both motivations equally developed.

Consequently, for most of the investigated people the achievement motivation is dominating (64.1 ± 5.22 %). There are statistically significant differences between the number of the participants belonging to the groups I ja II ($t=7.76$; $p<0.05$) and I and III, too ($t=7.15$; $p<0.05$). This fits well with what has been found by other investigators who have mentioned a more frequent domination of achievement motivation [3, 4, 7, 8, 10, 15, 17 et al].

Secondly, another important characteristic connected to the results of sportsmen in competition is their ability of self-assessing. In this study self-assessing includes evaluation of the level of physical, functional and psychological readiness. Adequate was considered self-assessing that was close to realistic possibilities and correlated to the estimate of the trainer.

Three different groups of self-assessing can be separated as follows: 1) adequate, 2) inadequate, that may be either too low or too high, and 3) unstable that is characteristic for some sportsmen who sometimes have quite adequate self-assessing but may also be very inadequate, usually much lower, seldom higher.

Thirdly, data on behaviour and activities while in competition are presented. These were estimated by external features of behaviour, detailed interviews and self-analysis of sportsmen. Also data from measurements of some characteristics of psychological condition as changes in hand tremor, variability of movement speed [5, 16] and attention qualities were used. In the following these results are presented for different groups as separated above.

Group I covers 282 sportsmen (64.1 %) with achievement motivation dominating. According to self-assessing two subgroups can be separated. One of these (I_1) includes 174 sportsmen with adequate self-assessing (39.5±5.43 % of total, 61.7±8.37 % of the first group) and the other (I_2) covers the remaining 108 with inadequate self-assessing (24.5±4.20 and 38.3±8.37 %).

Group I_1 with dominating achievement motivation and adequate self-assessing can be characterized by the following features of behaviour and condition.

– Their aim is clear, they know what they can and what the expected result could be.

– Usually they do not consider the possibility of failure and do not talk about it.

– Their psychological tension is optimal.

– They attune themselves to main – to excellent performance. They are ready to act, all attention is directed towards performance.

– They use ideomotoric training.

– They are characterized by good level of self-control and self-regulation.

– They are highly stable to disturbances. Even the behaviour of the trainer cannot disturb them if they consider it nonrational.

– The result in competition usually is as good as expected.

Group I_2 with dominating achievement motivation but inadequate self-assessing can be divided into two. I_{2a} of 66 sportsmen with too high self-assessing is characterized by the following.

– Hyperfixation of success.

– Domination of the idea to reach a certain place or result.

– Winning is important and they attune themselves to win. Therefore they sometimes have a fear of failure.

– They are often nervous, nonquiet, exited.

Competition results are changingly either expectedly high or much lower than their abilities.

Subgroup I_{2b} with dominating achievement motivation and too low self-assessing includes 42 persons. Characteristic to them features are what follows.

– Due to low self-assessing they are very sensitive to external disturbances, they are made nervous by spectators and competitors.

– Frequent is a fear of failure. Therefore they are convulsive and trying to direct their thoughts to the result.

– Self-control and self-regulation are relatively weak.

– Especially bad is the trainer reminding of previous failures.

Results in competition are often lower than expected. Common features for both subgroups I_{2a} and I_{2b} are the following.

– Lowering of self-control just before the competition.

– Dispersion of attention, difficulties getting concentrated.

– Both physical and mental tension are frequent.

The second group (II) of sportsmen has 74 persons in it (16.8 %) with the motivation of avoiding failure dominating and achievement motivation relatively weak. Subgroup II_1 includes a bit more than half of the whole group (38 persons) with nonstable self-assessing changing between adequate and nonadequate. The following features are characteristic for them before competition.

– Strong wish to avoid unsuccess.

– All attention is directed to avoiding failure.

– High stress condition and being easily disturbed by aquaintances, spectators, competitors, trainer etc.

– Fear of failure.

– Hyperfixation of avoiding failure is frequent and causes convulsive thinking how to avoid it.

– Occasionally they think they are well trained and should perform well.

– They are looking for possible excuses for failure. Often they talk about bad conditions, bad feeling.

As a rule the results are weak. The main reason for it is the sportsmen's not really doing anything to perform well. They do not use ideomotoric training, do not concentrate on the crucial parts of performance etc.

Subgroup II_2 includes 36 persons with inadequate, usually low self-assessing. More characteristic are the following features.

– Fear of failure, disquiet, sometimes unconcern, lack of willingness to compete.

– Negative selfassurance and pessimism can be found.

Results are usually low.

The third group covers 84 sportsmen with both achievement motivation and motivation of avoiding failure more or less equally expressed. Some of them have adequate self-assessing, some of them do not. The more characteristic features for these people are similar to those presented for persons with achievement motivation dominating. The results of these people are often quite good or medium. Freguent are also better than expected results.

Summarizing what has been said above, the following can be expressed.

Sportsmen with achievement motivation dominating were usually successful. Ability of adequate self-assessing is important to be successful. There were no remarkable differences between the representatives of different sports, neither were there sexual differences. The need for trainers to pay more attention to the relations of the motivations in sportsmen has to be mentioned. The achievement motivation and ability of adequate self-assessing have to be developed in young sportsmen. Expressed by V.S. Merlin [11] dependence of motivations on the type of character has to be considered. According to V.S. Merlin for introverts and people with strong excitement the motivation of avoiding failure is dominating. For extraverts and persons of low excitement achievement motivation is dominating. The viewpoint that a strong will to reach good results expresses the domination of achievement motivation and is a guarantee for relatively stable motivation structure, as expressed by V. Hoshek, M. Vanek and B. Svoboda [9] has to be agreed with. Therefore, trainers should more widely use their knowledge of the need of sportsmen in result for better psychological preparation of them.

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DEPENDENCE OF SELF-REGULATION ON SELECTIVE REACTION

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Introduction

Problems of quick decision and correct action are central in many fields of sport. Practical observations as well as scientific research have proved that high level of simple reactions does not always reflect positively in the quality of actions with selective character [Peisahhov, 1974]. The existence of probable relation between quickness in solving the tactical problems of a given field of sport and quickness of selective reaction has been observed by Konzag (1983).

We have found information about self-regulation in literature in the field of psychomotorics, memorizing techniques and thinking process [Cratty, 1973; Thoresen, 1974; Heckhausen, 1980; Konopkin, 1980; Carver, 1981; Singer, 1982; Surkov, 1984]. To avoid terminological misunderstanding we hold it necessary to stress that the present paper is striving to shed light on one narrow field of problems concerning psychomotorics. The aspect of self-regulation is limited by the study of the exhibition and inhibition processes of the nervous system on the basis of selective reaction. The work uses simple methods of wide usage range.

The present study has been induced by earlier practical observations in the field on coordinative abilities. Determination of separate motions and their combinations according to their complexity [Valgmaa, 1981] necessitated the comparison of the speed factors of same-side signal (SS) and cross signal (CS). As both cases concerned the possible influence of attention and quickness of reaction, it became necessary to find out the essence of these phenomena [Valgmaa, 1987].

There is few data on direct or indirect connection between selective reaction and self-regulation. First of all we have to generalize the information concerning selective reaction during this age period, when the general development of organism is intensive.

The purpose of the present research is to establish the level of self-regulation using selective reaction tests of different complexity. Special attention has been paid to the development dynamics of schoolchildren. We have also tried to explain the influence of sports on the intensity of development and the opportunities of using the results during initial training stages.

Methods

On investigating self regulation the simple methods based on selective reaction were used. The subject of experiment reacted in turns to red and green signals that appeared in the sequence unknown to him. The answer was given using switches of the same colours, the green signal appearing on the same side with the green switch and the red signal on the same side with the red switch (SS). Then the display board was turned round so that the red signal appeared crosswise to the green switch and the green signal crosswise to the red switch (CS).

The subject had to switch out, the light using the switch of the signal's colour.

When explaining the task it was stressed: "Don't try to guess the next signal, act upon the colour that appears!" Before the SS series the subject got 5–6 preliminary tries, then two series of testing followed, each containing ten signals. Then the display board was turned. There were no preliminary tries before CS and testing was started when the subject had announced his or her readiness. The best result with SS and CS signals was taken into account.

Subjects: In the first group schoolchildren of the age of 8, who did not actively go in for sports, performed the tests in October 1986 for the first time and repeated the programme thrice with a yearly interval. So in the course of 4 years the same persons, 66 boys and 92 girls took part in testing.

In the second group gymnasts aged between 8 and 14 (modern gymnastics and Olympic gymnastics) were studied. The aim of the girls was to achieve high results in sports, they practiced 4–6 times a week. Every gymnast participated in testing during 2–3 years (n=16).

The third group consisted of young badminton players (girls of 8–13 years). Each player participated in the testing thrise with a yearly interval (n=30).

In the fourth group tests were performed by adult experienced sportsmen (badminton, basketball, handball and volleyball players). The data are given after one testing (69 women, 62 men).

Means, standard deviations, variation coefficients and linear correlation coefficients were calculated using ordinary statistical methods. Differences between means were tested for significance using Student's t-test.

Results

The results of testing the selective reaction of schoolchildren demonstrated that in the age group of 8–11 the average result decreases ($p<0.05$–0.001) and the dispersion of results decreases (Table 1). On the average the time of answering to CS shortens more than the time of answering to SS.

Table 1

The results of selective reaction tests with schoolchildren

Age	n	Same-side signal $\overline{x}$	±SD	Best result	Cross signal $\overline{x}$	±SD	Best result
Boys							
7	33	5.73	1.01	4.16	7.40	1.64	4.90
8	66	5.36	0.85	4.05	6.89	1.38	4.41
9	66	4.98	0.85	3.32	5.85	0.92	4.51
10	51	4.44	0.50	3.51	5.04	0.77	3.81
11	39	3.84	0.49	3.00	4.30	1.01	3.80
Girls							
7	46	5.70	1.10	4.00	7.64	1.50	5.01
8	92	5.36	0.90	3.20	6.74	1.11	4.00
9	92	4.89	0.72	3.11	5.85	0.86	3.70
10	80	4.50	0.58	3.20	5.22	0.85	4.00
11	58	4.21	0.51	2.96	4.81	0.52	3.00

In relation to the best result, at 10 years of age a kind of halt occurs (at the age of 9 with boys in reacting to CS). Between individual results in answering to both signals there excists an easily perceivable connection in all age groups ($r = 0.30$–0.75). Starting from the age of 8 a pupil with better results never fell to the average level. It even occurred that a pupil showing average results during the first years of testing later became better and remained among better pupils.

It is also noteworthy that with girls the difference between average and better results was always greater than with boys ($p<0.05$). This observation is not, however, connected with similar dispersion of all the results (with boys $v = 11.3$–23.5 %, with girls 11.1–19.6 %). At the age of 10 to 11 the development of boys is notably quicker than that of girls as the average results demonstrated.

The results of testing young gymnasts (girls) show that the success in the group of one-year difference of age is statistically significant when comparing groups of 8–9 and 9–10 years of age

($p<0.05$). Comparison of average results shows probable differences in the data of age groups of 8–10, 9–11 and 10–12 years ($p<0.05$). The differences of average data in the age group of 11–13 were not statistically significant.

Between the average results of testing boys and girls with S and C signals the better result of boys is seen during the experiment at the age of II ($p<0.01$).

The comparison of SS and CS average results shown by gymnasts (girls) of 8–11 years and schoolchildren of the same age permits to stress notable success of children active in sports.

The time of answering SS and CS was in close connection in both groups. With children of 8 $r = 0.43$; with those of 9 $r = 0.61$, at the age of 11 $r = 0.64$ and at 12 $r = 0.84$. The connection was vague only at the age of 10. The range of dispersion of results at the age of 8–12 was 9.2–15.3 %, being 22 % only for gymnasts who were 8 years old.

The average result shown by girls (badminton) at the age of 8–13 grows constantly, but success during one year is statistically significant only for the average results with CS in age groups of 8–9 and 9–10. According to average data probable differences are observable with tests performed in the age groups of 8–10, 9–11 and 10–12 years. The period between 11–13 years does not show statistically significant changes in this test group (Table 2). The comparison of average results of SS and CS tests between badminton players (girls) and schoolchildren of the same age allows to underline a certain success of children active in sports. It is also noteworthy that in answers to SS signals the success of sportsmen was notably greater than in answers to CS.

Upon analysing the results of adult sportsmen (Table 2) no attention has been paid to comparing the results of different fields. We only want to stress that all sportsmen getting the best results were members of the country's team.

Discussion

The influence of sports on the quickness of selective reaction is best characterized through comparing the results of schoolchildren to those of regularly training sportsmen. The difference in the initial data at the age of 8 is insignificant. The difference in average results of gymnasts at the age of 9–11 in answering to SS was statistically significant ($p<0.001$). The average results of answers to CS were better with gymnasts in all cases ($p<0.001$). Figure 1 illustrates the average results of girls at the age of 8–11 with SS and CS. The beginning of the line denotes the average time of answering to SS, the length of the line the increase of reaction time in answer to CS.

Table 2

The results of selective reaction tests with young sportwomen

Age	n	Same-side signal $\bar{x}$	±SD	Best result	Cross signal $\bar{x}$	±SD	Best result
					GYMNASTICS		
8	11	4.98	1.10	3.11	6.37	1.29	4.60
9	18	4.18	0.90	3.61	4.98	0.62	4.00
10	13	3.70	0.38	3.15	4.36	0.63	3.36
11	16	3.68	0.51	2.97	4.24	0.47	3.74
12	16	3.39	0.32	2.90	3.81	0.58	2.96
13	17	3.31	0.35	2.65	3.99	0.73	2.93
14	17	3.25	0.61	2.53	3.78	0.68	3.13
					BADMINTON		
8	18	4.78	0.72	3.95	6.21	1.06	4.68
9	30	4.53	0.86	2.90	5.58	0.98	3.97
10	33	3.98	0.62	3.08	4.94	0.81	3.28
11	38	3.73	0.45	3.00	4.69	0.72	3.12
12	20	3.70	0.62	2.66	4.52	0.83	3.08
13	20	3.69	0.47	2.42	4.66	0.57	3.52
Adult sportswomen							
	69	2.88	0.32	2.26	3.66	0.55	2.86

The sucess of badminton players concerning the average results in answering to SS is better than the average of schoolchildren. Apparently the intensive training of gymnasts adds a strong stimulus to their natural development and self-regulation abilities.

When comparing the results shown by pupils who have entered school at 7 (33 boys, 46 girls) and 8 years of age on the basis of the same age (e.g. both groups being made up of 9-year-olds), the following facts can be established:

a) at 8 years of age, pupils who have attended school for one year have attained a considerably better level than pupils who have only entered school at this age. The difference $p<0.001$;

b) during the following years difference in the development of boys and girls can be observed. Boys who have entered school at 7 years of age preserve in most cases a certain advantage in the comparison of mean indices, but it is statistically relevant only up to the 9th year of age ($p<0.001$). Girls who have entered school at 7 years of age are always more successful than girls who have entered school at 8 years of age. Difference between the mean indices of CS tests 9 and 11 years $p<0.001$ and 10 years $p<0.05$. Difference

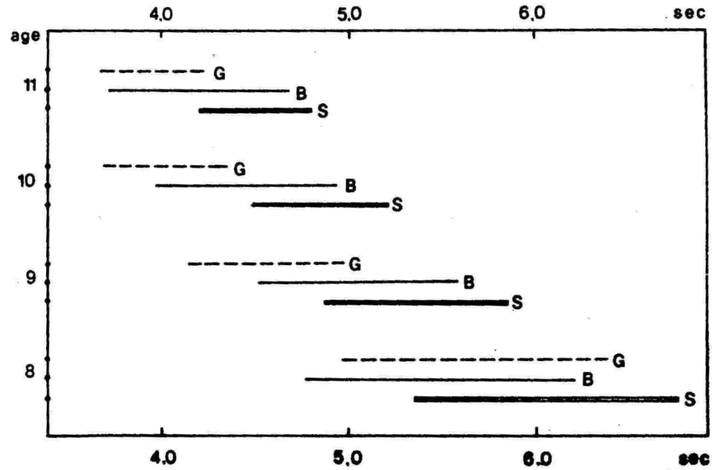

Fig. 1. Selective reaction tests to SS and CS with girls of 8–11 years (S – school, B – badminton, G – gymnastic).

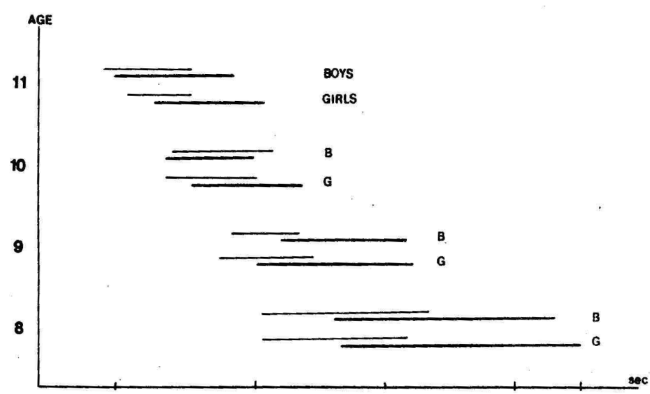

Fig. 2. Selective reaction tests to SS and CS of pupils who have entered school at the age of 7 and 8 years of age narrow line – pupils who have entered school at 7 year of age.

between the mean indices of SS tests is not so evident. Thin is illustrated in Figure 2.

The comparison of all results: those shown by schoolchildren, badminton players of average training intensity and gymnasts of very high training intensity allows to put forward an essential general conclusion. The development of self regulation is apparently dependent on the quality of selective reaction. The high results of gymnasts who train very intensively, demonstrate that upon working out training plans for several years, upon planning training lessons and choosing sportsmen, we should tackle the problems of self-regulation very seriously.

All sports games need the prognosing of the actios of one's own team, as well as of the actions of the opponent players. An analogous situation can occur in answering to the signals of selective reaction tests. In both cases the quickness of the process of self-regulation and its correspondence to actual stimuli serve as basis for the right action. A sportsman of quick and correct selective reaction rarely makes mistakes. A quick sportsman whose number of mistakes reaches above the average level in selective reaction tests makes more mistakes in games. Sportsman with slower selective reaction make less mistakes in tests as well as in games.

Every incorrect decision of a gymnast in timing her motions results in a severe punishment in competition conditions. In gymnastics the natural selection determines those who reach the top more severely than in games.

Of the relatively small contingent of our gymnasts under observation the title of World Champion was achieved by two athletes. For example gymnast J.M. was at 14 able to answer SS in 2.65 and CS in 3.13 sec., at 15 in 2.63 and 2.40 sec. accordingly. Gymnast S.M.'s result at 12 was 3.02 sec. and 2.90 sec. Cross signals did not disturb the correctness and speed of selective reaction. At II both gymnasts belonged to the elite of the corresponding age group.

When comparing the average results shown by young gymnasts who train with high intensity and by adult athletes, it turns out that: a) the average time of responding to SS is in the case of gymnasts relevantly slower ($p<0.01$) up to 13 years of age. In the case of 14-year-old gymnasts $p>0.05$; b) the average time of responding to CS is in the case of gymnasts relevantly slower up to 11 years of age. The reaction of 12–14 year-old gymnasts to CS is statistically insignificant on the basis of the average time.

On the basis of the data describing the time and correctness of self-regulation motions in contrasting situations it can generally be said:

1. The critical perception level of correctness and quickness of motion can be characterized through selective reaction.

2. The results of selective reaction tests performed by 8–11 year-old schoolchildren reflect the culmination period of these abilities in the characteristics of their natural development.

3. The influence of training on the self-regulation abilities of young sportsman is positive.

4. In seeking effective ways of building up training lessons the problem of self-regulation needs further study and new generalizations.

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FLEXIBILITY OF TARTU UNIVERSITY STUDENTS

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It is well known that flexibility is one of the most important aspects of sports performance. Flexibility increases the ability to avoid various injuries [3], inflexible individuals are apparently more susceptible to muscle strain and ruptures [7]. Normally flexibility increases from the age of 6 to 14 [1] and relatively short training programs can improve the flexibility of children [4]. Little is known about flexibility in recreational physical activity, especially in university students. In students flexibility decreased already in the second year of study at higher school [6]. No standard tests exist for measuring flexibility in relatively untrained persons, like, for example, Cooper's test for measuring endurance capacity.

The purpose of this study was to measure flexibility of relatively untrained university students by using two simple tests and to present standard scales for practical use.

Methods

A total of 135 male and 142 female stundents of Tartu University (from all faculties except physical education faculty) volunteered as subjects. They visited official physical education classes twice a week. Stature was measured to the nearest millimetre and body weight measured with the help of medical scales (±50 g). Shoulder width was measured with the help of tape. Before flexibility measurements a standard warming-up was used. Shoulder flexibility was measured by bringing a stick with two hands over the head. Shoulder flexibility = stick grip (in cm) – shoulder width (in cm).

Lower body flexibility was assessed by hamstring, sitting in the floor. In both tests the standard scales for practical use were presented by Martin [5].

Results and discussion

The physical characteristics and mean results of the two flexibility tests of students are presented in Table 1. The flexibility of females in both tests was significantly higher than in males ($p<0.001$). The mean shoulder flexibility of Tashkent students was worse than that of our students [6]. On the other hand, the flexibility of our stundents was worse than that of untrained Germans at the age of 20–30 years [2].

Standard scales for practical use are presented in Tables 2 and 3.

Table 1

Physical characteristics and mean flexibility of students (means ± SD)

	Males (n=135)	Females (n=142)
Age (yrs)	19.8 ± 1.9	19.3 ± 1.6
Stature (m)	1.79± 0.06	1.66± 0.05
Body weight (kg)	73.4 ± 9.5	60.2 ± 7.0
Shoulders width (cm)	45.5 ± 5.0	40.4 ± 2.2
Shoulders flexibility (cm)	65.0 ±16.2	45.4 ±16.0
Hamstring (cm)	+2.9 ± 4.0	+7.2 ± 6.1

Table 2

Sholders flexibility standard scales

Classification	Males (n=135)	Females (n=142)
Poor	over 89	over 69
Fair	73 – 89	53 – 69
Average	57 – 73	37 – 53
Good	41 – 57	21 – 37
Excellent	under 41	under 21

Table 3

Hamstrings standard scales

Classification	Males (n=135)	Females (n=142)
Poor	over −7	over−3
Fair	−1 -- −7	−3 – +3
Average	−1– +5	+3 – +10
Good	+5 – +11	+10 – +16
Excellent	under+11	under +16

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LANDING INTO A FALL IN SPORTS GAMES

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Falls are usual in sports games. Distinction is made between wilful and unintentional falls. The main difference lies in the following: in wilful falls purposeful and skillful landings are distinguished, while unintentional falls are falls in the proper sense of the word and we can speak about landing in these cases only in connexion with the personal skill of the player.

Wilful falls include falls performed on the wish of the player for either intercepting the ball (volleyball, basketball, handball etc.) or for scoring a goal (handball).

Unintentional falls include falls caused by stumbling, collision or other reasons. Unintentional falls often end with injuries, especially when the athlete lacks specific deftness and landing skill. Wilful falls should end with expediently carried out landing. For this reason the corresponding technique elements in sports games can be called falls with landing.

In the course of evolution in sports several ways of landing have been developed. In the present paper we are dealing only with those of them that occur more often in games of numerous falls and landings, e.g. volleyball and handball. Though the purpose of falls and landings in the respective games is diametrically opposite – in volleyball the defending and in handball the attacking action –, the final phase in both cases is still wilful falling and landing.

In volleyball most interceptions of "difficult" balls end with falling and landing.

In handball 30–40 % of throws are dive shots [Cercel, 1984; Latõškevitš, 1988].

The more effective a volleyball-player wants to be in defence, the longer and of higher arch are his jumps with which goes falling and landing. The same applies to handball: the more strongly and effectively the attacker wants to throw, the farther into the goal area he has to "dive" and the more dangerous the falling and landing is. Falls can bring in their wake injuries and the severity of the latter is in direct dependence on the length and height of the jump or "dive", as well as the landing technique.

The above-mentioned facts raise the problem – is it possible to land without an injury while the length and height of the jump or "dive" remains close to maximum and, if it is possible, then what should the landing technique be like and how should it be taught.

In the literature on sports games this problem has been relatively little dealt with. According to the way of extinguishing the kinetic energy of falling, three major groups of landing are distinguished: landing into sliding, swing and rolling [Huimerind, 1971; Mãnnik, 1976; Latõškevitš, 1988; Ignatjeva, 1983].

To the knowledge of the authors there exists no corresponding research on volleyball, but it is evident that all ways of landing are used depending on the individual abilities of the player and on the expediency of the return of service technique of the ball.

Some research has been conducted on handball at Tartu University from which it appears that landing into sliding is rare. Landing into rolling and swing occurs only when the attacker can throw without being hindered by the defender. The latter situation, however, is in handball relatively rare. More often the attacker is forced to throw while the defender is acting counter him. In this case the landing technique is disturbed and can end with an injury. For this reason together with the development of handball the so-called classic way of landing following the jump shot has been worked out, i.e. landing on all four limbs with the subsequent transition to the breast, side or into rolling.

There being few data in literature on the expediency, technique and teaching methods of the above mentioned ways of landing, the authors of the given paper try to fill in this gap.

The aim of the given research is to establish the values and durations of the overloads resulting from the stroke on landing in case of different landing ways, as well as the biomechanical criteria for finding out safe landing techniques.

In the course of the biomechanical experiment 16 attack throws in case of three different landing techniques were filmed. To every person under observation were attached inductive acceleration sensors, namely to the distal part of the arm and to the trunk in the lumber region. From the recorded accelograms maximum arm and trunk accelerations were measured and overload values figured up, i.e. the value of maximum acceleration divided to 9.81 m/s^2. The mean values presented in the table characterize the stroke caused by landing depending on its way. It follows from the experiment that overloads are the heaviest in case of the classic way of landing. In case of the corresponding stroke characteristics human tissues behave like stiff bodies [Savin, 1970], the stroke being transferred from the supporting surface to tissues and organs on which microinjuries can occur. The heaviest load falls on muscles and joint surfaces depending on their biomechanical characteristics [Vain, 1987]. When the stroke recurs, the work capacity of the organism falls considerably since the stroke results in the damage of the microcirculation of tissues [Markin, Kozlov, 1986].

When the duration of landing is seen as the period from the player's first touch with the ground up to the complete end of vertical movement, the direct relation between the value of the landing stroke (overloads resulting (see Table) the landing) and the duration of the landing becomes evident. In case of equal falling heights the less the overloads the more lengthy is the landing and thus also the possibilities for injuries resulting from the landing stroke are less. The character of the inhibition resulting from the stroke is also important. This can be explained by the damping characteristics of muscles [Vain, 1981; 1985; 1986].

When comparing the duration of ways of landing it is evident that of the longest duration is the landing into rolling, followed by swing and the shortest, thus the most dangerous is the landing in the classic technique.

The latter conclusion serves as a direct guideline for working out the teaching methods of landing.

Taking into account the above-mentioned facts, the advisable methods and order of learning the landing technique would be the following: one should begin with somersaults forward, back, to the side and over the shoulder up to flying somersaults. Certainly the beginning stage should take place in safe conditions, e.g. on soft lawn, but also on gymnastic mats. After the acquisition of the basic elements of the landing technique its elaborating should be conducted in natural conditions, i.e. on synthetic floor.

Afterwards, in the same order and with the help of methods media should be acquired the technique of landing into swing, sliding and finally the classic technique. The acquisition of the latter way of landing is in handball especially advisable in the opinion of the authors, particularly for line and side players. The technique of classic landing ending in rolling can be regarded as the most expedient one.

Table

Way of landing	Duration of landing (s)			Duration of maximum overloads (s) and value (g)	
	arms	trunk	total	arms	trunk
Classic	0.25	0.3	0.55	frontal direction: 0.01 and 15 saggital direction: 0.02 and 11.6 longitudinal direction: 0.35 and 15	saggital direction: 0.03 and 4.5 longitudinal direction: 0.04 and 6.8
Swing	0.25	0.4	0.65	frontal direction: 0.01 and 8 saggital direction: 0.02 and 11.5 longitudinal direction: 0.03 and 15	saggital direction: 0.03 and 2 longitudinal direction: 0.3 and 5
Rolling	0.2	0.65	0.85	frontal direction: 0.01 and 15 saggital direction: 0.015 and 4.5 longitudinal direc- tion: 0.015 and 4.5	saggital direction: 0.03 and 3.3 longitudinal direction: 0.15 and 3

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ON THE TONE OF THE SKELETAL MUSCLE

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Abstract

The historical survey of different definitions of the tone of the skeletal muscle is presented in the paper together with their comparative analysis. Proceeding from the traditional definitions published up to the present time and the new biomechanical model of the skeletal muscle [Vain 1990] the tone of the skeletal muscle is defined as the mechanical tension in the muscle, which determines the mutual position of the parts of the body and the body posture; at the same time it acts as the background tension in the active movements, the rats of which depends on the biomechanical properties of the skeletal muscle and is maintained on one hand via involuntary impulses from the central nervous system and on the other hand via the inner pressure of the muscle (the cellular tone).

Keywords: the tone of the skeletal muscle, the biomechanical model of the muscle.

Historically the term "muscle tone" has been used to denote the resistant force caused in the muscle without voluntary effort by palpitation or moving the part of the body. The tone and its importance have been popular themes for discussion and scientific papers, but there are very few scientifically proved facts and theories concerning the role of muscular tone in the process of diagnosing diseases, while certain pathological states are characterized mainly by hyper- or hypotonicity.

The absence of a scientifically founded theory concerning muscle tone accounts for the lack of a generally approved apparatus for measuring muscle tone at present. The explanation for the situation could be found in the fact that the model of skeletal muscle, free from contradictions, has not been created yet. There exists no generally approved and scientifically justified theory describing the phenomenon of the transfer of mechanical tension in muscles. In the present paper an attempt has been made to clarify the concept of the tone of the skeletal muscle, proceeding from the new biomechanical model of the muscle [Vain, 1990].

The notion of muscular tone has been defined using short yet exhaustive definitions but they all have had the same defect of one-sidedness. This tendency is expressed firstly in attempts to explain muscle tone through its neurological aspect only. J.F. Fulton [1926]: "A more adequate explanation of muscle tonus is that it is a proprioceptive reflex"; R.S. Snell [1984]: "Skeletal muscle tone, which can be appreciated by the recognition of a rubbery firmness of a muscle when it is palpated, is caused by the constant full contraction of a few muscle fibers within a muscle. Muscle tone is reflexly controlled from afferent nerve endings, the neuromuscular and neurotendinous spindles.

Although it has been emphasized that the basic mechanism underlying muscle tone is the integrity of a reflex arc, it must not be forgotten that this reflex activity is influenced by nervous impulses received by the motor nerve cells from all levels of the brain and spinal cord."

Some authors proceed from the function of the skeletal muscle to define muscular tone, as it is known that each concrete muscle has its different level of mechanical tension depending on the function of this muscle in the organism. J.W. Kimball [1978]: "Even at rest, most of skeletal muscles are in a state of practical contraction called tonus. If this were not so, we would have a very difficult time maintaining posture. The action of the motor units provides us with physical basis for tonus."; R.N.De Jong [1958] writes: "Tone, or tonus has been defined as the tension of muscles when they are relaxed, or as their resistance to passive movements when voluntary control is absent...Tone is a reflex phenomenon, and afferent as well as efferent components influence it."; In "Medical Physiology" [Ed. by Brown A.M. and Stubbs D.W., 1983] the following definition can be found: "The maintenance of any bodily posture requires certain skeletal muscles to exert relatively small amounts of tension over relatively long periods of time. This sustained tension is called muscle tone, or postural tone."; Thews G. et al. [1980] explain the notion of the muscle tone using the notions of the reflex tone and the cellular tone*.

An extensive treatise concerning muscle tone and its regulation has been written by E.P. Kesareva [1960]. She gives the following definition of muscle tone: "The tension of the skeletal muscles by

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* "Unter dem Muskeltonus wersteht man die Grundspannung eines ruhenden, nicht willkürlich innervierten Muskels in situ. Sie wird beim Skeletmuskel vor allem durch einen schwachen, aber stetigen Erregungsstrom aufrechterhalten (Reflextonus). In geringem Ausmass trägt auch die Formstabilität der Zellen zum Muskeltonus bei (zellulärer Tonus)."

which the equilibrium of the body and the initial background for muscle activities are established and which complexity is maintained in the organism via the mechanism of unconditioned and conditioned reflexes is called the muscle tone." The Big Medical Encyclopedia [1985] defines muscle tone as the continuous (background) activity of the nerve-centres which establishes the readiness of tissues and organs for activities. The tone is one of the forms of the homeostasis of the organism and at the same time one of the mechanisms to maintain it.

The common feature of the definitions given above is the steady mechanical background tension which is maintained without voluntary contractions in the skeletal muscle. The extent of the tension depends on the state of the nervous system innervating the muscle – on the reflex tone, and on the value of the inner pressure maintaining the shape of the muscular cells, of the bundle of muscle fibres surrounded by perimysium and of the muscle as an organ – on the cellular tone. As in our opinion muscular tone is determined not only by the stiffness of the constant length of the muscle, which can be estimated by palpitation, but also by the resisting force caused in the muscle by passive stretching of it, we can state that the essence of muscular tone could be explained with the help of the model describing the mechanical properties of the muscle.

The essence of the tone of the muscle can not be explained if we do not take into account the morphology and the mechanism of contraction of the muscle. Using well-known data E.N. Marieb [1989] explains the mechanism of muscular contraction as follows: "Contraction reflects the activity of individual sarcomeres. When a muscle cell contracts, its sarcomeres shorten and the distance between successive Z lines is reduced. As the length of their sarcomeres decreases, the myofibrils shorten as well, resulting in shortening of the cell as a whole.

Close examination of the contractile event reveals that the actin- and myosin-containing filaments do not change in length as the sarcomeres shorten. According to the sliding filament theory of contraction, first proposed in 1954 by Hugh Huxley, the contraction mechanism involves a sliding of the thin filaments past the thick ones so that the extent of myofilament overlap increases...When muscle fibers are stimulated by the nervous system, the cross bridges attach to active sites on the actin subunits of the thin filaments, and the sliding begins. Each cross bridge (myosin heads) attaches and detaches several times during a contraction, acting much like a tiny oar or ratchet to generate tension and pull the thin filaments forward the center of the sarcomere."

It is clear from the above-given that the mechanical tension in the skeletal muscle is determined by the reciprocal contraction (attraction, pull, draw) of the actin and myosin filaments. So the estimation of muscular tone also has to be based on the estimation of this contraction. Although the palpitation of the muscle at its constant length does not enable us to estimate the muscular tone so precisely as through the measurements of the resistant force, apparent in the muscle submitted to stretching, the majority of myotonometers are designed and constructed to measure the mechanical properties of the muscle crosswise the fibres.

Using the three-component mechanical model of the skeletal muscle [Hill, 1970] attempts have been made to explain the mechanical properties of the muscle as of an organ, but in the latest papers on this theme this model has been widely criticized [Fung, 1981; Morgan D.L., 1990; Nave R., 1990; Vain, 1990 et al.].

At the same time the sliding filaments theory, described by Huxley in 1957, has undergone substantial complementation [Smith D.A., 1989; Harry I.O. et al., 1990 et al.]. So the explanation of the nature of the muscular tone cannot be based on these models of the skeletal muscle.

The results of several scientific research programs have established that the sekeletal muscle has its inner pressure, which increases in the process of posture changes and active movements [Heukelom B. et al., 1988; Jerosch J., 1989; Jarvholm V. et al., 1989; Körner L. et al., 1982; Petrofsky J. et al., 1984; Kirby R. et al., 1988]. The above-given models of the skeletal muscle and the theory of muscular contraction are not able to explain the mechanism of the formation of this inner pressure, as in the process of the shortening of the sarcomere the mechanical strain is passed on from one sarcomere to another and at last via specific cemental substance to the tendon. There exist serious objections against this theory [Street S.F., Ramsey R.W., 1965; Fields R.W., 1970; Vain A., 1990].

Therefore the biomechanical model of the skeletal muscle presented by A. Vain (Fig. 1) appears to be more authentic.

According to this model, the contracting strain in myofilaments is created not by myosin cross-bridges contacting with actin filaments. In the process of retiring of the cross-bridges from the myosine filament the actin and titin filaments are forcibly averted in the axial direction and the perimeter of the muscle fibre increases.

Each muscle fibre is covered by endomyseum, in the outer layer of which the set of collagen microfibrils in situated [Bucher O., Wartenberg H., 1989]. This set makes impossible the increase of the volume of the muscular cells. Consequently the inner pressure increase causes the perimeter increase and the following shortening of the muscle fibre. The bunch of the muscle fibres surrounded by perimyseum has also its set of collagen microfibrils, the mechanical

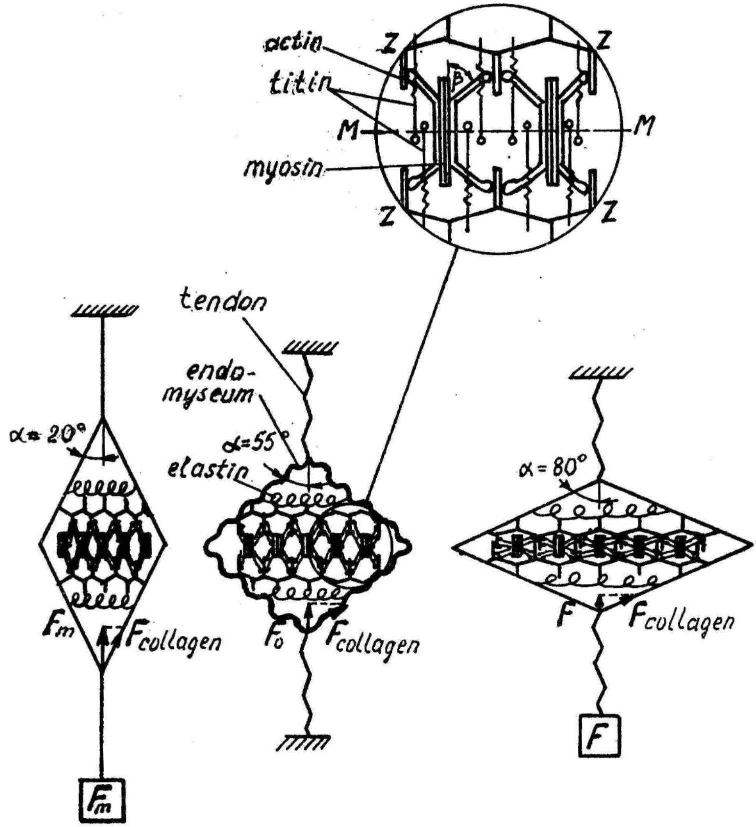

Fig. 1. New biomechanical model of the muscle.

characteristics of which describe the dynamical work of the muscle [Purslow P.P., 1989].

The function of the epimyseum surrounding the whole muscle is the same. Consequently the mechanical strain in the muscle is not transferred from one sarcomere to another but via the set of collagen microfibrils of endo-, peri- and epimyseum to the tendon. This interpretation changes in principle our conception of muscular tone, the possibilities of its estimation, the interpretation of the results of the measurements and the meaning of tone abnormalities in diagnostics of different pathological cases.

Therefore the term "muscular tone" should denote the mechanical resistance created in the process of muscle streching (deformation). The significant part of this resistant force is due to the slide of the titin filament heads relative to the myofilaments. The extent of this resistance is determined by the extent of the mechanical tension of the muscular tissue as well as by the inner friction originated in the process of that slide. For the elastic muscle the collagen microfibrils of endo-, peri- and epimyseum have wave-like constitution and on that account the inner pressure of the muscle is maintained on a relatively constant level. At certain values of the inner pressure the slide of the heads of titin filaments does not take place and the elastic part of the titin filament is deformed (stretched) by external force. In the case of hypotone the inner pressure of the muscle has dropped so much that the fixation of the heads of the titin filaments does not take place and the elastic parts of titin filaments are not noticeably deformed. So the renewal of the inital length of the streched muscle takes more time.

Hence we conclude that for proper characterization of the muscular tone two parameters as minimum should be considered – the degree of the mechanical tension (the magnitude of the inner pressure, the self-oscillation frequency) in the muscle and the inner friction or viscosity, apparent in the process of the stretching of the muscle.

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METHOD AND EQUIPMENT FOR BIO-MECHANICAL DIAGNOSIS OF THE FUNCTIONAL STATE OF THE SKELETAL MUSCLES

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Abstract

It is nearly impossible to overrate the importance of the functional state of the skeletal muscles as a component of the state of the organism as a whole. One of the significant criteria determining the functional state of a skeletal muscle is its tone. The measurement of the muscular tone is complicated, since the measurement procedure must not affect the biomechanical properties of the measured muscle.

A new method and apparatus to carry out the biomechanical diagnostics of the functional state of the skeletal muscles have been designed at Tartu University. The idea of the method lies in using an acceleration probe to registrate the reaction of the periferical skeletal muscle or its part to the mechanical impact and the following analysis of the resulting signal with the aid of the personal computer. The criteria have been worked out which enable us to contribute in the diagnostics of the functional condition of the skeletal muscles and correlate with certain criteria of the classical diagnostics. The apparatus consists of a semiautomatical myotonometrical transducer with a connecting cable, an analog-digital converter and a personal computer with the software, nesessary for the visualization, processing and storage of the experimental data.

Keywords: skeletal muscle, myotonometer, diagnostics.

Introduction

The viscoelastic behaviour of biological tissues, in general, is well established [1], but the real numbers and trends of viscoelastic properties of human tissues as related to health conditions, physical training, age etc. have not been extensively studied because of the lack of subsequent non-invasive technique. Moreover, even the theoretical approach to the determination of impedance in viscoelastic medium [2] is able to operate only with infinite homogeneous models. As we have no adequate biomechanical model of muscle together with its surrounding tissues, for example, we cannot interpret in valid mechanical terms any phenomena that we can observe when some measuring tool interacts with the tissue to be studied [4]. Nevertheless, the different biomechanical properties of different organs and tissues can well be studied by palpation – and this has been done during all the history of human society, and a lot of useful correlations have been established regardless of any problems with theoretical considerations that modern scientists would emphasize. Nowadays the practician, would he work in medical diagnostics or some other area, is not satisfied with qualitative and subjective knowledge that he can get from palpation. He cannot understand the theoretical problems and simply needs the method and apparatus to get some objective information about biomechanical conditions of soft tissues. An attempt has been made by us to overcome the situation by suggesting a measuring procedure and equipment for it.

Method

For the above-mentioned purpose, we have designed a handhold tool for biomechanical diagnosis (Fig. 1) that consists of a rocking

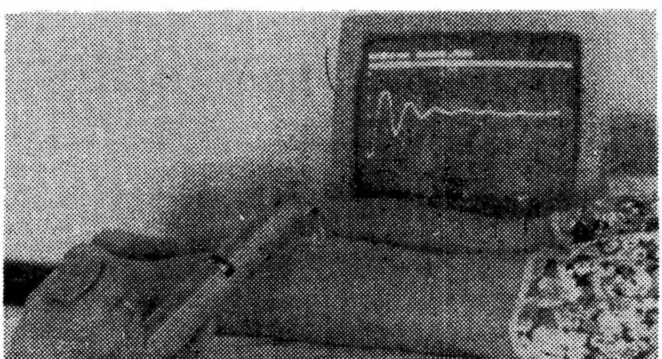
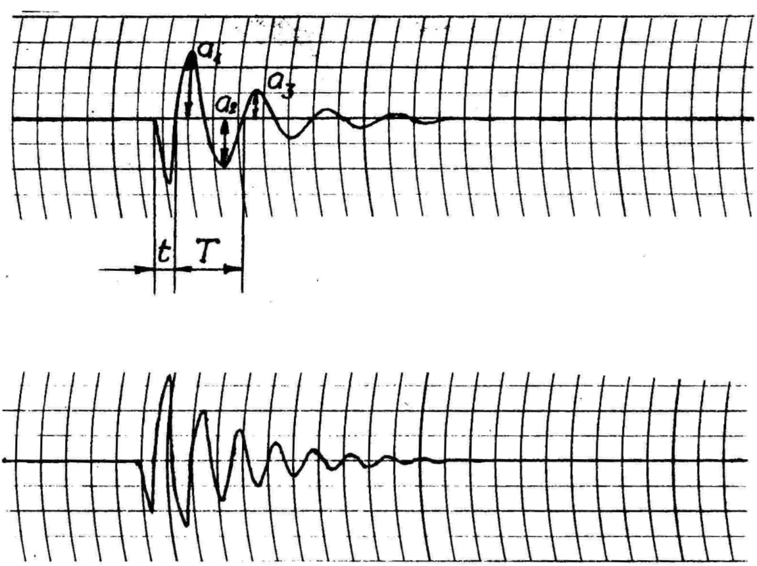


Fig. 1.

lever, pivotably mounted in the tool and carrying the acceleration transducer, the testing end with a wheel and an armature, between the poles of an electromagnet.

The lever is disbalanced and consequently the weight of the acceleration transducer presses the wheel of the testing end against the tissue to be tested (the force is about .3–.4 N). To perform the measurement, the electromagnet is supplied with a current impulse (duration of ca 10 ms) from the single impulse generator, the armature is pulled by the electromagnet and produces a short mechanical impulse, that rotates the lever and as a result the testing end performs an impact against the tissue. Due to the elastic behaviour of the tissue the testing end, together with the underlaying tissue, will perform decaying oscillations. These oscillations are picked up by the acceleration transducer and can be registered, for example, on **an ink-writer (Fig. 2).**



T PERIOD OF OSCILLATIONS

$\Theta = \ln \frac{a_1}{a_3}$ LOGARITHMIC DECREMENT OF DECAY

t TIME OF MECHANICAL IMPULSE

Fig. 2. Myotonograms of the relaxed and contracted muscles

The curve of oscillations resembles the typical answer of a mechanical system, ascribed by second-order equation, so we can use as a quantitative measure of the biomechanical properties of the tissue the well-known parameters: the period of oscillations T and the logarithmic decrement of dacay Q.

Concerning such specific tissue as skeletal muscle, it is obvious that its biomechanical properties depend greatly on its current state: is it relaxed or contracted. The same that we can establish simply by palpation – the relaxed muscle is soft and the stretched muscle is hard – is well reflected in the period of oscillations, but in contrast with the palpation our method gives some numerical, quantitative value. On the other hand, the second parameter – decrement of decay – is something new, something about what we cannot consider *a priori*, with what it must correlate, for what it is indicative. And, we think, to get any information about this parameter without the instrument (by palpation) is rather difficult.

Modern technology enables us to use instead of the inkwriter a personal computer, equipped with an a/d converter.

Special software can recognize the waves of oscillations and give the numerical values of the required parameters (period of oscillations and logarithmic decrement in our case). Our method and apparatus can be used for testing not only muscles of upper and lower limbs, but of body muscles too. Most of these muscles can be tested both in the relaxed state and under voluntary isometric contraction.

Results

As this paper is dedicated to the description of our method and apparatus, we present here only some illustrative results. As we can see in Figures 3 and 4, the periods of oscillations shorten from tonus to contraction about twice; their values for a certain muscle have slight differences over the age groups and somewhat greater differences between the muscles. The decrements of stretched muscles are high (1.0...1.4) in earlier childhood, but beginning with the age of 7 is rather uniform between .6 and .9. The decrements of different relaxed muscles are relatively close (between .9 and 1.2) in younger groups, but afterwards typical values for certain muscles develop that differ greatly from muscle to muscle.

After we have seen what figures are typical in a healthy contingent, let us look at the results in patients with traumatic injury in one of the upper limbs (Fig. 5). Notwithstanding with the great individual dispersion of the data, the general trends can well be followed: the decrements in injured limbs are higher; with contraction the decrements in injured limbs increase and not decrease, and the

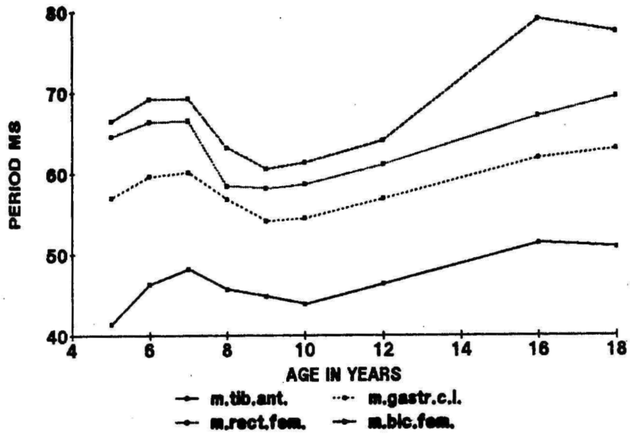


Fig. 3A. Contracted muscles

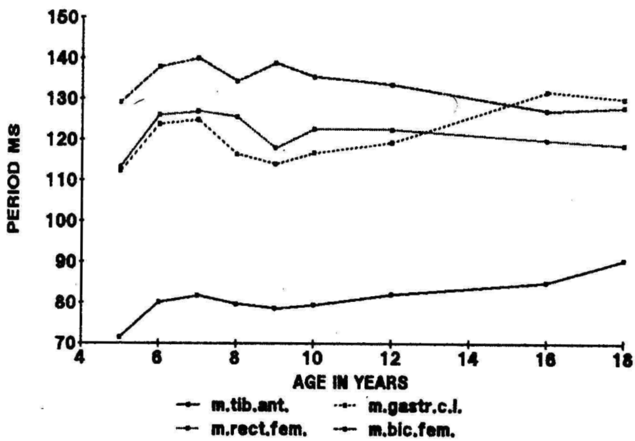


Fig. 3B. Relaxed muscles

changes of the period from tonus to voluntary contraction in injured limb cover somewhat smaller range.

Finally, let us try to establish which fluctuations can have the parameters if the measurements are repeated for a certain person over a long period and how they can be interpreted. In Figures 6 and 7 the data for a young athlete over the period of two years are presented.

During the first year he could not get, in spite of intensive trainings, any good sports results. For the next year, the training method was altered and the results improved significally. We can

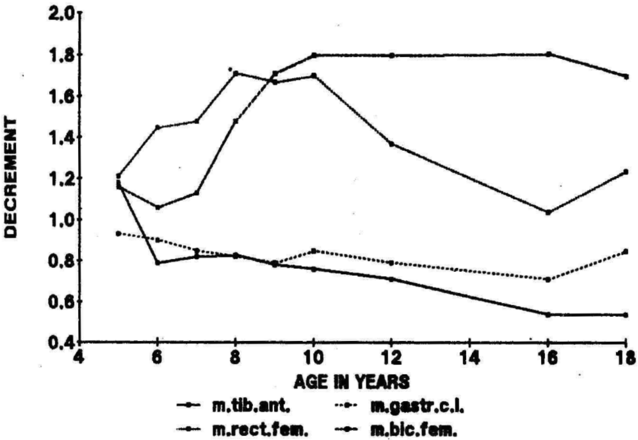


Fig. 4A. Relaxed muscles

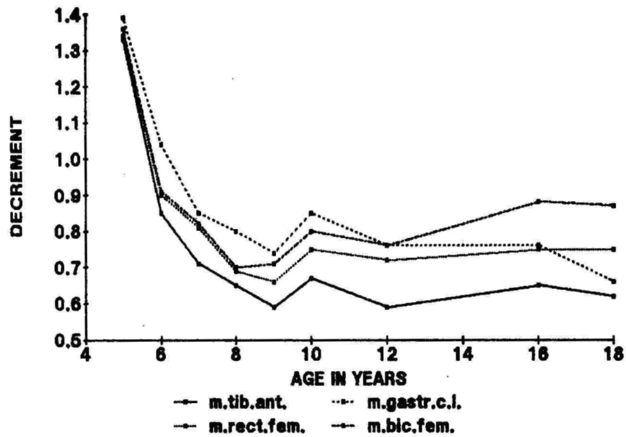


Fig. 4B. Contracted muscles

conclude that high decrements of contracted muscles did not allow the sportsman to show high results.

Conclusions:

1. The proposed measuring tool with the acceleration transducer that picks up the decaying oscillations of muscle after short mechanical excitement is able to measure the tonus of muscle in terms of the oscillation period that follows the generally accepted correlations.

2. The decrement of decay of the oscillations obtained with the

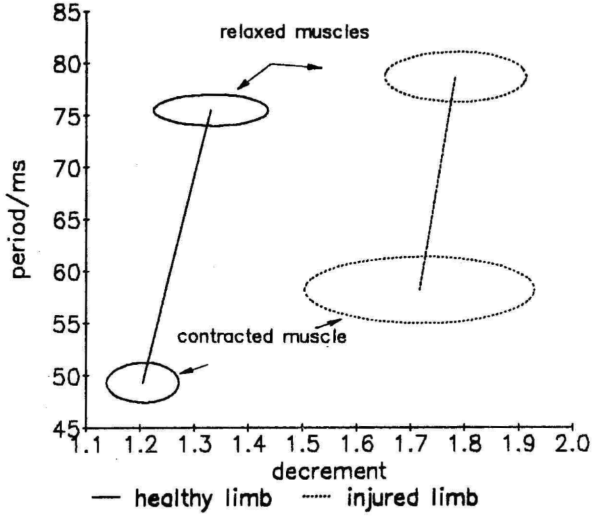


Fig. 5. Displacement of the two-dimensional dispersion of periods and decrements from tone to maximal voluntary contraction level.

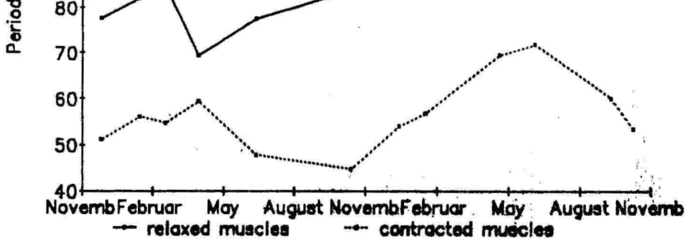


Fig. 6. Long-term trends of the biomechanical parameters for a young athlet – periods.

proposed measuring tool is a new indicator of the biomechanical state of tissue that can be used in practical diagnoses.

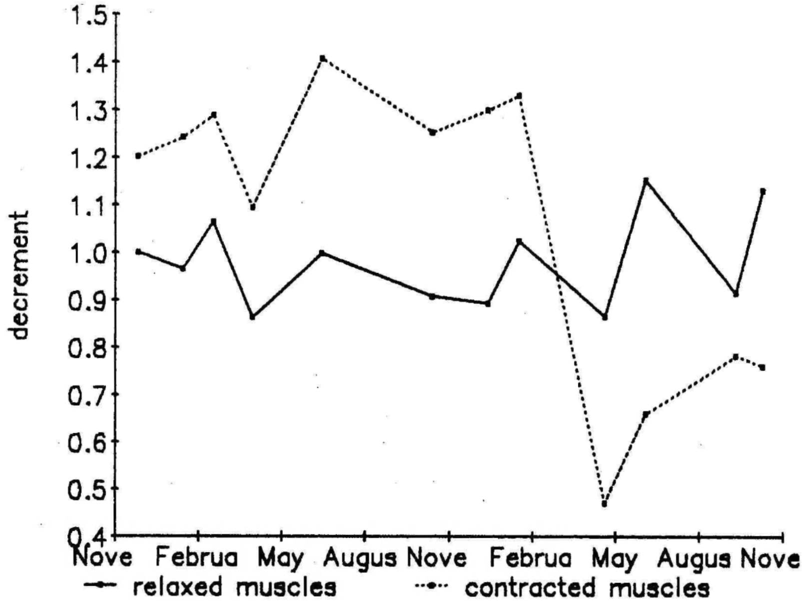


Fig. 7. Long-term trends of the biomechanical parameters for a young athlet – decrements.

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THE CHANGES OF SKELETAL MUSCLE TONE IN PREGNANT WOMEN

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Abstract

The changes of body position during pregnancy caused an increase of skeletal muscle tone and decrease of muscle elasticity, especially in the abdominal muscle. Physical activity during pregnancy, special relaxing, stretching and strenghtening exercises, can decrease muscle overtension and increase muscle elasticity. This guarantees the childbirth without complications and the birth of a healthy child. Physical activity before and during pregnancy helps significantly to recover after childbirth.

Key words: skeletal muscle tone and elasticity, physical activity, pregnancy, recarry after childbirth.

Introduction

Pregnancy is a woman's normal physiological state. The development of the embryo brings along a lot of changes in the organism of a woman, including the change of the place of the centre of gravity, which may cause the wrong carriage and make the maintenance of balance difficult. This may lead to a change of the tone of skeletal muscles [1, 2, 8]. In addition to this, it is known that pregnancy is a physiological stress for a woman. If she lacks the knowledge about pregnancy and childbirth, the changes during pregnancy and fear of childbirth may cause psychological stress, which results in the rising of the muscle tone [4, 11].

As there are special gymnastic exercises which help to influence the muscles taking part in childbirth, we assumed that with the help of gymnastic exercises during pregnancy it is possible to avoid unnecessary stress.

Muscle tone reflects the person's state of health as a whole. As measuring the tone is a noninvasive method, it is suitable to use it to judge over the state of health of the pregnant. Muscle tone is the state of skeletal muscle which distinguishes the readiness of the muscle for active work, for the keeping of the right carriage and for maintaining balance. The basis of the tone is myostatical reflex. The tone is dependent on age, sex, physical activity and general state of health [3, 9].

Material and method

The aim of the work was to study the changes of muscle tone and elasticity during pregnancy and 5 weeks after childbirth and the effect of special gymnastic exercises on muscle tone. To carry out the studies, 40 healthy pregnant women were examined during their 15th, 20th, 25th, 30th, 35th and 40th week of pregnancy and 5 weeks after childbirth. For measuring muscle tone the myotonometer UT 9002, worked out at Tartu University, and the computer "Tartu" were used. The examined muscles were measured in strained and in relaxed state. According to the results of measurements the period of the muscles natural oscillation and the logarithmic decrement of fading were calculated. Muscle oscillation period characterizes the degree of mechanical tension of the muscle, in the present case – muscle tone of the body. The decrement of fading expresses the loss of mechanical energy during the cycle of oscilliation, i.e. the level of dissipative losses of energy of elastic deformations according to the elastic quality of muscle [9].

The following muscles were measured in this research:

1. *M. biceps brachii.* In case of intentional relaxation, the hand was bent from and supported on the elbow, laying on the stand which was raised to the height of 12 cm, the muscle was tensioned by the holding of a stuffed ball, weighing 2 kg, at the same level.

2. *M. rectus abdominis.* The tense as well as relaxed muscles were measured. The relaxed muscle was measured at the end of exhaling. To strain the muscles, bent legs were raised from the ground.

3. *M. rectus femoris.* Tense and relaxed muscles were measured. To relax the muscle better, the heels of the person were over the edge of a couch. The muscle was strained by raising the stretched leg to the height of 45°.

4. *M. gastrocnemius.* The knees of the person were in an astride position with the width between them of two handbreadths and the thigh formed an angle of 90° with the couch. To relax the muscle better, the flats of the feet were over the edge of the couch.

5. *M. erector spinae.* The requirements for the position of the person were the same as in the case of the previous measurements. To relax the back muscles better, the back was as hollow as possible.

On the analysis of the dynamics of parametres characterizing muscle tone, the data of the pregnancy were compared to that of the 15th week of pregnancy, and the period after childbirth was compared to the 40th week of pregnancy. From the leibor history of the women whose babies were delivered during the observation period the data were taken about the cuts and ruptures of perineum to characterize the elasticity of that muscle.

The results of measurements were typed by the printer "Robotron CM 632801 M"and by the personal computer. The group's average qualities, standard deviation, the average mistake of the average were calculated. The statistical reliability of the data was checked by the student – t-criterium.

Characteristics of the contingent

The contingent consisted of 40 practically healthy pregnant women with the average age 22.8±5.6, the average weight before pregnancy 58.0±0.98 kg, the average height 166.9±0.52 cm.

The subjects of experiment were divided into two groups according to their physical activity. The experimental group was formed by 28 women. 64.3 % of them had gone in for sports before pregnancy for 5.1±2.9 years. 82.1 % of them had an active way of life. All the subjects of the experiments took exercises twice a week á 40 min. In one gymnastics lesson exercises were given to all muscle groups. The main emphasis was on stretching, relaxing and breathing exercises. To ground the strain, pacifying music was listened too. To the control group belonged 12 women who did not do gymnastics during pregnancy. 33.3 % for 7.8±2.6 years went in for sports before pregnancy. 25 % led an active way of life.

Results and discussion

The process of labour depends greatly on the woman's readiness for the childbirth. If the physical preparation is not satisfactory, psychical preparation only will not compensate completely for the deficit. One of the preconditions of giving birth to a healthy baby and avoiding the mother's birth trauma is good elasticity of muscles and normal muscle tone.

Let us look at the dynamics of the muscle tone after the 15th week of pregnancy.

1. The dynamics of muscle tone and elasticity of the subjects of observation of the experimental group.

The tone of the intentionally relaxed ***m. rectus abdominis*** rose constantly during the pregnancy (table 1). Statistically important changes regarding the first measuring were registered during the 25th ($p<0.05$), 30th, 35th and 40th (by all $p<0.001$) week of pregnancy. After childbirth the decline of the same muscle tone was observed ($p<0.001$).

In intentionally relaxed ***m. erector spinae*** there was a tendency to the rise of the tone. Statistically important change took place in the 40th week of pregnancy ($p<0.05$). In the case of intentional relaxion of the dynamics of the muscle tone of ***m. biceps brahii, m. rectus femoris*** and ***m. gastricnemius*** there were no changes.

The most important changes were registered in the decrements of the ***m. rectus abdominis*** and ***m. rectus femoris*** (table 2). The elasticity of the ***m. rectus abdominis*** improved during the 20th and 40th ($p<0.05$) and 20th and 30th ($p<0.01$) week of pregnancy. After childbirth the tendency to improve the elasticity of the same muscle was observed. The elasticity of the intentionally relaxed ***m. rectus femoris*** (on the 35th week $p<0.01$) and ***m. gastrognemius*** (on the 40th week $p<0.05$) decreased on the third trimester of pregnancy. In all the other muscles changes were not observed.

The rise of the muscle tone of the stretched ***m. rectus abdominis*** could be observed since the 20th week of pregnancy (table 3). Statistically important differences were registered between the 20th and 35th week ($p<0.01$) and the 20th and 40th week of pregnancy ($p<0.001$). After childbirth comparing to the 40th week of pregnancy we noted a lower tone while stretching same muscle ($p<0.001$). We did not register statistically significant changes of the other intentionally stretched muscles during pregnancy and after childbirth.

In the dynamics of the elasticity of the intentionally stretched muscles were registered the improvement of the elasticity of the ***m. rectus abdominis*** on the second half of pregnancy ($p<0.05$, table 4). The changes observed in the ***m. rectus femoris*** were contrary to the changes in the ***m. rectus abdominis***. Elasticity of ***m. rectus femoris*** decreased on the second half of pregnancy ($p<0.01$).

2. The dynamics of the muscle tone and elasticity of the subjects of observation of the control group.

The investigation of the tone of the intentionally relaxed muscles showed that the most important changes took place in the ***m. rectus abdominis*** (table 5). The tendency to an increase of tone on the first and second trimester of pregnancy was registered. Statistically significant changes were registered on the 35th ($p<0.01$) and on the 40th ($p<0.001$) week of pregnancy. After childbirth the tone of the same muscle declined ($p<0.001$) compared to the data of the 40th week of pregnancy. Comparing this muscle tone to the tone of the same muscle of the experimental group, the ***m. rectus abdominis*** of the control group's subjects had significantly higher tone ($p<0.01$).

Table 1

Statistical characteristics of dynamics of the tone of relaxed muscles of the experimental group

Muscle		Week of pregnancy						
		15	20	25	30	35	40	–5
M. biceps brachii	$\overline{x}$	100.96	102.09	100.41	101.1	101.58	101.68	101.72
	δ	8.24	8.01	7.72	10.2	6.36	8.21	12.11
	n	28	34	44	40	36	22	18
M. rect. abdominis	$\overline{x}$	112.15	111.03	105.91.	96.95...	93.78...	87...	129.94...
	σ	13.51	11.81	11.64	13.24	7.5	10.86	12.54
	n	28	34	44	40	36	22	18
M. rect. femoris	$\overline{x}$	96.71	98.91	98.72	97.43	97.97	95.86	94.39
	σ	8.51	10.1	12.14	9.05	9.71	8.36	12.61
	n	28	34	44	40	36	22	18
M. gastrocnemius	$\overline{x}$	101.71	104.76	99.98	102.2	102.4	101.27	105.17
	σ	9.76	7.7	7.65	10.84	11.04	7.53	7.52
	n	28	34	44	40	36	22	18
M. erector trunci	$\overline{x}$	80.57	79.03	76.68	76.38	76.31	74.59.	76.27
	σ	11.24	8.88	8.13	10	7.9	6.58	10.89
	n	28	34	44	40	36	22	18

In tables 1–8 statistically significantly different data regarding the 15th week of pregnancy are marked as follows:
. $p<0.05$; .. $p<0.01$; ... $p<0.001$

Table 2

Statistical characteristics of the dynamics of elasticity of relaxed muscles of the experimental group

Muscle		Week of pregnancy 15	20	25	30	35	40	–5
M. biceps brachii	$\overline{x}$	1.48	1.49	1.41	1.4	1.44	1.6	1.15.
	σ	0.46	0.55	0.39	0.43	0.53	0.59	0.46
	n	28	34	44	40	36	22	18
M. rect. abdominis	$\overline{x}$	1.87	2.09	1.84	1.62..	1.72	1.55.	1.4
	σ	0.76	0.84	0.69	0.55	0.63	0.76	0.67
	n	28	34	44	40	36	22	18
M. rect. femoris	$\overline{x}$	1.14	1.42	1.37	1.4 .	1.5 ..	1.64...	1.26
	σ	0.37	0.6	0.6	0.5	0.6	0.5	0.46
	n	28	34	44	40	36	22	18
M. gastrocnemius	$\overline{x}$	1.2	1.4	1.43	1.2	1.41	1.55.	1.32
	σ	0.54	0.45	0.53	0.51	0.6	0.66	0.69
	n	28	34	44	40	36	22	18
M. erector trunci	$\overline{x}$	1.03	1.06	1.07	1.05	1.08	0.95	1.17
	σ	0.38	0.38	0.5	0.38	0.45	0.37	0.37
	n	28	34	44	40	36	22	18

Table 3

Statistical characteristics of the dynamics of the tone of strained muscles of the experimental group

Muscle		Week of pregnancy						
		15	20	25	30	35	40	–5
M. biceps brachi	$\bar{x}$	57.36	57.03	57.52	57.85	55.86	56.18	57.22
	σ	5.69	4.41	5.04	5.62	5.18	5.97	7.56
	n	28	34	44	40	36	22	18
M. rect. abdominis	$\bar{x}$	73.4	83.13	83.04	79.82	69.21..	63.44...	97.94...
	σ	13.12	16.96	13.71	13.6	10.56	11.94	17.62
	n	10	16	26	28	28	16	18
M. rect. femoris	$\bar{x}$	79.43	80.15	78	80.35	78.36	77.55	80.33
	σ	10.92	10.13	10.32	10.61	10.39	8.76	12.68
	n	28	34	44	40	36	22	18

Table 4

Statistical characteristics of the dynamics of elasticity of strained muscles of the experimental group

Muscle		Week of pregnancy						
		15	20	25	30	35	40	–5
M. biceps brachi	$\overline{x}$	0.72	0.75	0.77	0.77	0.69	0.67	0.71
	σ	0.24	0.17	0.21	0.23	0.16	0.16	0.19
	n	28	34	44	40	36	22	18
M. rect. abdominis	$\overline{x}$	1.52	1.58	1.31	1.26	1.18.	1.34	1.27
	σ	0.42	0.67	0.5	0.44	0.34	0.55	0.57
	n	10	16	26	28	28	16	18
M. rect. femoris	$\overline{x}$	0.87	0.98	0.97	1.1..	1.09..	1.02	1.1
	σ	0.17	0.27	0.29	0.43	0.43	0.26	0.36
	n	28	34	44	40	36	22	18

In the dynamics of the other muscles the changes were not observed during the investigation period.

The elasticity of the intentionally relaxed ***m. rectus abdominis*** rose constantly until the end out pregnancy (table 6). Statistically significant changes were registered on the 35th week of pregnancy ($p<0.05$). After childbirth contrary to the data of the experimental group elasticity of the same muscle decreased ($p<0.01$). The elasticity of the ***m. gastrognemius*** improved between the 25th and 30th week of pregnancy ($p<0.05$), later on the tendency to the diminution of elasticity was registered. No significant changes were observed in the elasticity of the ***m. biceps brachii***, except during the 25th week of pregnancy, when this data improved ($p<0.05$).

Statistically important changes were found in the tone of all intentionally stretched muscles that were investigated (table 7). The tone of the ***m. biceps brachii*** rose until the 30th week of pregnancy when statistically significant changes ($p<0.05$) were registered. The dynamics of the muscle tone of the ***m. rectus abdominis*** of the control group is similar to that of the experimental group. Statistically important changes were noted in the 30th ($p<0.01$), 40th ($p<0.001$) week of pregnancy and in the 5th week after childbirth ($p<0.001$), but the muscle tension of the control group was significantly higher than that of the experimental group ($p<0.01$).

The change of the tone of the intentionally stretched ***m. rectus femoris*** was registered on the 30th week of pregnancy ($p<0.01$).

The dynamics of the elasticity of the intentionally stretched muscles is shown in the table 8. The ***m. rectus abdominis*** had a tendency to the diminution of elasticity until the 20th week of pregnancy. Later on the quality of elasticity of this muscle improved ($p<0.05$) and stayed unchangeable until the end of the investigation period. After childbirth there was a tendency to the improvement of the elasticity of the muscle.

The elasticity of the ***m. rectus femoris*** improved by the 20th week of pregnancy ($p<0.05$) and stayed on this level until the end of pregnancy.

The elasticity of the ***m. biceps brachii*** improved after childbirth ($p<0.01$).

Compendiously we can say that the most significant changes took place in the tone and elasticity of the ***m. rectus abdominis*** of both the experimental and control group. It is logical, because the growing uterus stretches significantly this muscle. Our result coincides with the data of literature [7, 8, 11].

Considering the changes during pregnancy (shifting of centre of gravity, relaxation and weakening of the ligaments) we assumed that also in the extensor muscles of the body extensive changes take place. Contrarily to our attitude and the data of literature [1, 7, 8]

Table 5

Statistical characteristics of the dynamics of the tone of relaxed muscles of the control group

Muscle		Week of pregnancy						
		15	20	25	30	35	40	–5
M. biceps brachii	$\overline{x}$	101.5	100.79	101.75	99.75	99.5	100.27	100.38
	σ	7	6.9	9.6	8.92	6.26	6.27	7.13
	n	8	14	16	20	22	22	19
M. rect. abdominis	$\overline{x}$	104.63	98.86	95.44	94.5	88.41..	85.55...	114.06...
	σ	14.83	7.21	14.73	10.95	10.34	8.13	16.55
	n	8	14	16	20	22	22	16
M. rect. femoris	$\overline{x}$	101.13	98.36	101.31	99.8	99.5	99.36	95.25
	σ	6.47	6.35	7.23	7.83	7.04	6	7.19
	n	8	14	16	20	22	22	16
M. gastrocnemius	$\overline{x}$	99.13	102	104.88	102.9	104.9	103.77	108.69
	σ	5.56	5.41	11.02	9.34	8.43	8.11	5.77
	n	8	14	16	20	22	22	16
M. erector trunci	$\overline{x}$	75.13	73.43	72.38	73	76.86	74.59	79.69
	σ	6.09	5.21	8.85	10.35	10.91	11.25	12.14
	n	8	14	16	20	22	22	16

Table 6

Statistical characteristics of the dynamics of elasticity of relaxed muscles of the control group

Muscle		Week of pregnancy						
		15	20	25	30	35	40	–5
M. biceps brachii	$\bar{x}$	1.47	1.75	1.28.	1.56	1.52	1.53	1.39
	σ	0.43	0.62	0.4	0.46	0.85	0.48	0.63
	n	8	14	16	20	22	22	16
M. rect. abdominis	$\bar{x}$	2.34	2.3	2.17	2.11	1.76.	1.3	1.86..
	σ	0.83	0.61	0.81	0.65	0.61	0.35	0.68
	n	8	14	16	20	22	22	16
M. rect. femoris	$\bar{x}$	1.4	1.17	1.38	1.39	1.35	1.37	1.32
	σ	0.63	0.31	0.7	0.4	0.35	0.47	0.41
	n	8	14	16	20	22	22	16
M. gastrocnemius	$\bar{x}$	1.55	1.61	1.18.	1.18.	1.51	1.5	1.2
	σ	0.57	0.53	0.45	0.52	0.75	0.67	0.66
	n	8	14	16	20	22	22	16
M. erector trunci	$\bar{x}$	1.16	1.14	1.04	1.03	1.02	1.04	1.02
	σ	0.35	0.3	0.36	0.26	0.34	0.37	0.29
	n	8	14	16	20	22	22	16

Table 7

Statistical characteristics of the dynamics of the tone of strained muscles of the control group

Muscle		Week of pregnancy 15	20	25	30	35	40	–5
M. biceps brachi	$\overline{x}$	58.63	56.5	58.38	55.	58.23	56.41	56.75
	σ	4.53	4.56	4.72	3.66	8.02	4.13	4.34
	n	8	14	16	20	22	22	16
M. rect. abdominis	$\overline{x}$	57.3	66.2	67.07	67.56..	60.35	55.33...	78.38...
	σ	5.76	9.73	15.14	11.77	8.14	8	8.13
	n	6	10	14	16	20	18	16
M. rect. femoris	$\overline{x}$	87.13	85.71	89.63	83..	86.32	82.91	80.88
	σ	3.18	6.56	6.34	7.73	7.89	7.34	6.89
	n	8	14	16	20	22	22	16

Table 8

Statistical characteristics of the dynamics of elasticity of strained muscles of the control group

Muscle		Week of pregnancy						
		15	20	25	30	35	40	–5
M. biceps brachii	$\bar{x}$	0.71	0.76	0.75	0.7	0.84	0.74	0.61..
	σ	0.1	0.17	0.16	0.16	0.38	0.16	0.09
	n	8	14	16	20	22	22	16
M. rect. abdominis	$\bar{x}$	1.33	1.86	1.58	1.31.	1.46	1.29	1.16
	σ	0.45	0.87	0.56	0.34	0.47	0.45	0.27
	n	6	10	14	16	20	18	16
M. rect. femoris	$\bar{x}$	1.21	0.92.	0.91	0.99	1.02	1.06	1.15
	σ	0.43	0.21	0.3	0.22	0.41	0.44	0.27
	n	8	14	16	20	22	22	16

we did not register changes. The reason may be in the posture of the measurement. Arm and knees support position relieves the back from load and tension, but at the same time immoderately hollow back is uncomfortable at the end of pregnency. Besides there was a correction of posture in the lesson of gymnastics, and probably the women of the experimental group took subconsciously the right and healthy posture during the measurements. With this fact we can explain the statistically significant tension of the extensor muscles on the 40th week of pregnancy. In addition to these observations we have to mention that the muscle tension of the *m. rectus abdominis* diminished by the 20th week of pregnancy both in the experimental and control group. This shows that the working capacity of this muscle compared to the 15th week of pregnancy had improved on the 20th week of pregnancy. We can suppose that by that time the woman's organism will be adapted to pregnancy. The increase of the muscle tension was noted on the 35th week of pregnancy. From this we can draw the conclusion that the working capacity at the end of pregnancy diminishes.

3. To learn whether the dynamical changes of the muscles of both the experimental and control group took place on the same numerical value level we computed the average period of oscillation and decrement of all muscles during the pregnancy (fig. 1 and 2).

The statistically significant changes were registered in both parametres both in intentionally relaxed and stretched *abdominal* muscles ($p<0.05$ and $p<0.01$).

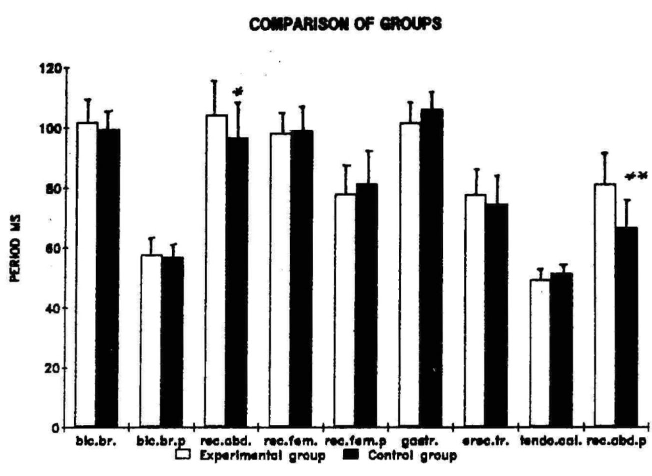

Fig. 1. Comparison of groups. Period of oscillation. * – $p<0.05$, ** – $p<0.01$

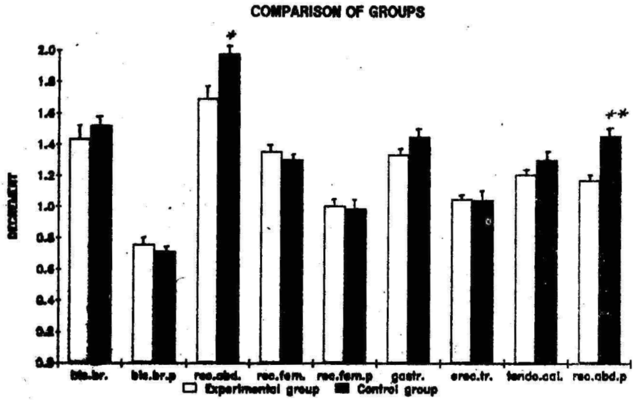

Fig. 2. Comparison of groups. Decrements. * – $p<0.05$, ** – $p<0.01$

Comparing the control group to the experimental group the natural oscillation frequency of the latter was higher and the decrement was lower in both states of *m. rectus abdominis*.

We can draw the conclusion that the women who go in for gymnastics during pregnancy can relax themselves better, their physical effort to bear the standard physical load is smaller and the elasticity of muscles is better. That could be assumed because we used both effort and strengthening exercises together with other gymnastics exercises and taught the women to relax their muscles.

To compare the muscle status after childbirth to the results of the 40th week of pregnancy it became evident that muscle tension diminished and elasticity improved in the majority of muscles in both the experimental and control group. Statistically important changes were registered in *m. rectus abdominis* of both groups, whereas the numerical value of the experimental group was better. Exception from that was the intentionally relaxed *m. rectus abdominis* of the control group, where the diminution of the elasticity was registered.

We can draw the conclusion that already 5 weeks after childbirth the muscles of both groups were in better functional condition than in the period before childbirth. It is also confirmed by the data of literature. P. Shrock [1984] states that the state of muscles & ligaments can retake their former shape already by the 4th week after childbirth.

From the best results of the experimental group we can conclude that the woman's physical activity before and during pregnancy helps the abdominal muscle to regain its former shape after childbirth. The same data occur in literature [1].

According to the results of the work the conclusion can be drawn that significant changes take place in tonic muscles that are

directly influenced by pregnancy, to a lesser extent in mixed and phasic muscles. The same is assured by A. Leega's research work [5].

In the dynamics of tone and elasticity of different muscles occured several changes to which in the present paper it is difficult to give final explanation. Probably it is necessary to do additional hormonal research because it is known from the literature [1, 4, 11] that several relaxants have influence on the elasticity of muscles and ligaments [6]. On the other hand, an important role may be played by hormone adrenalin, the production of which increases during the state of being frightened [4]. Most probably the study of carriage would be necessary to carry out during pregnancy.

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Nikolai Yakovlev. In Memory

August 23, 1992 was the last day of the fruitful life of Professor N. Yakovlev. He died on the 82nd year of his life. The thirties of this century were shattering for the Russian intelligentsia. The harmful influences reached also his family. However, at the end of the thirties he found opportunities and forces to be included into a scientific collective to begin systematic studies in biochemistry of muscular activity. After the period of war (N. Yakovlev was on the front line as a regiment physician, had to escape from the surround besieging at the river Luga, later he was the head of an epidemiological laboratory) it was the research work of his and his collaborators that founded exercise biochemistry as a branch of science. The landmarks were his books "What Is Happening in the Athlete's Organism during Exercising?" (1951, 1955). "Sportsmens Nutrition Regimen in Training and Competition Period" (1952, 1957), "Nutrition of Sportsmen in Competition Days" (1954), "Surveys of Sports Biochemistry" (1955), "Nutrition of Sportsmen" (1957, 1961, 1967), "Physiological and Biochemical Foundations for Theory and Methodology of Sports Training" (1957, 1960, co-written with A. Korobkov and S. Jananis), "Nutrition and Recovery of Performance Capacity in Sportsmen" (1959), "Physical Exercises for People in Various Ages. Biological Foundations" (1962, co-written with A. Korobkov, V. Shkurdada and E. Yakovleva), "Sports Biochemistry" (1974), "Chemistry of Movement" (1974), "Life and Environment" (1986) and Textbook in Biochemistry for physical education students (1964, 1969, 1974). Most of them were translated into a number of languages. If we want to generalize the product of his research work into a sentence, we have to point out the clarification of the biochemical characteristics of the postexercise recovery and energy supercompensation as well as the training effects, the establishment of relations between the supercompensation and improvement of performance capacity, specific nature of the biochemical adaptation to exercises, extensive studies in regulation of metabolism during muscular activity, sportsmens' nutrition, and biochemical control in sports training.

There were good contacts between N. Yakovlev and the sports physiologists and -biochemists of Tartu University. In 1954 he received a group of Tartu students to supply them with the first ideas of what exercise biochemistry is. The seed sown soon produced the first shoots, whose growing into a plant the mentor observed with great interest and support. He was repeatedly in Tartu as invited lecturer, organizer of scientific events, opponent of academic dissertations. He was a member of the Editorial board of the Acta et Commentationes Universitatis Tartuensis series "Hormonal Regulation of Adaptation to Muscular Activity". Also during the last years of life fruitful scientific contacts remained between him and Tartu University. He participated in composing textbooks for students and in writing of review articles. In preparation for publication is the last product of the collaboration – a

survey on the history of exercise physiology and biochemistry.

N. Yakovlev was an outstanding scientist. He was a member of the Research Group on the Biochemistry of Exercise, International Council of Sports and Physical Education, UNESCO. He was a very kind and honest man, a productive educator of young scientists. He was best at continuing the positive tradition of the Russian intelligentsia. A vivid memory remained of him.

A. Viru