Objective: The present analysis is part of the research of adolescents’ physical development at the age of 11 – 14 in Plovdiv and it aims to analyze and evaluate their somatotype depending on sex and age.

Materials and methods: a method for somatotype determination after The Heath -Carter method and mathematical-statistical methods have been applied (Pearson non-parametric test, dispersion analysis Oneway – ANOVA test). The results have been processed with SPSS Statistics v.19 program package.

Results: Somatotype changes for adolescents and for the 11 and 12 years old endomorphic somatotype is predominant, respectively 32 (40 %) and 34 (39.1 %). The greatest change in somatotype comes at the age of 14. The biggest share here is for ectomorphic 18 (48.6 %), and the smallest share is for endomorphic somatotype 6 (16.2 %). It has been established a statistically significant variance in both group age 11 - 12 and 13 - 14 somatotype, respectively for the boys ($\chi^2 = 9.29; \text{df} = 2; p = 0.01$), but there is no similar correlation for the girls ($\chi^2 = 0.65; \text{df} = 2; p = 0.72$).

Conclusion: The boys are more athletic especially for the age 13 - 14 years old in comparison to the girls where endomorphic somatotype is predominant for both age groups - they have more developed adipose tissue, but less developed muscle mass.

Keywords: somatotype, adolescents, physical development.

INTRODUCTION:

Physical development of man is a complex and compound concept. It is a collection of morphological and functional features of the organism that characterize those aspects of the shape and structure of the human body that determine certain physical and muscular qualities and relate to the physical and human health. Physical development can be seen as a dynamically changing state from the moment of birth to the death of the man. It is a complex of morphofunctional signs at the level of biological development, determined genetically by environmental factors [1]. Adverse environmental factors had a significant impact on the physical development of children. The unfavorable conditions of the external environment are particularly vulnerable to such components of physical development as harmony and somatotype [2, 3]. The presence of such adverse factors reduced the rate of development of the organism [4, 5] and had a direct effect on the somatotype, which is a generalized characteristic for body development [6].

Somatotype is a method of complex assessment of the structure and shape of the human body based on 10 anthropometric indicators / variables (height, body mass, arm circumference in centimeters, lower circumference, Biepicondial shoulder’ diameter in centimeters, byepicondial diameter of the femur in centimeters and four skinfolds) [7, 8].

The three main components of the somatotype are endomorphic, which characterizes the relative development of adipose tissue, mesomorphic, which characterizes the relative musculoskeletal development and ectomorphic component characterizing the relative linearity of the body. Depending on which component predominates among the three, it is the human somatotype [1, 6, 7, 9].

Somatotype or so-called body structure is a complex morphological characteristic with significant genetic determinants, but its individual components undergo different changes through postnatal ontogenetic development. Their eco-sensitivity reflects mainly the type of physical activity of the individual, the specifics of nutrition and eating habits, the various diseases, etc. All previous targeted studies had been shown that age affiliation was not having a significant effect on changes in the basic somatotype of a person, and it remains in the same somatotype zone throughout the individual’s life. The established changes with age are mainly expressed only in passing to adjacent somatotype categories. This is due to the changes in the values of the three somatotype components during different age ranges that reflect the age-related eco-sensitivity of different tissues and systems in the human body.

According to the Heath-Carter’ methodology, which is generally accepted in somatotypes, there are 13 somatypes, respectively four variants of the Endomorphic, Mesomorphic and Ectomorphic groups and one Central Somatotype [8, 10]. This detailed classification is extremely important in adolescent’ sports orientation, where different types of somatotype, besides being typical of different sports disciplines, can have a beneficial effect on athletes’ sports performance [11].
MATERIALS AND METHODS:
The scientific research includes the so called group of adolescents and teenagers 11 - 14 years old. The research includes 261 students from 17 schools - the territory of the city of Plovdiv for the period 2015 - 2017.

Descriptive statistics have been used for the data processing and summarizing of the quantity of measurable indicators. The results are presented through an average arithmetic value and standard error (mean ± SEM). The evaluation of a relative share and frequency distribution at the qualitative (non-metric) and grouped data have been done through an alternative analysis. The received data are presented through an evaluation of a relative share and standard error (p ± Sp). Criterion $\chi^2$ has been applied for comparison of the results at double-dimensional distributions. This criterion is used at multiple frequency tables for the evaluation of the presence of a correlation between the researched indicators. Fisher’s exact test has been applied for analyzing binary frequencies distributions presented in four-times frequency tables and for proving the presence of the analyzed factors influence.

$P < 0.05$ has been accepted for a level of significance of the zero hypotheses. The data processing has been supported by the specialized statistical product SPSS (version 21). Microsoft Excel 2012 has been used for the graphical presentation of the results.

RESULTS:
The analyzed students are 139 (53.3 %) boys and 122 (46.7 %) girls. When comparing boys and girls with the basic three somatotype components, the following results have been achieved: approximately equal shares from both genders fall for the ectomorphic somatotype respectively 48 (34.5 %) boys and 44 (36.1 %) girls. The boys’ largest group is about the mesomorphic somatotype - 56 (40.3 %), and the girls’ largest group is about the endomorphic somatotype - 57 (46.7 %) (Fig. 1).

It has been established a statistic variation between boys and girls ($\chi^2 = 20.32; df = 2; p < 0.0001$) that shows greater part of the boys are athletic, with harmonious proportions, and the adipose tissue is predominant for the girls – it a feature of the endomorphic somatotype that is abdominal, with relatively big corpse and short upper and lower limbs. All body zones have rounded soft shapes [7].

Compared by their age, the data analysis shows the somatotype is changing for the adolescents and 11 and 12 years old are predominant with endomorphic somatotype respectively 32 (40 %) and 34 (39.1 %). Almost equal shares for three basic somatotypes fall for 13 years old, and the most significant somatotype change is at 14 years old. Ectomorphic somatotype has the biggest share here 18 (48.6 %), and the smallest part is for the endomorphic somatotype 6 (16.2 %) (fig. 2). At that age, the adolescents are predominantly more athletic with better muscular mass.
When analyzing the somatotype by gender for the girls, it has been determined that for the age 11 - 12 years old, all three somatotypes are in relatively equal shares. Mesomorphic somatotype is predominant for the 13 years old, and the endomorphic has a significantly lower share, and for 14 years old, it is even missing (fig. 3).

**Fig. 3.** Somatotypes for boys at different ages

Endomorphic somatotype is predominant for the girls at all ages exclusively 14 years old where the somatotype is shifted from ectomorphic type 7 (46.7 %) and 6 (40 %) for the endomorphic type (fig. 4).

**Fig. 4.** Somatotypes for girls at different ages

Despite all these variations in different ages a statistically significant difference is not proven for the both genders – for the boys ($\chi^2 = 14.20$; df = 10; $p = 0.16$), for the girls ($\chi^2 = 2.92$; df = 8; $p = 0.93$).

When comparing both age groups (11 – 12 and 13 – 14), statistical difference has been defined in both boys’ age groups ($\chi^2 = 9.29$; df = 2; $p = 0.01$), and no similar correlation has been proven for the girls ($\chi^2 = 0.65$; df = 2; $p = 0.72$). At 11 - 12 years old boys group the three somatotypes are in equal share while for 13 - 14 years old greater relative share is for the mesomorphic somatotype (51.0%). For both girls’ age groups greatest relative share is for endomorphic somatotype, followed by ectomorphic, and mesomorphic somatotype has the smallest share (fig. 5).
Fig. 5. Somatotype of the two boys’ and girls’ age groups 11 – 12 and 13 - 14

The parameters received by the measurement have given the opportunity to calculate children’s BMI by calculating the mean values for somatotypes and its significance by the somatotype (Table 1).

Table 1. Mean BMI values by somatotypes

<table>
<thead>
<tr>
<th>Somatotype</th>
<th>Number (n)</th>
<th>Mean (x ± SD)</th>
<th>Standard deviation (x ± SD)</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endomorphic</td>
<td>92</td>
<td>22.432205</td>
<td>3.2418022</td>
<td>88.44</td>
<td>0.0001</td>
</tr>
<tr>
<td>Mesomorphic</td>
<td>78</td>
<td>22.563885</td>
<td>3.9330779</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ectomorphic</td>
<td>93</td>
<td>17.345961</td>
<td>1.4522675</td>
<td>1.4522675</td>
<td></td>
</tr>
</tbody>
</table>

It has been proved a correlational dependence between BMI and somatotype (p = 0.0001; F = 88.44). A higher BMI has been found in people with endomorphic and mesomorphic somatotypes where the average BMI for the endomorphic type is 22.43 (SD ± 3.24) and for the mesomorphic somatotype is 22.56 (SD ± 3.93). The lowest BMI is for the ectomorphic type 17.34 (SD ± 1.45). The average somatotype BMIs for every gender have been calculated (Table 2) and the statistical correlation is proven for both genders (for the boys p = 0.0001; F = 44.82 and for the girls p = 0.0001; F = 46.51). The highest BMI for the boys is at endomorphic somatotypes, such as 23.27 (SD ± 3.40) and for the girls, the highest BMI comes at mesomorphic type 22.17 (SD ± 2.85).

Table 2. Average somatotype BMIs for boys and girls

<table>
<thead>
<tr>
<th>Somatotype</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (x ± SD)</td>
<td>F</td>
</tr>
<tr>
<td>Endomorphic</td>
<td>35</td>
<td>23.27</td>
</tr>
<tr>
<td>Mesomorphic</td>
<td>56</td>
<td>22.76</td>
</tr>
<tr>
<td>Ectomorphic</td>
<td>48</td>
<td>17.32</td>
</tr>
</tbody>
</table>

DISCUSSION:
The proven correlation between BMI and somatotype can be used for analysis and prevention of a number of diseases that are directly related to overweight and obesity. A study in India among adolescents found that some somatotypes are more likely to develop a particular disease by proving the link between obesity and overweight with CVD in this age group [9]. There is a link between elevated obesity and lower SES (socioeconomic status), mainly in girls, indicating that girls with low SES may be at higher risk of obesity [12]. At the same time, a number of authors explore the relationship between self-perception
and obesity. Women, compared to men, are generally perceived as more complete than men and want to look weaker. This is confirmed in other studies among students [13], adolescents [14] and adults [15], and is an objective reason for women to have a motivation to exercise more leisure time. The relationship between somatotype and the practice of active sport in the free time has been proven. Somatic growth and sexual maturation of elite athletes are predominantly sport-specific, as each sport favours the development of a particular somatotype and requires a specific training method [16]. The results we received confirm a gender-specific difference between boys and girls, which is also influenced by a number of additional factors such as BMI, self-perception, SES, active sports and more.

CONCLUSION:
In all ages, that had been studied, the girls in roughly equal proportions are the endomorphic and the exomorphic somatotype, and the mesomorphic somatotype had the lowest relative share. In boys, the mesomorphic somatotype is leading, especially after 12 years of age.

The comparison of the two age groups 11-12 and 13-14-year-olds found that boys had been more athletic at the age of 13-14 years, compared to the girls in whom the endometrial somatotype had been the advantage in both age groups. They have more developed fat tissue at the expense of muscle mass. In both sexes, the highest BMI had been found for the endomorphic and mesomorphic somatotype.

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