SOMATIC PROFILE OF MALE ADOLESCENTS IN THE PRESOV REGION

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Keywords:

- body height,
- body weight,
- BMI,
- somatotypes,
- high-school students.

Abstract:

Introduction: Studies point out to an increasing negative trend in the field of eating habits and insufficient physical activity, especially in adolescent population. The paper presents partial results of the research task supported by the Slovak Research and Development Agency based on agreement No. APVV-0768-11 titled 'Physical, functional and motoric development of high-school youth in relation to their physical activity'.

Aim: The aim of the study is to assess basic anthropometric parameters and body constitution of male high-school students in the Presov region.

Material and methods: A non-randomized cross-section study in high-school students from Eastern Slovak region was used. A research sample consisted of 434 male adolescents aged between 15 and 18 years. Prevalence of obesity was assessed according to Slovak National Reference Standards. Identification of somatotype components was carried out according to the method by Heath, Carter [9]. To assess statistical significance of differences in somatotype components ANOVA (1x4) was used.

Results: Using an intra-individual analysis, we identified 6.9 % of boys in the zone of overweight and 8.5 % in the zone of obesity (> 97th percentile). Average somatotype of the whole group was set as central, similarly as in individual age categories. In the category of 15-years-old boys, mesomorphic ectomorph shared the greatest proportion, namely 26.2 %. In the category of 16-years-old boys, there were two dominant somatotypes, ectomorphic mesomorph and mesomorphic ectomorph, proportion of which was 16.2 %. Concerning the 17-years-old boys, endomorphic mesomorph with its share of 16.5 % was dominant. It was similar to the category of 18-years-olds, where the dominant endomorphic mesomorph achieved 21 %. With increasing age, the proportion of mesomorphic component was getting dominant; in addition, endomorphic component was increasing, as well. Analysis of variance did not show any significant differences in the comparison of somatotypes with respect to participants' age.

Conclusions: Analysis of body constitution indicates increasing muscular development in most of the tested adolescents along with increasing age; however, it is accompanied by increasing fat component, as well.

INTRODUCTION

Many recent studies focused on physical activity and life-style point out to decrease of physical activity, not only in adulthood but also in childhood. Active life-style remarkably influences body composition and physical fitness [4]. Somatic growth and development, as an elementary predictor of health, is especially determined by genetic, nutritional and environmental factors, which also include social-economic and psycho-social environment. In case of overweight, as a result of unhealthy life-style, the risk of chronical diseases appears and the quality of life is deteriorated [23]; moreover, overweight or obesity in childhood predisposes the occurrence of this unfavourable state in adulthood [6]. Research shows that this negative trend is raising, especially in adolescent population. Since 1980 the prevalence

of obesity has tripled [20]. Overweight and obesity in adolescents can also be attributed to improper habits in family, lack of physical activity, frequent and long time spent watching television or using computer and other negative effects of modern society [2]. Basic anthropometric parameters include body height and body weight [10]. These parameters are an inseparable part of calculation of other somatic parameters in several anthropometric methods, for instance in setting somatotype. Monitoring individual somatic indicators can reveal not only physical development of population but also health status, developmental and growth patterns of population as well as the effect of external changes [12]. Body composition can be significantly influenced by life-style; especially body fat is the most variable component [24].On the contrary, somatotype identifying the current morphological state of an individual does not substantially change during ontogeny as about 70% of it is genetically determined [29]. Although genetics significantly influences individual's phenotype, the role of life-style factors, such as nutrition, physical activity and health status, is more important [3].

AIM

The aim of the paper is to assess basic anthropometric parameters and body constitution of male high-school students in the Presov region.

MATERIAL AND METHODS

A non-randomized cross-section study in high-school students from Eastern Slovak region was used. A research sample consisted of 434 male adolescents aged between 15 to 18 years. The participants' average age at the time of measurements was 17.0 ± 1.1 years, average body weight 68.6 ± 12.1 kg and average body height 177.0 ± 6.4 cm. The research group was divided into four subgroups according to their age. Basic somatic characteristics of subgroups are listed in Table 1.

Table 1 Basic somatic characteristic of subgroups

Age group	***Age (years)***		***Body weight (cm)***		***Body height (kg)***		***BMI ($kg.m^{-2}$)***	
	$\bar{x}$	***s***	$\bar{x}$	***s***	$\bar{x}$	***s***	$\bar{x}$	***s***
15 year (n = 103)	15.6	0.3	64.5	11.1	175.2	6.2	21.0	3.3
16 year (n = 105)	16.5	0.3	68.6	12.9	176.9	6.2	21.9	4.1
17 year (n = 127)	17.5	0.3	69.3	11.8	177.1	6.5	22.1	3.3
18 year (n = 99)	18.5	0.3	71.8	11.8	178.7	6.4	22.5	3.2
Total (n = 434)	17.0	1.1	68.6	12.1	177.0	6.4	21.9	3.5

At the beginning of measurement, participants' basic somatic characteristics were identified. Body height was measured using a portable stadiometer (SECA 217, Hamburg, Germany) with an accuracy of 0.1 cm. Body weight measured with an accuracy of 0.1 kg together with body fat percentage parameter was tested using digital scale InBody 230 device (Biospace Co., Ltd.; Seoul, Korea).

Identification of somatotype components was carried out according to the method by Heath – Carter [9]. In addition to basic somatology characteristics, to assess individual somatotype components we measured thickness of four skin folds (triceps, subscapular, supraspinale and medial calf) using Best calliper (Trystom, Olomouc, Czech Republic), biepicondylar breadth of humerus and femur using a digital calliper with an accuracy of 0.1 mm and the flexed arm and calf girth in the greatest circumference using a tape measure.

Somatotypes were further evaluated according to dominancy of respective components and their mutual ratio. Values of somatotype components were set using Somatotyp 1.2.5 for Windows software.

Prevalence of obesity was assessed according to Slovak National Reference Standards based on the 7th National anthropometric survey 2011, which was carried out on representative groups of boys in all age categories, taking into account eating habits and demographic specifics. BMI value below the 25th percentile was classified as underweight, BMI value between the 25th and 75th percentile was classified as proportional, between the 75th and 90th percentile it was assessed as plump, between the 90th and 97th percentile it means being overweight and value exceeding 97th percentile indicates obesity. The participants were assessed in regard to their age since the level of the degree of obesity (BMI value) is shift in relation to participant's age.

Measurements were taken according to the ethical standards of the Declaration of Helsinki [8]. Participant's legal representative (in the case when a subject was younger than 18 years) or participants (in the case when a subject was older than 18 years) received a verbal description of the study procedures before testing and completed a written informed consent that was approved by the ethical committee of University of Presov.

Collected data were subjected to statistical analysis. From methods of descriptive statistics we used the mean as a measure of central tendency and standard deviation. The statistical significance of differences in somatotype components of the participants was identified based on results of One way analysis of variance (ANOVA 1x4). Null hypothesis on the equality of variance was assessed at a level of significance $\alpha = 0.05$.

Statistical analysis was carried out using IBM SPSS Statistics, version 20 (IBM SPSS Inc., Chicago, IL).

RESULTS

Table 2 presents reference values of descriptive characteristics of basic somatic indicators according to the 7th National anthropometric survey 2011. Based on the values mentioned in Table 1 compared with the reference values, we can state that average values of body height, weight and BMI of boys in individual age categories take place at the level from the 50th to 70th percentile, i.e. in the zone of medium body height and normal weight. Average values of the monitored indicators increased with higher age.

The comparison with the results of the 7th National anthropometric survey 2011 (Table 2) indicates that average values of the monitored anthropometric parameters of boys in individual age categories are lower than reference values.

Table 2. Reference values of basic somatic characteristics (7th National anthropometric survey 2011)

	15 years			16 years			17 years			18 years		
	BH (cm)	***BW*** (kg)	***BMI*** (kg/m^2)	***BH*** (cm)	***BW*** (kg)	***BMI*** (kg/m^2)	***BH*** (cm)	***BW*** (kg)	***BMI*** (kg/m^2)	***BH*** (cm)	***BW*** (kg)	***BMI*** (kg/m^2)
$\bar{x}$	175.8	66.0	21.3	177.6	69.2	21.9	178.4	72.1	22.6	179.3	74.1	23.1
s	7.6	12.9	3.5	7.1	12.6	3.6	7.1	13.0	3.6	6.7	12.2	3.6

Table 3 presents percentage of boys in individual percentile zones according to BMI. Analysis of BMI values shows that 52.5 % of the tested group of boys take place in the zone of normal weight (25th – 75th percentile). The greatest representation was found in the 16-years-old boys, 57.1 %, and the lowest, 44.7 %, in the 15-years-olds. In the zone of underweight (< 25th percentile), 19.8 % of boys were found, while the greatest representation

was in the category of 17-years-old boys, namely 22 %. In the zone over the 75t^{h} percentile, 27.6 % of boys were placed, out of whose 12.2 % were plump, 6.9 % were overweight and 8.5% were obese. The 15-years-old boys had the greatest share, when more than a third of them took place in the zone over the 75th percentile, namely 34 %. Similarly, in the same age category, there was the greatest representation of plump and overweight subjects, 16.5 % and 9.7 %. The greatest proportion of obese boys, 10.5 %, was detected in the category of the 16-years-old boys.

Table 3 Percentage of boys in the percentile zones according to BMI

BMI	15 y		16 y		17 y		18 y		Total	
	n	%	n	%	n	%	n	%	n	%
Under the 25th percentile - underweight	22	21.4	17	16.2	28	22.0	19	19.2	86	19.8
Under the 75th percentile - proportional	46	44.7	60	57.1	69	54.3	53	53.5	228	52.5
Under the 90th percentile - plump	17	16.5	12	11.4	12	9.4	12	12.1	53	12.2
Under the 97th percentile - overweight	10	9.7	5	4.8	8	6.3	7	7.1	30	6.9
Over the 97th percentile - obesity	8	7.8	11	10.5	10	7.9	8	8.1	37	8.5

From the perspective of increasing age, we observed a diverse progress of prevalence of overweight and obesity. Concerning overweight, in 16-years-old boys we recorded its decrease in comparison to the 15-years-olds; however, overweight in 17 and 18-years old boys increased to 6.3 %, 7.1 % respectively. In case of obesity, values in 15, 17 and 18-years-old boys ranged between 7.8% and 8.1%.

When assessing somatotypes, average somatotype in the category of 15-years-old boys was central somatotype, 3-3.8-3.6. The category 4 – mesomorphic ectomorph had the greatest percentage proportion, namely 26.2%. Average somatotype of 16-years-olds was 3-4-3.3, central somatotype. The greatest proportion, 16.2%, was found in category 2, ectomorphic mesomorph and category 4, mesomorphic ectomorph. Average somatotype of 17-years-old boys was 3-4.3-3.2 central somatotype and the greatest proportion, 16.5 %, was detected in somatotype 12, endomorphic mesomorph. In the category of 18-years-old boys, average somatotype was central somatotype, 3.2-4.2-3.7, while the category 12, endomorphic mesomorph, had the greatest proportion, namely 21.0 % (Table 4).

Table 4 Somatotypes of the tested group

Somatotype	15 y	16 y	17 y	18 y	Total
average	3-3.8-3.6	3-4-3.3	3-4.3-3.2	3.2-4.2-3.7	3.0-4.1-3.4
category with highest percentage	4	2 - 4	12	12	4

Note: 4 - mesomorphic ectomorph, 2 - ectomorphic mesomorph, 12 - endomorphic mesomorph

Average somatotype of the whole group was central somatotype, with the greatest share of somatotype category 4, mesomorphic ectomorph, with its 18.4 % (Figure 1).

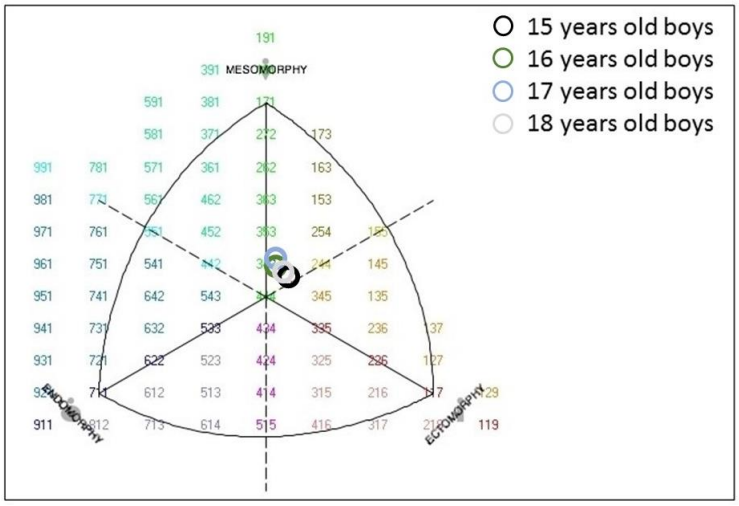

Figure 2. Average somatotypes of boys in different age categories

With increasing age, proportion of mesomorphic component was largely dominant. Up to the 17th year, its value was gradually increasing when in the 18th year, we recorded its slight decrease. Concerning the endomorphic component, we observed its gradual increase, when the noticeably highest value was found in the 18th year. On the contrary, in younger age categories, the ectomorphic component prevailed, which decreased with increasing age up to the 17th year. Interestingly, in the 18th year, we recorded the highest values (Figure 2).

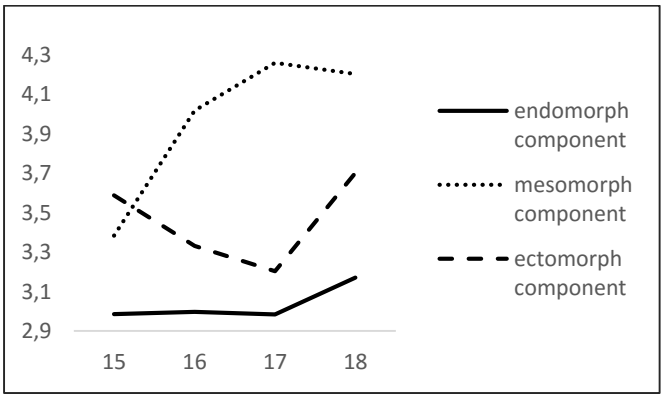

Figure 3. Representation of somatotype components in boys with respect to age

Based on statistical processing, we can state that One way analysis of variance (ANOVA 1x4) did not show any significant differences in comparison of somatotype components with respect to participants' age. Results of the analysis of variance are listed in Table 5.

Table 5 Results of analysis of variance with respect age category (ANOVA 1x4)

		Sum of Squares	df	Mean Square	F	Sig.
Endomorphy	Between Groups	2.535	3	0.845	0.264	0.851
	Within Groups	1380.189	431	3.202		
	Total	1382.723	434			
Mesomorphy	Between Groups	12.223	3	4.074	1.541	0.203
	Within Groups	1139.285	431	2.643		
	Total	1151.508	434			
Ectomorphy	Between Groups	17.463	3	5.821	0.903	0.440
	Within Groups	2778.537	431	6.447		
	Total	2796.000	434			

DISCUSSION

In the group of boys, we observed continuation of the increasing trend when body height and body weight increased with higher age. In comparison to the previous measurements, the recorded values of BH and BW are lower in all age categories, which could indicate a slowing secular trend. Also BMI values decreased in comparison to tests carried out in 2011. Calculation of BMI for the adult category is given but assessment of children and youth is different when compared to adults. BMI in children and adolescents is assessed using percentile graphs. BMI in adolescents up to 20 years is calculated according to the identical formula then for adults but it is further evaluated according to percentile, the value of which is assessed according to graphs which are renewed every ten years. However, [17] notes that evaluation of graphs differentiates sex because physical development of boys and girls considerably varies. Concerning BMI, our tested boys did not take place in the risk group, according to [22], who set standards separately for boys and girls in age categories from 14 to 18 years beginning at the BMI value of 25.5. Anthropometric measurements carried out on the representative group of Slovak children and youth aged between 7-18 years in 2011 indicate that acceleration trends in the mentioned population groups, as well as secular trend are slowing. In 2011, accelerated increase appeared in values of body weight with slowing growth which was reflected in significant increase of average values of BMI in all categories and also in greater circumferential measures [34].

In our group, we have not observed such situation. Values of body weight, similarly to body height, were lower in all age categories when comparing tests carried out in 2011 and 2013 [1, 13]. In spite of that, according to Neščáková et al. [18], overweight in the group of 15-years-old boys was represented by 16.7 % and obesity by 3.3 % of boys. This indicates that the tested boys achieved higher values of body weight and obesity than the group of Czech and Slovak children tested in the past. This fact points to continual growth acceleration which is probably related to nutrition and physical activity, i.e. inactivity, of children.

According to recent available statistics, 12.7 % of boys aged between 7 and 18 years are overweight. The higher degree, obesity, occurs in 8 % of boys. „Endogenous obesity is rather exceptional; according to literature it only makes 4 % of overall prevalence of childhood obesity“. The absolute majority (96 %) is thus represented by so called exogenous childhood obesity, which is caused by poor eating habits, improper life-style and lack of physical activity [31].

So far, there has not been any study on data representing the area of Slovak Republic that would be also processed according to IOTF guidelines. The authors of the recent international overview report 12 % for overweight or obese children aged 7-11 and 8 % for youth aged 14-17 years (2013) [5]. Since proportionality changes during ontogeny, indices provide good information value on child's development [25]. BMI is the most commonly used for assessing the ratio between body height and body weight. However, the value of index significantly varies in children and youth [28]. Furthermore, childhood overweight and obesity using these BMI thresholds is predictive of adult obesity [7]. The secular trend of increased values of body height in the 18^{th} year has been observed in most of European countries since the end of the 19^{th} century. Increase by 1 – 3 cm over the decade was reported. It was attributed to better living conditions, especially nutrition, health status of children, hygiene and reduction of family members. Results of the last measurements showed continuation of this trend in some countries (Netherlands, Germany, USA, Canada, Brazil, China, Malaysia) and, on the contrary, it's stopping in some Scandinavian countries, Poland, Czech and Slovak Republics [27]. The detected trend of increasing body weight in the monitored age groups of children and youth in Slovakia is similar as in other European and world countries; in comparison to previous decades, it is more remarkable and unfavourable. Childhood obesity is an acute health crisis. Approximately 20 % of children are overweight

and the third of them is obese [32]. It is estimated that up to 155 million of children and adolescents in world are overweight or obese [33]. The prevalence of childhood overweight and obesity is rapidly increasing in USA, Canada, Australia, Great Britain, Czech Republic, Italy and other European countries. Obesity is a multifactorial disease [19] and over the past decades it has reached a pandemic state by doubling its worldwide prevalence [30]. Prevalence of obesity is high as more than a half of world population is overweight or obese and it is „epidemically" increasing. Over the last years, obesity increased by about 10 – 40 % in most of European countries. 30 – 80 % of adult population in Europe is overweight. Average values of BMI in this region approach the value of 26.5. More than a third of adult population in this region is obese. The critical period in the prevalence of obesity is the beginning of school attendance and the period just before puberty, taking into account sex specific differences [11, 14].

Authors [15, 16, 21] state that adolescence is a critical period for development of obesity and it is the base of civilisation diseases. They also warn of increasing body weight of youth, mainly determined by increased body fat. According to Sorof et al. [26], the risk of hypertension is almost doubled in children placed over the 90th percentile due to overweight (23 %) than in children at the level of the 75th percentile (12 %). In case of obesity, over the 95th percentile, it is almost tripled (34 %) than in children at the 75th percentile. Regarding the prevalence of obesity in the Slovak population, it is believed to be in 12 % of children at school-age with its prevalence between 10 – 14 %, when the lower value is for children living in village and the higher number for those in cities http://www.zzz.sk/?clanok=11577. Gradual increase of the mesomorphic component points to muscular development, which is associated with maturation of the male organism and formation of typical male stature. Gradual decrease of the ectomorphic component due to slowing growth is also characteristic. However, an accompanying phenomenon is the increase of the fat component, which was observed in terms of higher values of the endomorphic components in adolescents. It is related to the need of effective intervention in terms of promotion of active life-style already in this age category. In this period, the greatest development of physical and mental skills is finished. The muscle mass is developed and typical male stature is formed [1, 13].

CONCLUSIONS

Assessment of the state of physical development is very important from the perspective of monitoring developmental trends of youth, which provides the basis for development of national standards. The position of Slovakia, in comparison to other European countries, is very good, when the prevalence of obesity is not epidemic, which was also confirmed by our measurements. Identifying somatotype plays an important role in examining proportion and development of individual body components, which enables us to comprehensively assess physical development from the perspective of relations among them.

REFERENCES

1. ATKINSON, J. M. et al. 2003. *Psychologie*. 1. vyd. Praha : Portál. 753 s. ISBN 808560535.
2. BURKE V., BEILIN L. J., DUNBAR D. 2001. Family lifestyle and parental body mass index as predictors of body mass index in Australian children: a longitudinal study. *International Journal of Obesity and Related Metabolic Disorders,* 25(2), p. 147–157. ISSN 1476-5497.
3. CARTER, J. E. L., HEATH, B. H. 1990. *Somatotyping – development and applications.* Cambridge University press. ISBN 0-521-35117-0.
4. CEPERO, M. et al. 2011. Fitness test profiles in children aged 8–12 years old in Granada (Spain). *Journal of Human Sport and Exercise,* 6 (1), p. 135–145. **ISSN** 1988-5202.

5. DOBIÁŠOVÁ, V., BUČKOVÁ, Ľ. 2013. *Zdravý štýl života a nadhmotnosť a obezita* [online]. Trenčín: RÚVZ. [Cit. 20.8.2015]. http://szstn.edupage.org/files/Obezita.pdf
6. FIELD A. E., COOK N. R., GILLMAN M. W. 2005. Weight status in childhood as a predictor of becoming overweight or hypertensive in early adulthood. *Obesity Research*, 13(1), p. 163-169. ISSN 1930-739X.
7. GUO, S.S., WU, W., CHUMLEA, W.C., & ROCHE, A.F. 2002. Predicting overweight and obesity in adulthood from body mass index values in childhood and adolescence. *The American Journal of Clinical Nutrition*, *76*(3), p. 653-658. ISSN 1938-3207.
8. HARRISS, D.J., ATKINSON, G., 2011. Update - Ethical Standards in Sport and Exercise Science Research. *International Journal of Sports Medicine*. 32 (11), p. 819-821. ISSN 0172-4622.
9. HEATH, H., CARTER, L. 1967. A Modified Somatotype Method. *American Journal of Physical Anthropology,* 27(1), p.57-74. ISSN 0002-6597.
10. HEYWARD, V. H., WAGNER, D. R. 2004. *Applied body composition assessment.* Champaing: Human Kinetics. ISBN-13: 9780736046305.
11. KOLLÁR, J. 2001. Body mass index a detský vek. *Ateroskleróza*, 5(4), p. 257-8.
12. KOPECKÝ, M. 2006. *Somatický a motorický vývoj 7 až 15 letých chlapců a dívek v olomouckém regionu.* Olomouc: Univerzita Palackého v Olomouci. 1. vyd. 192 s. ISBN 80-244-1281-0.
13. MACEK, P. 2003. *Adolescence.* 1. vyd. Praha : Portál. ISBN 80-7178-7477.
14. MORAVCOVÁ, A. 1998. Deti a obezita. *Zdravie*, 54 (7). 27 s.
15. MOLINER, D. et al, 2009. Association of objectively assessed of psychical activity with total and central body fat in Spanish adolescents. Eds: Ruiz, J., Rey-Lopez, J., Ortega, F. *International journal of obesity.* Sevilla: Universidad Pablo de Olavide. vol 33, p. 1126-1135. ISSN 0307-0565.
16. MORENO, L., 2008. Design and implementation of the Healthy Lifestyle in Europe by Nutrition in Adolescence Cross-Sectional Study. Eds: Kesrting, M., Kafatos, A., Manios, Y., Marcos, A. *International journal of obesity.* Spain: Universidad de Zagaroza. vol. 32, p.4-11. ISSN 0307-0565.
17. NALAZENCOVÁ, R. 2012. BMI: Historie až současnost: bakalářská práce. Olomouc: Univerzita Palackého.
18. NEŠČÁKOVÁ, E., LANDLOVÁ, V., DORNHOFEROVÁ, M., UHROVÁ, P., BODORIKOVA, S. 2013. Somatotypologická charakteristika chlapcov staršieho školského veku z Bratislavského kraja. *Slovenská antropológia*, 16(1), p. 44-50
19. NEWELL, A., ZLOT, A., SILVEY, K., ARAIL, K. 2007. Addressing the obesity epidemic: agenomics perspective. *Preventing Chronic Disease*, 4(2), A31. ISSN 1545-1151.
20. OMS/WHO. 2003. *Global Strategy on Diet, Physical Activity and Health.* http://www.who.int/hpr/global.strategy.shtml
21. OTTEAVERE, CH. et al. 2011. Clustering patterns of physical acitivity, sedentary and dietary behavior among European adolescents – The Helena study. *BMC Public Health.* Belgium: Ghend University. 11:328. ISSN 1471-2458.
22. PAŘÍZKOVÁ, J., LISÁ, L. 2007. *Obezita v dětství a dospívání*. 1. vyd. Praha : Galen. ISBN 978-80-7262-466-9.
23. RAJ M., KUMAR K. 2010. Obesity in children and adolescents. *Indian Journal of Medical Research*, 132(5), p. 598-607. ISSN 0971-5916.
24. RIEGEROVÁ, J., PŘIDALOVÁ, M., ULBRICHOVÁ, M. 2006. *Aplikace fyzické antropologie v tělesné výchově a sportu.* Olomouc: Hanex. ISBN 80-85783-52-5.

25. RIEGEROVÁ, J., ULBRICHOVÁ, M.Ľ . 1998. *Aplikace fyzické antropologie v tělesné výchově a sportu*. Olomouc: Vydavatelství Univerzity Palackého, 185 s. ISBN 80-7067-847-X.
26. SOROF, J. M., LAI, D., TURNER, J., POFFENBARGER, T., PORTMAN, R.J. 2004. Overweight, ethnicity, and the prevalence of hypertension in school-aged children. *Pediatrics*, 113, 475–482.
27. ŠEVČÍKOVÁ, Ľ., REGECOVÁ, V., HAMADE, J., JANECHOVÁ, H., BABJAKOVÁ, J., JURKOVIČOVÁ, J., ŠTEFÁNIKOVÁ, Z., ARGALÁŠOVÁ, Ľ. 2014. Trendy v somatometrických parametroch u detí a mládeže v SR. *Životné podmienky a zdravie* [elektronický zdroj]. Bratislava : Úrad verejného zdravotníctva. p. 178-188 [CD-ROM]. Bratislava: Ústav hygieny, Lekárska fakulta UK, Ústav normálnej a patologickej fyziológie SAV, Úrad verejného zdravotníctva SR. ISBN 978-80-7159-216-7.
28. ŠEVČÍKOVÁ, Ľ., ROVNÝ, J., NOVÁKOVÁ, J., HAMADE, J., TATARA, M., JANECHOVÁ, H., ŠEĆOVÁ, M. 2004. *Telesný vývoj detí a mládeže v SR*. Bratislava: Úrad verejného zdravotníctva SR, 184 s.
29. ŠTĚPNIČKA, J., CHYTRÁČKOVÁ, J., KASALICKÁ, V. 1977. Somatotyp a pohybové nadání u žákú ZDŠ. *Teorie a praxi tělesné výchovy,* 25(9), p.551-558. ISSN 0040-358X.
30. World Health Organization. 2012. *Obesity and overweight*: Fact sheet no. 311. Last accessed September 10th 2012. http://www.who.int/mediacentre/factsheets/fs311/en/.
31. *Boj proti detskej obezite: Odstráňte 10 chýb v stravovaní!* [online]. [Cit. 10.08.2015]. Last accessed November 15th 2012. http://www.cas.sk/poradne
32. *Národný program prevencie obezity* [online]. [Cit. 10.08.2015]. http://www.uvzsr.sk/docs/info/podpora/Narodny_program_prevencie_obezity.pdf
33. *Obezita detí* [online]. [Cit. 10.08.2015]. http://www.google.sk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CC4QFjAB&url=http%3A%2F%2Fwww.ruvztn.sk%2Fobezita08.doc&ei=CB9MVI-NKMHeaoCwgbgN&usg=AFQjCNH_e98RpoWGLDnJX5vpD4N1pS0INg&sig2=6HDhkmPeF0aobKWLLmo1OA&bvm=bv.77880786,d.d2s
34. *Telesný vývoj detí a mládeže v SR Výsledky VII. celoštátneho prieskumu v roku 2011* [online]. [Cit. 20.07.2015]. http://www.uvzsr.sk/docs/info/hdm/Antropometria.pdf