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AGE DEPENDENCE OF EXERCISE OXYGEN PULSE IN ATHLETIC BOYS AGED 11 TO 15

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Abstract: *Relationships of peak execise oxygen pulse to calendar and morphological age were studied in 203 regularly exercizing active boy athletes (fencing, jodo, kayak and canoe, modern pentathlon, soccer, track and field). The test exercise was of the all-out type. The results were analyzed by linear correlation. Grouped by age, the subjects could be regarded as a selected sample at least in respect of body mass and relative fat content. Their mean body mass was lighter than that of peer-age Budapest boys, proportionately to their lower body fat content. Despite that the respective means of calendar and morphological age were not statistically different in any of the five age groups, peak exercise oxygen pulse correlated with morphological age while was uncorrelated with calendar age at every age.*

Key words: *Athletic boys; Oxygen pulse; Body measurements.*

Introduction

Exercise oxygen pulse is a valid indicator of cardiac performance capacity. Similarly to the physical ones, the physiological indicators of performance depend on age in general. Bar-Or (1983) reported a slow age-dependent decrease of peak exercise heart rate and a parallel moderate increase of oxygen pulse in not regularly athletic children. Demeter (1981) reported a significant but moderate relationship of resting and exercise oxygen pulse with age in a cross-sectional study. He found that an intense training of 6 to 8 weeks for cardio-respiratory endurance failed to bring about an appreciable change in either resting or exercise oxygen pulse.

In general, oxygen pulse at the end of an all-out exercise has been reported to be higher in athletic children and adolescents with a training history of several years (Frenkl 1991, Mészáros 1991) than in peer-age non-athletic youth (Bar-Or 1983). In this respect, the preferred event of sport is of relevance as well. Pekkarinen and associates (1991) found a difference of 2.5 ml . beat^{-1} between the exercise oxygen pulse means of skiers and non-athletes of similar body height and mass at the age of 13!

The authors referred to are all of the opinion that any of the physiological variables measured by volume depend on the size of the body so also on the volumes of the heart and lungs. Frenkl (1990) in his review of the literature gave a summary of physical training effects occurring in children and adolescents. Unfortunately, he failed to mention data on how long it would take to develop significant changes under these effects.

Researchers differ in their opinions on how to calculate relative physiological characteristics so the same indicator has been related to body dimensions of length, volume or even surface (Åstrand and Rodahl 1977, Bar-Or 1983, Kereszty 1967). Since we did not want to take sides in this matter, peak exercise oxygen pulse was related to age as an absolute value in the present study. The purpose was to disclose differences, if any, in the relationship of peak exercise oxygen pulse with calendar and morphological age.

Material and Methods

All of the 203 boy subjects lived in the capital Budapest, had at least one year of training history and 5 to 8 training sessions a week. They were subdivided into age groups by their calendar age. The occurrence of events (fencing, judo, kayak and canoe, modern pentathlon, soccer, track and field) within the age groups was uncontrolled.

Anthropometric dimensions were taken before the exercise tests, observing the recommendations of the IBP (Weiner and Lourie 1969). Morphological age (an equivalent of biological age validated by bone age, Mészáros et al. 1984, 1985) was estimated by using five body dimensions and calendar age. Relative body fat was estimated by skinfolds (using a regression formula based on Pařízková's technique, 1961).

The all-out exercise tests were carried out on a Jaeger treadmill. Exygen pulse values were obtained by dividing continuously monitored oxygen uptake and heart rate values.

Both calendar and morphological age were expressed in decimal years and correlated with peak exercise oxygen pulse values in every age group. Linear coefficients were compared after z-transformation. Differences between age-group means were tested by one-sample t-tests at the 5% level of random error.

Results and Discussion

Table 1 contains the means, sd's and case numbers for the respective variables and age groups.

Table 1. **The studied variables (mean ± sd)**

Age	11	12	13	14	15
DA	11.1 ± 0.3	12.0 ± 0.3	12.9 ± 0.3	13.6 ± 0.2	14.9 ± 0.3
MA	10.7 ± 0.6	11.9 ± 0.7	12.9 ± 0.7	13.9 ± 0.6	15.0 ± 0.5
BH	144.4 ± 6.4	149.5 ± 6.8	156.5 ± 6.6	164.9 ± 6.7	171.1 ± 7.0
BM	34.1 ± 5.6	39.6 ± 7.3	44.7 ± 6.8	52.3 ± 7.5	58.4 ± 7.5
F%	12.3 ± 4.2	14.8 ± 4.3	14.5 ± 3.6	14.7 ± 3.1	13.1 ± 3.8
O_2P	9.3 ± 1.6	11.0 ± 2.1	13.0 ± 3.0	14.1 ± 2.3	16.3 ± 2.1
n	49	44	26	33	51

Abbr.: DA = calendar age in decimal years; MA = morphological age in decimal years; BH = body height in cm; O_2P = oxygen pulse in ml .beat^{-1}; n = case numbers.
Note: Age groups were formed around nominal years to range from .51 of previous to .50 of current.

The means of calendar and morphological ages were statistically equal consistently in every age group. This finding was regarded as favourable since exercise parameters of children with considerable acceleration or retardation had often been misinterpreted (cf. Mészáros et al. 1987). Stature in the age groups of 11 through 13 was very close to the Budapest reference values while those aged 14 and 15 were slightly taller than their non-athletic peers (Mohácsi and Mészáros 1987). This finding is attributable, in our opinion, to differences in the event occurrence within the age groups.

Body mass means were smaller than the Budapest reference values in all the five age groups. This smaller body mass is related to the 12 to 15% content of body fat characteristic of our sample.

The means of peak exercise oxygen pulse increased with age almost linearly. The observed values exceeded those reported for non-athletes in every age group (Bar-Or 1983, Demeter 1981), but were slightly below those reported for age groups engaged in endurance sports and homogenous in respect of preferred event (Frenkl et al. 1991, Pekkarinen et al. 1991). This finding has been regarded as arising from a specificity of the respective sport events rather than being attributable to a diversity in athletic preparation. Cardio-respiratory training stress is much higher in modern pentathlon, paddling, skiing or track-and-field athletics than e.g. in ball games or fencing.

Table 2 summarizes the coefficients between peak exercise oxygen pulse and calendar, respectively morphological age as well as those between the two kinds of ages.

Table 2. **Some coefficients of the correlation analysis**

Age-Group	DA & MA	MA & O_2P	DA & O_2P	$r_{0.05}$
11 yr	.33	.53	.08	.28
12 yr	.36	.76	.03	.30
13 yr	.26	.76	.25	.38
14 yr	.26	.64	.32	.34
15 yr	.27	.48	.10	.27

Abbreviations as in Table 1; $r_{0.05}$: significance limit

Relationship of peak exercise oxygen pulse with chronological age was found to be statistically not different from zero in all the age groups. In contrast, it was significantly correlated with morphological age throughout the studied ages. Close correlation was found for ages between 12 and 14 while a loose to moderate one for ages 11 and 15.

The finding that our athletic boys had higher peak exercise oxygen pulse values than the non-athletic peers has been considered an effect of regular physical training. As our matgerial contained very young subjects as well, this effect was attributed primarily to adaptive changes in the control mechanism of the heart rate and secondarily or to a smaller extent (particularly in the groups aged 13 to 15) to a larger stroke volume due to exercise-induced myocardial hypertrophy.

Correlation analysis results have again drawn attention to the necessity of assessing biologically based age, in particular when some or other motor performance has to be evaluated. In this respect, differences between coefficients are thought to reflect the characteristic properties of adolescence. The intense growth of the body and the internal organs between ages 12 and 14 may be an important contributor to better performance. On the other hand, the almost linear increase of peak exercise oxygen pulse is a definite result of physical training. Frenkl (1990) and Falkner and Tanner (1978) agree in stating that in regularly exercizing youth the amplitude of "oscillations" in the age dependence of functional parameters is much smaller while the rate of development is much faster.

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