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Obesity in Moscow School Age Students: Prevalence, Age- and Gender- Related Features

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Abstract Background: obesity in children and adolescents became one of the most globally challenging medical problems over the past decades. Method: School-age children and adolescents from the Moscow's schools were examined. Height and weight data were obtained from screening examination records found in school medical charts. BMI (body mass index) was calculated. Derived data was analyzed according to the World Health Organization growth charts, for gender and age. Results: We demonstrated that in Moscow students aged 5 to 16 years old, obesity occurs mostly in the prepuberty period: boys 10-13, and girls 9-10. At the same time obesity prevalence is significantly higher in male adolescents than in female. In older groups decline in obesity prevalence provides for decrease in overweight prevalence. Obesity in specific groups with its maximum prevalence shows unfavorable features due to the predominance of central obesity indices both in boys and in girls. The most significant growth registered in thickness of abdominal and subscupular skinfolds (ASF and SSF, respectively) which was found in boys (4.3 and 4 times greater). In males abdominal obesity prevails, whereas in females, distribution of subcutaneous adipose tissue is more even. Conclusion: The value of ASF and SSF as a tool for cardiovascular pathology risk factors assessment in urban students ages 9-13 was confirmed by correlative analysis. These parameters have the strongest correlation with all the others evalu-ated in this investigation. Waist-to-hip ratio didn't show any significance in assessment of obesity in persons of prepuberty age.

Keywords Obesity, Schoolchildren, Risk of Cardiovascular Pathology

1. Introduction

Obesity in children and adolescents has become one of the most globally challenging medical problems over the past decades[1-3]. It is acknowledged that several serious consequences of excess weight occur in adults with the most common being cardio-vascular diseases and glucose metabolism disorders[4]. To the present it has also been demonstrated that different deviations from a healthy condition have been observed[3,5]. Another unfavorable consequence related to childhood obesity is that there is a strong tendency for the continuation of obesity in adulthood[3,6]. That is why public health specialists today predict a pessimistic morbidity and mortality expectation for future decades of adults[1].

In spite of a wide range of investigations and reviews that consider the early onset of on excess weight problem from various perspectives, we didn't find works on detailed analyses of the relationship between obesity and age in children and adolescent populations.

It is also evident that there is a lack of data the prevalence of obesity in specific age groups in the Russian Federation in general. The last statistical data that was presented in the works of Peterkova V.A. (data from 1999-2001)[7], Popkin B.M. et al. (2006; data from 1995-2004)[2] and Dedov I.I. et al. (2007; period of data collection did not have a specified)[8]. Data provided by Peterkova V.A (2005) is presented in Table 1[7].

Table 1. Obesity Prevalence in Children and Adolescents 6-18 Years of Age from 1999-2001[7]

Age, number of children examined	Rural, %		Urban, %	
	Male	Female	Male	Female
6-11, 4900	4.1	4.9	7.9	7.3
12-18, 8800	5.1	8.3	8.0	10.2
Mean	5.6		8.4	

In review by Popkin B.M. et al. (2006), the prevalence of obesity in children and adolescents (10-18 years old.) reaches 11.3% in 1995 and 11.1% in 2004. In this work, Russia is presented as the only country where an increase in childhood obesity hadn't been detected in the mentioned years[2].

Dedov I.I. et al. (2007) provided the data on adolescents (12-17 years old) who were studying in the schools of main Russian cities. Results of that study are described in Table 2[8]. In this paper Dedov I.I. et al. (2007), mentioned that the maximum levels of obesity were registered in adolescents from Moscow schools – 4.8%. The excess weight

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levels were similar in Moscow (11.8%) and Novosibirsk (11.9%)[8].

Table 2. Excess Body Weight and Obesity in Russian Adolescents, Attending Schools in Main Russian Cities[8]

Age, number of children examined	Excess body weight, %		Obesity, %	
	Male	Female	Male	Female
12-17, 10223 (male – 45.6%; female – 53.5%)	8.7	7.7	2.5	1.6
12-17, 10223; mean	11.8		2.3	
12, 576; mean	≈14.3		3.1	
17, 1566; mean	7.7		1.4	

Considering obvious economic growth in Russia during the last several years and a strong tendency for an western lifestyle the adopter of the among the Russian population, especially those dwelling in cities, an increase in obesity rates might be expected.

The aims of the presented study were to investigate age and gender-related correlations between the obesity prevalence among school-age students (5-16 years old) and assess to the possibility of using anthropometric indices as predictors of related cardio-vascular disorders in specific groups.

2. Research Methods and Procedures

School-age children and adolescents were examined (2008-2009). Beforehand, written informed consent was signed by parents confirming participation of their children in that investigation.

Height and weight data were obtained from screening examination records found in school medical charts. Finally, data from participants (5-16 years old) was included in a statistical analysis that was formed by 10,122 cases using data paired weight and height. BMI (body mass index) was calculated for each of data pair. Derived data was analyzed according to the World Health Organization growth charts, for gender and age (at the children last birthday). Participants were considered to be obese if their BMI was ≥ 95 percentile. Overweight was defined if the person had a BMI < 95 and ≥ 75 percentile. Those with a BMI ≥ 25 and < 75 percentile were considered to be the normal weight group. We applied a median index for the overall age groups' assessment.

Based on statistical analysis, age groups with the highest level of overweight and obesity were established. Subsequently they underwent further examination including waist circumference (WC) and hip circumference (HC), and skinfold thickness measurement. 65 boys aged 10-13 years old and 41 girls aged 9-10 years old were examined at this second phase of research. Among boys, 27 (41.5%) had a normal BMI index, 17 (26.2%) were overweight and 21 (32.3%) were obese. In the female group, 22 girls (53.7%) were referred to the normal weight group, 8 (19.5%) were overweight and 11 (26.8%) were obese.

Indicated results were derived according to standard examination methods using a measuring tape (accurate to 1cm) and a caliper (accurate to 1mm). Skinfolds were measured in three standard points: triceps (TSF), subscapular (SSF), abdominal (ASF). TSF was assessed in the upper third of the upper arm's back (posterior) surface. SSF was assessed at the end of the lower (inferior) angle of the shoulder-blade (scapula). ASF was done on umbilicus level along the mid-clavicular line.

Statistics included the Student's T-test, Wilcoxon-Mann-Whitney U test and F-Test.

3. Results

An analysis of the BMI data revealed the highest median exceeding level the for 10-13 years old groups of boys and 9-10 years old group of girls. Obesity also prevailed in the same age-gender groups (Tables 3, 4).

Tables 3 and 4 show that in the 12 years old male group, almost 40% abose and the level with the 13 years old group of the same sex was very similar – 37.9%. Obesity was also diagnosed in approximately 30% of boys at the age of 10 and 11.

Table 3. Relative BMI Levels in Examined Age Groups.

Group's age	Male	Female
5	1.07±0.15	1.02±0.11
6	1.04±0.06	1.03±0.06
7	1.09±0.16	1.04±0.12
8	1.09±0.15	1.06±0.05
9	1.08±0.17	1.08±0.07*
10	1.14±0.13*	1.11±0.10*
11	1.17±0.14*	1.06±0.16
12	1.20±0.12*	1.03±0.06
13	1.20±0.11*	1.06±0.15
14	1.15±0.15	1.03±0.09
15	1.07±0.10	1.04±0.10
16	1.05±0.12	1.04±0.08

* p<0.05

Table 4. Overweight and Obesity Levels in Groups with the Highest Median BMI Indices.

Group Age	Relative BMI level in the group		% of overweight individuals in group		% of individuals with obesity in group	
	Male	Female	Male	Female	Male	Female
13	1.20±0.11*	1.06±0.15	20.7*	36.7*	37.9*	3.3
12	1.20±0.12*	1.03±0.06	23.5*	20.9*	39.2*	6.9*
11	1.17±0.14*	1.06±0.16	29.8*	25.9*	29.8*	7.4*
10	1.14±0.13*	1.11±0.10*	22.4*	15.0*	29.9*	25.0*
9	1.08±0.17	1.08±0.07*	3.3	30.6*	23.3*	16.7*

* p<0.05

In mentioned age groups, overweight (BMI ≥ 75th and <95th percentile) was mostly observed at the age of 11 (almost 30%). Further analyzing data from the male students examined, revealed the highest levels of overweight was found at the age of 14 and 15 (33.3% and 30% accordingly). Whereas, lower obesity levels in boys were found only in a small proportion of the group (11.1% and 15% respectively).

In the female group the highest level of obesity was registered at the age of 10 (25%). In 8 and 9 years old girls, obesity was found to be to 16.7% with the overweight maximum level (among those of 8-10 years old) at the age of 9 (30.6%). However, the highest levels of overweight prevalence in the female group in general was recorded in girls aged 13 (36.7%), 16 (36.4%) and 14 (32.1%). In these groups (as well as in male groups with the highest levels of overweight), the prevalence of being obesity was not so pronounced. In girls 16 years old there was no obesity registered at all. In age group of 13 years old, obesity was found in 3.3% of cases. In age group of 14 years old, obesity was found in 3.6% cases.

According to data indicated above, the prevalence of obesity is the highest in male adolescents. Among them, the most prominent figures are registered during prepuberty and early puberty ages (10-13 years old). In the girls prepuberty age groups (9-10 years old) have the maximum levels of obesity. The subsequently pronounced lowering of obesity levels could be explained with its relationship to a puberty growth spurt.

Detailed anthropometric examination of students from groups with the highest levels of obesity revealed a significant difference between groups in the following indices. Among boys those are: WC, TSF, SSF, ASF. A ratio of SSF to TSF (SSF/TSF index) significantly differed only in the group of boys with obesity. Among the groups of girls with the high obesity levels, a significant difference was detected for all of mentioned indices. Obtained data is presented in Table 5.

Table 5. Difference in Anthropometric Indices in Groups with Overweight and Obesity as Compared to Groups with Normal Levels of BMI Within Boys of 10-13 Years and Girls of 9-10 Years.

Index	Groups with normal level of BMI		Groups with over-weight children		Groups with obese children	
	Boys	Girls	Boys	Girls	Boys	Girls
WC, cm	60.2 ± 3.4	53.6± 2.4	66.6±3.7*	59.0± 2.4*	77.0± 8.1**	67.2± 6.7**
TSF, mm	6.8 ±3.1	7.3 ±2.8	11.6± 3.9*	11.1 ±3.1*	17.1± 4.7**	14.2± 3.1**
SSF, mm	3.6± 1.7	3.2± 1.5	6.8 ±3.1*	7.4 ±3.2*	14.3 ±3.1**	11.6± 4.2**
ASF, mm	5.3± 2.7	5.2 ±3.3	12.6± 6.2*	9.3± 1.9*	22.7± 7.7**	17.5± 5.8**
SSF/TSF index	0.54± 0.17	0.46± 0.17	0.59± 0.14	0.7 ±0.3*	0.84± 0.24**	0.83± 0.3**

* - data with significant difference as compared to normal BMI group ($p<0.05$)

** - data with significant difference compared to groups with normal BMI and overweight groups ($p<0.05$)

As can be seen from Table 5, the greatest difference between groups was shown by the abdominal and subscapular skinfolds for boys with obesity which is an increase of 428.3% (4.3 times) in ASF and 397.2% (4 times) in TSF. In girls, the difference between these indices was also the largest but less pronounced when compared to boys with an increase of 336.5% (3.4 times) in ASF and of 362.5% (in 3,6 times) in TSF. At the same time, the difference in SSF/TSF index was slightly higher in girls with obesity with an increase of 180.4% (1.8 times) compared to the girls with normal weight. In comparison in boys the difference is 155.6% (1.5 times). There's almost no difference in absolute values between gender groups with obesity. Furthermore, the significant difference in SSF/TSF index for participants with overweight was found only in girls groups of 152.2% (16 times) and an insignificant increase in boys groups.

Thus, within students examined during the second phase of the study of obesity, the unfavorable tendency was an increase of indices which indicate centralization of distribution of adipose tissue. That shows that cardiovascular risk factors appear along with obesity in childhood and adolescence. In male groups the main increase was revealed for indices of abdominal obesity (WC, ASF). Where as in girls, the difference between an increase of various indices of central obesity is not as high or significant.

No significant difference between values of waist-to-hip ratio (WHR) in examined groups of peripuberty age with different BMI levels was found. Changes of HC in groups with different BMI also were not significant.

Correlation analysis also revealed a strong association between ASF and SSF in girls as well as in boys ($r=0.9$ and 0.93 respectively; Table 6). A high degree of correlation between WC and ASF confirms the significance of a subcutaneous fraction of adipose tissue in the formation of body size in obesity for both genders.

Table 6. Significant correlations between anthropometric indices (2nd phase).

	Sex	WC	TSF	SSF	ASF
WHR	Boys	0.31			
	Gils	0.51			
TSF	Boys	0.79			
	Gils	0.7			
SSF	Boys	0.88	0.84		
	Gils	0.91	0.73		
ASF	Boys	0.9	0.9	0.93	
	Gils	0.9	0.81	0.9	
SSF/TSF Index	Boys	0.6	0.32	0.74	0.58
	Gils	0.71	-	0.8	0.61

The highest level of correlation between directly measured indices discovered in this study is related to ASF. A quite strong association was found between all parameters apart from WHR with SSF (r= from 0.73 to 0.91; see Table 6). Moderate correlation (r= from 0.58 to 0.79) was detected between WC and TSF, WC and SSF/TSF index, and ASF and SSF/TSF index.

Thus, prevalence of a central type of adipose tissue allocation related to weight increase is observed in investigated samples of peripuberty children. Based on the above findings, a conclusion can be made that ASF and SSF have a high value as an indicator of an unfavorable prognosis related to cardiovascular pathology in future specified age groups. Further investigations are required to verify significance of the SSF/TSF index as a risk assessment tool for cardiovascular pathology development and also in the evaluation of gender specificity of the SSF/TSF index.

Discussion: Childhood obesity has become an epidemic on a worldwide scale[9] and it continues to increase[10]. Several serious consequences of excess weight occur in adults with the most common being chronic non-communic able diseases[1-5]. Anthropometric measurements as BMI are important for epidemiological investigations of obesity prevalence. Anthropometric indexes can best predict childhood obesity[11-12]. Unfortunally, there is a lack of anthropometric data in schoolchildren in the Russian Federation.

We established that in Moscow, for students aged 5 to 16 years old, obesity occurs mostly in the peripuberty period. Obesity prevalence is significantly higher in male adolescents than in female.

Detailed anthropometric examination of students demonstrated the greatest difference between groups by the abdominal and subscapular skinfolds. No significant difference between values of WHR in examined groups of peripuberty age with different BMI levels was found. WHR is widely used in adults to access central obesity and as a risk factor of different complications of obesity including cardiovascular ones[13]. However, limitations of WHR using for children population are discussed[12,14-16].

Ketel I.J.G. et al. (2007) reported that trunk skinfolds and WC are appropriate for assessment of central obesity (measured by computerized tomography). Peripheral skinfolds are the best index in peripheral fat deposition assessment. Whereas WHR had a weak correlation with computerized tomography's parameters of adipose tissue assessment[17]. Semiz S. et al. (2008) showed that thickness of subcutaneous fat in the abdominal area is a better predictor of obesity in children of peripuberty age[18]. Hence it can be supposed that ASF, SSF and SSF/TSF indices can be more valuable in children for qualitative assessment of fat mass distribution by means of a caliper.

Obesity maximum prevalence shows unfavorable features due to the predominance of central obesity indices both in boys and in girls. The most significant growth registered in thickness of abdominal and subscupular skinfolds was in boys. Botton J. et al. (2007) supported that such foundation might be associated with the high-level cardiovascular risk factor[19].

4. Conclusions

In Moscow, for students aged 5 to 16 years old, obesity occurs mostly in the peripuberty period: for boys at the age of 10-13, and for girls at the age of 9-10. At the same time, obesity prevalence is significantly higher in male adolescents than in female. Maximum of obese individuals in male cohort was registered at the age of 12 (39.2%) and in female cohort at the age of 10 (25.0%). In older groups, decline in obesity prevalence provides for a decrease in overweight prevalence. In male group it is more common at the age of 14 (33.3%) and in females at the ages of 13 and 16 (36.5%).

Obesity in named groups with its maximum prevalence shows unfavorable features due to the predominance of central obesity indices both in boys and in girls. The most significant growth registered in thickness of abdominal and subscupular skinfolds was in boys (4.3 and 4 times respectively). In the male group, abdominal obesity prevails in accordance with the assessment of all investigated parameters. Where as in females, distribution of subcutaneous adipose tissue is less significant.

The value of ASF and SSF as a tool for cardiovascular pathology risk factors assessment in urban students aged 9-13 was confirmed by correlative analysis. These parameters have the strongest correlation with all the others evaluated in this investigation. WHR didn't show any significance in the assessment of obesity in persons of peripuberty age.

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