Anthrop. Közl. *45:* 133–142. (2004)

SKINFOLD THICKNESS AND AGE IN PHYSICALLY ACTIVE BOYS

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Abstract: *Regular physical exercise during the period of growth has a beneficial influence on the body composition of youngsters and children when compared to their less active or inactive peers in the population. It seemed therefore reasonable to check the amount of fat stores in youth engaged in systematic physical training. As an a priori working hypothesis we only relied on the relationship concerning which the majority of experts would agree, namely that the thickness of subcutaneous adipose tissue was proportionate to body fat content. Accordingly, we simply expected to find certain regional dissimilarities in the age-related changes of the skinfolds. This paper only reports on the skinfold measures measured half-yearly in a mixed longitudinal and cross-sectional sample (n=2661) of boys grouped by half year intervals of decimal age between 6.5 and 19.0 years, all of whom attended physical training sessions 4 to 6 times a week and took part in sport competitions every weekend. The skinfolds were measured on the left side of the body over the biceps, triceps, forearm, front thigh, medial calf, scapula, iliac spine and umbilicus. The analysis referred to the half-yearly absolute means of body mass, stature and respective skinfold thicknesses, but for the skinfolds also the raw first-order differences were calculated and expressed as percentage of the sum of skinfolds.*

The inferences for this boy sample of above average habitual physical exercise and sport competition regimen were as follows. (1) With advancing age there were few items that were similar in the differences observed in the skinfold thickness (ST) of the respective body regions (e.g., the gross coincidence of estimated peak growth velocities, or certain common trends in the behaviour of limb skinfolds). (2) ST on the limbs, respectively on the trunk differed with age: while limb skinfolds were consistently thinner with age, on the trunk they were nearly constant or increased even after the age of peak weight velocity. (3) The age sequence of ST on the upper and lower extremity was dissimilar and, expressed as the percentage of skinfold total, it differed even on the same limb. (4) Also the age sequences on the trunk were different, both in the age distribution of their local peak velocities and in their extent of growth. (5) The specific differences observed in absolute and relative ST in the respective body regions ought to warn the researcher to take every skinfold "on its own" in dealing with the problem. To infer body composition from one or a few skinfolds seems unjustifiable. On the contrary, it is advisable to extend ST measurements to other skinfolds that until now were perhaps less often measured or were left unmeasured: in part because this might give a more balanced number of skinfolds in the respective body regions, and in part to gather a more detailed knowledge about the age trends of skinfold behaviour in every important body region.

Keywords: *Skinfold thickness; Regional differences; Physical activity; Child growth.*

Introduction

Regular exercise has a favourable effect on body composition in children and youth when compared to peer populations of average or lower activity (Davies et al. 1972, Meen and Oseid 1982, Tremblay et al. 1984, Bouchard et al. 1990, Mészáros 1990, Szabó et al. 1992, Pápai et al. 1994). While overweight or obesity as health risks are not uncommon in the child and adult populations (Bodzsár 2001, Becque et al. 1986, Rolland-Cachera et al. 1987), low body fat content has become an important factor of selection in sports (Glick and Kaufmann 1976, Wilmore 1983, Mohácsi et al. 1987, Bouchard et al. 1990, Mészáros 1990). A good number of reports support the argument that obese and overweight youngsters tend to become obese or overweight adults (Rolland-Cachera et al. 1987, Pavilonis and Tutkuviene 1989).

By the existing paradigms of health preservation regular physical activity can help maintaining body fat content within healthy limits even in subjects of good appetite (Szabó et al. 1992). So it seemed reasonable to assess the fat stores of children and adolescents engaged in regular physical exercise. Despite ongoing technical refinement the commonly used methods of fat content estimation meet renewed criticisms (Ross et al. 1984, Lukaski 1987, Rolland-Cachera et al. 1987, Marshall et al. 1991, Gasser et al. 1994), in part for their lack of accuracy, in part because of the difficulty of validation. Accordingly, we only relied on the relationship in which most experts agree, namely that skinfold thickness (ST) is proportionate to body fat content (Parížková 1961, Jaeger 1983, Wilmore 1983, Clarys et al. 1984, Ross et al. 1984, Bodzsár 1991, 1996 Marshall et al. 1991).

The point under study was therefore the manner in which subcutaneous fat tissue is related to age in a physically regularly active sample. Although depending on gender, children, adolescents and youth of average physical activity have been reported to deposit more and more subcutaneous fat during their school years (Parížková 1961, Jaeger 1983, Bodzsár and Pápai 1989, 1992, Bodzsár 1993, Pápai et al. 1994). By our working hypothesis we expected to find regionally different STs. This paper only reports on the regional ST of boys engaged in regular physical exercise.

Subjects and Methods

All the studied subjects (n=2661) were members of one section of sport events in the Central School of Sports (the immediate forerunner of the National Institute of Junior Sports). Their regular exercise implied 4 to 6 training sessions of 2–3 hr per week in addition to the week-end competitions. Measurements were taken in spring and autumn. Age was calculated in decimal years. The subjects were grouped by half-year intervals of age (with ± 0.25 yr. limits, i.e. 7.75 through 8.24 yr. old ones were the group of 8 years old). Table 1 gives their distribution by age.

We note that a fraction of the subjects contributed data several times to the data base so the sample was not purely cross-sectional, further that in the youngest and oldest groups of schoolchildren case numbers were low as events have specific lower boundaries of age, and one has to reckon with school-leavers too. Thus their data serve at most informative purposes.

Table 1. The age distribution of the subjects.

Age group (yr.) ± 0.25	Case number	Age group yr. ± 0.25	Case number	Age group (yr.) ± 0.25	Case number
6.5	11	11.0	93	15.5	145
7.0	24	11.5	130	16.0	124
7.5	34	12.0	124	16.5	101
8.0	38	12.5	197	17.0	83
8.5	38	13.0	229	17.5	73
9.0	44	13.5	253	18.0	50
9.5	50	14.0	259	18.5	17
10.0	62	14.5	213	19.0	19
10.5	76	15.0	172	Total	2661

The subjects were measured in minimum underwear on the right side of the body. Skinfolds over the biceps and triceps were measured at the recommended sites (Weiner and Lourie 1969), the forearm fold was lifted laterally and perpendicularly to the largest girth. ST over the relaxed middle of the thigh was measured in the axis of the segment frontally, knee slightly bent with heel placed on a low stool. Calf ST was measured in the same position medially perpendicularly to the largest girth. On the trunk subscapular and suprailiac STs were measured in the natural cleavage oblique of the skin. The umbilical fold was lifted vertically. All STs were recorded to the nearest half mm using a Lange caliper of 10 g/mm^2 constant spring pressure. Relative STs were expressed as percentages of the sum of eight skinfolds.

Body mass was measured to the nearest 50 g, stature to the nearest mm. Mass fractions of muscle, bone, fat and residual tissue were estimated by using the Drinkwater-Ross formulas (1980) inclusive of height correction and expressed in kg.

"Growth velocity" was interpreted as the simple differences of the means between the half-year age-groups, i.e. they were not recalculated into full-year differences. The diagrams show the standard errors of the means; no specific tests for significance were done.

Results and Discussion

The left diagram of Figure 1 shows the age dependence of body mass and its mass fractions. As in a number of other fields, the fractionation of body mass has been developed for adults and validated by autopsy material (Drinkwater and Ross 1980, Clarys et al. 1984). So far as we know, it has only been put to extensive use in the Central School of Sports, Budapest, and at the Faculty of Sport Sciences, Semmelweis University, Budapest. So for the time being one cannot compare results. Non-invasive techniques are expected to show sooner or later whether and how acceptably the fractionation procedure can reflect true body composition. The method is dimensionally correct and takes account of individual stature. One strong argument for it is that there are no other simple and cheap methods of estimating body components that could be regarded as similarly or more reliable.

As shown in the diagram, the largest fraction was muscle and the smallest one was fat. The share of the parenchymal tissues, i.e. of the residual fraction was larger than that of bone. The variability of bone mass was the smallest while muscle mass changed the most.

Significant correlation was only demonstrable between residual and muscle mass fraction means, their dispersion differed to some extent from the normal as did that of total body mass.

The right diagram of Figure 1 demonstrates the differences between the successive half years of age as estimates of the rate of change. The same principle applies to all subsequent data. These differences are illustrative not merely of seasonal factors (Butler et al. 1990). All fractions except bone reached their top rate of change between age 14 and 15. The fastest rate of bone was seen around 12.5 years of age. Negative "velocities" in the age extremes may be attributed to small sample sizes. In the age groups of acceptable sample size slightly negative rates were seen in the fractions of fat and bone. The fractional and total mass diagrams serve an easier interpretation of skinfold thicknesses.

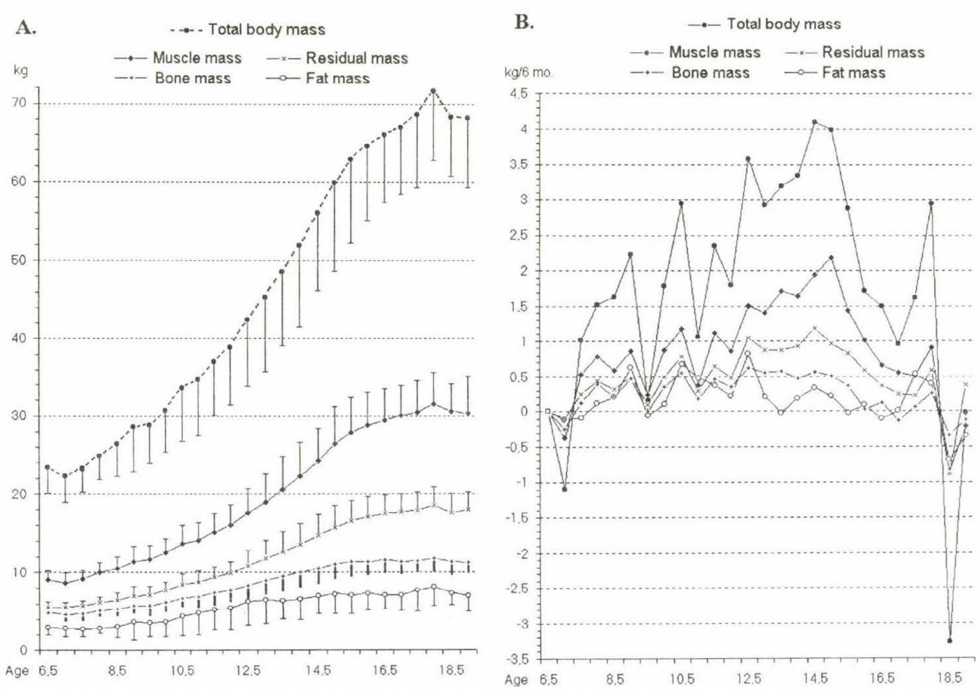

Figure 1: A. Means and sd's of total and fractional masses (Drinkwater and Ross 1984).
B. Half-yearly differences between the respective age groups.

Skinfold thicknesses are presented by body regions. Absolute skinfolds and relative ones expressed as percentages of the sum of all skinfolds are shown consecutively.

Figure 2 shows the absolute means and standard errors of the means, respectively the half-year differences on the upper limb. The age dependent courses (Figure 2A) were very similar, i.e. sites differed mainly quantitatively. The triceps skinfold thickness was the largest, that above the biceps was the smallest while the forearm skinfold that so far as we know had not been measured in recent studies took an in-between magnitude. There were simultaneous local peaks and troughs in all the three skinfolds at 9.0 and 9.5, then at 11.0

and 11.5 yrs of age. All the three of them were thickest at the age of 12.5 after which age they were smaller to show another local peak after the age of 16 to 17 years.

Local maximums and minimums are more conspicuous in Figure 2B. As demonstrated by the zero line, one should not assume that fat losses do not occur during general growth, seasonal oscillations can be present even in cross-sectional samples.

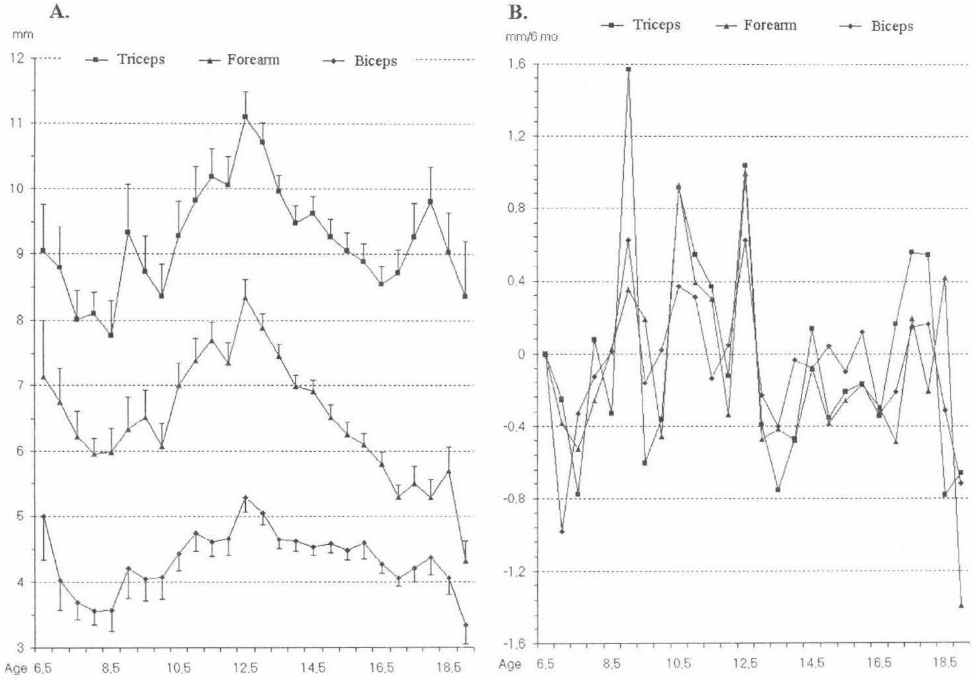

Figure 2: A. Absolute skinfold means and SE's on the upper limb.
B. Half-year differences between the respective age-groups.

Figure 3 shows skinfold thicknesses on the upper limb as percentages of the sum of the measured skinfolds. These relative thicknesses (Figure 3A) were much more homogeneous than the absolute ones. Except for the biceps skinfold for which this was less conspicuous, the relative thickness of the other two became gradually less with age, in particular in the case of the forearm skinfold. As clearly shown by the employed measure of variability, even subsequent half-year age groups differed mostly significantly for the latter. The two other skinfolds showed stepwise thinning. On the upper limb therefore skinfolds tend to become smaller during schoolage, in addition to local maxima. The difference curves (Figure 3B) demonstrate that oscillations usually did not exceed one per cent.

Since only two skinfolds were measured on the lower limb, Figure 4A shows the absolute and relative changes with age together. The age-dependent course was somewhat similar to that observed on the upper limb. The main dissimilarity was that absolute thicknesses had considerably broader local and overall maxima. While the timing of the changes mostly agreed with the upper limb, the pattern extended over a larger period of age.

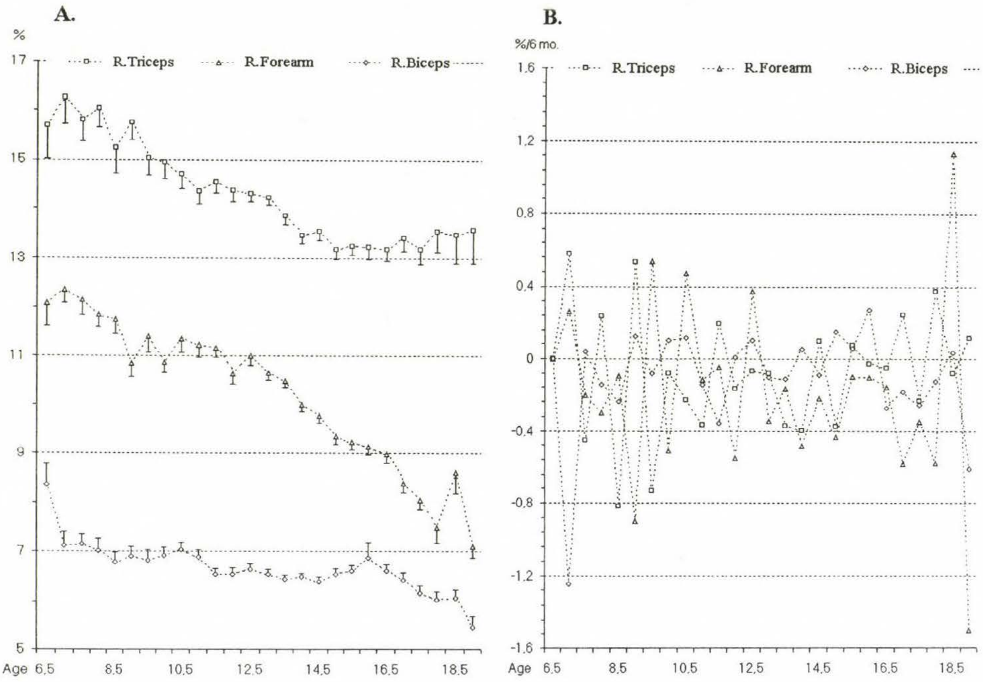

Figure 3: A. Relative skinfold means and SE's expressed in percentages of the sum of all skinfolds on the upper limb. B. half-yearly differences between the respective age groups.

Of the relative thicknesses the calf skinfold only resembled the gradual thinning of the upper limb skinfolds. The front thigh skinfold was larger and larger until 12.5 years and began to decrease only after that age. As the thigh skinfold was the thickest in all studied ages both absolutely and relatively, it obviously had a considerable impact on all other relative measures.

Both absolute and relative thickness differences (Figure 4B) showed synchronization. Negative differences were the main trend after the age of peak weight velocity. Another observation common to the two skinfolds was that on the threshold of adult age the last positive peak of the relative thickness followed the same of the absolute skinfolds with a lag.

The absolute and relative skinfolds of the trunk are again presented separately. The main difference between the absolute thickness of the trunk and limb skinfolds (Figure 5A) was that except for smaller local oscillations the former became gradually thicker along the ages, i.e. even after the age of peak weight velocity. Significant decrease was only observed after age 18 if one dared to draw any inference from these small samples.

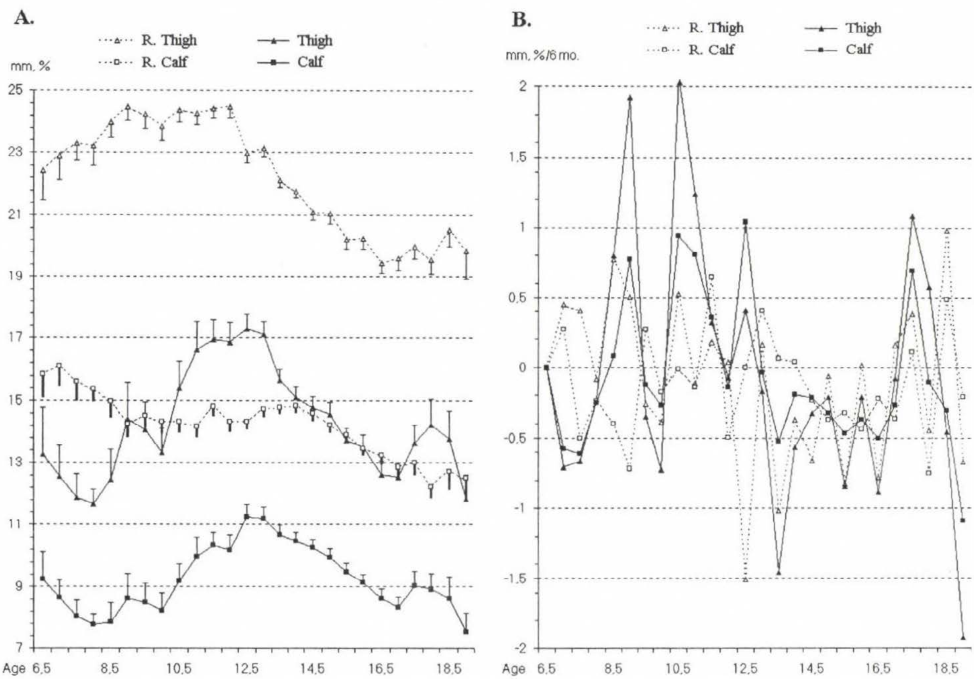

Figure 4: A. Absolute and relative skinfold means and SE's on the lower limb.
B. Half-year differences between the respective age-groups.

On the other hand, trunk skinfolds resembled those on the limbs in that local extremes coincided as expected. The difference curves (Figure 5B) show that negative values did not exceed 1 mm. Local maxima were, however, far from synchronous so skinfolds on the upper and lower half of the trunk may have different timing.

When expressed as percentages of the sum of the skinfolds, those on the trunk (Figure 6A) behaved in a somewhat more homogeneous manner than on the limbs, their variability was smaller. Attributably above all to their thickness, the individual pattern of the three skinfolds was not quite similar. The umbilical skinfold grew almost unbroken. The thickness of the subscapular began to increase steeply after the age of peak weight velocity while the skinfold over the iliac spine hardly changes after the age of 15. This dissimilar behaviour was also supported by the observation that difference peaks were almost independent of one another (Figure 6B).

At this point the question of the so-called negative fat wave is worth mentioning. The fat loss that has been regarded as characteristic of boys just beginning their growth spurt (Holliday 1978) is by no means common to all samples. Although longitudinal samples might support this phenomenon obviously better, even there they might be missing (Bodzsár and Pápai 1992).

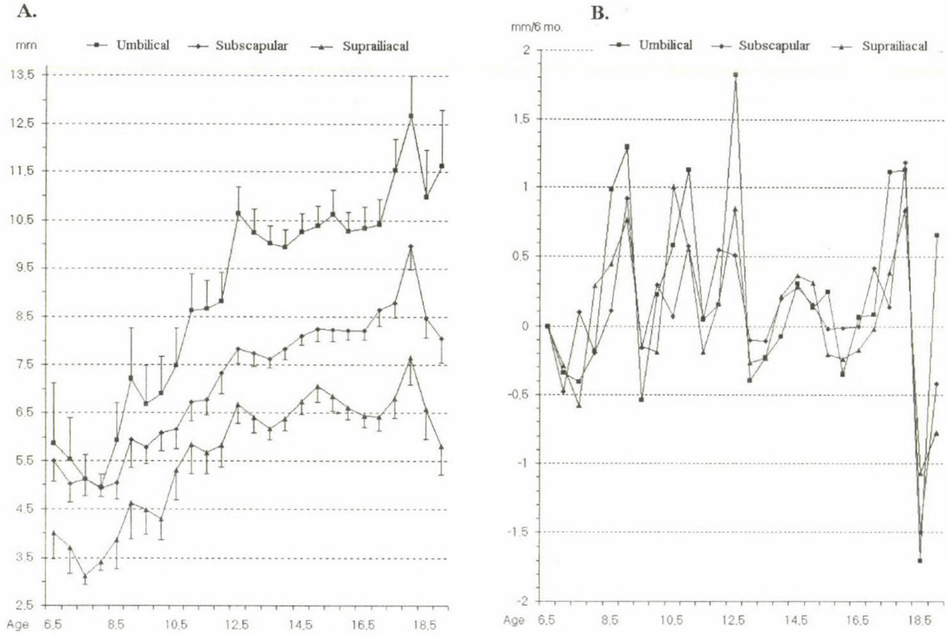

Figure 5: A. Absolute skinfold means and SE's on the trunk.
B. Half-year differences between the respective age-groups.

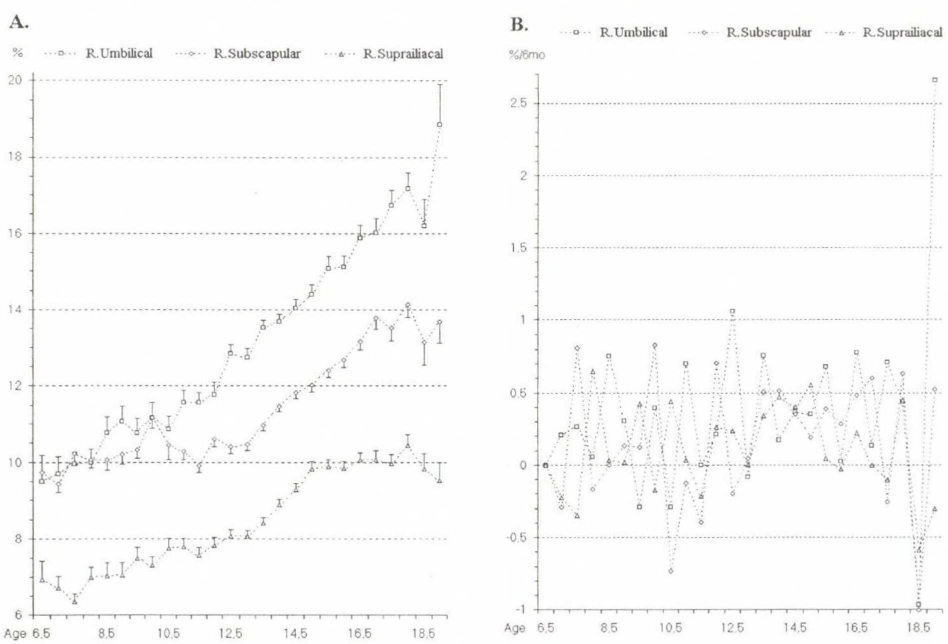

Figure 6: A. Relative skinfold means and SE's expressed in % of the sum of all measured skinfolds on the upper limb. B. Half-year differences between the respective age-groups.

Conclusions

In this sample consisting of boys pursuing competitive sports and thus exceeding the physical activity of the average peer population markedly both in intensity, volume and regularity

- the age changes in regional skinfold thickness were similar in only some features (age coincidence of the peaks of the estimated growth velocity, similar trends in the upper and lower limbs)
- there were definite differences between the skinfolds of the limbs and the trunk: on the trunk – gradually nearing the trunk-oriented pattern of subcutaneous fat distribution of adult males – skinfold thicknesses did not decrease after the peak weight velocity, instead they either levelled off or they grew while on the limbs they became consistently slimmer.
- pattern differences were also noted not merely between the upper and lower limbs but even within a limb in respect of the relative thickness of skinfolds
- also trunk skinfolds differed in behaviour: in part in the age variability of their local peaks and troughs, in part in the magnitude of their increase.

The peculiarities observed in the age course of the absolute and relative skinfold thicknesses in our material may stimulate those interested to handle every skinfold "in its own right". It seems hardly justifiable to draw an inference on body composition by one or a few skinfolds. Obversely, it would be wise to extend the measurements to such skinfolds that are not among the usually measured ones, in part for a better balance of skinfold distribution, in part for gaining a better overview on all important body regions.

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