

Distribution and Correlations of Non-High-Density Lipoprotein Cholesterol in Roma and Caucasian Children: The Slovak Lipid Community Study

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ABSTRACT

Non-high-density lipoprotein (non-HDL) cholesterol [total cholesterol minus high-density lipoprotein (HDL) cholesterol] is considered a better predictor of coronary heart disease (CHD) risk than low-density lipoprotein (LDL) cholesterol. The Slovak Roma population have approximately 2.5-fold higher premature CHD mortality than the overall population. It is agreed that detection of dyslipidemia and prevention of atherosclerosis by controlling CHD risk factors should begin in childhood. However, only limited population-based data are available for non-HDL cholesterol in children. Hence the aim of the present cross-sectional study has been to determine population frequency data and correlations of non-HDL cholesterol in 788 Roma and Caucasian children (42% Roma, 51% male), aged 7–17, from Central Slovakia, as part of the Slovak Lipid Community Study. Roma children, compared to Caucasians, had higher serum levels of total cholesterol, LDL cholesterol and HDL cholesterol, were less physically active, smoked more, and had lower body mass index and blood pressure (all at $p < 0.05$). Serum non-HDL cholesterol levels were similar in Roma and Caucasians (in mmol/L: 2.74 vs. 2.65, $p = 0.062$) and similar too in boys and girls (2.66 vs. 2.73, $p = 0.092$), but higher in the younger (7–11 yrs.) than in the older (12–17 yrs.) age group (2.77 vs. 2.62, $p < 0.001$). Non-HDL cholesterol was negatively associated with age and cigarette smoking ($r = -0.09$ and -0.11 respectively, $p < 0.05$), whereas general obesity as measured by body mass index, waist circumference and per capita income were positively correlated with non-HDL cholesterol ($r = 0.09–0.14$, $p < 0.05$). Intermediate or strong positive correlations were found with other lipid variables under study: triglycerides, total and LDL cholesterol and apolipoprotein (Apo) B ($r = 0.43–0.93$, $p < 0.001$). No significant association was noted between non-HDL cholesterol and blood pressure, physical activity status, and HDL cholesterol and Apo AI. In a multivariate analysis: body mass index, age and cigarette smoking accounted for 3.3% of the variance in non-HDL cholesterol. The non-HDL cholesterol cut-off points identified as corresponding to the recommended cut-off points of LDL cholesterol for CHD risk assessment and treatment of dyslipidemia in pediatric population were: acceptable < 3.30 , borderline 3.31–3.81 and high ≥ 3.82 mmol/L. The prevalence of dyslipidemia according to the high non-HDL cholesterol value was 5.4% in Roma and 4.2% in Caucasian children ($p = 0.098$). In conclusion, our results confirm no ethnic-, gender- or age-related differences in non-HDL cholesterol levels between Slovak Roma and Caucasian children. In both ethnic groups, overweight and obesity and also higher socio-economic status – but not cigarette smoking – are adversely associated with non-HDL cholesterol levels in childhood.

Key words: Roma, children, non-HDL cholesterol, ethnicity, coronary heart disease, Slovakia

Introduction

Several clinical trials in adult populations have shown that non-high-density lipoprotein (non-HDL) cholesterol, routinely measured as total cholesterol minus protective high-density lipoprotein (HDL) cholesterol, is a

better predictor of coronary heart disease (CHD) risk than low-density lipoprotein (LDL) cholesterol^{1–3} because its concentration includes all of the potentially atherogenic lipoprotein subspecies⁴. Although atherosclerotic

changes begin very early in life and progress throughout adulthood, only limited data on non-HDL cholesterol are available for the child population. In the Bogalusa Heart Study of CHD risk factors in North American children and adolescents, the population frequency distribution of non-HDL cholesterol and the usefulness of its determination in the prediction of adult dyslipidemia were reported^{5,6}. Most recently, Seki et al.⁷ and Uçar et al.⁸ have described non-HDL cholesterol distribution data in Brazilian and Turkish urban and rural schoolchildren respectively. No other extensive data, to our knowledge, have been published about children.

In Europe, there are about nine million Roma living today⁹. They are best characterized as a conglomerate of genetically isolated founder populations¹⁰. The Roma migrated in several waves from northern India into Europe between the ninth and fourteenth centuries. The current size of the Slovak Roma population is about 400,000, which means that these ethnic Asian descendants represent 7.2% of the general population, a 31.2% increase on the 1990 figure¹¹. Their poor health status is notorious and stems from bad long-term economic circumstances, low level of educational attainment and unhealthy lifestyle. Roma have approximately 2.5-fold higher premature CHD mortality than the overall Slovak population, and among their children there is generally a higher prevalence of infectious diseases, injuries, genetic disorders, obesity, and insulin resistance^{12,13}.

In the present analysis, we have used population-based data from the biracial (Roma–Caucasian) Slovak Lipid Community Study (SLCS), in order to assess the distribution and relationship of non-HDL cholesterol levels to other lipid and non-lipid CHD risk factors in children aged 7–17.

Materials and Methods

The SLCS is a community-based study of CHD risk factors among children and adolescents living in the Rimavská Sobota district (1,471 km²) in the southern part of Central Slovakia. In 2000, the population of this district was more-less biracial: of a total of 82,970 inhabitants 23,535 were Roma, with 40–50% of children younger than 15 years of age¹¹. Rimavská Sobota district includes the cities of Rimavská Sobota, Tisovec and Hnúšť'a, as well as the surrounding rural areas.

Study population

Between October 2005 and January 2007, a random sampling method was used to interview a representative sample of 7- to 17-year-old Roma children (n=535), and a neighbourhood comparison group of Caucasian children (n=514) for participation in a cross-sectional biracial study. Evaluation of ethnicity according to skin, eye and hair colour, including antecedents, cultural traditions and language was used to identify Roma individuals. In relation to the majority population, this Roma population sample may be considered as semi-integrated. Of the 823 eligible participants (positive response 78%), 16 were

excluded for lack of fasting blood samples, 11 because of some missing data and 8 for acute infectious disease, and 788 remained for final analysis (42% Roma, 51% male).

The parents or guardians of each child gave their informed consent to participate in the study. Ethical approval was granted by the Ethics Committee of the F. D. Roosevelt Faculty Hospital.

General examination

Biometric and anthropometric measurements of blood pressure, height and weight were made by trained health personnel. Height was measured by a permanently fixed stadiometer, in metres. Waist circumference, as an index of visceral obesity, was measured to the nearest 0.5 cm with a non-stretchable measuring tape at the high point of the iliac crest, at the end of normal expiration. As a measure of overall body fatness, the body mass index values were calculated as weight (in kilogrammes) divided by height squared (in square metres) and were compared with age- and gender-specific normal-weight standards for Czech and Slovak pediatric population¹⁴. Blood pressure measurement was performed in sitting position through the use of a mercury-gravity manometer, in millimetres of Hg; the mean of ≥ 2 measurements obtained under relaxed conditions was used.

Information regarding age, socio-economic status, cigarette smoking, and physical activity were collected by questionnaire. Socio-economic status was represented by *per capita* income, received from salaries coming from regular or occasional jobs, social welfare support allowance and child allowance. The households were divided into three income groups: less than 2.5 *per day*, i. e. children living below the poverty line, up to 15 *per day*, satisfactory living standard, and more than 15 *per day* – higher living standard.

Smoking status was assessed qualitatively, as a proportion of current smokers, and quantitatively, using the number cigarettes smoked weekly. According to self-reported data the average number of hours *per week* of different types of physical activity, in school and free time, was calculated. Information regarding the family history of premature CHD and diabetes mellitus among relatives was also obtained. Data concerning the alcohol intake assessment in children were, in our opinion, unreliable: therefore, they were omitted from the final analysis.

Laboratory procedures

Blood samples were obtained after overnight fasting, in sitting position by venipuncture. Blood specimens were processed in the local clinical laboratory (Rimavská Sobota), where the obtained sera were temporarily stored frozen at -20°C , and then transported in coolbags to the central laboratory of F. D. Roosevelt Faculty Hospital in Banská Bystrica. Here, total cholesterol, HDL cholesterol, and triglyceride standardized methods were performed on an Olympus AU2700 analyzer (Olympus Diagnostics Systems, Melville, NY, USA). Total cholesterol was measured by a coupled enzymatic reaction, HDL

cholesterol by means of homogeneous enzymatic colourimetric assay with anti-beta-lipoproteins antibodies, and triglycerides were assayed enzymatically, after hydrolysis to glycerol (Pliva-Lachema reagents and calibrators, Brno, Czech Republic). The sera were analyzed in a few analytical runs to reduce systematic bias and interassay variation; all coefficients of variation (CVs) were <3%. LDL cholesterol was calculated using a Friedewald formula¹⁵, while non-HDL cholesterol was calculated as the difference between total cholesterol and HDL cholesterol. Total apolipoprotein (Apo) B and Apo AI concentrations were measured by an immunonephelometric technique on an Immage analyzer (Beckman-Coulter Inc., Fullertown, CA, USA) using the diagnostics of the same manufacturer, with CVs of 5%.

Statistical analysis

Descriptive characteristics of the participants in the analysis were calculated separately for Roma and Caucasian children. Means, confidence intervals, standard deviations and percentiles were calculated for continuous variables, and frequencies or percentages were calculated for categorical variables. Differences in quantitative variables were tested using Student's t-test for unpaired data, and differences in categorical variables by Fisher's exact test.

Analysis of the covariance method was used to assess differences in mean non-HDL cholesterol levels between gender and ethnic groups. Multiple comparisons were performed by using the Tukey test. Age-adjusted Spearman's partial correlation coefficients were calculated to determine the bivariate relationships between non-HDL

cholesterol and investigated variables. A forward stepwise regression method was used to determine which anthropometric and behavioural factors correlated independently with non-HDL cholesterol; the criterion for entry into the model was $p < 0.05$. A simple regression model predicting non-HDL cholesterol concentration from LDL cholesterol was also computed.

All probability values presented are 2-tailed, and probability values <0.05 were considered as statistically significant. The statistical package SPSS version 13.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for data analyses.

Results

The baseline characteristics of Roma and Caucasian children at the time of the blood sampling are presented in Table 1. Roma children, compared to Caucasians, were slightly younger and much leaner, and had significantly lower systolic and diastolic blood pressure values, without hypertension in both ethnic groups. By contrast, the proportion of persons who smoked and reported a low level of physical activity was higher in Roma than in Caucasian children. For Roma, significantly higher mean levels of total cholesterol, LDL cholesterol, HDL cholesterol and Apo AI were confirmed. Poverty and family history rates of premature CHD or diabetes mellitus were also substantially higher among the relatives of Roma children.

Serum non-HDL cholesterol means and selected percentiles by ethnicity, gender and age group are shown in Table 2. For children of 7 to 17 years of age, the 95th per-

TABLE 1
BASELINE CHARACTERISTICS OF 788 ROMA AND CAUCASIAN CHILDREN AGED 7–17: THE SLOVAK LIPID COMMUNITY STUDY

Characteristic	Roma (n=331)	Caucasians (n=457)	p-value
Age, mean (SD), yrs.	12.4 (3.8)	12.8 (3.7)	0.141
Body mass index, mean (SD)	18.1 (3.8)	19.7 (3.9)	<0.001
Waist circumference, mean (SD), cm	63 (12)	69 (13)	<0.001
Overweight or obesity	40 (12)	92 (20)	<0.001
Blood pressure, mean (SD), mm Hg			
– systolic	102.9 (11.6)	107.7 (10.6)	<0.001
– diastolic	67.1 (9.5)	70.1 (8.7)	<0.001
Current smokers	73 (22)	73 (16)	0.009
Physical inactivity (less than 2 hr per week)	263 (79)	289 (63)	<0.001
Total cholesterol, mean (SD), mmol/L	3.91 (0.73)	3.79 (0.74)	0.015
LDL cholesterol, mean (SD), mmol/L	2.30 (0.56)	2.21 (0.59)	0.049
HDL cholesterol, mean (SD), mmol/L	1.18 (0.27)	1.13 (0.29)	0.032
Triglycerides, mean (SD), mmol/L	0.94 (0.49)	0.97 (0.47)	0.261
Apo AI, mean (SD), g/L	1.27 (0.26)	1.20 (0.22)	0.009
Apo B, mean (SD), g/L	0.70 (0.17)	0.69 (0.17)	0.281
Poverty (less than 2.5 euro per day)	192 (58)	41 (9)	<0.001
History of CHD and diabetes mellitus	136 (41)	151 (33)	0.006

SD – standard deviation; other abbreviations as defined in text
Data are expressed as *n* (%) unless otherwise indicated

TABLE 2
MEAN, CONFIDENCE INTERVAL OF MEAN AND SELECTED PERCENTILES OF SERUM NON-HDL CHOLESTEROL IN CHILDREN BY AGE, GENDER AND ETHNICITY: THE SLOVAK LIPID COMMUNITY STUDY

Participants	n	Age (years)	Mean (95% CI) (mmol/L)	Percentiles (mmol/L)				
				5	25	50	75	95
Roma male	82	7–11	2.84 (2.70–2.98)	1.94	2.37	2.72	3.18	3.92
	83	12–17	2.63 (2.49–2.77)	1.67	2.04	2.58	3.13	3.86
	165	7–17	2.74 (2.64–2.83)	1.70	2.32	2.66	3.16	3.86
Caucasian male	110	7–11	2.60 (2.48–2.72)	1.53	2.07	2.57	3.01	3.83
	130	12–17	2.59 (2.48–2.70)	1.65	2.13	2.55	2.98	3.82
	240	7–17	2.59 (2.51–2.67)	1.60	2.11	2.55	2.99	3.83
Roma female	79	7–11	2.82 (2.68–2.97)	2.05	2.45	2.74	3.01	3.95
	87	12–17	2.67 (2.54–2.81)	1.70	2.27	2.67	2.98	3.88
	166	7–17	2.74 (2.65–2.83)	1.82	2.35	2.72	2.99	3.94
Caucasian female	97	7–11	2.86 (2.74–2.99) ^{a,b}	1.93	2.30	2.79	3.38	4.29
	120	12–17	2.60 (2.48–2.71)	1.67	2.14	2.48	2.98	3.76
	217	7–17	2.72 (2.63–2.80)	1.76	2.23	2.59	3.08	3.86
Total	788	7–17	2.69 (2.64–2.73)	1.72	2.25	2.62	3.05	3.86

^a Females > males and ^b younger > older age group ($P < 0.05$), controlling for age, body mass index and cigarette smoking (n/week)

TABLE 3
AGE-ADJUSTED SPEARMAN'S PARTIAL CORRELATION COEFFICIENTS BETWEEN SERUM NON-HDL CHOLESTEROL AND RISK FACTORS AMONG 788 ROMA AND CAUCASIAN CHILDREN: THE SLOVAK LIPID COMMUNITY STUDY

Characteristic	Body mass index	Waist circumference	Blood pressure ^b	Income	Physical activity	Cigarette smoking ^c	Non-HDL-C
Age ^a	0.54 [†]	0.69 [†]	0.75 [†]	0.02	-0.03	0.38 [†]	-0.09*
Body mass index		0.65 [†]	0.35 [†]	0.10*	-0.13 [†]	-0.03	0.14 [†]
Waist circumference			0.47 [†]	0.18 [†]	0.01	-0.10*	0.09*
Blood pressure ^b				-0.01	-0.05	-0.01	0.02
Income					0.23 [†]	-0.22 [†]	0.09*
Physical activity						-0.13 [†]	-0.05
Cigarette smoking ^c							-0.11 [†]

* Correlation is significant at the 0.05 level (2-tailed)

[†] Correlation is significant at the 0.01 level (2-tailed)

^a Spearman correlation coefficients no controlling for age

^b Systolic blood pressure only

^c Number of smoked cigarettes per week

Non-HDL-C – non-HDL cholesterol

centile for non-HDL cholesterol was 3.86 mmol/L and the mean was 2.69 mmol/L (95% CI 2.64–2.73). Overall, Roma children aged from 7 to 17 had a similar mean level of non-HDL cholesterol to Caucasian children of the same age (in mmol/L: 2.74 vs. 2.65, $p=0.062$). Furthermore, there were no significant differences between Roma and Caucasians in the means among gender and age groups. Similarly, no significant male-female difference was seen in the total sample of participants (2.66 vs. 2.73, $p=0.092$). However, Caucasian girls aged 7 to 11, but not those aged 12 to 17, had significantly higher levels of non-HDL cholesterol than Caucasian boys. Except for Caucasian boys of 7 to 11 years of age, a markedly increase in mean

non-HDL cholesterol levels was seen in younger age groups when compared to children aged 12 to 17 (2.77 vs. 2.62, $p<0.001$).

The relation of non-HDL cholesterol to age, body fatness, blood pressure, income, physical activity and cigarette smoking is presented in Table 3. Age was strongly positively correlated to body mass index, waist circumference, blood pressure and cigarette smoking, whereas an inverse association was found to non-HDL cholesterol. Body mass index and waist circumference were positively associated with non-HDL cholesterol, although these correlations were of borderline significance. When we compared age-matched overweight and obese chil-

TABLE 4
AGE-ADJUSTED SPEARMAN'S PARTIAL CORRELATION COEFFICIENTS BETWEEN LIPID ANALYTES AMONG 788 ROMA AND CAUCASIAN CHILDREN: THE SLOVAK LIPID COMMUNITY STUDY

Analyte	LDL-C	HDL-C	TG	Apo AI	Apo B	Non-HDL-C
TC	0.89 [†]	0.46 [†]	0.31 [†]	0.30 [†]	0.70 [†]	0.92 [†]
LDL-C		0.16 [†]	0.14 [†]	0.11 [†]	0.77 [†]	0.93 [†]
HDL-C			-0.19 [†]	0.63 [†]	-0.02	0.08
TG				-0.15 [†]	0.33 [†]	0.43 [†]
Apo AI					0.06	-0.06
Apo B						0.80 [†]

[†]Correlation is significant at the 0.01 level (2-tailed)
TC – total cholesterol; TG – triglycerides

TABLE 5
FORWARD STEPWISE REGRESSION MODEL TO PREDICT NON-HDL CHOLESTEROL: THE SLOVAK LIPID COMMUNITY STUDY

Independent variable ^a	Coefficient <i>b</i>	Standard error <i>se(b)</i>	t	p-value
Constant	2.570	0.149	17.210	0.000
Body mass index	0.026	0.009	2.994	0.003
Age	-0.021	0.009	-2.372	0.018
Cigarettes/week	-0.004	0.002	-1.753	0.080

$R^2 = 0.033$ (adjusted $R^2 = 0.027$)

^aThe variables listed in table entered the model in the order as shown at $p < 0.05$

dren with those of normal weight, serum levels of non-HDL cholesterol were significantly higher in overweight and obese than in normal weight Roma children (2.97 *vs.* 2.71, $p = 0.016$), but not in Caucasian children (2.89 *vs.* 2.72, $p = 0.122$). A weak inverse association was seen between non-HDL cholesterol and cigarette smoking. In children aged 12–17, however, smokers had significantly lower levels of non-HDL cholesterol than non-smokers, especially among Caucasians (2.45 *vs.* 2.78, $p < 0.001$). Income was positively associated with non-HDL cholesterol; children living below the poverty line had significantly lower non-HDL cholesterol than those with a higher living standard (2.72 *vs.* 2.97, $p < 0.043$). No other significant correlations were found between non-HDL cholesterol and blood pressure and physical activity status.

The relation of non-HDL cholesterol to selected lipid and lipoprotein variables is shown in Table 4. As expected, both non-HDL cholesterol and LDL cholesterol associated strongly both with each other and with total cholesterol and Apo B. Although both non-HDL cholesterol and LDL cholesterol were related positively to triglycerides, the magnitude of correlation was relatively higher for the former. No significant association was noted between non-HDL cholesterol and HDL cholesterol or Apo AI.

The results of forward stepwise regression analysis of non-HDL cholesterol on each independently related variable are presented in Table 5. Body mass index, age and cigarette smoking were the major factors that contributed to the explained variance of non-HDL cholesterol.

Gender and ethnicity contributed to a lesser extent to the variance and were excluded from the fit-model. Overall, the identified independent variables accounted for 3.3% (adjusted $R^2 = 2.7\%$) of the variance in non-HDL cholesterol levels.

To present non-HDL cholesterol concentrations in a context of obviously used LDL cholesterol cut-off points in clinical decision making, a regression of non-HDL cholesterol on LDL cholesterol was performed. Several LDL cholesterol levels determine the steps for risk assessment and treatment in children. In Table 6 we present the non-HDL cholesterol values that correspond to those of the LDL cholesterol cut-off points from the National Cholesterol Education Programme (NCEP)¹⁶ and the American Academy of Pediatrics¹⁷. Using this approach, non-HDL cholesterol levels were (on average 0.5 mmol/L)

TABLE 6
CLASSIFICATION OF LDL CHOLESTEROL FROM NCEP PEDIATRIC PANEL AND EQUIVALENT NON-HDL CHOLESTEROL LEVELS IN CHILDREN: THE SLOVAK LIPID COMMUNITY STUDY*

Category	LDL cholesterol (mmol/L)	Non-HDL cholesterol [†] (mmol/L)
Acceptable	<2.83	<3.30
Borderline	2.83–3.37	3.30–3.81
High	≥3.37	≥3.82

* Sample size: 788

[†] Non-HDL cholesterol = $0.311 + 1.056 \times \text{LDL cholesterol}$

higher than LDL cholesterol levels over this range. The prevalence of a risk dyslipidemia according to non-HDL cholesterol cut-off value was comparable between Roma and Caucasian children: 5.4% and 4.2% ($p=0.098$) respectively.

Discussion

The SLCS first of all provides the population-based data on the distribution and correlations of non-HDL cholesterol for Roma children in a biracial (Roma-Caucasian) study. The levels of non-HDL cholesterol were similar in Roma and Caucasian children, higher in younger Caucasian girls than in boys of the same age and origin, and inversely correlated to age and cigarette smoking. In addition, non-HDL cholesterol was adversely associated to overweight or obesity, and higher income of households.

The mean concentration of serum non-HDL cholesterol levels determined in the whole group of participants in SLCS was similar to Turkish children of the same age⁸, but higher than in Brazilian children⁷ and markedly lower than those from Bogalusa⁶. Geographic and ethnic-specific differences of serum lipid and lipoprotein levels were observed repeatedly, resulting from genetic differences in the investigated populations and environmental factors¹⁸.

Perhaps the most interesting result in the present study, regarding increased CHD incidence and mortality in Roma, is the finding of no Roma-Caucasian differences in non-HDL cholesterol levels, especially in adolescent children. Recent comparative studies of adults have reported higher levels of lipoprotein(a) and lower levels of HDL cholesterol in women, but not in men, of Asian Indian origin when compared to Caucasian Americans^{19,20}. Reports on Oriental-Caucasian differences in blood lipids and lipoproteins in childhood, however, are scarce. An earlier representative study reported markedly lower levels of total cholesterol in Pakistanis than in other ethnic groups, including Caucasians²¹. In this context, the similar levels of non-HDL cholesterol in Roma and Caucasian children observed in our study may reflect a high dietary intake of animal fats and low consumption of food with low glycemic index and fibre, as well as the lesser educational attainment of the Roma population¹³.

The observed significant male-female difference of non-HDL cholesterol in Caucasian children corresponds with the previous data, showing higher LDL and very low-density lipoprotein (VLDL) cholesterol and lower HDL cholesterol in girls than in boys, especially among adolescent children^{5–8}. Similarly, the significantly lower levels of non-HDL cholesterol in the older age groups in the present study may reflect the previously well-documented puberty-related decreases in total cholesterol, LDL cholesterol and HDL cholesterol levels^{5,8,22}. These differences are undoubtedly related to the hormonal system transformation in puberty which directly influences serum levels of lipids and lipoproteins. Furthermore, a variation of lipid and lipoprotein levels in childhood may

affect anthropometric characteristics increasing linearly with age²³.

As expected, the correlations between non-HDL cholesterol and total cholesterol is strong and similar to that of Bogalusa and to the Brazilian study^{5,7}. Similarly, the finding that inverse association of triglycerides with non-HDL cholesterol is better, compared with LDL cholesterol, is in consistency with previous research^{5,7}. In the present study, non-HDL cholesterol levels, unlike LDL cholesterol, were more strongly correlated with Apo B, which suggests that they can be used as a relatively accurate surrogate for total Apo B levels at least in normolipidemic subjects. In contrast to the studies cited above, non-HDL cholesterol was weakly positively correlated with HDL cholesterol. This finding indicates that the cholesterol component of non-HDL cholesterol may be insufficiently removed *via* reverse cholesterol transport. However, it should be noted that neither HDL nor non-HDL cholesterol reflect the activity of reverse cholesterol transport²⁴. Although Asian Indians have shown a size-specific proportion of HDL particles, with significantly higher concentrations of small HDL subtype²⁵, the reason for this correlation inconsistency remains unclear.

Previous research has demonstrated that a degree of atherosclerotic lesion is associated with obesity (body mass index ≥ 30 kg/m²), while waist circumference measurement is useful as an identifier in children with prepubertal alteration of lipids^{26,27}. In our study, body mass index, and to a lesser degree waist circumference, were associated in positive direction to non-HDL cholesterol levels. The finding of markedly higher non-HDL cholesterol levels in overweight and obese children seen in this study may reflect well-documented secular trends in blood lipids when a higher degree of adiposity is associated with greater and more adverse temporal changes in lipid concentrations²⁸. In a multivariate analysis, body mass index was the major modifiable risk factor that contributed to the explained variance of non-HDL cholesterol levels in children. Therefore, it seems rational to use non-HDL cholesterol for monitoring the outcomes related to weight control, prudent diet, and physical activity⁵.

An extensive meta-analysis study has demonstrated that smokers in the 8- to 19-year-old age group, when compared with non-smokers of similar age, have significantly higher serum levels of triglycerides, VLDL cholesterol and LDL cholesterol and significantly lower serum levels of total and HDL cholesterol²⁹. All of these smoking-associated changes follow the same trend as in adults, with the exception of total cholesterol levels, which are significantly increased in adult smokers³⁰. In our study, the prevalence of smoking habits and the number of cigarettes smoked per week were significantly higher in the Roma than in Caucasian children. We showed that the non-HDL cholesterol levels in smokers are lower than those of non-smokers, especially among 12- to 17-year-old Caucasians. Although the reason for this discrepancy is not clear, some ethnic differences including di-

etary habits, physical activities or lifestyle may contribute to the inconsistency in observations between us and others. In this context, the effect of smoking on the key enzymes regulating serum lipid and lipoprotein levels (e.g. hepatic lipase, lipoprotein lipase, lecithin:cholesterol acyl transferase or cholesterol ester transfer protein) is ambiguous. In different studies, the mass or activity of these enzymes is either increased, unchanged or decreased in smokers^{31–34}. It seems that the effect of smoking on these enzymes is dependent on the age, gender, genetic background, or ethnicity of the subjects.

A modern lifestyle promotes sedentary behaviour and reduces the practice of sports or organized physical exercise in schoolchildren and adolescents. In adults, low physical activity associated with sedentary behaviour is an important CHD risk factor³⁵. To qualify and quantify physical activity, especially in epidemiological practice, is difficult. Using self-reported data from the present study, the proportion of children who perform vigorous physical activity (regular sports training or heavy manual labour) is negligible. This is probably a reason why physical activity status is not correlated with non-HDL cholesterol levels in this, as well as in another, study investigating the relationship of non-HDL cholesterol to physical activity⁸.

Roma are the most prominent poverty risk group in many of the countries of Central and Eastern Europe⁹. In the present study, Roma poverty rates are more than six times that of Caucasians. The expected association of the low socio-economic status with the increase of CHD risk factors is in strong contrast to our findings³⁶. Thus children living below the poverty line had significantly lower non-HDL cholesterol levels than those with a higher living standard. At least two current studies, however, have demonstrated a lower prevalence of some major CHD risk factors in the more deprived socio-economic population groups at the early stages of economic development in »transient« countries^{37,38}. We can suppose that with the westernization of their lifestyle, along with the improvement in spending power, the prevalence of CHD risk factors will reach the same level as that of the majority population.

The small epidemiological correlations of non-HDL cholesterol with traditional CHD risk factors, namely age, body mass index and smoking, confirmed in this

study, may be important clinically. In a multivariate analysis, however, age, body mass index and cigarette smoking explain only 3.3% in the variance of serum non-HDL cholesterol levels. Perhaps more accurate self-reported data dealing with modifiable risk factors would permit us to explain a higher proportion of this variance. Current understanding supports the idea of a complex interaction among many genes, with environmental factors as complications. Three gene loci with significant epistatic interaction, for example, have been identified in mice that control the plasma non-HDL cholesterol levels. Their forced gene expression explains from 4 to 12% of the variance in non-HDL cholesterol levels³⁹.

Distribution data of non-HDL cholesterol were also used for the calculation of the corresponding LDL cholesterol values recommended by NCEP for intervention and treatment of dyslipidemias in childhood. Values of LDL cholesterol above 3.37 mmol/L (130 mg/dL; i.e., 95th percentile) are defined as a necessary intervention, with the aim of decreasing these in children and adolescents¹⁷. The calculated cut-off point of non-HDL cholesterol by the method of linear regression corresponds to 3.82 mmol/L, regardless of gender or ethnic character. In this context, the prevalence of children with high non-HDL cholesterol levels was comparable in Roma and Caucasians and lower than in U.S. children and adolescents recruited in National Health and Nutrition Examination Survey III and the Bogalusa Heart Study^{22,5}.

In conclusion, the results of this study have shown that the levels of non-HDL cholesterol in Roma children and adolescents do not indicate a greater risk of developing CHD in later life. Thus we should consider another cardiometabolic, blood coagulation and inflammatory predicting markers of CHD in Roma ethnic group.

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DISTRIBUCIJA I KORELACIJE »NON-HDL« KOLESTEROLA KOD ROMSKE I NEROMSKE DJECE: ISTRAŽIVANJE SLOVAČKE ZAJEDNICE ZA LIPIDE

SAŽETAK

»Non-high-density lipoprotein« (non-HDL) kolesterol, koji se računa kao ukupni kolesterol minus »high-density lipoprotein« (HDL) kolesterol, se smatra boljim prediktorom koronarnih srčanih oboljenja nego »low-density-lipoprotein« (LDL) kolesterol. Populacija slovačkih Roma ima otprilike 2,5 puta višu stopu smrtnosti od koronarnih srčanih oboljenja nego ostatak populacije. Danas se svi slažu sa činjenicom da bi se sa otkrivanjem dislipidemije i prevencijom ateroskleroze kontroliranjem rizičnih faktora za kronična srčana oboljenja trebalo početi već u djetinjstvu. No, postoji vrlo malo populacijskih studija o non-HDL kolesterolu kod djece. Zbog toga je cilj ove studije utvrditi podatke o frekvenciji i korelaciji non-HDL kolesterola u populaciji od 788 romske i neromske djece (42% Romi, 51% muškog spola), u dobi od 7 do 17 godina, iz srednje Slovačke, u sklopu istraživanja Slovačke zajednice za lipide. U usporedbi sa neromskom djecom, romska djeca imaju višu razinu ukupnog, HDL i LDL kolesterola, nižu razinu fizičke aktivnosti, više puše i imaju niži indeks tjelesne mase i krvni tlak ($p < 0,05$). Vrijednosti non-HDL kolesterola su slične kod romske i neromske djece (2,74 mmol/L vs. 2,65 mmol/L, $p = 0,062$), kao i kod dječaka i djevojčica (2,66 mmol/L vs. 2,73 mmol/L, $p = 0,092$). No, vrijednosti su više za mlađu (7–11 godina) nego za stariju dobnu skupinu (12–17 godina) (2,77 mmol/L vs. 2,62 mmol/L, $p = 0,001$). Non-HDL kolesterol je u negativnoj korelaciji sa dobi i pušenjem cigareta ($r = -0,09$ i $-0,11$, $p < 0,05$), dok su opća pretilost mjerena prema indeksu tjelesne mase, opseg struka i dohodak po glavi stanovnika u pozitivnoj korelaciji sa non-HDL kolesterolom. Ustanovljena je srednja odjaka korelacija sa ostalim proučavanim varijablama lipida: trigliceridima, ukupnim i LDL kolesterolom te apolipoproteinom (Apo) B ($r = 0,43$ – $0,93$, $p < 0,001$). Nije ustanovljena povezanost između non-HDL kolesterola i krvnog tlaka, fizičke aktivnosti, HDL kolesterola te Apo AI. Prema multivarijantnoj analizi: indeks tjelesne mase, dob i pušenje cigareta su obuhvaćali 3,3% varijance kod non-HDL kolesterola. Cut-off vrijednost non-HDL kolesterola koje su odgovarale preporučenim cut-off vrijednostima LDL kolesterola za procjenu rizika od koronarnih srčanih oboljenja i liječenje dislipidemije kod djece su: prihvatljivo $< 3,30$, granično 3,31–3,81 i visoko $\geq 3,82$. Prevalencija dislipidemije prema vrijednostima non-HDL kolesterola je 5,4% kod romske i 4,2% kod neromske djece ($p = 0,098$). Iz navedenog se može zaključiti da rezultati ove studije potvrđuju kako nema etničke, spolne niti dobne razlike u razini non-HDL kolesterola između romske i neromske slovačke djece. Kod obje etničke skupine su prekomjerna težina i pretilost te viši socioekonomski status, no ne i pušenje cigareta, bili obrnuto proporcionalni sa non-HDL kolesterolom u djetinjstvu.