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GROWTH TYPE AND EXERCISE CHANGES IN SKIN TEMPERATURE IN ATHLETIC BOYS

M. Petrekanits, A. Farkas, J. Mohácsi and *J. Mészáros*

Department of Medicine, University of Physical Education, Budapest, Hungary

Abstract: *A group of 51 regularly exercizing athletic boys of 15 years was subdivided into moderately leptomorphic and moderately pyknomorphic subjects by Conrad's metric index (1963). The anthropometric properties (morphological age, body mass and height, relative fat content and Conrad's plastic index) did not differ statistically between the two subgroups except of stature that was taller in the more leptomorphic subgroup. The analysis of skin temperature changes recorded during a graded all-out ergometric treadmill exercise revealed that the more linear subjects had a higher skin temperature during the exercise. Most of the exercise physiology parameters were comparable in the two groups, but maximum stroke volume was significantly greater in the moderately pyknomorphic group.*

Key words: *Growth type; Skin temperature; Athletic boy.*

Introduction

Efficiency of thermoregulation during continuous physical exercise has been a point early recognized and studied in exercise physiology. Nielsen (1938) stated already 50 years ago that changes in body temperature during steady-state exercise were essentially independent from ambient temperature between 5 and 30 °C and were mainly related to the intensity of metabolic processes. Using a more modern technique for measuring the variously weighted components of the thermoregulatory mechanism, Saltin and Hermansen (1966) confirmed Nielsen's results. Gisolfi (1983) reported that thermoregulatory mechanisms work actually in a similar way both at rest and during exercise. In our opinion, this is merely a relative similarity since only the integrated output of the thermoregulatory "input mechanisms" (hydration status, increase of the temperature and osmolality of the internal milieu, sweating intensity, changes in skin blood flow, etc.) can be measured. Gisolfi (1983) and Stolvijk and Nadel (1973) thought that during exercise a new plateau (new reference level) of internal temperature would develop and this could be modified by the regulatory systems at each grade of exercise when necessary.

Bar-Or (1983) and Araki et al. (1979) have drawn attention to the fact that the development of the new reference level depends on age as well. In young subjects the same intensity of exercise would bring about faster changes, the level of internal temperature that would force one to stop exercizing could develop earlier. As Drinkwater and Horvath (1979) found, the rate of heat exchange between the body and skin of young subjects is lower than in adults, accordingly, the heat stress of a warm environment or repetitive exercise is greater for them. Functional relationships of the regulatory mechanisms (thus of thermoregulation, too) with body build have hardly been investigated till now.

A group of 51 of athletically regularly active boys of age 15 was subdivided into more and less leptomorphic groups by using the metric index of Conrad's growth type. This index describes the linearity of the body so the less leptomorphic subgroup was taken as having an "athletic build". The purpose of the study was to compare the exercise physiological parameters and thermoregulatory patterns (as reflected by changes in chest skin temperature) of the subgroups.

Material and Methods

The subjects were male modern pentathlonists and triathlonists, paddlers (kayak and canoe) and track-and-field athletes. They had a sports history of 4 years and 5 to 9 training sessions a week.

Anthropometry was taken before the exercise test. Morphological age (Mészáros et al. 1985), the metric and plastic indices of the growth type (Conrad 1963) and weight-related body fat by skinfolds (by using a regression formula based on Parízková's 1961 suggestions) were calculated.

The all-out graded exercise test was carried out by using Jaeger model analysers and treadmill. Starting on the level, the incline of the 12 kmh belt was increased by 3 degrees every second min until exhaustion.

Changes in the skin temperature of the chest (recording point corresponding to the V6 lead of the ecg) were measured by a YSI–709 transducer connected via an impedance bridge amplifier to a computer. Readings were accurate to the nearest 0.01 °C, mean response time was 1 s.

Exercise changes in the physiological parameters and skin temperature were analyzed at the relative timespoints of 0, 25, 50, 75 and 100% of net running time.

The obtained means of the subgroups were tested for differences by *t*-tests for dependent and independent samples at the 5% level of random error.

Results and Discussion

Table 1 contains the means, sd's, case numbers and two-sample *t*-values for the observed variables in the groups. No significant differences were found between the calendar and morphological age means either within or between the groups. Anyone classified as more leptomorphic would not necessarily be tall as this property refers to the relationship of chest dimensions to height. Yet, the more leptomorphic group was found to be significantly taller than the more pyknomorphic group or the mean of non-athletic peers reported by Mohácsi and Mészáros (1987). Mean body mass was statistically equal in the two groups, this also meaning that the athletic-build group had a larger height-related mass. This finding was explained by a larger muscle mass in the latter group since there was no difference in their relative fat content. As the measure of body linearity or gracility, the metric index of the growth type, was used as a classifying criterion, the significant difference in that was obvious. Statistical equivalence of the respective plastic index means should not mislead one to assume an equal developmental grade of the skeleto-muscular system: The athletic-build subgroup was more robust, because they were smaller.

Table 1. **Anthropometric variables (mean ± sd)**

Var	Leptomorphic (n = 17)	t	Athletic-build (n = 34)
DA	14.88 ± 0.27	NS	14.88 ± 0.26
MA	14.92 ± 0.47	NS	14.94 ± 0.54
BH	173.42 ± 7.81	2.15	168.58 ± 6.59
BM	55.17 ± 7.25	NS	58.23 ± 9.09
F%	13.04 ± 3.78	NS	13.68 ± 4.65
MIX	−1.53 ± 0.22	6.79	−0.99 ± 0.27
PLX	82.46 ± 2.77	NS	83.56 ± 4.44

Abbr.: DA = calendar age in decimal yrs; MA = morphological age in decimal yrs; BH = body height in cm; BM = body mass in kg; F% = weight-related body fat percentage; MIX = metric index in cm; PLX = plastic index in cm; NS = not significant

Table 2 summarizes the means, sd's asnd *t*-tests of skin temperatures, weight-related oxygen uptakes und the oxygen pulse values. The latter are expressions of myocardial performance capacity.

Table 2. **Exercise physiological variables (mean ± sd)**

Groups according to NRT%	Leptomorphic (n = 17)	t	Athletic-build (n = 34)
Skin temperature °C			
0	33.51 ± 1.22	2.96	32.52 ± 1.08
25	33.59 ± 1.06	3.25	32.56 ± 1.07
50	33.79 ± 1.14	3.56	32.64 ± 1.06
75	34.08 ± 1.14	4.02	32.76 ± 1.09
100	34.12 ± 1.25	3.90	32.80 ± 1.09
Relative oxygen uptake ml .min^{-1} .kg^{-1}			
0	36.09 ± 4.17	NS	36.63 ± 4.35
25	43.79 ± 4.54	NS	45.09 ± 4.73
50	48.41 ± 4.81	NS	49.62 ± 4.93
75	52.09 ± 4.05	NS	54.52 ± 4.37
100	55.53 ± 4.65	2.03	58.57 ± 4.08
Oxygen pulse ml .beat^{-1}			
0	11.51 ± 2.45	NS	12.00 ± 3.05
25	13.88 ± 2.03	NS	14.81 ± 1.60
50	14.48 ± 2.92	NS	15.48 ± 2.07
75	15.16 ± 1.94	2.59	16.73 ± 2.09
100	15.73 ± 2.37	2.61	17.81 ± 2.82

Abbr.: NRT% = relative exercise intensity expressed as percentage of net running time

The direction of change in skin temperature during exercise was similar in the two groups. However, skin temperature in the more leptomorphic groups was higher already at the outset and by 0.33 °C higher by the end of the exercise. Relative oxygen uptakes did not differ between the 0 and 75% points of running, but at the 100% point the athletic-build group had a 3 ml higher relative aerobic capacity. Peak exercise oxygen uptake was higher in both groups than that reported for non-athletes (Bar-Or 1983, Demeter 1981).

Means for the oxygen pulse became statistically higher in the more pyknomorphic group already from the 75% point.

The conclusion arrived at by analyzing the results was that the relationship between quantitative measures of thermoregulation and body build was not due to chance. Delamarche et al. (1990) reported a parallel change of core and skin temperatures. This would imply for our study that the more leptomorphic group produced more heat during exercise. The same authors also stated that sweat production became more intense around a core temperature of 38 °C. This finding might explain the large interindividual differences in the timing of intense sweating.

When this side of the problem is approached from another aspect, a rather interesting point emerges. The group described as having an athletic body build displayed a larger relative body mass and motor system development, thus also the relative fraction of muscle mass could be thought of as being larger. This larger muscle mass should, however, have produced more heat during exercise rather than less.

Larger relative aerobic power and higher oxygen pulse are indirectly also related with one another and with body build as well. As shown by reports on X-ray and echographic studies, the shape of the heart is individually different. Left ventricular shape, consequently also size is important not only for oxygen uptake: Circulation has the additional duty of transferring heat from the inside of the body to the skin. This requires a not negligible fraction of cardiac output. The relationship between skin circulation and sweat production is well established (Bar-Or 1983, Araki et al. 1979) and, as known, the extent of sweating is rather variable from individual to individual.

We consider the obtained results have mainly an informative value because of the small number of cases and narrow age range. Anyway, already a partially developed adaptation to exercise and constitutional build, as in our sample, seem to be of importance in thermoregulation during exercise. The differences termed input factors by Gisolfi (1983) as well as central effects (so e.g. the sensitivity of the hypothalamic thermal centre) may also have a role in the observed dissimilar ways of function.

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Mailing address: Dr Petrekanits Máté
TF Orvosi tanszék
H–Mailing address:1123 Budapest, Alkotás u. 44.
Hungary