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# Physical Development and Body Nutritional Status of Schoolchildren from Sofia (Bulgaria) — Preliminary Data

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In the present study anthropometric data about stature, body weight body mass index (BMI) and per cent body fat (%BF) of 215 boys and 176 girls from three age groups are analyzed. An evaluation of the physical development and the body nutritional status of schoolchildren from Sofia at pre-pubertal age — 9, 10 years and active puberty age — 14 years are presented. Most significant intersexual differences concerning stature and body weight measurements are found only among the 14 years old schoolchildren, as both values are higher in boys. With the age increment (between 9 and 14 years), a clear tendency to decrease of the relative number of girls with overweight status and obesity are observed. At the same time, analyzing the intersexual differences is established that the 9-, 10- and 14-years-old girls have higher % BF than boys do. The t-criteria test and Piersons' coefficient about correlation show that our sample is sufficient and allows valid conclusions to be drawn.

*Key words:* pre-puberty and active puberty ages, physical development, body mass index, per cent body fat.

## Introduction

The study of the specificity of schoolchildren physical development during the different stages of their development is of great importance, both for their health control and for the prevention of various socially important diseases. It is well known that during the pre-puberty and puberty age rapid and serious changes take place in the growing up organism, which mark the future directions of the physical development of the adult individual. During this period of dynamic processes of growth and development very often hormonally based preconditions for the accumulation of larger amount of fat tissue are marked. This is a prognostic indicator for obesity at a mature age.

The aim of the present study was to evaluate the physical development and the nutritional status of schoolchildren from Sofia at pre-pubertal age — 9, 10 years and at an active puberty age — 14 years.

## Material and Methods

The anthropometric data of schoolchildren from three schools in Sofia (Public schools Nos 7, 68 and 112) are taken during March-December 2001. 215 boys and 176 girls from three age groups are examined: 9 years old (77 boys and 60 girls), 10 years old (66 boys and 54 girls), 14 years old, (72 boys and 62 girls). Stature, body weight and thickness of triceps and calf skinfolds are measured for each individual. The anthropometrics is carried out by the first author according to the classical method of M a r t i n, S a l l e r [2] with standard anthropometric instruments — anthropometer; body fat monitor "Tanita", model TBF 612; and Holtain caliper. The data of skinfolds thickness are taken to calculate the per cent of body fat (% BF) with the regression equation of S l a u g h t e r et al. [3]:

$\%BF_{(boys)} = 0.735 \times (\text{triceps} + \text{calf skinfolds}) + 1.0$

$\%BF_{(girls)} = 0.610 \times (\text{triceps} + \text{calf skin fold}) + 5.1.$

The body mass index (BMI) is calculated by the formula: weight (kg)/height $(m)^2$ [1, 4] and the data are used as an indicator of the type of body nutritional status. The intersexual differences are evaluated based on the absolute differences, as well as on the data of the Index of intersexual differences (ISD), which is calculated by the formula:

$ISD = X_{(girls)} \times 100/X_{(boys)}$, where X is the mean value of the corresponding feature [6].

The metric data are statistically processed with STATISTIX (version 4.0, Analytical software 92). The inter-group differences are evaluated by ANOVA—test and t-criteria at $p<0.05$.

The mean values of stature and body weight of the 14 years old boys and girls are compared with those of grown up men and women from Sofia, received by the National anthropological investigation of the Bulgarian Academy of Sciences, carried out in 1989-1992 [5].

BMI data are used to determine the type of body nutritional status based on the cut off point values, which are specific for each sex and age group as recommended by the World Health Organization (WHO)[1]. In the publication cited, for the distinction of healthy nutritional status, overweight and obesity in children and adolescents are used cut off point values of BMI derived by passing through BMI of 25 $kg/m^2$ and 30 $kg/m^2$ accepted from the WHO as cut off point values in adults. Since the mean age of the investigated by us boys and girls is about 9.5, 10.5 and 14.5 years, we use the corresponding BMI reference values for these age groups, which are presented in Table 1.

In order to check whether the size of our sample allows making valid conclusions, we compare our data with that published in Bulgaria [6] and WHO [1]. For the purpose the t-criteria and the Piersons' coefficient for correlation are used. The correlation analysis is done with the above-mentioned version of STATISTIX.

T a b l e 1. International cut off points of BMI for determination of nutritional status (after literature data [1])

| Age (years) | Adult's BMI 25 | | Adult's BMI 30 | |
|---|---|---|---|---|
| | Boys | Girls | Boys | Girls |
| 9.5 | 19.50 | 19.50 | 23.40 | 23.50 |
| 10.5 | 20.20 | 20.30 | 24.60 | 24.80 |
| 14.5 | 23.00 | 23.70 | 28.00 | 28.90 |

Table 2. Basic metrical data of investigated features

| Age (years) | n | Stature (cm) | | | | Weight (kg) | | | | BMI | | | | % body fat | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | SD | min | max | X | SD | min | max | X | SD | min | max | X | SD | min | max |
| **Boys** | | | | | | | | | | | | | | | | | |
| 9 | 77 | 137.52 | 5.81 | 127.5 | 154.2 | 33.18 | 7.03 | 23.8 | 58.2 | 17.42 | 2.63 | 13.58 | 26.11 | 17.84 | 7.99 | 7.17 | 45.1 |
| 10 | 66 | 142.04 | 6.54 | 130.00 | 157.5 | 34.59 | 6.74 | 24.0 | 53.4 | 17.05 | 2.53 | 13.13 | 26.3 | 17.38 | 7.03 | 8.64 | 37.31 |
| 14 | 72 | 168.82 | 7.45 | 138.70 | 185.0 | 57.37 | 11.2 | 33.2 | 89.6 | 20.05 | 3.35 | 13.34 | 31.0 | 18.98 | 8.24 | 8.79 | 45.98 |
| **Girls** | | | | | | | | | | | | | | | | | |
| 9 | 60 | 137.59 | 7.46 | 119.1 | 153.0 | 32.81 | 8.2 | 21.2 | 55.8 | 17.15 | 3.12 | 13.00 | 25.61 | 21.59 | 7.78 | 12.05 | 41.21 |
| 10 | 54 | 142.39 | 7.09 | 128.2 | 166.0 | 36.15 | 7.53 | 22.8 | 52.2 | 17.68 | 2.62 | 13.41 | 24.77 | 22.24 | 6.24 | 12.05 | 37.8 |
| 14 | 62 | 160.82 | 6.04 | 146.4 | 178.0 | 51.55 | 9.01 | 38.2 | 78.2 | 19.93 | 3.33 | 13.53 | 30.85 | 25.06 | 7.37 | 13.64 | 48.53 |

Table 3. Intersexual differences according to the data from ISD (%)

| Age (years) | For Stature | For Weight | For BMI | For Body fat |
|---|---|---|---|---|
| 9 | 100.05 | 98.88 | 98.45 | 121.02 |
| 10 | 100.25 | 104.51 | 103.70 | 127.96 |
| 14 | 95.26 | 89.36 | 99.40 | 132.03 |

## Results and Discussion

The basic statistical characteristics of stature, body weight, BMI and %BF are presented in Table 2. The data of the features studied for the six ages and sex groups are compared in order to find statistically significant differences (Fig. 1-4). The specific intersexual differences of the four features are illustrated by a diagram in Fig. 5, which is made on the base of data from the ISD index (Table 3).

### Stature

Our investigation shows that the 9 years old boys (137.52 cm) and the girls (137.59 cm) have comparatively equal stature. The same tendency is observed for the 10 years old boys (142.04 cm) and girls (142.39 cm). In these age groups, the girls are higher than boys with only some hundredths of the cm, but the 14 years old boys are significantly higher (8 cm) than girls. The ANOVA test for determination of inter-group differences at a level of significance $p<0.05$ distinguish 4 similar stature groups. The first is of the 9 years old boys and girls, the second — of the 10 years old boys and girls, the third one of the 14 years old boys and the last one of the 14 years old girls (Fig. 1). This means that there are statistically significant inter-age differences among the three age groups but the intersexual differences are statistically significant only between the boys and the girls at the age of 14.

It is noteworthy that the 14 years old girls have already reached 99.89% of the stature in adult women from Sofia, respectively 160.82 cm/161.0 cm. The boys of the same age have reached 97.58 % of the mean stature in adult men from Sofia, respectively 168.82 cm/173.0 cm — i.e. the boys have to grow another 4.18 cm.

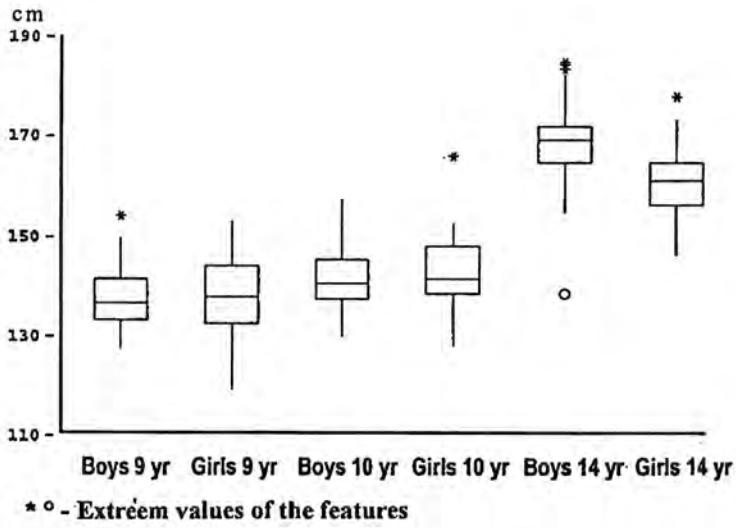


Fig. 1. Plot of Stature for different age and sex groups

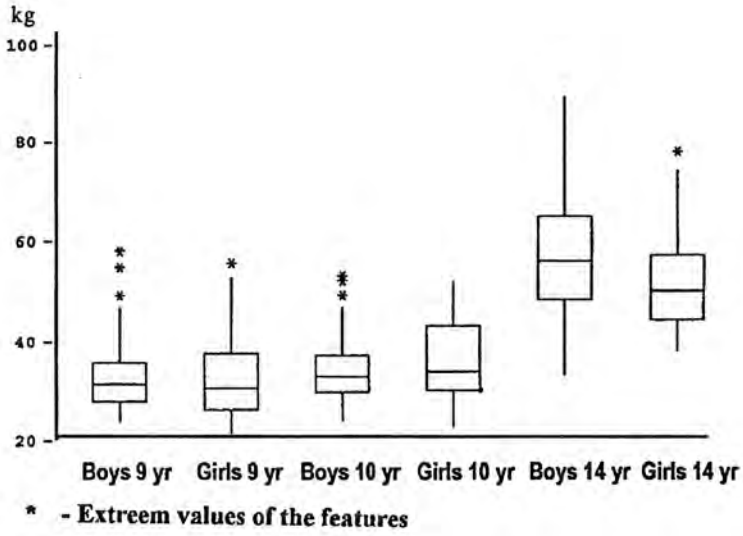


Fig. 2. Plot of Body Weight for different age and sex groups

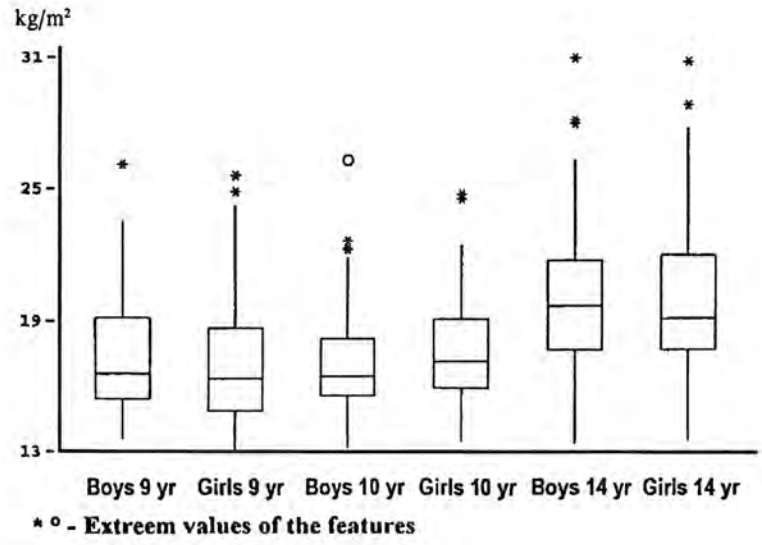


Fig. 3. Plot of BMI for different age and sex groups

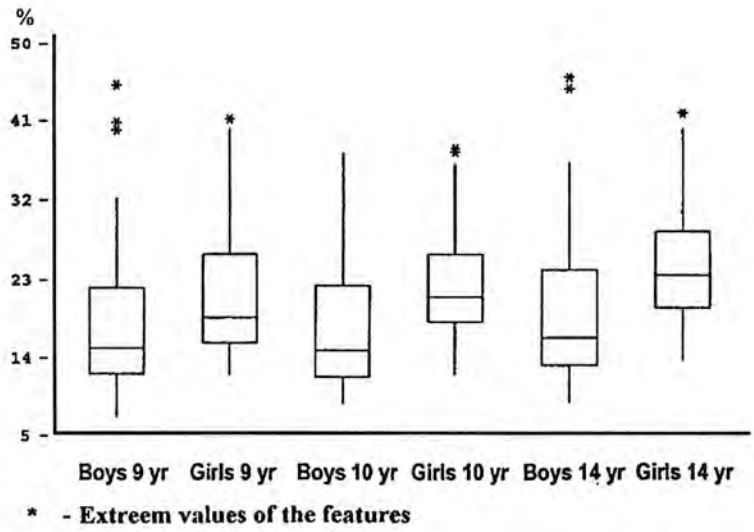


Fig. 4. Plot of Body Fat for different age and sex groups

## Body weight

The intersexual differences concerning the body weight (Fig. 2) are similar to those for the stature. The comparative analysis of the absolute values for body weight in both sexes of the 9 and 10 years old schoolchildren show that the 9 years old boys (33.18 kg) are heavier than the 9 years old girls (32.81 kg) (without statistical significance), and the opposite is observed in the 10 years old schoolchildren — the boys are lighter (34.59 kg) than the girls (36.15 kg). The ANOVA test from the six ages and sex groups forms three similar weight groups. The first one is that of the 9 and 10 years old boys and girls. The second group and the third one are presented separately by 14 years old boys and 14 years old girls. This indicated that at the active age of puberty — 14 years, boys are not only taller but also heavier than girls with 5.82 kg. Although at 14 year of age the girls have a smaller body weight than boys, at this age they reach a higher per cent (78.86%) of the mean body weight of the adult women in Sofia (65.37 kg). In comparison the boys from the same age group reach about 72.65 % of the mean body weight of the adult men in Sofia (78.97 kg).

The mean values of stature and body weight of the 9, 10 and 14 years old schoolchildren in the present investigation are identical with those of the cited representative longitudinal investigation in Sofia carried out from 1993 to 2000 [6].

## Body nutritional status

One of the purposes of the present investigation is to determine the per cent of the schoolchildren with healthy nutritional status, overweight and obesity.

The most frequent way to determine the body nutritional status in epidemiological investigations is to use the data of BMI. Despite the fact that it is often discussed whether it is the most suitable, still there is no other universal and easily applicable criteria for determination of the body nutritional status. We also use the BMI values as an indicator for body nutritional status based on the reference values recommended by WHO [1].

The ANOVA test applied to the six different age and sex groups for the BMI values distinguish only two similar groups of body nutritional status. The first one includes the 9 and 10 years old boys and girls and the second one — the 14 years old boys and girls in which the values of BMI are highest (20.05 for the boys and 19.93 for the girls) (Fig. 3). The data are presented in Table 4 and Fig. 6. The analysis of the data about schoolchildren percentage distribution toward the three types of body nutritional status shows that the individuals with healthy nutritional status dominate in both sexes and all age's groups (76.67 %-87.10 % for the boys and 79.22 %-86.36 % for the girls). In the group with overweight status the per cent of 9 years old boys and

Table 4. Body nutritional status — percentage distribution of schoolchildren according to the data BMI

| Age (years) | Boys | | | | | | | Girls | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Normal | | Overweight | | Obesity | | Total | Normal | | Overweight | | Obesity | |
| | n | n | % | n | % | n | % | n | n | % | n | % | n | % |
| 9 | 77 | 63 | 81.82 | 12 | 15.59 | 2 | 2.60 | 60 | 46 | 76.67 | 10 | 16.67 | 4 | 6.66 |
| 10 | 66 | 57 | 86.36 | 8 | 12.12 | 1 | 1.52 | 54 | 43 | 79.63 | 10 | 18.52 | 1 | 1.85 |
| 14 | 72 | 59 | 81.94 | 11 | 15.28 | 2 | 2.78 | 62 | 56 | 90.32 | 5 | 8.07 | 1 | 1.61 |

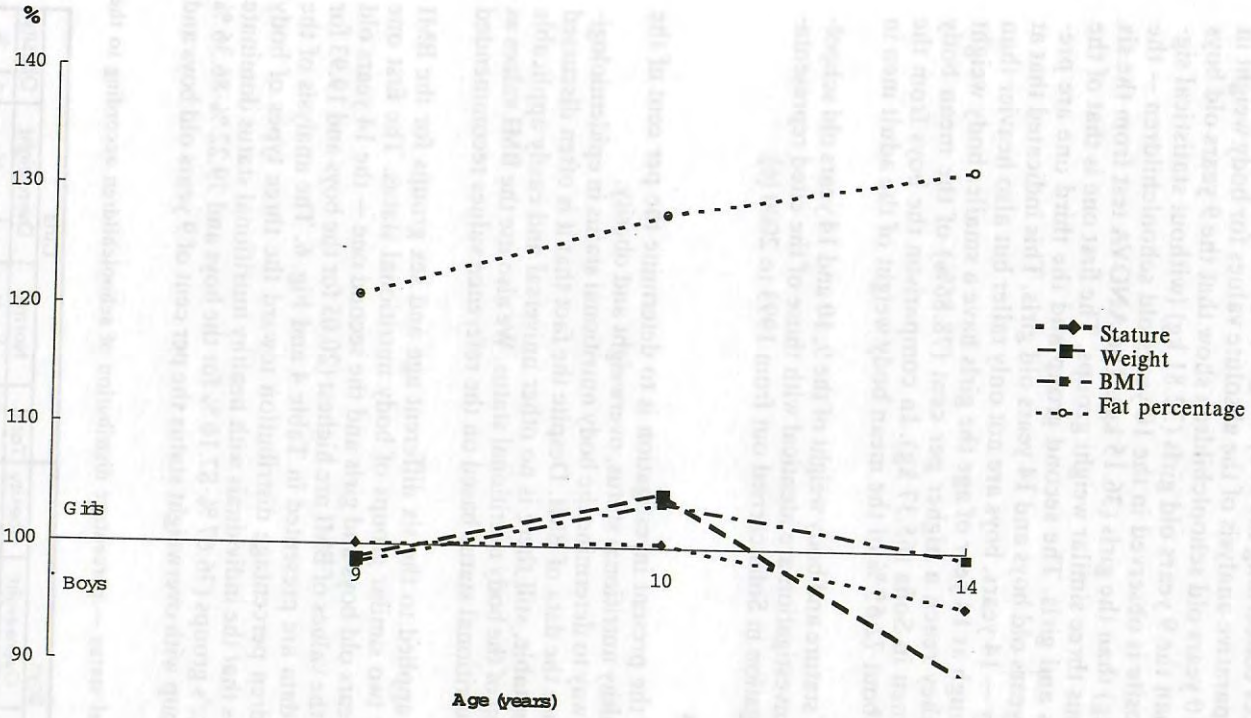


Fig. 5. Intersexual differences according to the data from ISD

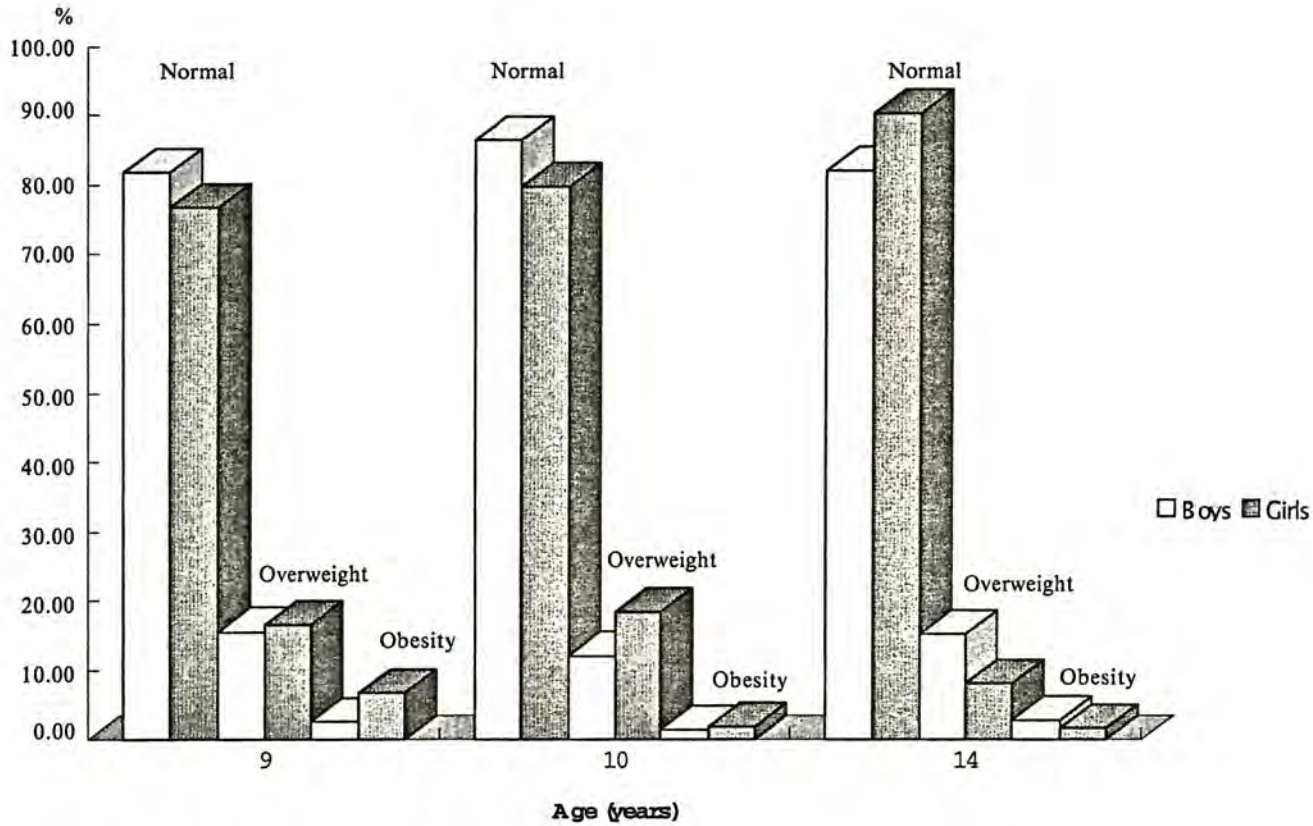


Fig. 6. Body nutritional status — perecentage distribution of schoolchildren according to the data of BMI

girls is equal — approximately about 16 %. At 10 years of age, the per cent of the overweighed boys diminishes to 12.12 %, while the per cent in girls remains unchanged (16.67%). The per cent of the overweight 14 years old girls drastically falls down (9.68%), while in the 14 years old boys it is still relatively high — 13.89%, which is typical of the pre-puberty age.

Moving from the pre-puberty ages (9-10 years) to the active puberty age (14 years), a clear tendency for declining of the per cent of girls with overweight and obesity is observed (Table 4). The same tendency has been observed in a longitudinal investigation of 10-14 year old girls in Slovenia [4].

The correlation analysis shows that the cut off point values for BMI (at 85$^{th}$ and 95$^{th}$ cantle) calculated from the data of our sample almost coincide with the reference values of the international cut off point values accepted from WHO [1]. In this case the coefficient of correlation of Pierson is 0.9964 for the girls and 0.9934 for the boys (the mean value for the whole sample is 0.9952), which proves that our sample is sufficient and allows valid conclusions to be drawn.

**Body fat**

The per cent of the body fat of the boys and girls from the different age groups are calculated by using the regression equations of Slaughter et al. [3], Table 2. The mean values of the %BF for the boys from the three age groups are relatively equal (between 17.38% and 18.88%). For girls, highest %BF have the 14 years old ones (25.06%), while for the 9 and 10 years old girls %BF are smaller (21.59% and 22.24%), but compared with 9-10 years old boys, they are considerably higher. The ANOVA test distinguished only two %BF groups — the first includes all investigated boys, and the second — all investigated girls (Fig. 4). This is due to the fact that the %BF for the girls from the three age groups is significantly higher than that of the boys (Table 3, Fig. 5).

## Conclusions

In conclusion we can generalize that:

Stature and body weight in pre-puberty schoolchildren (9 and 10 years old) do not show significant intersexual differences.

During the active puberty age (14 years) the boys and the girls differ significantly in respect to stature and body weight, the values of the boys being higher for both features.

Moving throughout the ages (9-14 years), a clear tendency for increment of the relative number of girls with healthy nutritional status, and decrement of those with overweight and obesity are observed.

No statistically significant inter-age differences about %BF in both sexes are observed, but as about the intersexual differences, all the investigated girls have highest %BF than all the investigated boys.

The correlation analysis determines that our sample is sufficient and allows the above-mentioned conclusions to be drawn.

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## References


1. Cole, T. J., M. C. Bellizzi, K. M. Flegal, W. H. Dietz. Establishing a standard definition for child overweight and obesity: worldwide international survey. — BMJ, **320**, 2000, 1240-1243.
2. Martin, R., K. Saller. Lehrbuch der Anthropologie in sistematischer Darstellung. Stuttgart, Gustav Fischer Verlag, 1957, 308-385.
3. Slaughter, M. H., T. G. Lohman, R. A. Boileau et al. Skinfold equations for estimation of body fatness in children and youth. — Hum. Biol., **60**, 1988, 709-723.
4. Stefancic, M., T. Tomazo-Ravnik. A longitudinal observation of growth and body comparison in a sample of 10 to 14-year-old children from Ljubljana, Slovenia. — Acta Med. Auxol., **30**, 1998, No 3, 161-167.
5. Yordanov, Y., A. Nacheva, S. Tornyova. Physical Development and Blood Pressure in Adult Bulgarian Population aaat the End of the XXth Century. — Acta morph. et anthrop., **6**, 2001, 76-89.
6. Начева, А., Н. Кондова, Л. Йорданова, Е. Лазарова. Физическо развитие, кръвно налягане и пулс при 7—14-годишни ученици от София. — Спорт и наука (под печат).