J. Training at Different Ages

RELATIONSHIP OF SPORTS EFFICIENCY TO LABORATORY TESTS IN PUPILS OF “EXPERIMENTAL SPORT SCHOOLS” AGED 11-15 YEARS, IN CZECHOSLOVAKIA

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ABSTRACT

In 1964 “Experimental sport schools” were created in 5 towns in Czechoslovakia, with specialisation in athletics, swimming and gymnastics. One of the aims was to allow deeper study of the problems of long term training in youth. Pupils aged 11-15 years were exercised from 9 to 15 hours weekly.

We present detailed data of the correlations between training load, age, sporting skills and the various body measures, and of the overall effects of such training programmes.

Experimental Sports Schools with specialization in track and field athletics, swimming and gymnastics were created in 1964 in five towns of Czechoslovakia. The pupils, aged 11-15 years, exercised from 9 hours weekly to 15 years to 15 hours per week at 15. One of the aims of these schools was to study in depth the problems of sport preparation in youth. We examined the health, state of physical development, functional capacity, general physical fitness, sport efficiency, development of the personality and general educational problems of the sporting youth.

During 1965-1969 we examined yearly 310 children. At the end of this period we had complete records of 263 children, 129 boys and 134 girls. The group was composed of 88 track runners, 95 swimmers and 80 gymnasts.

The relationship of sport efficiency to the state of physical development was examined separately in each sport. The groups of sportsmen were homogeneous because the pupils were chosen from a three to four times greater number of candidates. As indicators of physical development we used biological age, body height, body weight and assessment of relative physical development. The values obtained were correlated with a general index of sport efficiency. This index summarises the performance in several disciplines and the results are expressed in cluster values, i.e. in points or Z-score.

In track and field athletics we evaluated the sports efficiency of 47 boys and 48 girls aged 14 after 3 years training. In the group of boys, we found statistically significant correlations of athletic efficiency on the biological age, body weight and body height (p < 0.01). In the group of girls the athletic efficiency showed significant correlations to body height (p < 0.01) and to biological age (p < 0.05). According to these results the general athletic efficiency of boys was determined through body height to 30% and through body weight to 15%. In the group of girls the general efficiency related body height to 9% and biological age to 11% only.

The influence of physical development upon performance in some events showed differences between the sexes, e.g. the performance in high jump in boys was related to body height by 42%, but in girls to 8% only. In boys jumping efficiency depended on physical development transformed through body height and weight, but in girls primarily through biological maturity. Similar results were found in shot-putting and running.

A close correlation of swimming efficiency with biological age (p< 0.01), with body weight (p< 0.01) and body height (p< 0.05) was found in 45 boys. The multiple correlation showed a relationship of marginal significance. In 48 girls the relationship of swimming efficiency to the indices of body development did not show any significant correlation and neither partial nor multiple correlations were of statistical significance.

We examined the same problems also in gymnastics, in a group of 36 boys and 34 girls aged 14 after 3 years training. The partial and multiple correlations confirmed that the general gymnastic efficiency in boys was not dependent upon physical development, but in girls several values were near to statistical significance, body proportionality reached the border of significance (p < 0.05).

We examined also the correlation of sports efficiency to fitness tests (run 50 m and 300 m, standing long
jump, 2 kilograms medicine-ball throw, pull-ups, push-ups, leg raises, the extent of forward bend, hurdle track running and back muscles dynamometry). In 49 track and field pupils aged 11 years, the intercorrelated relationship showed a statistically significant dependence of the general athletic efficiency on the factors of explosive strength, of general motor coordination and of general endurance. The factor of dynamic strength examined by back muscles dynamometry was insignificant. General fitness correlated significantly with general efficiency in track and field, the highest determination coefficient of general fitness was found in the standing long jump.

In gymnastics we examined the relationship of sport efficiency to the results of fitness tests in a group of 19 boys aged 11-15 during a 4 years training period and in an other group of 20 boys during a 3 years training period. Neither in the first nor in the second group we did find any positive correlation. It seems that in gymnastics the sport efficiency is of a special kind and most fitness tests are not related to gymnastics.

From the battery of laboratory functional tests used in our longitudinal examination the step test and the maximal minute ventilation proved to be of low accuracy.

We examined the correlation of swimming efficiency with the results of the laboratory test of working capacity W 170/kg in a group of 85 swimmers (40 boys and 45 girls) aged 15, after a 4 years training period. Working capacity W 170 correlated in boys at the 5% significance level with their best swimming performance, on the 1% significance level with their performance in 400 m crawl but we did not find correlation with their performance in 200 m breast-stroke. In the girls the significance of 1% was found in all three correlations examined. When the correlation values were transformed in the determination coefficient we found that in boys to 15% and in girls to 31% of the variance of swimming performance can be explained through functional abilities tested by working capacity W 170/kg. This test was twice as valid for the girls as for the boys. It can be explained by the greater maturity and better swimming performance level of girls in the groups examined. It seems that the relationship of sport efficiency to laboratory functional tests depends largely on age, sex and swimming performance.

The results of our longitudinal large scale examination shown a great complexity of relationships between sport efficiency and the results of laboratory examination in dependence on the age and on the sex, and no general and simple correlation valid for ages 11 to 15 years, and for both sexes could be found.

PWC 170 OF JAPANESE BOYS AND GIRLS

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ABSTRACT

PWC 170 is defined as the load in kgm/min with which the subject can perform a bicycling work under the heart rate of 170 beats per minute. The author measured PWC 170 of 208 healthy Japanese boys and girls from 8 to 17 years old.

Experiment was executed by pedalling for 18 minutes with three kinds of workload stepwisely increased every six minutes. Heart rate was counted by auscultation at the final stage of each load. Then, PWC 170 was calculated as the workload corresponded to the heart rate 170 by plotting workload-heart rate relationship.

PWC 170 per body weight showed 11-15 kgm/min in males and 10-13 kgm/min in females. Sex difference was already observed at 8 years of age and increased with age. PWC 170 per body weight of the Japanese boys showed no difference with that of Canadians. On the contrary, PWC 170 of the Canadian girls was inferior to the Japanese from 10 to 17 years of age, due to the gradual decrease of the former accompanying the advance of age.
LUNG FUNCTION STUDIES ON FORMER ATHLETES WHO ARE NOW FOOTBALL REFEREES

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ABSTRACT

The effects of practising sports on the age induced deterioration in the lung functions are investigated. For this purpose, physical examination, ECG, lung function measurements and physical fitness tests were performed on 26 football referees aged 22-50, who were previously amateur and average athletes and have been actually practising some sports for several years. For practical purposes the subjects were divided into three age groups. The values of vital capacity, functional residual capacity, residual volume, total lung capacity, maximal breathing capacity, forced expiratory volume in 1 second (FEV₁ %) are compared with the results of 200 healthy male nonathletes of the same ages. Although there were no differences between the referees and the nonathletes in VC, TLC for all ages, RV was smaller for the referees, particularly more pronounced in the older age groups. MBC values were higher for the referees especially in the group of 40-50; FEV₁ % was also higher, the difference getting larger among the older subjects. All these findings confirm that the age induced regression in lung functions is retarded through practising sports.

In our age of developing technology and automation, the human being is losing his vitality and physical capacity; for that reason we have the problem of the so-called hypokinetic diseases, so the importance of participating in physical education and sports is getting to be better understood.

The physical fitness of a person is best determined by his maximal oxygen uptake, or his aerobic capacity. It is well known that, with adequate physical training, this capacity may be increased to a maximum; but with aging it decreases. The factors responsible for this decrease in the maximal oxygen uptake can be listed as follows:

1. Changes in pulmonary ventilation.
2. diffusion of oxygen to the blood through the alveolar membrane,
3. minute volume of the heart,
4. velocity of the blood flow through the muscles and in the periphery,
5. diffusion of oxygen to the working cells.

One can not ignore that, with aging the physical activity of man decreases and this is another factor for the deterioration seen in his maximal oxygen uptake and his physical working capacity.

Among these factors limiting the maximal oxygen consumption, pulmonary ventilation is widely studied in high performance athletes. Nevertheless the results are not in accordance with each other. Some of the investigators (Pyörälä and al. (15), Shapiro and al. (17), Stuart and Collings (19)) showed that the athletes have a greater vital capacity, compared with the nonathletes. On the other hand many others (Grimby and Saltin (9), Newman and al. (11, 12), Spangenberg (18)) state no important difference between them. Investigations on the total lung capacity are very few and the results are again confusing. Pyörälä and al. (15) show higher values for the athletes, but others (Newman and al. (11, 12), Özgonül (14)) indicate no difference.

Maximal breathing capacity was found significantly higher in the athletes by most of the investigators (Grimby and Saltin (9), Özgonül (14), Pyörälä and al. (15), Shapiro and al. (17), Stuart and Collings (19)). This is easily explained by the fact that the respiratory muscles play an important role in maximal breathing capacity among other factors (Agostoni and Fenn (1)). Some authors report that forced expiratory volume in 1 second is increased in the athletes (Grimby and Saltin (9)), while others indicate no difference between the athletes and nonathletes (Newman and al. (11), Pyörälä and al. (15)).

These differences in the results may be partly due to the voluntary changes in respiration, emotional factors, nonvoluntary changes according to the state of health, altitude, humidity and pollution in the air, and also to sex, age, and degree of daily physical activity. It is generally accepted that the lung functions deteriorate with aging. Vital capacity, total lung capacity, maximal breathing capacity, forced expiratory volume in 1 second show a decrease; on the other hand, functional residual capacity, residual volume show an increase both in their absolute values and also in their relative values.
calculated as a percentage of total lung capacity (Åstrand (5), Berglund and al. (6), Greifenstein and al. (8), Norris and al. (13)). Could these deteriorations be retarded with regular physical training?

In the investigations mentioned above, the changes in the lung functions due to age and physical activity are studied mostly in high performance and particularly in endurance athletes, and comparisons are made with the nonathletes of the same ages. But such investigations are not made among the average athletes, who practise sports for a long time, but not intensively.

Starting from this idea, we carried out physical examinations, including various respiratory function measurements, in 26 football referees, aged between 22-50, who were previously amateur players and who are participating in training for one hour, once or twice a week, and only during some months of the year. As a control group we used the results of 200 normal healthy men of the same ages, who are not practising sports, including university students, physicians, manual and office workers. The nomograms of the spirometric measurements of the other groups of Turkish people were prepared with the results of this group. (Akgün and Özgonül (4)).

After a complete physical examination, blood pressure was determined, the subjects lying 10-15 minutes at rest in supine position, followed by ECG recording with 12 standard extremity and unipolar chest leads. The resting pulse was calculated from the standard lead II on ECG by measuring the distance between ten QRS complexes.

Static and dynamic lung volumes and capacities were measured with a 9 litre Godart Pulmonet apparatus. All the measurements were made between 9-12 a.m. in sitting position, in the same laboratory, by the same staff.

After finishing the measurements, the referees were tested for their physical fitness, with the Harvard-Pack test, which is accepted as one of the most precise methods (Akgün (2)). The persons tested wore a vest charged with a load of 1/3 of their body weight and climbed rhythmically up and down a step of 40 cm height in one second and for five minutes. The fitness index is calculated according to the recuperation of the pulse rate.

The referees and the control subjects were healthy, having no pathological signs in physical examination and ECG, and without any chronic heart and lung diseases. Their smoking habits were practically the same in all groups.

In respect of their physical activities, the referees had left active sports at least two years before; they had only once or twice a week, one hour of light training, six or eight months a year. They had always been amateur average athletes in their sporting life. The control subjects were nonathletes, having no regular sporting activity. The referees and the control subjects did not have any occupations needing a high degree of physical activities.

As it is seen in Table I., the results of the Harvard Pack test indicate that the physical condition of the

### TABLE I

**The Physical Characteristics**

<table>
<thead>
<tr>
<th>Age groups</th>
<th>No. of cases</th>
<th>Age (sd)</th>
<th>Height (cm) (sd)</th>
<th>Weight (kg) (sd)</th>
<th>Body surf. area (m²) (sd)</th>
<th>Art blood pressure syst (mm Hg) (sd)</th>
<th>Art blood pressure diast (mm Hg) (sd)</th>
<th>Rest puls rate (sd)</th>
<th>Harvard Pack test (sd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>40-50</td>
<td>11</td>
<td>44</td>
<td>171</td>
<td>75.2</td>
<td>1.853 (7.1)</td>
<td>123 (7.1)</td>
<td>88.2 (7.1)</td>
<td>67 (7.4)</td>
</tr>
<tr>
<td>B</td>
<td>30-40</td>
<td>8</td>
<td>35</td>
<td>170.5</td>
<td>68.6</td>
<td>1.785 (8.9)</td>
<td>127 (3.4)</td>
<td>85 (8.1)</td>
<td>67 (10.1)</td>
</tr>
<tr>
<td>C</td>
<td>20-30</td>
<td>7</td>
<td>25</td>
<td>174</td>
<td>69.0</td>
<td>1.810 (11.8)</td>
<td>121 (5.2)</td>
<td>81 (8.7)</td>
<td>68 (8.7)</td>
</tr>
</tbody>
</table>

*Table I. The physical characteristics of the referees in mean values, including arterial blood pressure, resting pulse rate and Harvard Pack test results, divided into age groups. The figures in parantheses show the standard deviations.*
referees in all ages are fair, but not excellent. Akgün (2) evaluates the test results of 50-75 points as average, 75-90 points good, over 90 very good. This means the referees had rather good physical condition, although they did not have much sporting activity. In a study made in our institute among the football players of 18-30 years of age, the test result was 108 points (Ozgonul (14)), whereas among medical students aged 19-29 it was 74 points. This indicates that, the referees are between the active sportmen and nonathletes with regards to their physical activities and their fitness.

The physical characteristics of the referees are given also in Table I as mean values; divided into 40-50, 30-40, 20-30 age groups. Group A is composed of 11 referees, mean age 44; Group B of 8 referees, mean age 35; and Group C of 7 referees, mean age 25. Their height and weight do not differ too much, being almost the same; only Group A is a little heavier in weight but this is not significant. Body surface area shows no difference among the groups. The physical characteristics of the people used as controls were not different and they had a mean age of 30.5 (Akgün and Özgonül (4)).

Among the various lung function measurements to be discussed are mean values of the vital capacity (VC), functional residual capacity (FRC), residual volume (RV), total lung capacity (TLC), the ratio of residual volume/total lung capacity (RV/TLC), maximal breathing capacity (MBC) and forced expiratory volume in 1 second (FEV₁). All the measurements were corrected to BTPS conditions. To eliminate the influence of the physical status of the persons on the results, the predicted values of these measurements were calculated for all of the referees with the formulas obtained from the nomograms, according to their age and body size. Absolute values are presented as a percentage of the predicted values in Table II; where it is seen that, VC, TLC and FRC do not differ from the controls. But the referees are differentiated with their smaller values in their residual volume and the ratio of RV/TLC. Residual volume is 89% smaller than the controls in the first group, in the second group this is 94% and in the third group 86%.

MBC and FEV₁% seems to be greater in the referees than the controls, although not significantly. These differences are seen in the next figures (Figures 1-5), on which are marked the results as percentages of predicted values against the ages in graph forms for all the cases. In these figures the triangles represent the mean for the age groups. It is seen that VC is not much different, but the results of RV, RV/TLC, MBC, FEV₁% are all in favour of the referees.

The VC and TLC show no change in the referees and the nonathletes in the same ages, and this can be regarded as normal; many investigators (Akgün and Özgonül (4), Berglund and al. (6), Greifenstein and al. (8), Grimby and Saltin (9), Newman and al. (11, 12), Spangenberg (18)) have shown that, both values decreased with aging, but they were not influenced by physical fitness. Nevertheless some of the investigators (Pyörälä and al. (15), Shapiro and al. (17), Stuart and Collings (19)) reported higher values for vital capacity in endurance athletes. Investigations on TLC of the athletes are very rare and only Pyörälä and al. (15) give higher values for the athletes. It is known that with aging, RV increases, almost proportionally to the decrease seen in VC (Akgün and Özgonül (4), Greifenstein and al. (8), Robinson (16)).

We found this increase slighter in the referees, which is a favourable finding. Briscoe (7) reports an increase of 200 ml in RV for each decade of aging. In our results this finding shows little difference in the ages 30-40 but in the referees aged 40-50 the difference is more favourable for the referees than the nonathletes, who have a sedentary life. FRC results are almost parallel to the RV results but not so pronounced when expressed as a percentage of the predicted values. That means, the age-induced increase in the residual volume seems to be retarded with sporting activities. The increase in FRC being the same as in the nonathletes, but without any increase in residual volume in the referees, could be explained by a greater expiratory reserve. Pyörälä and al. (15) report larger RV and FRC among well-trained older athletes, which is an unexpected finding. They try to explain it with the slower respiratory rhythm which is common in well-trained athletes and which could necessitate a greater volume of the lungs for its greater damping effect.
Figure 1: Vital capacity results of the referees, expressed as a percentage of predicted values, plotted against their age (apsis). Triangles represent mean for the age groups.

Figure 2: Residual volume results of the referees, expressed as a percentage of predicted values, plotted against their age (apsis). Triangles represent mean for the age group.

Figure 3: The ratio of residual volume/total lung capacity results of the referees, expressed as a percentage of predicted values, plotted against their age (apsis). Triangles represent mean for the age groups.

Figure 4: Maximal Breathing Capacity results, expressed as a percentage of predicted values, plotted against their age (apsis). Triangles represent mean for the age groups.

Figure 5: Forced respiratory volume in 1 second results of the referees, expressed as a percentage of predicted values, plotted against their age (apsis). Triangles represent the mean for the age groups.
In respiratory dynamics it is a well known fact that, MBC is strongly influenced by physical fitness (Agostoni and Fenn (1), Akgün (3), Grimby and Saltin (9), Hollmann (10), Pyörälä and al. (15), Stuart and Collings (19)). Our results confirm this opinion too, especially in the older age group, which means that the deterioration in lung dynamics caused by aging is retarded. Also the results of the FEV₁% were better in the referees than in the nonathletes. It is shown that in this finding begins with the age of 35 (Bergland and al. (6), Robinson (16)), but in the referees until the age of 50 it remains normal with 84%.

To summarize, the beneficial effects of regular sporting activities on the lung functions are evident in the well-trained athletes, but they are also present to a smaller degree among the persons who practise sports for a long time, but not intensively. Nevertheless, to generalize this, one should wait for the results of longitudinal studies, beginning from early to older ages in the same individuals.

REFERENCES


ABSTRACT

Fox and Skinner have asked the question, “Will an increase in physical activity be useful in the prevention of Coronary Heart Disease (CHD)?”. Keys has stated that the use of exercise as a deterrent to CHD needs thorough investigation. Numerous investigators have alluded to the value of physical activity measured in sedentary adults. This study investigated the effect of physical training on the circulatory function of sedentary middle-aged males over a 24 month period.

Twenty-five sedentary male subjects 35-60 years were selected for study. Nineteen elected physical training and six remained as controls. Two initial tests included maximum oxygen uptake and associated measurements. A bicycle ergometer was the stress medium, while the Douglas Bag Method was used for determining the oxygen consumption. Gas analysis was accomplished by double determinations on the micro-Scholander. Heart rates were monitored on a Sanborn ECG recorder. Tests were repeated at six-month intervals throughout the 24-month period.

Training commenced at approximately 60% of max V0₂ and gradually increased during the first year to 80-90% of aerobic capacity, where it remained throughout the remainder of the 24 months training period.

The maximal oxygen uptake rose over the test period from 31.4 to 39.5 ml/min/kg (25%) in the training group. The control subjects had a slight drop from 33.8 to 32.7 ml/min/kg. An average of 2.0 training days per week was maintained during the 104 week training period by the exercising men.

The post exercise venous blood lactate remained relatively constant in the experimental subjects, being 106.9 mg% initially, and 94.6 mg% at 24 months. The control group had a similar result, being 100.2 and 93.7 mg%. Body weight dropped 2.8 kg from 82.4 to 79.6 kg in the trained men, while a slight rise from 72.1 to 73.2 kg occurred in the control subjects.

Ventilatory response rose in the experimental group from 85.6 L/min to 104.5 L/min (STPD), while a decrease occurred in the controls from 94.5 to 86.9 L/min (STPD). Maximal heart rate decreased from 180 to 174 in the trained men, while the controls decreased from 173 to 167 beats per minute.

Oxygen pulse remained steady in the control subjects, 14.0 to 14.2 ml/beat, while it rose in the trained men from 14.3 to 17.9 ml/beat. Resting hematocrit, haemoglobin, and glucose levels remained relatively constant in both groups.

Performance on the continuous 15-minute run showed a slightly greater aerobic level than that found on the bicycle ergometer.

It was concluded that the circulatory response over a 24-month period was greatly improved by training in previously sedentary middle-aged men, as seen by the increase in maximal oxygen uptake. The training frequency of 3.0 days per week was adequate for such circulatory changes. No men developed CHD or M.I. during the 24-month training period. It remains to be seen over a more extended time period if physical training acts as a deterrent in CHD.
PHYSIOLOGICAL FINDINGS IN WELL-TRAINED MIDDLE-AGED AMERICAN MEN

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ABSTRACT

Thirty-two men between 38 and 57 years of age, who had been in training for 5.3 years, were evaluated in the following physiological parameters: work capacity, cardiovascular and respiratory functions, body compositions and serum cholesterol. They were considered as excellent in most all parameters tested when compared to sedentary and moderately trained populations of comparable age.

Electrocardiographic analysis at maximal stress showed a higher percentage of asymptomatic abnormalities than reported for sedentary populations. Possible implications were discussed and guidelines for the evaluation and training of sedentary and trained men were suggested.

Short-term investigations dealing with the physiological effects of endurance training on adult men are prevalent; however, most of them are on young men and adults under 40 years of age. This investigation was designed to analyze the working capacity, cardiovascular and respiratory functions, body composition, and serum cholesterol levels of well-trained men, 38 to 57 years of age. Thirty-two men, mean age 47.4 years, enrolled in the fitness programme at North Carolina State University for two to nine years (mean 5.3 years), volunteered for this investigation. Their training regimen emphasized endurance running, with distance and pace being logged after each exercise session. During the 1968-69 school year (32 weeks), the subjects ran 344 total miles and averaged 11.1 miles per week. Working capacity and cardiovascular function data were considered excellent when compared to norm data of similar aged men. This was depicted by high values for maximal oxygen intake (3.68 L/min and 47.5 ml/Kg. min), O₂ pulse (21.5 ml/beat), pulmonary ventilation (144.5 L/min, BTPS), and mile and a half run time (10.6 minutes). Resting heart rate (53.9 beats/min), and diastolic blood pressure (82.8 mm Hg) were considered better than average, while systolic blood pressure (130.6 mm Hg) was average for comparable ages. Spirometry measures were better than predicted values for vital capacity (5.22 L), forced expiratory volume 1.0 (3.99 L), and percent forced expiratory volume 1.0 (76%). Subjects were considered leaner than comparable sedentary men and men completing their first year of training. Serum cholesterol (207 mg/100 ml) was slightly lower than normal for men in the fourth and fifth decades.

Short-term investigations dealing with the physiological effects of endurance training on adult men are prevalent; however, most of them are on young men (6, 20, 48) and adults under forty years of age (19, 22, 40, 42). More recent emphasis has been placed upon the trainability of sedentary men between 40 to 60 (30, 43, 45, 57) and older ages (8, 10). Generally, the results from these investigations reflect an approximately 15 to 30% improvement in maximum oxygen intake capacity (max VO₂) after 3 to 6 months of training (33, 39, 40, 42-45, 50, 57). This improvement is dependent upon intensity, frequency, duration of the exercise regimen, and initial status of fitness of the subjects (49, 52). Further improvement has been noted with additional months of training (29).

Long-term training data (several years) is generally lacking except for a few case study reports (7, 21, 23), most of them completed on athletes. Group data have been chiefly restricted to the Scandinavian countries (26) and includes middle-aged and old athletes. These investigations have shown that if endurance training persists a high status of physical fitness can be maintained through old age (after 60 years of age). Thus, the need for additional information on well-trained men from various countries who have had little or no experience in endurance training prior to the third or fourth decade is apparent. These data will aid the physician and exercise physiologist in determining standards for well-trained men of the 4th and 5th decades.

Description of sample

Thirty-two men between 38 and 57 years of age (mean 47.4 years), enrolled in a physical fitness programme at North Carolina State University, located in Raleigh, North Carolina, USA for 2 to 9 years (mean
5.3 years), volunteered as subjects for this investigation. Their physical characteristics and years in training are listed in Table I. The subjects’ general composition as to occupation would be considered of a professional nature, and included several doctors, dentists; and lawyers, and professors. 34% participated in college sports, with 6% (2 out of 32) competing for 3 or more years. Two men could have been considered as endurance athletes in college and only one of them maintained any regular endurance exercise prior to entering the programme.

Methods

Subjects reported to the laboratory prior to 10.00 a.m. in the post-absorptive state. Raleigh is located 100 miles from Winston-Salem, which necessitated a 2 hour drive prior to testing. After a 15 minute quiet sit, heart rate and blood pressure were taken by the auscultation technique. This was followed by a standard 12 lead ECG recording administered in the supine position.

Body composition evaluation included height, total body weight and skinfold fat measurements at the chest, axilla, triceps, abdominal, supra-iliac, and front thigh. The sum of the latter 6 measures is referred to as the total skinfold fat index (TFI). Recommendations published by the Committee on Nutritional Anthropometry of the Food and Nutrition Board of the National Research Council were followed in obtaining skinfold fat data (32). Body density was calculated with the formula of Pascale (41) and percent fat with Grandes formula reported by Brozek and Henschel (14).

Spirometry evaluation included measurements in vital capacity (V.C.) and forced expiratory volume for one second (FEV1) (34).

Upon completion of these tests, subjects were administered a treadmill run for determination of maximal oxygen intake capacity (VO2 max). A modification of the Mitchell, Sproule, and Chapman (38) technique was used, with duplicate expired air samples being collected during the 3rd, 4th and 5th minutes of each run by 30 cc syringes, and analyzed for O2 and CO2 content by a modified Lloyd Haldane Gas Analyzer. Pulmonary Ventilation (VE) was determined by means of a Parkinson-Cowan gas meter, Model CD-4. The metabolic techniques and procedures outlined by Consolazio, Johnson and Percora were followed (16). Continuous heart rates were monitored during exercise via a biotelemetry system (E and M Instrument Company). Subjects were monitored with a V5 lead during exercise and leads 2, 3, AVL, AVF, and V5 immediately, 1, 2, 4, and 6 minutes after completion of the run (Sanborn 1500 A recorder).

The 1½ mile run was administered approximately one week later on a quarter-mile track. Subjects reported to the laboratory after a 12-hour fast, and approximately 15 ml of blood was drawn from the antecubital vein. Serum concentrations of cholesterol were analyzed by a modification of the direct Leibermann-Burchard technique (35). The latter 2 tests were administered in Raleigh.

Training included stretching and calisthenics with the emphasis placed on endurance running. To facilitate the quantification of training, distance and pace were recorded after each exercise session.

The data were dichotomized by age into the following categories: 38 to 47 and 48 to 57 years. The analysis of variance was used to determine group differences. A P value equal to or less than 0.05 was accepted as significant.

**TABLE I**

<p>| Physical characteristics and number of years in training of well-trained American men. |
|------------------------------------------|-----------------|------------------|------------------|------------------|</p>
<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Weight (Kg)</th>
<th>Height (Cm)</th>
<th>Years in Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>15</td>
<td>42.7</td>
<td>78.8</td>
</tr>
<tr>
<td>SD</td>
<td>2.94</td>
<td>7.38</td>
<td>6.70</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>51.6**</td>
<td>75.8</td>
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<tr>
<td>SD</td>
<td>2.81</td>
<td>9.00</td>
<td>7.05</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>47.4</td>
<td>77.2</td>
</tr>
<tr>
<td>SD</td>
<td>5.30</td>
<td>8.23</td>
<td>6.84</td>
</tr>
</tbody>
</table>

P less than .05
P less than .01

Results

Training occurred 3 to 5 days a week and the men ran from 6 to 25 miles per week. During the 1968-69 school year (32 weeks) the subjects ran 344 miles (total) and averaged 11.1 miles per week. Maximum metabolic and related measures (Table II) showed the working capacity and cardiovascular function to be excellent when compared to norm data of similar aged men. This was shown by high values in VO2 max (3.66 L/min and 47.5 ml/Kg. min), O2 pulse (21.5 ml/beat), VE (144.5 L/min, BTPS), and 1½ mile run (10 min 33 sec). Resting heart rate, blood pressure (Table III) and percent fat, TFI and serum cholesterol (Table IV) were considered lower than normal for men in the 4th and 5th decade. Spirometry values (Table III) reflected higher than normal values. There were no significant differences when groups were compared, except in age and years in training (Table I), thus showing the ability of men to maintain a high state of fitness through the 5th decade.
**TABLE II**

*Maximal metabolic and related performance measures of well-trained American men.*

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>n</th>
<th>Oxygen intake (L/min.) STPD</th>
<th>Pulmonary ventilation (L/min.) BTPS</th>
<th>Heart Rate (beat/min.)</th>
<th>Oxygen Pulse (ml/beat)</th>
<th>1½ mile run (min:sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>38-47</td>
<td>15</td>
<td>X 3.79</td>
<td>145.8</td>
<td>177.8</td>
<td>21.9</td>
<td>10:42</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>0.56</td>
<td>16.1</td>
<td>7.47</td>
<td>3.66</td>
<td>1:42</td>
</tr>
<tr>
<td>48-57</td>
<td>17</td>
<td>X 3.54</td>
<td>143.4</td>
<td>174.1</td>
<td>21.2</td>
<td>10:30</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>0.47</td>
<td>21.7</td>
<td>8.41</td>
<td>3.15</td>
<td>1:06</td>
</tr>
<tr>
<td>38-57</td>
<td>32</td>
<td>X 3.66</td>
<td>144.5</td>
<td>175.8</td>
<td>21.5</td>
<td>10:33</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>0.52</td>
<td>19.0</td>
<td>8.1</td>
<td>3.4</td>
<td>1:21</td>
</tr>
</tbody>
</table>

**TABLE III**

*Resting heart rate blood pressure and spirometry measures of well-trained American men.*

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>n</th>
<th>Heart rate (beats/min.)</th>
<th>Systolic B.P. (mm Hg)</th>
<th>Diastolic B.P. (mm Hg)</th>
<th>Vital Capacity (litres:BTPS)</th>
<th>FEV₁ (litres:BTPS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>38-47</td>
<td>15</td>
<td>X 55.5</td>
<td>124.7</td>
<td>81.2</td>
<td>5.47</td>
<td>4.17</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>9.15</td>
<td>13.9</td>
<td>10.6</td>
<td>0.65</td>
<td>0.49</td>
</tr>
<tr>
<td>48-57</td>
<td>17</td>
<td>X 52.4</td>
<td>135.8</td>
<td>94.3</td>
<td>5.08</td>
<td>3.83</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>6.47</td>
<td>15.4</td>
<td>7.84</td>
<td>0.74</td>
<td>0.67</td>
</tr>
<tr>
<td>38-57</td>
<td>32</td>
<td>X 53.9</td>
<td>130.6</td>
<td>82.8</td>
<td>5.26</td>
<td>3.99</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>7.87</td>
<td>15.5</td>
<td>9.23</td>
<td>0.72</td>
<td>0.61</td>
</tr>
</tbody>
</table>

**TABLE IV**

*Body composition and serum cholesterol of well-trained American men.*

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>n</th>
<th>Total body weight (Kg)</th>
<th>Percent fat</th>
<th>Fatfree weight (Kg)</th>
<th>Skinfold fat (mm)</th>
<th>Serum cholesterol (mg/100cc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>38-47</td>
<td>15</td>
<td>X 78.8</td>
<td>19.0</td>
<td>63.7</td>
<td>3.70</td>
<td>208.9</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>7.38</td>
<td>3.70</td>
<td>6.00</td>
<td>39.3</td>
<td>34.7</td>
</tr>
<tr>
<td>48-57</td>
<td>17</td>
<td>X 75.8</td>
<td>18.2</td>
<td>61.9</td>
<td>3.48</td>
<td>203.9</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>9.00</td>
<td>6.03</td>
<td>30.3</td>
<td>30.3</td>
<td>22.8</td>
</tr>
<tr>
<td>38-57</td>
<td>32</td>
<td>X 77.2</td>
<td>18.6</td>
<td>62.7</td>
<td>3.56</td>
<td>206.5</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>8.29</td>
<td>5.56</td>
<td>35.1</td>
<td>29.1</td>
<td>29.1</td>
</tr>
</tbody>
</table>

With maximum exercise, many subjects had electrocardiographic changes worthy of note. Eight had ST segment depressions of 1.5 mm or more with QX/QT ratios greater than 50%. Eleven other subjects had J point depressions of 2 mm or less with QX/QT ratios of less than 50%. Arrhythmias were common with two men having multiple atrial and ventricular premature beats and two had runs of multifocal premature beats. In addition, one of the latter two men also had significant ST segment depression. Atrial tachycardia of 1.5 min
duration developed in two men, with four subjects having sinus bradycardia with nodal and escape beats. Arrhythmias occurred during the immediate and one minute tracings (post exercise) with one starting during the latter stage of exercise, but not persisting beyond 2 min. Most significant ST depression had disappeared by 2 min post exercise.

Discussion

**Maximum metabolic and related variables.** The high max \( \text{VO}_2 \) values of the well-trained men in this investigation ranged from 20 to 35% higher when compared with the untrained populations of Canada, United States, Scandinavia, England, Germany and Australia (1, 2, 5, 9, 27, 36, 47, 51). Moderately trained groups are approximately 15% lower in these variables (39, 57, 46, 43). The Raleigh group results are approximately 5 to 10% lower than those reported by Grimby and Saltin (26), and Balke and Clark (7). These studies were on middle-aged and old athletes who have continued their training. These lower values may be a result of the lesser number of years in training, and a fewer number of athletic types included in the Raleigh group. Max \( \text{VO}_2 \) of marathon runners and other endurance athletes show above 60 ml/Kg. min values during this same age span (23). Evidence is lacking concerning the decrement which has occurred with age in these highly trained individuals.

Because of the problems involved in the interpretation of comparative data (51), the findings from this investigation are compared with results from two 5-month training investigations conducted by this laboratory (Table V). The initial (sedentary) values compare favourably with aforementioned data. On normal sedentary men, with significant improvements occurring with training (43, 44). The Raleigh group shows significantly higher values for both age groups.

<table>
<thead>
<tr>
<th>TABLE V</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximal oxygen intake, pulmonary ventilation, heart rate, oxygen pulse, resting heart rate, blood pressure, and body composition comparison of sedentary, moderately-trained, and well-trained men, 40 to 59 years of age. (Data represents mean scores observed from the physical fitness research laboratory. Wake Forest University.)</strong></td>
</tr>
<tr>
<td><strong>GROUP</strong></td>
</tr>
<tr>
<td>Walking*</td>
</tr>
<tr>
<td>Running**</td>
</tr>
</tbody>
</table>

1  | I = initial test |
2  | F = final test |
*  | F = results after 5 month's training |
** | F = results after 5 year's training |

\( \text{O}_2 \) pulse (36) and \( \text{VE} \) (47) show similar comparative relationships as max \( \text{VO}_2 \) results except for the \( \text{VE} \) values for Grimby and Saltin (26). The lower ventilations reported by them could be a result of differences in height and weight, and technique. Taking 30 sec ventilation readings could have inflated the values from this investigation. Maximal heart rates of the Raleigh group do not differ much from previously reported data on sedentary and trained men of comparable age (4, 5, 26, 36, 47), that is, heart rates of this magnitude are common for this age and usually are not affected by training.

Comparative data on the 1½ mile run is lacking. Balke (6), Ribisl (46), and Cooper (17), have found a high relationship between max \( \text{VO}_2 \) and running distances from 1½ to 3 miles. The 10 min 33 sec 1½ mile run performed by the Raleigh group would be considered excellent by Cooper’s standards designed for U.S. Air Force men under 29 years (18). It would also result in a predicted max \( \text{VO}_2 \) greater than 50 ml/Kg. min.

Resting heart rate, blood pressure, and spirometry measures. Resting heart rate is approximately 15 to 25% lower than sedentary (26, 47) and moderately trained (26, 54) men of comparable age (Table V). Although diastolic blood pressure was considered lower than normal (26, 55) this is not clear cut when compared with other data from this laboratory (Table V). All 3 resting measures compare favourably with Grimby’s and Saltin’s (26). Spirometry results were considered larger than normal when compared with most standards (11, 12, 25, 34, 36, 47), but comparable to that reported by Åstrand (5). It is believed that the latter investigation included a more physically fit sample.
Body composition and serum cholesterol. Brozek (13) showed percent fat ranging from 20.7 to 25% from age 40 to 55, respectively. Sedentary and moderately trained men from this laboratory fall into this category, with the Raleigh group being substantially leaner — 10 to 25% (Table V). This relationship was also observed in the TFI measure.

Serum cholesterol was well within the normal range and considered to be 20 to 40 mg/100 cc lower than for comparable men of this age (15, 31). Whether this is a result of diet or an indirect effect of exercise is not clear. The question is complex and needs further investigation.

Electrocardiogram after maximal stress. The presence of ectopic beats and ST T-wave changes in exercise tests in middle-aged men is well documented (3, 24, 28, 37, 53). Changes noted in middle-aged men in good physical condition have been found by Doan et al. (24) and Grimby and Saltin (26). The frequency of their ischaemic changes after maximal stress were 24 and 6%, respectively. The data from this investigation agrees with Grimby and Saltin, i.e., approximately 25% showed positive ischaemic changes. Results from studies including sedentary and slightly trained middle-aged men show less frequency of ischaemic change. Data from this laboratory showed a marked increase in ST segment depression after 5 months of vigorous training (5). These changes occurred with no significant change in maximal heart rate. Although much of this evidence is perplexing, it suggests the possibility of highly motivated men extending themselves beyond safe limit. This may particularly be the case with subjects who develop multifocal premature ventricular beats with associated ST segment change. These results probably cause more questions than they answer; that is, first, what do the asymptomatic, but significant appearing ST T-wave changes and multifocal and sustained ectopic arrhythmias mean in relation to other physiological parameters and safety of the subjects? Secondly, what is the long range effect of these asymptomatic ECG changes on physically well conditioned men? Skinner (54) emphasised that although these asymptomatic ECG findings occur in maximal stress with trained individuals, the efficiency they have developed with training will allow them to perform more work (submaximal) before symptoms occur. That is for any given submaximal workload, heart rate (oxygen cost) is lower, thus, causing less myocardial stress. The data suggests that maximum or near maximum stress tests following conditioning may be as important as initial evaluations for indicating safe levels of training, that is, determining at what heart rate level ECG changes appear.

Acknowledgements

This study was supported by the North Carolina Heart Association and NIH Grant, RR-00011-08

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EFFECT OF AN EIGHT-MONTH EXERCISE PROGRAM ON SELECTED
PHYSIOLOGICAL, BIOCHEMICAL AND AUDIOLOGICAL VARIABLES
IN ADULT MEN

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Purdue University, Lafayette, Indiana 47907, U.S.A.

¹ Director of Research, Physical Education Department, ² Graduate Assistant, Pulmonary Function Laboratory,
³ Director of Pulmonary Function Laboratory of the University Hospital.

INTRODUCTION

The greatest single cause of death in the United States, accounting for one-quarter of all deaths, is cardiovascular disease and, in particular, coronary heart disease (CHD) (10). This disease not only causes premature death, especially in men, but is also responsible for seriously disabling many men when they are in the prime of their productive work years. The specific causes of this disease are not known although a large body of evidence concerning pathological manifestations has been discovered and investigated.

The term “risk factors” has been coined to describe a large number of physiological, psychological and sociological factors which a researcher believes is either directly or indirectly related to heart disease (8, 10, 24, 25, 30). A large number of studies have associated elevated serum cholesterol, abnormal glucose levels, and hypertension with the disease. These findings are not universally accepted and the relationships in no way prove causality. However, the findings are substantial enough to encourage further work involving these variables.

Physical activity, either in the form of work or pleasure, has been associated with atherosclerotic disease by attempting to investigate the role of physical activities in providing protection from the disease. This hypothesis dealing with the effects of habitual physical activity on the prevention of ischaemic heart disease is derived mainly from studies which show a relationship between levels of exercise involved in different occupations and the incidence prevalence and mortality rates of this disease (10, 27, 28, 31, 32, 33, 39, 40, 41).

Recently, audiological research has suggested that hearing loss could be regarded as diagnostic evidence of a predisposition to CHD. The results of testing revealed that early hearing loss may be an indication of future CHD (34). This conclusion is based on studies of populations characterized by lower incidence of coronary heart disease and arteriosclerosis who have been found to possess better hearing at high frequencies and less auditory fatigue than populations which do not exhibit the aforementioned traits (22). Our cultural characteristics precipitate the decline of hearing acuity with age (presbycusis). What are the possible factors which may account for such phenomenon? Numerous investigations concerning the environment and personal habits have disclosed some interesting results (6, 7, 11, 12, 13, 14, 16, 17, 18, 19, 20, 22, 23, 34, 35, 36, 37, 38, 44). It would be of interest to determine if exercise and especially a physical fitness programme could reverse or act as a catalyst to prevent this degenerative process. It is also of interest to see how the hearing variables are related to other biochemical and physiological risk factors. Based on the review of related literature and the results achieved in our previous studies (42, 43) an important extension of our research has been completed. Specifically, several physiological, biochemical and audiological variables have been studied, before, during, and after an eight-month exercise programme.

PURPOSE

The purpose of the study is to investigate the effect of an eight-month exercise programme on selected physiological, biochemical and audiological variables.

METHODS AND PROCEDURES

Selection of Subjects

Ninety-one Purdue University staff and faculty members between the ages of 23 and 62 years volunteered to take part in the eight-month physical fitness programme. From the original group of 91 subjects, complete data were obtained on 64 participants; 54 were selected and designated as experimental, and 10 as controls. Twenty-seven subjects were not included because of incomplete data and/or poor attendance. The ten subjects designated as controls were chosen to represent the three levels of fitness; three individuals were classified as high fit, four as medium fit, and three as low fit. These ten individuals did not participate in the programme and were instructed to continue their normal daily routines.

All participants received a physical examination from their family physicians and were given
The 64 subjects comprising the experimental and control groups were divided into three fitness classifications using the test criterion by Ismail et al. (21).

The 54 individuals involved in the experimental group were divided into three sub-groups. Eighteen subjects were designated as "high fit", 18 as "medium fit", and 18 as "low fit". Ten subjects were designated controls as indicated. All subjects remained in their classification group throughout the programme.

The Conditioning Programme

The conditioning programme was conducted three times per week during the lunch hour in the Co-Recreational Gymnasium at Purdue University from October, 1968 through May, 1969. Similar programmes have been described by Greig (15), Leedy (29), Falls (9), Teraslinna (42), and Tolson (43).

After the subjects reported to the gymnasium, they checked the attendance sheet. Then, a 15-20 minute calisthenics programme was performed in accordance with the abilities and the needs of the group. Following the calisthenics, the men ran a specified number of laps around the gymnasium's indoor track. After running, the subjects participated in either basketball, volleyball, squash, or handball as they desired.

The calisthenics and running were progressively intensified during the eight-month period. The major emphasis in the running programme was on distance, and most subjects were able to run four miles without stopping at the conclusion of the programme.

Selection of Variables

Teraslinna (42) in a previous study investigated "physical fitness" in terms of its relationship to selected biochemical and physiological variables at four stages of metabolic stress, using a group of Purdue University faculty and staff members as subjects. Tolson (43), using a similar population, studied the effects of a four-month physical fitness programme on selected physiological and audiological variables. This study combined most of the variables of the two studies and extended the conditioning programme from four to eight months' duration. In order that the data could be compared to the previous studies and in order that longitudinal data could be acquired on subjects who had participated in previous studies, the variables, methods and procedures were similar to those employed in the Tolson and Teraslinna studies (42, 43).

The variables included in this study were divided into three categories: physiological, biochemical and audiological. Data were collected on the following variables:

1. Physiological Variables

Thirteen physiological variables in addition to age, height and weight were involved. Six of the physiological variables were used in a regression equation to classify the subjects into three fitness groups and to assign each subject a physical fitness score. These variables were selected from a regression equation developed by Ismail et al. (21) which accounted for 88 per cent of the factor variance accounted for by 29 fitness variables. The regression equation is: 

\[ \text{score} = -1.329 \times (\text{submaximal exercise heart rate}) + 4.880 \times (\text{percent lean body weight}) + 2.502 \times (\text{maximal oxygen uptake}) - 119.017 \times (\text{submaximal minute volume ventilation}) - 1.357 \times (\text{resting diastolic blood pressure}) - 1.310 \times (\text{resting pulse pressure}) + 61.9 \times \text{constant}. \]

The variables are:

a. Heart rates during rest, submaximal and maximal performance by the conventional method.

b. Resting, diastolic, systolic and pulse pressures by the conventional method.

c. Submaximal \( \text{O}_2 \) uptake and maximal \( \text{O}_2 \) uptake by the adaptation of Balke method (3).

d. Maximal and submaximal volumes of ventilation.

e. Lean body weight and percent lean body weight by 40\( \text{K} \) determination.

f. Physical fitness score utilizing the criterion developed by Ismail et al. (21).

g. Age, height and weight.

2. Biochemical Variables

Three biochemical variables were involved and each was collected at four different stages: namely, rest, at submaximal, maximal exercises and during recovery. The variables are:

a. Serum cholesterol by the Hycel method of Stable Cholesterol Reagent Determinations (1, 26).

b. Serum pH by the glass microelectrode radiometer method (2).
3. Audiological Variables

The audiometric measurements were chosen to provide information as to the degree of hearing loss and the range to which these measurements are manifested. The variables are:

a. Conventional and high-frequency thresholds at 2, 4, 6, 8, 10, 12 and 14 kHz by a modified Hughson-Westlake technique and conventional high pure-tone audiometer.

b. Temporary threshold shifts after exposure to noise for a five-minute period during 30, 60, 90, 120, 150 and 180 seconds by the pulsing circuitry of a Grayson-Stadler Bekesy Audiometer.

Statistical Analysis

Using the analysis of variance technique, the differences between the initial, intermediate and final means were tested. In addition, comparisons between the experimental and control groups were made. All statistical analyses were obtained using the DC6500 and BMD4M at Purdue University Computer Center.

RESULTS

The means and standard deviations of the physiological data for the total experimental group at the three testing periods are presented in Table I.

Observing the data in Table I, improvements are noticed relative to physical fitness scores, percentage of lean body mass, diastolic blood pressure, pulse pressure, resting heart rate, submaximal heart rate, submaximal \( O_2 \), maximal heart rate, maximal volume of ventilation and maximal \( O_2 \). The analysis of variance revealed significant improvement at the .05 level and beyond in all these variables except for diastolic blood pressure and pulse pressure.

The means and standard deviations of the biochemical data for the total experimental group at the three testing periods are presented in Table II.

Table I

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre Test (n=54)</th>
<th>Mid-Test (n=54)</th>
<th>Post-Test (n=54)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \bar{X} )</td>
<td>S.D.</td>
<td>( \bar{X} )</td>
</tr>
<tr>
<td>Pre-Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Age</td>
<td>39.66</td>
<td>7.38</td>
<td>40.00</td>
</tr>
<tr>
<td>3. Wt.</td>
<td>80.86</td>
<td>8.78</td>
<td>9.69</td>
</tr>
<tr>
<td>4. PF Score</td>
<td>301.89</td>
<td>57.91</td>
<td>329.50</td>
</tr>
<tr>
<td>5. Percent Lean</td>
<td>77.58</td>
<td>6.45</td>
<td>77.34</td>
</tr>
<tr>
<td>6. Lean Wt.</td>
<td>63.40</td>
<td>9.26</td>
<td>63.21</td>
</tr>
<tr>
<td>7. D.B.P.</td>
<td>72.65</td>
<td>9.65</td>
<td>69.24</td>
</tr>
<tr>
<td>9. P.P.</td>
<td>47.02</td>
<td>9.32</td>
<td>47.61</td>
</tr>
<tr>
<td>11. S.H.R.</td>
<td>131.67</td>
<td>14.11</td>
<td>125.52</td>
</tr>
<tr>
<td>12. S.V.V. (L/min/Kg wt)</td>
<td>.415</td>
<td>.08</td>
<td>.348</td>
</tr>
<tr>
<td>13. S. ( O_2 )</td>
<td>2.099</td>
<td>.420</td>
<td>2.534</td>
</tr>
<tr>
<td>14. M.H.R.</td>
<td>172.91</td>
<td>11.66</td>
<td>165.89</td>
</tr>
<tr>
<td>15. M.V.V. (L/min/Kg wt)</td>
<td>.935</td>
<td>.23</td>
<td>.875</td>
</tr>
<tr>
<td>16. Max. ( O_2 )</td>
<td>3.728</td>
<td>.752</td>
<td>4.299</td>
</tr>
</tbody>
</table>

* (2 and 159) degrees of freedom
f (2 and 159) degrees of freedom

\( F = 4.73 \) to be significant at the .01 level.
\( F = 3.05 \) to be significant at the .05 level.
Means and Standard Deviations of the Biochemical Variables for the Pre, Mid and Post Physical Fitness Programme Tests – Total Group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-Test (n=54)</th>
<th>Mid-Test (n=54)</th>
<th>Post-Test (n=54)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>S.D.</td>
<td>X</td>
</tr>
<tr>
<td>Glucose (mg%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Rest</td>
<td>95.1</td>
<td>8.8</td>
<td>98.9</td>
</tr>
<tr>
<td>2. Submaximal</td>
<td>91.2</td>
<td>9.4</td>
<td>95.2</td>
</tr>
<tr>
<td>3. Maximal</td>
<td>94.6</td>
<td>12.6</td>
<td>96.7</td>
</tr>
<tr>
<td>4. Recovery</td>
<td>102.3</td>
<td>16.7</td>
<td>105.0</td>
</tr>
<tr>
<td>Cholesterol (mg%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Rest</td>
<td>203.6</td>
<td>34.5</td>
<td>195.4</td>
</tr>
<tr>
<td>6. Submaximal</td>
<td>223.9</td>
<td>37.4</td>
<td>217.1</td>
</tr>
<tr>
<td>7. Maximal</td>
<td>245.8</td>
<td>46.9</td>
<td>242.1</td>
</tr>
<tr>
<td>8. Recovery pH</td>
<td>215.8</td>
<td>39.3</td>
<td>212.0</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Rest</td>
<td>7.351</td>
<td>.046</td>
<td>7.335</td>
</tr>
<tr>
<td>10. Submaximal</td>
<td>7.319</td>
<td>.052</td>
<td>7.307</td>
</tr>
<tr>
<td>11. Maximal</td>
<td>7.216</td>
<td>.113</td>
<td>7.222</td>
</tr>
<tr>
<td>12. Recovery</td>
<td>7.291</td>
<td>.083</td>
<td>7.292</td>
</tr>
</tbody>
</table>

* (2 and 159) degrees of freedom: F = 4.73 to be significant at the .01 level
f (2 and 159) degrees of freedom: F = 3.05 to be significant at the .05 level

Observing the data in Table II, there is a significant increase in serum glucose beyond the .05 level at rest, submaximal, maximal and recovery. No explanation can be given for the increase of serum glucose levels. However, a plausible explanation could be presented in terms of the organisms’ preference for another energy source such as NEFA as a result of the exercise programme. None of the cholesterol values showed significant results during the exercise programme. However, there was a general decline in values at each testing period. Since the subjects in the study had relatively low resting serum cholesterol values at the start of the programme, this finding was expected. Both the resting and recovery pH were significant beyond the .01 level. This finding was probably the result of the individual’s ability to push themselves harder at the middle and end of the testing programme than at the beginning of the programme which is responsible for the lower pH values.

The means and standard deviation of audiological variables for the total experimental group are presented in Table III.

Means and Standard Deviations for the Audiological Variables for the Pre, Mid, and Post Physical Fitness Programme Tests – Total Group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-Test (n=54)</th>
<th>Mid-Test (n=54)</th>
<th>Post-Test (n=54)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>S.D.</td>
<td>X</td>
</tr>
<tr>
<td>2. T-4000 Hz</td>
<td>31.22</td>
<td>17.23</td>
<td>29.46</td>
</tr>
<tr>
<td>3. T-6000 Hz</td>
<td>40.39</td>
<td>18.67</td>
<td>35.76</td>
</tr>
<tr>
<td>4. T-8000 Hz</td>
<td>30.72</td>
<td>18.45</td>
<td>27.85</td>
</tr>
<tr>
<td>5. T-10000 Hz</td>
<td>45.94</td>
<td>20.50</td>
<td>42.78</td>
</tr>
</tbody>
</table>
Observing the data in Table III no significant improvements were observed for the pure-tone threshold measurements. However, there was a consistent decrease in most of the mean values as well as the standard deviations during the exercise programme. As to the temporary threshold shift measurements from 30 through 180 seconds, significant differences beyond the .01 level were found. The results of the temporary threshold shift measurements indicate that the individuals recovered faster from auditory fatigue after they had been subjected to the exercise programme.

Comparing the above results with those of the control group, the results are presented in Tables IV, V and VI.

The means and standard deviations of the physiological data for the control group at the three testing periods are presented in Table IV.

Table IV

Means and Standard Deviations of the Physiological Variables for the Pre, Mid and Post Physical Fitness Programme Tests – Control Group.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-Test (n=10)</th>
<th>Mid-Test (n=10)</th>
<th>Post-Test (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>S.D.</td>
<td>X</td>
</tr>
<tr>
<td>1. Age</td>
<td>39.13</td>
<td>8.20</td>
<td>39.35</td>
</tr>
<tr>
<td>2. Ht.</td>
<td>178.70</td>
<td>4.69</td>
<td>178.70</td>
</tr>
<tr>
<td>3. Wt.</td>
<td>80.64</td>
<td>11.16</td>
<td>80.65</td>
</tr>
<tr>
<td>4. PF Score</td>
<td>314.70</td>
<td>79.96</td>
<td>310.30</td>
</tr>
<tr>
<td>5. % Lean</td>
<td>75.72</td>
<td>7.73</td>
<td>75.72</td>
</tr>
<tr>
<td>6. Lean Wt.</td>
<td>61.60</td>
<td>9.47</td>
<td>61.98</td>
</tr>
<tr>
<td>7. D.B.P.</td>
<td>76.40</td>
<td>12.37</td>
<td>73.70</td>
</tr>
<tr>
<td>8. S.B.P.</td>
<td>120.60</td>
<td>11.28</td>
<td>121.10</td>
</tr>
<tr>
<td>9. P.P.</td>
<td>44.20</td>
<td>8.23</td>
<td>47.40</td>
</tr>
<tr>
<td>10. R.H.R.</td>
<td>63.40</td>
<td>9.05</td>
<td>61.60</td>
</tr>
<tr>
<td>11. S.H.R.</td>
<td>127.40</td>
<td>17.84</td>
<td>135.20</td>
</tr>
<tr>
<td>12. S.V.V. (L/min/Kg wt)</td>
<td>.384</td>
<td>.05</td>
<td>.416</td>
</tr>
<tr>
<td>13. S. O₂</td>
<td>2.172</td>
<td>.487</td>
<td>2.492</td>
</tr>
<tr>
<td>14. M.H.R.</td>
<td>172.40</td>
<td>11.54</td>
<td>174.60</td>
</tr>
<tr>
<td>15. M.V.V. (L/min/Kg wt)</td>
<td>.958</td>
<td>.26</td>
<td>.892</td>
</tr>
</tbody>
</table>

None of the physiological variables for the control group was found to be significant at the .05 level.

The means and standard deviations of the biochemical data for the control group at the three testing periods are presented in Table V.
Table V

Means and Standard Deviations of the Biochemical Variables for the Pre, Mid, and Post Physical Fitness Programme Tests – Control Group.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-Test (n=10)</th>
<th>Mid-Test (n=10)</th>
<th>Post-Test (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>S.D.</td>
<td>X</td>
</tr>
<tr>
<td>Glucose (mg%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Rest</td>
<td>97.6</td>
<td>9.6</td>
<td>99.6</td>
</tr>
<tr>
<td>2. Submaximal</td>
<td>93.4</td>
<td>14.1</td>
<td>95.5</td>
</tr>
<tr>
<td>3. Maximal</td>
<td>97.6</td>
<td>17.5</td>
<td>100.8</td>
</tr>
<tr>
<td>4. Recovery</td>
<td>102.3</td>
<td>18.1</td>
<td>109.2</td>
</tr>
<tr>
<td>Cholesterol (mg%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Rest</td>
<td>197.6</td>
<td>48.0</td>
<td>206.7</td>
</tr>
<tr>
<td>6. Submaximal</td>
<td>228.3</td>
<td>52.9</td>
<td>237.2</td>
</tr>
<tr>
<td>7. Maximal</td>
<td>258.4</td>
<td>62.2</td>
<td>252.3</td>
</tr>
<tr>
<td>8. Recovery</td>
<td>215.4</td>
<td>47.7</td>
<td>215.7</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Submaximal</td>
<td>7.302</td>
<td>.049</td>
<td>7.283</td>
</tr>
<tr>
<td>11. Maximal</td>
<td>7.208</td>
<td>.071</td>
<td>7.189</td>
</tr>
<tr>
<td>12. Recovery</td>
<td>7.310</td>
<td>.074</td>
<td>7.275</td>
</tr>
</tbody>
</table>

None of the biochemical variables for the control group was found to be significant at the .05 level.

The means and standard deviations of the audiological data for the control group at the three testing periods are presented in Table VI.

Table VI

Means and Standard Deviations of the Audiological Variables for the Pre, Mid and Post Physical Fitness Programme Tests – Control Group.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-Test (n=10)</th>
<th>Mid-Test (n=10)</th>
<th>Post-Test (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>S.D.</td>
<td>X</td>
</tr>
<tr>
<td>1. T-2000 Hz</td>
<td>16.8</td>
<td>4.02</td>
<td>16.30</td>
</tr>
<tr>
<td>2. T-4000 Hz</td>
<td>28.70</td>
<td>23.89</td>
<td>27.80</td>
</tr>
<tr>
<td>3. T-6000 Hz</td>
<td>41.30</td>
<td>22.65</td>
<td>37.30</td>
</tr>
<tr>
<td>4. T-8000 Hz</td>
<td>34.00</td>
<td>23.78</td>
<td>31.20</td>
</tr>
<tr>
<td>5. T-10000 Hz</td>
<td>51.50</td>
<td>19.57</td>
<td>48.00</td>
</tr>
<tr>
<td>6. T-12000 Hz</td>
<td>57.30</td>
<td>26.86</td>
<td>55.30</td>
</tr>
<tr>
<td>7. T-14000 Hz</td>
<td>82.50</td>
<td>17.07</td>
<td>72.10</td>
</tr>
<tr>
<td>8. TTS-30 sec.</td>
<td>17.60</td>
<td>13.61</td>
<td>16.50</td>
</tr>
<tr>
<td>9. TTS-60 sec.</td>
<td>15.40</td>
<td>13.31</td>
<td>12.30</td>
</tr>
<tr>
<td>10. TTS-90 sec.</td>
<td>15.10</td>
<td>11.12</td>
<td>13.70</td>
</tr>
<tr>
<td>12. TTS-150 sec.</td>
<td>13.00</td>
<td>9.32</td>
<td>12.20</td>
</tr>
<tr>
<td>13. TTS-180 sec.</td>
<td>11.40</td>
<td>8.63</td>
<td>11.20</td>
</tr>
</tbody>
</table>

None of the audiological variables for the control group was found to be significant at the .05 level.

CONCLUSION

From the above findings it could be concluded that
the exercise programme was effective in producing beneficial physiological, biochemical and audiological changes which could prevent cardiovascular deterioration.

ACKNOWLEDGEMENT

The study is supported in part by a Grant #2458-63-361 from the Indiana Heart Association Inc.

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**Figure 1:** Mean Serum Glucose Values (mg%) Assessed at Four Stages for Pre, Mid, and Post Physical Fitness Programme Tests — Total Group.

**Figure 2:** Mean Serum Cholesterol Values (mg%) Assessed at Four Stages for Pre, Mid and Post Physical Fitness Programme Tests — Total Group.
Figure 3. Mean pH Values Assessed at Four Stages for Pre, Mid, and Post Physical Fitness Programme Tests — Total Group.

Figure 4. Mean Pure-Tone Thresholds at Seven Frequencies for Pre, Mid and Post Physical Fitness Programme Tests — Total Group.

Figure 5. Mean Temporary Threshold Shift Measurements (dB) at Six Stages of Recovery (Seconds) for Pre, Mid, and Post Physical Fitness Programme Tests — Total Group.

Figure 6. Mean Serum Glucose Values (mg%) Assessed at Four Stages for Pre, Mid and Post Physical Fitness Programme Tests — Control Group.
Figure 7. Mean Serum Cholesterol Values (mg%) Assessed at Four Stages for Pre, Mid and Post Physical Fitness Programme Tests - Control Group.

Figure 8. Mean pH Values Assessed at Four Stages for Pre, Mid and Post Physical Fitness Programme Tests - Control Group.

Figure 9. Mean Pure-Tone Thresholds at Seven Frequencies for Pre, Mid and Post Physical Fitness Programme Tests - Control Group.

Figure 10. Mean Temporary Threshold Shift Measurements (dB) at Six Stages of Recovery (Seconds) for Pre, Mid and Post Physical Fitness Programme Tests - Control Group.
CHANGES OF THE HEART VOLUME AND OF THE BASIC SOMATOMETRIC INDICES IN 12-15 YEARS OLD BOYS WITH AN INTENSE EXERCISE REGIME. A LONG-TERM STUDY

DIE VERÄNDERUNGEN DES HERZVOLUMENS UND DER SOMATOMETRISCHEN GRUNDKRITERIEN BEI 12 BIS 15 JÄHRIGEN KNaben MIT INTENSIVER KÖRPERLICHEN BELASTUNG. LANGFRISTIGE STUDIE

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Research Institute of Physical Culture, Prague, Czechoslovakia

ABSTRACT

For four years, i.e. from the age of 12-15 years three groups of boys with a different intensity of their exercise regime were followed. A systematic training of the pupils of an experimental swimming class (n = 13) is considered as physiologically most exacting. A group of boys in training for athletics, and basketball, (n = 14) and a group of boys not systematically performing sports (n = 20) were examined as controls.

For four years the physical development characterized by body height and weight was practically identical in the three groups. This means that it was not influenced by the intensity of the exercise regime.


Abb. 1. Die in vier nacheinanderfolgenden Jahren ermittelten Werte des HV/kg bei dem gleichen Komplex (n = 91) gesunder Knaben. Schraffiert ist der Bereich angegeben, in dem MUSSHOFF und Mitarb. bei Querschnittuntersuchung 10-19 jährigen Knaben die Mittelwerte des HV/kg fanden.
Der Untersuchungskomplex:

Da das Schwimmtraining physiologisch noch anstrengender ist als das Training in anderen Sportarten, beobachteten wir durch vier Jahre Knaben der Prager Schwimmexperimentalklasse (n = 13) im gleichen Zeitabschnitt d.h. zwischen dem 12. bis 15 Lebensjahr. Das ist die Periode, in der sich der Organismus stürmisch entwickelt.

Die Schüler der Experimentalklasse absolvierten – neben der elementaren Körpererziehung – ein Schwimmtraining, dem bei den 13jährigen 5 x 60, bei den 14jährigen 6 x 60 und bei den 15jährigen 8 x 60 Minuten wöchentlich gewidmet wurden.


Die Gruppe Knaben, die wir als nicht sporttreibende bezeichnen (n = 20), widmete sich während der ganzen Zeit keiner systematischen Sportbetätigung. Die Knaben der zweiten Gruppe (n = 14), die wir als sporttreibende bezeichnen, haben während der ganzen vier Jahre intensiv Sport getrieben. Sie widmeten sich dem Wettkampftraining in der Leichtathletik oder im Korbball und dazu noch in einer beliebig gewählten Sportart. Trotzdem nehmen wir an, dass die an den Organismus der Jungschwimmer gestellten Ansprüche noch höher waren als bei dieser Gruppe.

Ergebnisse:

Bei den 12jährigen fanden wir keine Unterschiede zwischen den Vergleichsgruppen, weder in der Körperhöhe noch im Körpergewicht. Bis auf den Unterschied in der Körperhöhe zwischen der Gruppe der 13jährigen Sporttreibenden und der nicht Sporttreibenden haben wir in den vier Jahren Unterschiede zwischen den drei Vergleichsgruppen


![Graphik](http://bjsm.bmj.com/)

Abb. 6. Änderungen des HV/kg in der Wachstumsperiode zwischen dem 12-15 Lebensjahr.


Der Trend der Veränderungen des relativen Herzvolumens (HV/kg des Körperfargewichtes — der sog.


Unser Befund bestätigt die Ansicht, dass das Schwimmtraining eine physiologisch äußerst schwere Belastung des Organismus darstellt. Hierbei ist uns bekannt, dass das Training, das unsere Jungschwimmer absolvierten, bei weitem nicht so intensiv war wie das in einigen anderen Sportvereinen bei noch jüngeren Kindern praktizierte Training. Die Beobachtung dieses Kinders könnte sehr wertvolle Erkenntnisse darüber bringen, in welcher Weise sich der junge Organismus an eine hohe und langandauernde physische Belastung adaptiert.

REFERENCES


APLICACION DE LOS TEST PSICOLOGICOS Y VALORACION SEGUN EDADES

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ABSTRACT

The author explores the question of the individual’s choice of sport, related to psychological orientation and proposes a prospective study of children to clarify the attitudes determining choice of sports.

El rendimiento del deportista está en función de múltiples factores, que siempre han pretendido ser controlados por los responsables del deporte. De los muchos aspectos que se desearían conocer para -en función de su conocimiento llevar un entrenamiento metodico, el psicólogo es quizá el menos estudiado.

En los deportistas formados se han hecho muchas pruebas con el fin de conocer la estructura de su personalidad. Los rendimientos deportivos están relacionados con diferentes factores psicológicos: la capacidad de comprensión, el nivel de aspiración, el índice de frustración, la perseverancia, capacidad de atención, capacidad espacial, velocidad de reacción, son factores entre otros que pueden ser valorados.

El estudio de estos factores permiten una valoración transversal de la personalidad en un momento determinado y apreciar las características de un deportista que ha evolucionado psicológicamente. En este aspecto ha habido desajuste y un verdadero desfase entre los criterios psicológicos y los resultados obtenidos a raíz de la falta de compenetración entre los psicólogos y los entrenadores. A éste respecto es conveniente la formación psicológica de los entrenadores para el ejercicio de su función. Todo reconocimiento psicológico debe ir orientado hacia el conocimiento del entrenador en cuanto a la persona más vinculada al deportista.

Desde el punto de vista de la estructura funcional de una buena preparación física, la cadena de información debe seguir una vía que partiendo del atleta retorne al atleta-psicólogo:

- Entrenador
- Médico
- Preparador físico
- ATLETA

Los perfiles psicológicos para el estudios de deportistas dan escasos resultados positivos, con frecuencia la situación social del deportista va a determinar muchas veces la aptitud antela vida y a condicionar el futuro deportivo de los sujetos. Es conveniente recordar las relaciones que se encuentran entre ciertos tipos de personalidad de algunos deportes, estas relaciones son debidas más a tendencias de determinados grupos sociales que orientan a los practicantes a determinados deportes, que a una verdadera selección psicológica.

Ante ésta situación solo es posible la buena selección deportiva tanto física como psicológicamente mediante una información previa adecuada y facilitando el conocimiento de mucha mayoría de ésta técnica por todos los participantes.

Solo el conocimiento polideportivo y la falta de especialización de las primeras edades, permite hacer una selección adecuada del deporte por parte de los interesados.

A este respecto, se propone el estudio psicológico del niño en su evolución, sus características, las actitudes que toma ante el deporte, sus preferencias en el curso de su desarrollo para ver si estas tendencias son significativas.

Test biométricos siguiendo las escuelas biotipológicas, se reconoce la relación de determinadas características físicas y psicológicas. Se considera que los resultados más fiables se pueden obtener a través de los cuestionarios de Seldon que permiten diferenciar los viscerotónicos de los cerebrotónicos y somatotónicos. La dificultad estriba en que cuanto más pequeña es la edad más difícil es responder a estos cuestionarios y determinar el biotipo psicológico.

Un dato de gran interés para estudiar la evolución motriz del niño es el test de psicomotricidad de Otzeretky, que permite determinar la edad motora a partir de cuatro años y descubrir posibles desfasadas entre el desarrollo psicomotor y la edad cronológica.

Hasta la edad de cuatro años en el juego predomina un principio de Hedonismo, el juego es sinónimo de placer y el movimiento manifestación de vida. No hay test para determinar cuales son los juegos más adecuados para estas edades. Los juegos que predominan son los sensorio-motores. El juego a ésta edad no tiene una
carácterística de factor educativo, sino que es una actividad sin significado, un simple desahogo y una manifestación de una energía superflua. El juego es informal y es difícil determinar las características que debe reunir. Su función fundamental al no ser educadora se reduce a la incorporación del ser al mundo y a su maduración motriz.

A la edad de 4 a 7 años aparece el significado simbólico y el pensamiento mágico simbólico, en ésta época es conveniente la aplicación de test que valoren la sugestionabilidad, sentido de la realidad y el sentido de la imitación. En este nivel en el que el individuo busca una identificación con los mayores hay que valorar también la capacidad de asociación de los sujetos, pues en esta edad a pesar de no haberse aun desarrollado el juego organizado los juegos de imaginación son habitualmente de colaboración. A los siete años con la capacidad de razonar aparece una tendencia en el niño al juego ordenado. Es apartir de entonces cuando se debe valorar la capacidad de aprender, su inteligencia, capacidad asociativa, puesto que el tipo de juego que predomina en estas edades es un juego reglado con un fin determinado.

A consecuencia de las características dichas es conveniente valorar en los niños mediante pruebas su reacción ante el miedo, pues esta característica psicológica puede determinar su comportamiento en el juego. A este respecto hay un miedo racional que el niño tiene a partir de los siete años cuando es capaz de concienciar los peligros que le rodean. La angustia como manifestación ante algo desconocido es propia de la fase de pensamiento mágico-simbólico que se dá de los 4 a los 7 años. Hay un miedo experiencial que se da en función de los acontecimientos que se han vivenciado penosamente y que condicionan negativamente. Todos estos mecanismos deben ser conocidos por el psicólogo que debe de trasmitirlo al pedagogo.

En resumen el estudio de las tendencias y actitudes como medio de explorar las apetencias o temores hacia determinados deportes puede ser un buen camino en la orientación deportiva de los niños.
FUNCTIONAL CAPACITY AND SOMATIC DEVELOPMENT IN CHILDREN OF TUNIS


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Most authors characterise the age of 11-12 years as a prepubertal period. Examination of various populations showed, that the prevailing majority of the children in this age belong to the stage 1 of sexual maturation (according to Tanner (5)) or stage 2 when the first signs of sexual maturation appear. But especially when adequate or even abundant nutrition is assured, the onset of puberty varies, and later stages of maturation can be proved. When preparing norms for the evaluation of the level of functional capacity and physical fitness development it is therefore indispensable to respect the age and sex irregularities in children above ten years of age, as well as the deviations due to different stages of sexual maturation.

In a representative sample (n = 263) of children 11-12 years old from the capital of Tunis (10% of the pupils from high schools) the level of somatic and functional development was analysed in the relationship to the degree of sexual maturation evaluated according to Tanner (-5; pubic and axillary hair, the age of menarche and development of the breast in girls and genitals in boys).

Results of individual analysis in the sample of Tunisian children have shown, that in one third of the children there were no signs of the puberty onset. In 13% of children the 3rd-5th degree of the development of secondary sexual characteristics was observed, mostly in girls, which corresponds to the data of many other authors on earlier onset of puberty in girls of other populations. The development of individual characteristics of sexual maturation was not always simultaneous; in most children the development was parallel (44%) or there was a deviation by one degree (46%). But there occurred deviations by three degrees (3%) and even four degrees (1%).

The comparison of somatic and functional indicators as well as motor performance in children with 3rd-5th degree of sexual maturation showed marked differences from mean values of a given sample. Most of the boys and girls from the group with the higher degree of sexual maturation were more advanced from the somatic point of view, and the girls had greater breadth measures and more fat.

Greatest number of individuals with 3rd-5th degree of sexual maturation belonged to the group of 12 years old girls (28%). Among boys of this age the number of early maturing boys was very low (6%). Girls in this group had higher mean values of height and weight as compared with girls with earlier stage of sexual maturation of the same age. As regards body composition a higher relative as well as absolute amount of depot fat and lower proportion of lean body (3) was ascertained. With the exception of ankle breadth robusticity of the skeleton (measured as breadth of the wrist and ankle, humeral and femoral condyles) was also greater in earlier maturing girls. When evaluating indexes characterising body build, higher values of the index relating bicristal breadth to height, and bicristal breadth to biacromial breadth were found. Early maturing girls have significantly longer limbs; when relating their leg length to total body height this index was also smaller.

The measurement of muscle strength (1, 2) has proved significantly higher absolute values for extensors of the trunk, hand grip, flexors and extensors of the knee joint in earlier maturing girls; in other muscle groups measured the differences were not significant. But muscle strength related to body weight in the earlier maturing girls proved to be significantly lower.

The analysis of the adaptability of the circulatory system evaluated by means of a step-test (1, 2) showed poorer result in early maturing girls. There was a greater increase in pulse frequency during the step-test, slower recovery to normal values and lower values of step-test index. In this group also a lower level of speed development was found: a longer duration of latent period of the contraction and relaxation of the muscle, and lower values of muscle tension during rapid contraction. This is manifested also in the performance of 50 m sprint, when the earlier maturing girls had poorer results too.

The results of our analysis prove what the earlier maturing girls are advanced from the morphological point of view, and in body build and composition manifest certain features characteristic for an adult woman (broader pelvis, more fat). But there exist certain disproportions from the functional point of view — lower values of relative strength, poorer adaptation to a work load during step-test etc. which is retarded as compared with the degree of somatic development. Good harmony between somatic and functional development influence the overall level of physical fitness and performance ability. Our results prove that there is a lack of balance between these indicators.
especially at the period of acceleration in sexual maturation, and that a higher level of somatic development (i.e. absolute values of height, weight, and even lean body mass) does not guarantee a corresponding level of functional development. As regards practical consequences, in the evaluation of physical fitness and motor performance it would be desirable to consider in addition the degree of sexual maturation, and not to include subjects with too different a degree of sexual maturation in normal groups of a given age when elaborating mean "model" values.

Two other important points are the socio-economic conditions, and the degree of habitual physical activity in the daily regime. In our previous evaluations (4) there were significantly lower values of height, weight, absolute amount of lean body mass, circumferential measures etc. in 11 years old boys from poorer families (T1; n = 29) as compared with boys of the same age from well-off families (T2; n = 28). However, not only relative, but in some cases even absolute values of muscle strength of abovementioned muscle groups, results of step-test and performance ability in selected sport
disciplines were better in boys with poorer somatic development. Also in this case except age and somatic development additional factors and influences which could have a profound impact on the functional development of the child in this age period must be taken into consideration.

REFERENCES


