TOPICAL DISTRIBUTION OF THE SUBCUTANEOUS FAT TISSUE ON SOME PARTS AND REGIONS OF THE BODY IN CHILDREN AND ADOLESCENTS FROM SOUTH BULGARIA

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ABSTRACT
The purpose of this paper is to assess, in intersexual and interage aspects, the topical distribution of SFT on the various body parts and areas of children and adolescents from different territorial regions of southern Bulgaria. We transversally examined 1491 children and adolescents aged 10 to 17 years (753 girls and 738 boys) from schools in the municipalities of Plovdiv, Pazardjik, Haskovo, Svilengrad. The subjects were divided into 8 one-year age groups. We measured calliper metrically the thicknesses of 9 SF on the body and limbs. The topical SFT distribution on different body parts and areas was estimated basing on the following ratios: Ratio of SFT - torso/limbs of 4 SF; Ratio of SFT - torso/limbs of 6 SF; Ratio of SFT - upper/lower torso - 4 SF; Two Ratio of SFT - upper /lower limbs: (1) and (2). The results show that in students from both genders, the processes of redistribution of SFT on the upper and lower parts of the body are most intensive in the period 15-16 years. In boys there is a tendency towards an increase of the SFT on the upper torso - chest, while in girls – on the lower part the abdomen. Throughout the period 10-17 years, in both genders, the thickness of SFT is higher on the lower limbs in comparison with the upper limbs.

Keywords: skin folds, ratios, age, gender, children, adolescents

Introduction
It is known that the thickness of skin folds (SF) is one of the variable anthropometric signs during the individual human development. This is associated with the high eco-sensitivity of subcutaneous fat tissue (SFT) and the strong influence of various factors on it – regimens of diet and motional and health statuses (3, 4). Studying the quantity and the topical distribution of SFT has an essential role in clarifying the body composition and body type obesity in different age periods. It is particularly important during the childhood and adolescence to monitor the processes of growth, sexual maturation and the motional physical activity of adolescents from different populations (6). Identifying the changes in the development of SFT and its distribution during the puberty provides an opportunity for prevention and early diagnosis of obesity and other socially significant diseases. According to some leading experts (1, 2, 5), we can obtain a summary characteristics of the topical distribution of SFT by using different ratios between the thickness of measured skin folds – the so-called SFT ratio of trunk/limbs, ratio of SFT on upper/lower torso, the ratio of SFT on upper/lower limbs. The data obtained from these ratios provide a comprehensive picture of the peculiarities of the topography and the distribution of SFT in separate areas of the body. Results can sufficiently precisely and specifically objectify the consequential biological processes of redistribution of SFT in the period of intense morphological development.

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Materials and Methods
We transversally examined 1491 children and adolescents...
aged 10 to 17 years (753 girls and 738 boys) from schools in the municipalities of Plovdiv, Pazardjik, Haskovo, Svilengrad. The subjects were divided into 8 one-year age groups. We measured calliper-metrically the thicknesses of 9 SF on the body and limbs (SF subscapular, SF-biceps, SF - triceps, SF-forearm, SF-X rib, SF-abdomen, SF-suprailiac, SF-thigh, and SF-calf). The topical SFT distribution on different body parts and areas was estimated basing on the following ratios:

- Ratio of SFT – torso/limbs of 4 SF:
  - (SF subscapular + SF suprailiac)/ (SF triceps + SF biceps)

- Ratio of SFT – torso/limbs of 6 SF:
  - (SF subscapular + SF suprailiac + SF abdomen)/ (SF triceps + SF biceps + SF forearm)

- Ratio of SFT - upper/lower torso – 4 SF:
  - (SF subscapular + SF of X rib)/ (SF suprailiac + SF abdomen)

Ratio of SFT – upper / lower limbs:

1. (SF triceps + SF biceps)/ (SF thigh + SF calf)
2. (SF triceps + SF forearm) / (SF thigh + SF calf)

Data were analyzed with SPSS statistical package. The reliability of the intersexual and interage differences was verified by the criterion of t-Student at the level of significance P < 0.05.

Results and Discussion

- Ratio of SFT - torso/limbs of 4 SF:
  According to Rolland-Cachera et al. (5), a summary characteristics of the topical distribution of SFT may be obtained on the basis of the data from 4 SF through using the ratio between the sum of the thicknesses of the 2 SF torso (SF subscapular + SF suprailiac) and respectively on 2 SF of the upper limbs (SF triceps + SF biceps).

  The results from the assessment of this ratio in the examined children and adolescents can be seen in Fig. 1.
  At the age of 10, the ratios in both genders have different values. In boys it is below 1.0 mm / mm (0.94 mm / mm), and this indicates a greater accumulation of SFT on the limbs compared to the torso – a characteristic of the childhood (5). In girls, the value of the ratio is 1.00 mm / mm, which means that the SFT is equal on the torso and limbs.

  At the age of 11 in boys, the ratio increases to 1.02 mm/mm and reaches that of girls’ (1.02 mm / mm) - i.e. between both genders there are no reliable differences in the distribution of SFT in the torso and limbs (p> 0.05). This trend is retained during the puberty period (12-13 years). The differences occurred at the age of 14, when in boys began progressive accumulation of SFT in the torso and its decrease on limbs. This is objectified with the increase of the ratio in them, which reaches the highest value at the age of 16 (1.31 mm / mm). In 14-year-old girls, although the ratio is higher than 1.0 mm / mm (1.09 mm / mm), its value is significantly lower than that of boys’ (p <0.05). At the age of 15, boys and girls again have close values of the ratio torso/limbs – 4 SF (p> 0.05), but after that age the differences between them increase, and in the period 16-17 years boys have already sustained a reliably thicker layer of SFT on the torso towards the SFT on limbs, compared to girls (p <0.05).

![Graph showing ratio of SFT - torso/limbs of 4 SF](image)

- Ratio of SFT - torso / limbs of 6 SF:
  According to Malina (1), a more comprehensive picture of the peculiarities in the distribution of SFT in the body can be obtained basing on the data from 6 SF, using the ratio in the sum of the thicknesses of 3 SF on the trunk (SF subscapular + SF suprailiac + SF abdomen) and respectively 3 SF on limbs (SF triceps + SF biceps + SF forearm). The results from the assessment of this ratio for 10-17-year-old children and adolescents can be seen in Fig. 2.

  The age changes of this ratio are generally similar to those of the ratio torso/limbs-4SF, but there are some differences. At the age of 10, the value of the ratio trunk / limbs - 6 SF in boys was 1.01 mm / mm, it follows from this
that the equalization of the thickness of the SFT on the torso and limbs occur in them as early as the age of 10, i.e. one year earlier, compared with the data obtained from the ratio trunk/limbs 4SF.

Almost throughout the growth period (10-16 years) there was a gradual increase in subcutaneous fats on the torso as compared to limbs, but reliable differences between both genders were not found. In girls, the highest accumulation was at the age of 15 (1.22 mm / mm), then it declined. In boys, the highest accumulation was at the age of 16 (1.26 mm / mm), and then tends to detainment. Statistically significant differences in the ratio torso / limbs - 6 SF were recorded only at the end of the investigated period – at the age of 17 (p <0.05), when boys have reliably thicker layer of SFT on the torso as compared to girls.

The bigger number of the reliable intersexual differences that we found throughout the investigated age period in the ratio trunk / limbs - 4SF gives us grounds to assume that this ratio evaluates more sensitively and objectively the biological processes of redistribution of SFT on the body and limbs of children and adolescents during their intensive morphological growth, compared with the ratio trunk / limbs - 6SF.

- **Ratio of SFT - upper / lower torso - 4SF:**
  Age-sex peculiarities in the distribution of SFT on the upper and lower torso in the examined children and adolescents were defined through the ratio of the sum of 2 SF on the chest (SF subcapular + SF X rib) and the sum of 2 SF on the abdomen (SF suprailiac + SF abdomen) by Malina (1). The results from the evaluation of this ratio can be seen in Fig.3.

  [Fig. 2. Ratio of SFT – torso/limbs of 6 SF]

  [Fig. 3. Ratio of SFT - upper/lower torso – 4 SF]

  It is notable that the age curves are located below the line of the level of 1.0 mm / mm, which means that in students of both genders there is a proportionally thicker layer of SFT on the abdomen, towards that on the chest.

  In girls, the values of this ratio, though uneven and fluctuating, stayed the same at one level throughout the growth period, except for the age between 15-16 years, when the ratio tended to decrease slightly. This is the period during which girls have the highest accumulation of fat in the lower torso and especially on the abdomen.

  In boys, with the exception at the initial period of study (10-year-olds), the values of the ratio upper / lower torso-4SF are higher than those of girls'. This means that they have relatively more SFT on the upper part against the lower part of the torso as compared to girls. After the age of 14 years, the ratio in boys starts to grow, as at the age of 16 it reaches the highest value of 0.97 mm / mm. This result shows that in boys the processes of redistribution of SFT in the body are the most intensive in the period between 14-17 years of age. At this age there is a tendency to an increase in the SFT on the chest and its reducing on the abdomen.

- **Ratio of SFT - upper / lower limbs:**
  The peculiarities in the distribution of SFT on the upper and
lower limbs associated with the age and gender of the investigated 10-17-year-old children and adolescents were identified through two different ratios by Malina (1). 

(SF triceps + SF biceps) / (SF thigh + SF calf) (1).  
(SF triceps + SF forearm) / (SF thigh + SF calf) (2).  

The data obtained from the two applied ratios are illustrated in Fig. 4 and Fig. 5.

The results show that the changes with the age advancing of the ratio (1) and ratio (2) are almost identical. In both genders, the values of both ratios are below 1 mm / mm, which shows a higher thickness of SFT in the lower limbs compared to the SFT on the upper limbs throughout the period of 10-17 years. Reliable intersexual differences in the distribution of SFT on limbs according to both ratios can be observed only in the first half of the investigated period. Boys at the age of 11 have a relatively greater amount of SFT on the upper limbs compared to the lower limbs, while girls - at the age of 13. In the second half of the period 14-17 years, the distribution of SFT on the upper and lower limbs in boys and girls is similar.

The obtained very similar results from the ratio (1) and ratio (2) give us reason to believe that both ratios sufficiently accurately and objectively evaluate the topical distribution of SFT on the upper and lower limbs in the 10-17-year-old children and adolescents.

**Conclusions**

By the age of 13 the distribution of SFT on trunk and limbs is in the same amount in boys and girls. In the second half of the survey, in boys, a distinct redistribution of SFT occurs, as in them a thick layer of SFT is formed on the torso, towards the SFT on limbs, compared to girls. In students from both genders, the processes of redistribution of SFT on the upper and lower parts of the body are most intensive in the period 15-16 years. In boys there is a tendency towards an increase of the SFT on the upper torso - chest, while in girls – on the lower part – the abdomen. Throughout the period 10-17 years, in both genders, the thickness of SFT is higher on the lower limbs in comparison with the upper limbs.

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