Anthropometric and Lipid Parameters Trends in School Children: One Decade of YUSAD Study

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SUMMARY
Introduction Athersclerosis is a multifactorial disease that begins in childhood. There are few reports regarding influence of risk factors on the atherosclerotic processes in early period of life and adolescence.
Objective The aim of this study was to present and analyze risk factor trends in school children over a 10-year period that were included and followed-up by the Yugoslav Study of Atherosclerosis Precursors in School Children (YUSAD Study).
Methods There were three examinations of selected population from 13 centres. The first examination was performed when children were 10 years of age (first group; N=6381 participants), the second examination on the same population when they were 15 years of age (second group; N=5017) and third when children were 19/20 years of age (third group; N=1293). Evaluated parameters included: BMI, waist circumference (WaC) and lipid profile (total cholesterol, HDL cholesterol, LDL cholesterol and triglyceride).
Results A significant elevation of values (p<0.001) of BMI, WaC and triglycerides and a significant decline (p<0.001) of total cholesterol and LDL cholesterol in boys over 5 and 10-year period was noticed. There was a significant elevation (p<0.001) of BMI, WaC and HDL values and a significant decline in LDL cholesterol values in girls over the 5 and 10-year period.
Conclusion Our results point out that girls between 10 and 19/20 years have a better lipid profile during growth. It should be stressed out that childhood and adolescence can be more beneficial in the observation of risk factor influences on pathological, genetic and clinical levels.
Keywords: atherosclerosis; body mass index; cholesterol; children

INTRODUCTION

Atherosclerosis is a complex chronic disease that begins in childhood with accumulation of foam cells and T lymphocytes in the arterial intima [1]. It is often unrecognized in children, since this period of life is characterized by asymptomatic phase of the disease [2]. Beside well documented correlation of risk factors on the development of cardiovascular diseases (CVD) in adults, there is still limited data regarding its influence in children. However, there are studies stressing out the correlation of body mass index (BMI) and proatherosclerotic profile in children [3, 4]. It has been also noticed that hypertension in paediatric population is more likely to persist in later life, influencing the intima media thickness (IMT) changes [1] and that children with diabetes type I present with changes of IMT as well [5]. These observations clearly point out that even in early childhood there is a great need for establishing healthy life style habits to reduce the influence of risk [6].

OBJECTIVE

The aim of our study was to present and analyze risk factors trends in school children over 10 years that were included and followed-up in the Yugoslav Study of Atherosclerosis Precursors in School Children (YUSAD study).

MATERIAL AND METHODS

Study group

YUSAD study is a prospective multicentric study that began in 1998. It involved 13 centres from Serbia (Čukarica, Palilula, Požarevac, Užice, Kraljevo, Knjaževac, Bor, Niš, Priština, Subotica, Zaječar, Arilje and Despotovac), a centre from Greece (Athens), a centre from Montenegro (Podgorica) and a centre from Bosnia and Herzegovina (Gradiška).

There were three examinations of selected population. The first examination was conducted when children were 10 years of age (first group), the second examination of the same population done after 5 years when they were aged 15 years (second group) and the third one also after 5 years when the children were aged 19-20 years (third group). On the first examination the evaluated children included 6381 participants (3257 boys and 3124 girls). The second examination included 5017 participants (2567 boys and 2450 girls), while the

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third one evaluated 1293 participants (555 boys and 738 girls).

Evaluated parameters included BMI, waist circumference (WaC) and lipid profile (total cholesterol, HDL cholesterol, LDL cholesterol and triglyceride).

Data collection

Prior the inclusion of children into the study, a written informed consent was obtained from parents or guardians. A standardized questionnaire was used and performed by board certified paediatricians. In all 3 examinations protocols were identical. The children from all groups were randomly chosen from both genders.

Statistical presentation and analysis

For the presentation of BMI, WaC and lipid profile we used percentual distribution of the interval 5%, 25%, 50%, 75% and 95%, while mean values with standard deviation were used for the determination of trends and statistical significance among different age groups and between genders of the same age groups. For statistical analysis of BMI, WaC and lipid profile values we used students t test, with statistical significance set on $p<0.05$. For 5 years and 10 years trends presentation we used difference between two mean values (ΔMV); the positive trend was presented by sign +, while the negative one by -, and these differences between genders in same age groups were presented by ΔMV, but for higher values for boys a "b" letter was added and for higher values for girls a "g" letter.

RESULTS

In our study on the first and second examinations we evaluated 4208 children (50.48% boys and 49.52% girls) regarding BMI and WaC. For the evaluation of total cholesterol on the first examination we included 5770 participants (51.27% boys and 48.73% girls), for HDL 5758 school children (51.29% boys and 48.71% girls), LDL 5732 children (51.31% boys and 48.69% girls) and 5770 regarding triglycerides (51.27% boys and 48.73%

girls). For the evaluation of total cholesterol on the second examination we included 3958 children (51.04% boys and 48.96% girls), for HDL 3585 children (51.24% boys and 48.76% girls), for LDL 3578 children (51.26% boys and 48.74% girls) and for triglycerides 3959 children (51.07% boys and 48.93% girls). On the third examination for BMI and WaC we included 1293 participants (42.92% boys and 57.08% girls). For the evaluation of total cholesterol on the third examination we included 1278 children (42.98% boys and 57.02% girls), for HDL 1274 children (42.94% boys and 57.06% girls), for LDL 1270 participants (42.99% boys and 57.01% girls) and for triglycerides 1278 children (42.96% boys and 57.04% girls).

In Table 1 and Table 2 we present the percentual distribution of anthropometric and lipid parameters in different age groups (10 years, 15 years and 19-20 years) separately for boys and girls.

In Table 3 we present trends and correlation of observed anthropometric parameters (BMI and WaC) and lipid profile parameters (HDL, LDL and triglycerides) in the boys. There was a significant elevation of values ($p<0.001$) for BMI, WaC and triglycerides in boys population over 5 and 10 year period, while regarding other parameters of the lipid profile there were no statistically significant changes in HDL cholesterol values over 5 and 10 year period. For total cholesterol and LDL cholesterol, between the first and second age group, as well as over the 10-year period, a significant decline ($p<0.001$) was observed.

In Table 4 we present trends and correlation of observed anthropometric parameters (BMI and WaC) and lipid profile parameters (HDL, LDL and triglycerides) for the girl population. We found a significant elevation of values ($p<0.001$) for BMI, WaC and HDL in the girls population over 5 and 10-year period, while for other parameters from the lipid profile there was a significant decline in LDL cholesterol values over 5 and 10-year period. In the children between 10 and 15 years of age we did not find statistical significance ($p>0.05$) regarding total cholesterol, while between 15 and 19-20 years we noticed a significant decline ($p<0.001$). Regarding triglyceride value trends, there was a significant elevation ($p<0.001$) between 10 and 15 years of life, while during the next 5 years we noticed a significant decline ($p<0.001$) in triglyceride values, implicating the absence of statistical significance ($p>0.05$) in trend values changes over 10-year period.

Table 1. Percentual distribution of anthropometric parameters

| Parameters | Gender | Age group | Percentiles | | | | |
			5	25	50	75	95
BMI (kg/m²)	Boys	First	13.98	15.26	16.45	18.25	22.89
		Second	16.06	18.02	19.60	21.84	26.89
		Third	18.41	20.61	22.44	24.45	29.01
	Girls	First	13.52	14.92	16.30	18.29	22.96
		Second	16.32	18.31	19.90	21.97	27.15
		Third	17.60	19.15	20.57	22.31	26.81
WaC (cm)	Boys	First	51.50	57.00	60.00	65.50	79.00
		Second	53.00	67.00	71.50	77.00	91.50
		Third	69.00	75.00	80.00	86.00	98.00
	Girls	First	51.00	55.70	59.00	65.00	77.00
		Second	60.00	64.50	69.00	74.00	87.00
		Third	62.00	68.00	73.00	78.00	89.00

Table 2. Percentual distribution of lipid parameters

Parameters	Gender	Age group	Percentiles				
			5	25	50	75	95
Total cholesterol (mmol/L)	Boys	First	3.16	3.80	4.27	4.77	5.60
		Second	3.00	3.60	4.02	4.60	5.60
		Third	3.10	3.61	4.10	4.59	5.41
	Girls	First	3.20	3.85	4.36	4.84	5.70
		Second	3.19	3.86	4.31	4.91	5.94
		Third	3.15	3.80	4.25	4.77	5.53
HDL (mmol/L)	Boys	First	0.90	1.20	1.41	1.64	2.06
		Second	0.80	1.06	1.36	1.70	2.20
		Third	0.85	1.16	1.39	1.68	2.07
	Girls	First	0.90	1.16	1.39	1.60	2.00
		Second	0.87	1.11	1.46	1.86	2.38
		Third	1.00	1.37	1.62	1.99	2.59
LDL (mmol/L)	Boys	First	1.54	2.16	2.57	3.12	3.90
		Second	1.11	1.80	2.24	2.90	4.00
		Third	1.32	1.87	2.24	2.70	3.50
	Girls	First	1.63	2.22	2.68	3.19	4.10
		Second	1.20	1.93	2.40	3.00	4.10
		Third	1.19	1.82	2.21	2.70	3.47
Triglycerides (mmol/L)	Boys	First	0.35	0.51	0.68	0.90	1.40
		Second	0.40	0.60	0.81	1.00	1.59
		Third	0.43	0.63	0.81	1.11	1.89
	Girls	First	0.40	0.58	0.73	0.98	1.53
		Second	0.42	0.65	0.86	1.03	1.60
		Third	0.40	0.57	0.72	0.93	1.43

Table 3. Anthropometric and lipid parameters trends and correlation in boys

Boys	First and second group		Second and third group		First and third group	
	ΔMV	t-test	ΔMV	t-test	ΔMV	t-test
BMI (kg/m²)	+3.14	33.11*	+2.57	16.29*	+5.81	41.30*
WaC (cm)	+11.16	41.58*	+7.81	17.67*	+18.97	48.46*
Total cholesterol (mmol/L)	-0.13	5.81*	-0.01	0.26	-0.14	4.03*
HDL (mmol/L)	-0.02	1.74	+0.01	0.46	-0.01	0.58
LDL (mmol/L)	-0.29	12.37*	-0.05	1.24	-0.34	9.96*
Triglycerides (mmol/L)	+0.12	10.37*	+0.08	3.61*	+0.20	10.41*

* p<0.001

Table 4. Anthropometric and lipid parameters trends and correlation in girls

Girls	First and second group		Second and third group		First and third group	
	ΔMV	t-test	ΔMV	t-test	ΔMV	t-test
BMI (kg/m²)	+3.58	36.46**	+0.61	4.31**	+4.19	33.43**
WaC (cm)	+8.96	34.41**	+3.57	9.71**	+12.53	35.76**
Total cholesterol (mmol/L)	+0.04	1.66	-0.12	3.35**	-0.08	2.42*
HDL (mmol/L)	+0.11	8.92**	+0.18	8.45**	+0.29	18.19**
LDL (mmol/L)	-0.23	9.14**	-0.24	6.43**	-0.47	14.67**
Triglycerides (mmol/L)	+0.08	6.87**	-0.08	4.25**	0.00	0.00

* p<0.05; ** p<0.001

Table 5. Anthropometric and lipid parameters trends and correlation between genders (boys/girls)

T test	First group		Second group		Third group	
	ΔMV	t-test	ΔMV	t-test	ΔMV	t-test
BMI (kg/m²)	0.20 (b)	2.26*	0.24 (g)	2.31*	1.72 (b)	9.98***
WaC (cm)	0.94 (b)	3.77***	3.14 (b)	11.26***	7.38 (b)	15.40***
Total cholesterol (mmol/L)	0.08 (g)	3.92***	0.25 (g)	9.53***	0.14 (g)	3.25**
HDL (mmol/L)	0.04 (b)	4.33***	0.09 (g)	5.86***	0.26 (g)	9.54***
LDL (mmol/L)	0.09 (g)	4.48***	0.15 (g)	5.13***	0.04 (b)	1.00
Triglycerides (mmol/L)	0.07 (g)	6.91***	0.03 (g)	2.27*	0.13 (b)	4.32***

* p<0.05; ** p<0.01; *** p<0.001

In Table 5 we present trends and correlation of observed anthropometric parameters (BMI and WaC) and lipid profile parameters (HDL, LDL and triglycerides) between genders of the same age group. We found a significantly higher BMI, WaC and HDL cholesterol values in the boy population aged 10 years, WaC values in boys aged 15 years and BMI, WaC, LDL and triglyceride values in boys aged 19/20 years. Other parameters in the observed age groups were significantly frequent in the girl population.

DISCUSSION

Over the past years, it was Vague in 1947 that was among the first to question the importance of fat distribution on obesity complications over excess fatness [7]. Nowadays, we are the witnesses of epidemiological proportions of obesity in children that are rising especially in last decades. It is important to stress out that obesity, particularly abdominal, is independent risk factor for the elevation of blood pressure values and later development of CVD [8]. Also, the abdominal fat correlates with BMI, implicating a higher proportion in obese rather than in overweight children and adolescents [9].

We demonstrated that over 5 and 10 year period, BMI and waist circumference values were increased. Such an observation is in correlation with physiological changes (growth) during this period. However, the proportion of WaC increase was higher in girls between 10 and 15 years of age than between 15 and 19-20 years of age, while there was less discrepancy in the difference between the proportions of the two 5-year age groups in boy population.

The importance of abdominal fat on overall health status and the need for its reduction was presented by Despres, who critically questioned abdominal fat as cholesterol of the 21st century [10].

Regarding the lipid profile, in the group of boys there was a negative trend for total cholesterol that was significant for the age group between 10 and 15 years and 10 and 19-20 years. This observation was not found in the girl population, where a significant decline in total cholesterol values was noticed later in life (between 15 and 19-20 years).

Recent studies have demonstrated that inflammation and factors influencing inflammatory processes are equally important as other risk factors for atherosclerosis development [11, 12]. Therefore, LDL cholesterol fraction levels are important to follow-up, since it has been described that oxidized fraction of LDL could initiate and maintain the production of inflammatory mediators [13]. For females, our study showed that there was a strong association between age and positive profile for the LDL fraction of cholesterol. It was shown that the decline of values was significant over 5-year period in the first and second age group, while in boys the significant decline was shown only for the age group between 10 and 15 years and for overall 10 year period. However, LDL values were compared between genders of the same age group; it was noticed that girls were among those who had a significantly higher levels for age groups of 10 and 15 years, while gender inversion for LDL values was seen in the third age group but without significance.

Our study demonstrated that girls had better lipid profile during growth between 10 and 19-20 years of life than boys, especially regarding the HDL fraction of cholesterol and for triglycerides between 15 and 19-20 years of life.

CONCLUSION

Expansion of knowledge and modernization of science lead us to seek more effectively other risk factors and to evaluate cellular and molecular interactions in order to obtain directions for possible new insights into atherosclerosis processes, to predict influences between different factors and to establish more effective treatment possibilities. For this purpose, childhood, as an early period of life, and the adolescent period can be more beneficial in the observation of risk factor influences on pathological, genetic and clinical levels.

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Трендови антропометријских и липидних параметара код деце школског узраста: десет година студије ЈУСАД

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КРАТАК САДРЖАЈ

Увод Атеросклероза је мултифакторска болест која започиње још у детињству. Објављено је мало података о утицају фактора ризика на процесе атеросклерозе у раном периоду живота и адолесценцији.

Циљ рада Циљ рада је био да се прикажу и анализирају трендови фактора ризика код деце школског узраста која су била укључена у Југословенску студију прекурсора атеросклерозе код школске деце (ЈУСАД) током десетогодишњег периода.

Методе рада Обављена су три прегледа на одабраној популацији из 13 центара. Први преглед је обухватио децу узраста од 10 година (прва група; 6.318 испитаника), други преглед је урађен на истој популацији када су деца имала 15 година (друга група; 5.017 испитаника), а трећи преглед је обављен код деце узраста 19-20 година (трећа група; 1.293 испитаника). Испитивани су следећи параметри: индекс телесне масе (енгл. *Body Mass Index – BMI*), обим струка (ОС) и липидни профил (ниво укупног, *LDL* и *HDL* холестерола и ниво триглицерида).

Резултати Током петогодишњег и десетогодишњег периода код дечака су уочени значајно повећање вредности *BMI*, ОС и триглицерида (*p*<0,001) и значајно смањење вредности укупног и *LDL* холестерола (*p*<0,001). Код девојчица су током посматраног периода запажени значајно повећање вредности *BMI*, ОС и *HDL*-холестерола (*p*<0,001) и значајно смањење нивоа *LDL*-холестерола (*p*<0,001).

Закључак Резултати истраживања су показали да девојчице узраста од 10 и 19-20 година имају бољи липидни профил. Неопходно је истаћи да детињство и адолесценција, као рани периоди живота, могу имати велику корист у истраживањима утицаја фактора ризика на патолошком, генетичком и клиничком нивоу.

Кључне речи: атеросклероза; индекс телесне масе; холестерол; деца