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SYMPOSIUM

Anthropometry and competitive sport in Hungary

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ABSTRACT Sport anthropometry has developed from the techniques and results of general physical anthropology. Thus, in the beginning, the main questions and methods were also similar to those of general physical anthropology, only the investigated subjects were taken of a different population. Following the initial, mainly descriptive and comparative, phases of data manipulation, the predictive functions of sport anthropometry have also developed. Continuous progress in the methods of sport training, consequently in athletic performances and the changes in athletic rules and equipment, have developed a need for the investigation of such (indirect) human biological factors that may have a role in competitive sport performance. The analytical approach in sport anthropometry has only become dominant during the past 10 years. A clear recognition of the relationship between structural characteristics and functions can – beyond the scientific importance of the matter – help sports practice in both the selection of talented youngsters and the process of athletic preparation. The most recent tendencies in sport anthropometry attempt to answer such questions that cannot be connected to the direct and traditional measurements of physical anthropology. An analysis of the relationship between inherited characteristics (physique and metabolic pathways, functional regulation during exercise, etc.) means a new challenge for sport anthropometry. **Acta Biol Szeged 44(1-4):189-192 (2000)**

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Sport, physical education (PE) and physical activity exist as synonymous expressions in common usage, though in addition to real similarities, sharp differences can also be perceived between these three meanings. Namely, it is the aim of the three activities that is different. In what follows the term competitive sport means an interaction in which individuals or groups struggle toward a goal that can be attained by only one of these groups or individuals. The administrative and financial backgrounds of these activities are also different. Elite competitive sports belong to the authority of the Ministry of Youth and Sports (MYS) and the Hungarian Olympic Committee (HOC), whereas PE belongs to the Ministry of Education in our modern society. Both physical education at school and competitive sports depend heavily on financial support. The HOC and MYS support only competitive sports and certain related research activities.

The present paper summarises the anthropometric investigations that have had close connection with elite competitive sports.

The early stage of Hungarian sport anthropometry

Increasing popularity of elite competitive sports and the spectacular development in athletic performances aroused considerable interest in the morphological qualities that characterise successful athletes. Among others, the works of Tanner (1964), Heath and Carter (1966), Carter (1970), Tittel and Wutscherk (1972) and Stepnièka (1972) have given the final motivation to the Hungarian human biologists to deal with top athletes.

During the past three decades three trends could be identified in our national sport anthropometry. The first attempt in Hungarian kinanthropometry was the representative investigation of Eiben (1972). Following the descriptive and comparative analysis of elite European woman track and field athletes a very important question has immediately arisen: ”Are women athletes born or being made?” His answer was completely right already at that time: ”women athletes are born and being made.” Demonstration of the sport- or event-dependent differences in body dimensions and proportions were and still are very important both theoretically and practically, nevertheless we have to be aware of the fact that the rules, techniques and also the facilities employed in sports do change continuously. The recognition that the importance of a number of previously described human biological advantages for sports performance is relative and limited in time (Mészáros and Mohácsi 1982) was relatively late, therefore the number of the descriptive, but not analytical, studies has markedly increased

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during the next two decades (Eiben et al. 1977; Szmodis and Mészáros 1980; Mészáros and Mohácsi 1982a; Farmosi 1983; Farmosi and Mészáros 1986; Mohácsi and Mészáros 1986).

In summary, the observations reported by these studies were:

- Young and adult elite athletes represent extremes of the population in their height and body mass. Consequently, the body mass over height ratio is smaller in athletes than in their non-athletic peers;
- The relative frequency of heights significantly taller or shorter than the average stature is about 5% in the population, however, this ratio is less than 1% if both height and body mass are criteria for the selection.

The investigation of physique and body composition

Another direction of the descriptive studies has been the analysis of body build, *i.e.* physique and body composition. A good number of analytical research work has been published in this field; this article cannot list all the details because of its limited space. In our opinion the most important works are: Eiben et al. 1977; Mészáros et al. 1980; Szmodis and Mészáros 1980; Szabó and Mészáros 1980; Mohácsi and Mészáros 1982, 1986; Szabó et al. 1984; Farmosi 1985, 1986; Farmosi et al. 1987.

The most important results and observations were:

- The most frequent body build among our elite athletes is the ectomorphic mesomorph somatotype of Heath and Carter (1966) or the slightly leptomorphic growth type of Conrad (1963);
- When athletes are grouped by their athletic (sport) performance, no significant differences can be observed between their physique;
- No significant relationship can be found between somatotype components and the motor performance scores characterising basic ability levels;
- No significant relationship can be found between peak-exercise oxygen consumption, peak anaerobic power and somatotype components either in the young or in the adult athletes;
- Relative body fat content is less than 17-18% in elite adult female athletes and about 11-12% in the male ones. The variability around the mean of sport or event groups is large (± 3%), irrespective of gender. The desirable (or optimum) body fat content can be determined as the ratio that does not interfere with physical and physiological performance.

The present status of sport anthropometry

Owing to the results of descriptive investigations a new demand has appeared in sport anthropometric research. The focus of the new investigations became the analysis of the relationship between anthropometric characteristics and physical, physiological functions. Two research groups – the Central School of Sports and the Department of Health Sciences and Sports Medicine – play a definite part in this area of human biology and are supported by MYS and HOC. Their technical repertoire has developed during the past 10 years, and in addition to using traditional anthropometric methods they have the facilities to measure aerobic and anaerobic exercise performances as well as the exercise changes in cardio-respiratory function. Their traditional anthropometric repertory has increased by the four-component (bone, muscle, fat and residual volumes) estimation of body composition (Drinkwater and Ross 1980). Nomen est omen! The research team in the Central School of Sports has specialised in the selection and education of talented young athletes, the Department of Health Sciences and Sports Medicine has focused on adults athletes. Nevertheless, no strict separation exists between the tasks of the two institutions.

Many of the former results of the mentioned two workgroups already serve the goals set by the HOC and MYS. Graduate and postgraduate lectures at the university and courses for the coaches belong to their duty as well.

What we know already and can apply in practice

Szabó (1977) has published a new scoring system for the evaluation of general motor abilities of children of both genders between 7 to 18 years of age. The critical threshold to develop into an adult athlete of at least class I is 40 points by this system. The development of somatic characteristics and motor abilities follows various patterns. There are many healthy children with extremely good physical abilities but, unfortunately, their human biological attributes are not suitable for the chosen kind of sport. The prediction of final height and physique is very important. One of the basic preconditions for any reliable prediction of these traits is an acceptably accurate estimation of biological age.

Morphological age as one of the valid estimates of biological age was developed by Mészáros and associates (1984, 1987). The accuracy of the estimation procedure is 0.25 year. The reliability was checked by an X-ray method of bone age assessment and also by a prediction and follow-up of adult stature in a longitudinal investigation of 8 years (n=485). By using morphological age and the developmental patterns of height as the entries of prediction, adult stature can be determined within a range of 1-2 cm in 89% of the 11-13-year old subjects. Morphological age as an estimate of biological age gives important help also in the evaluation of motor test performance scores described in the previous paragraph.

Relative bone mass significantly decreases and relative muscle mass increases with age between 7 and 18 years.

However, a significant positive correlation (with coefficients ranging from 0.45 to 0.75) can be found between relative bone and muscle masses in young and adult athletes (Pápai et al. 1991; Mészáros et al. 1991; Mohácsi et al. 1996/97).

Conrad's metric index (1963) has a significant exponential relationship with relative bone mass estimated by the Drinkwater-Ross (1980) technique. The peak of this exponential curve lies between the metric index values of –1.10 and –1.45 where the majority of adult male athletes is situated. Consequently, also the development of muscle mass has human biological limitations.

Relative muscle mass relates inversely to relative fat mass in qualified young and adult athletes. There is a significant relationship between absolute muscle mass and aerobic, anaerobic power both in youngsters and adults.

The newly identified relationships and parallelisms constitute the basis of present-day human biology. Though body dimensions and proportions (as inherited attributes) constitute a very important part of selecting and educating junior and adult top athletes, the mentioned relationships indicate a new point of view. Malina and Bouchard (1991) have stressed that peak aerobic power can also be interpreted as one of the inherited characters of elite athletes. Frenkl and co-workers (1990) have emphasized that a peak oxygen uptake of 62-65 ml kg^{-1} min^{-1} seems to be the lower limit of metabolism in adult top athletes, irrespective of the events of sports in question. Taking the significant age-dependent decrease in relative peak oxygen uptake into account (Bar-Or 1983; Malina and Bouchard 1991), experts have to select the required levels of three inherited characteristics, (a) motor performances and skills, (b) body dimensions and proportions, and (c) exercise physiological attributes. The probability of a concurrent presence of all the three characteristics is less than 1 over 10,000 in the healthy population!

What we would like to know

In order to be excellent, physical and physiological performance in general requires flawless regulation during exercise. It seems to be one of the very important factors how physique as one of the inherited traits relates to regulatory functions.

The effectiveness of thermoregulation is one of the limits or determinants during exercise. Petrekanits (1995) has stressed how sharp differences in the thermoregulatory functions can exist between top athletes, independently from age, gender and sport performance. A greater minute ventilation alone does not account for these differences. An answer has to be found to the question: What are the indicators, be they either measurable or human biological ones, that can be expected to behave as predictors?

Excellent sport performance requires a high level of both aerobic and anaerobic metabolism. The metabolism of lactate during exercise can be regarded as a problem of fuel utilization. No significant relationship has been found between the studied parameters of the two metabolic pathways. Neither physique, nor body composition, nor training history do determine the ratio between aerobic and anaerobic metabolisms.

What are the possible predictors of concurrently high aerobic and anaerobic performances?

Haematological changes (for instance, an exercise-induced decrease of relative plasma volume) also have a significant effect on physiological performance. The greater the decrease in plasma volume, the lower is the peak exercise cardiac output (Mészáros et al. 1997). By our present knowledge no significant relationship can be observed between somatic characters, peak oxygen consumption (as partly inherited attributes), respectively the extent of the exercise-induced decrease in relative plasma volume.

Outstanding athletic performance requires the presence of appropriate and flexible psychological adaptation and functions.

How do morphological body build and constitution relate to the psychological characteristics?

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