

Components of the Metabolic Syndrome in Children and Adolescents With Different Levels of Vitamin D: Results of a Cross-Sectional Study

Corresponding author:

Andrej V. Lebedev, MD, PhD, Associate Professor of the Department of Pathological Physiology of the SSMU

Address: 51, Troitsky Ave, Arkhangelsk 163000, phone: +7 (8182) 21-12-52, e-mail: andruleb@yandex.ru

Article received: Dec 20, 2016, submitted to publication: Jun 26, 2017

Background. Vitamin D is a significant risk factor for atherogenic disorders. It is of interest to study the relationship between vitamin D deficiency and the components of the metabolic syndrome, insulin resistance and markers of chronic inflammation in different age groups.

Objective. Our aim was to study association of the components of the metabolic syndrome and pro-atherogenic metabolic disorders with vitamin D levels in children and adolescents.

Methods. In a cross-sectional (one-stage) study, the serum 25(OH)D level in children and adolescents was determined. The relationship between the 25(OH)D level and the presence of the metabolic syndrome was assessed in quartile groups. **Results.** The study included 319 children and adolescents (49% — girls) aged 10-15 years. In the quartile I in terms of the 25(OH)D level, higher (as compared with the quartile IV) mean level values of insulin (11.5 ± 6.3 and 7.3 ± 4.0 mmol/L, $p < 0.001$), HOMA index (2.4 ± 0.8 and 1.6 ± 0.7 , $p < 0.001$), body mass index (22.6 ± 4.3 and 19.3 ± 3.9 kg/m², $p = 0.012$), waist circumference (68 ± 11 and 61 ± 12 cm, $p = 0.034$), blood concentration of C-reactive protein (2.3 ± 1 and 0.9 ± 0.7 mg/ml, $p < 0.001$), diastolic blood pressure (70 ± 7 and 65 ± 6 mm Hg, $p = 0.028$), uric acid (0.29 ± 0.06 and 0.21 ± 0.06 mmol/L, $p = 0.021$), glucose (4.8 ± 0.6 and 4.6 ± 0.6 mmol/L, $p = 0.011$), triglycerides (0.86 ± 0.37 and 0.72 ± 0.31 mmol/L, $p = 0.017$), and lower mean level values of high-density lipoprotein cholesterol (1.38 ± 0.36 and 1.58 ± 0.31 mmol/L, $p = 0.011$) were noted. Multivariate regression analysis showed an independent relationship between the 25(OH)D level, C-reactive protein level ($\beta = -0.55$, $p < 0.001$), and HOMA index ($\beta = -0.96$, $p < 0.001$). **Conclusion.** A low vitamin D level in the blood serum in children is associated with the components of the metabolic syndrome.

Key words: children, vitamin D, vitamin D deficiency, metabolic syndrome, insulin resistance, inflammation.

(For citation: Malyavskaya Svetlana I., Lebedev Andrej V., Kostrova Galina N. Components of the Metabolic Syndrome in Children and Adolescents With Different Levels of Vitamin D: Results of a Cross-Sectional Study. *Voprosy sovremennoi pediatrii — Current Pediatrics*. 2017; 16 (3): 228–234. doi: 10.15690/vsp.v16i3.1733)

RESULTS

Table 1. The mean values of pro-atherogenic metabolic disorders in children and adolescents with a quartile ranking in terms of 25(OH)D

Indicator	Quartile I (n = 80)	Quartile II (n = 79)	Quartile III (n = 80)	Quartile IV (n = 80)	p*	p**
Age, years	13.2 ± 1.3	13.2 ± 1.2	13.3 ± 1.3	13.3 ± 1.4	0.434	0.153
Girls, abs. (%)	42 (52.5)	36 (45.6)	38 (47.5)	41 (51.5)	0.804	0.863
HOMA index	2.3 ± 0.9	1.6 ± 0.7	1.3 ± 0.5	1.1 ± 0.8	0.003	0.001
Insulin, μIU/mL	11.4 ± 6.3	7.7 ± 4.3	6.1 ± 4.2	5.2 ± 3.1	0.001	0.001
BMI, kg/m ²	22.6 ± 4.2	20.8 ± 4.7	20.2 ± 4.4	19.6 ± 3.4	0.006	0.012
Waist circumference, cm	65 ± 12	62 ± 11	59 ± 13	62 ± 12	0.032	0.034
Uric acid, mmol/L	0.3 ± 0.1	0.3 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.014	0.021
Triglycerides, mmol/L	0.8 ± 0.3	0.8 ± 0.4	0.7 ± 0.4	0.7 ± 0.3	0.009	0.017
HDL cholesterol, mol/L	1.4 ± 0.4	1.5 ± 0.4	1.5 ± 0.4	1.6 ± 0.4	0.021	0.011
Total cholesterol, mmol/L	4.1 ± 0.6	4.1 ± 0.7	4.0 ± 0.7	3.8 ± 0.6	0.032	0.059
LDL cholesterol, mol/L	2.2 ± 0.6	2.2 ± 0.7	2.1 ± 0.7	2.0 ± 0.5	0.038	0.015
Glucose, mmol/L	4.7 ± 0.6	4.6 ± 0.6	4.6 ± 0.6	4.6 ± 0.6	0.026	0.011
CRP, mg/ml	2.9 ± 0.9	2.3 ± 0.6	1.5 ± 1.1	0.9 ± 0.8	0.001	0.001
SBP, mm Hg	109 ± 10	108 ± 10	108 ± 10	108 ± 11	0.072	0.051
DBP, mm Hg	69 ± 7	67 ± 6	66 ± 6	66 ± 7	0.009	0.028

Note. * — the results of comparing four quartile groups simultaneously (ANOVA test for quantitative characters, chi-square test (df = 3) for nominal characters). ** — the results of a pair-wise comparison of the quartile groups I and IV. HOMA — Homeostasis Model Assessment of Insulin Resistance, BMI — body mass index, HDL/LDL cholesterol — high/low-density lipoprotein cholesterol, CRP — C-reactive protein, SBP — systolic blood pressure, DBP — diastolic blood pressure. The data is presented as a mean (M) and standard deviation ($\pm \sigma$).

Table 2. Incidence of lipid profile disorders in children and adolescents in the quartile groups ranked by the 25(OH)D concentration

Indicator	Quartile I (n = 80)	Quartile IV (n = 80)	p
High TC (N < 4.4 mmol/L), abs. (%)	17 (21)	3 (4)	0.001
Hypercholesterolemia in terms of LDL (N < 2.85 mmol/L), abs. (%)	14 (18)	4 (5)	0.012
Hypercholesterolemia in terms of HDL (N > 1.2 mmol/L), abs. (%)	25 (31)	12 (15)	0.015
Hypertriglyceridemia (N < 1.0 mmol/L), abs. (%)	11 (14)	7 (9)	0.317

Note. TC — total cholesterol, LDL/HDL — low/high-density lipoproteins; N — norm.

Table 3. The results of correlation analysis and multivariate regression analysis of the study of association between the 25(OH)D level and pro-atherogenic metabolic disorders in children and adolescents

Indicator	Correlation rate (r)	p
HOMA index	-0.46	0.001
Insulin, $\mu\text{IU/mL}$	-0.44	0.001
BMI, kg/m^2	-0.13	0.092
Waist circumference, cm	-0.25	0.021
Uric acid, mmol/L	-0.30	0.001
Triglycerides, mmol/L	-0.05	0.217
Total cholesterol, mmol/L	-0.03	0.387
HDL cholesterol, mol/L	0.07	0.261
LDL cholesterol, mol/L	-0.06	0.367
Glucose, mmol/L	-0.10	0.135
CRP, mg/ml	-0.41	0.001
SBP, mm Hg	-0.15	0.114
DBP, mm Hg	-0.27	0.005

Note. HOMA — Homeostasis Model Assessment of Insulin Resistance, BMI — body mass index, HDL/LDL cholesterol — high/low-density lipoprotein cholesterol, CRP — C-reactive protein, SBP/DBP — systolic/diastolic blood pressure.

Fig. 1. Sampling during management of a cross-sectional study

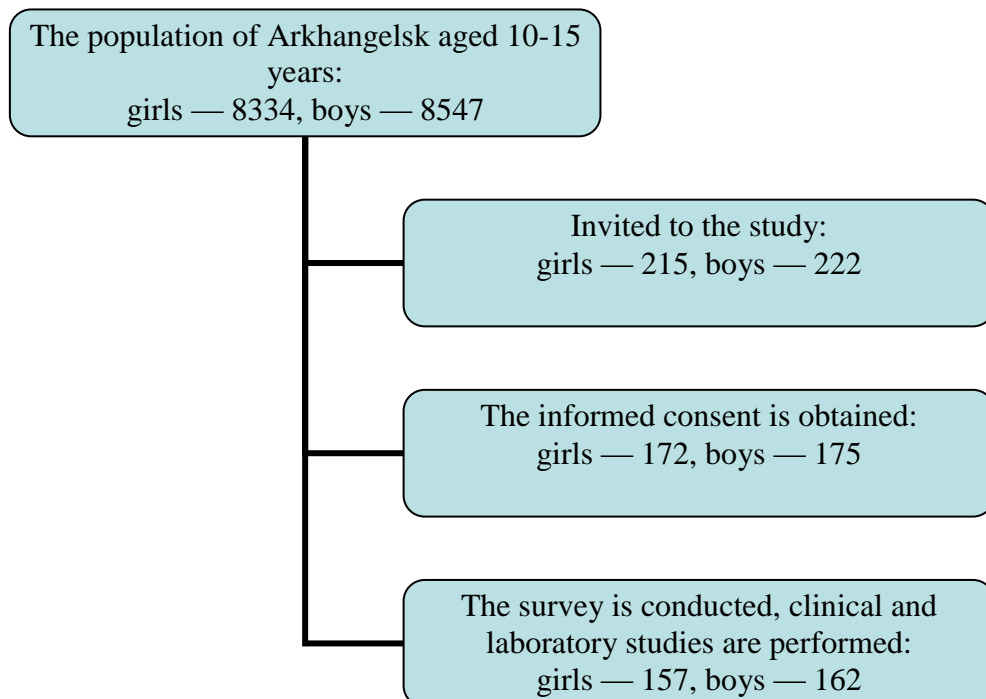
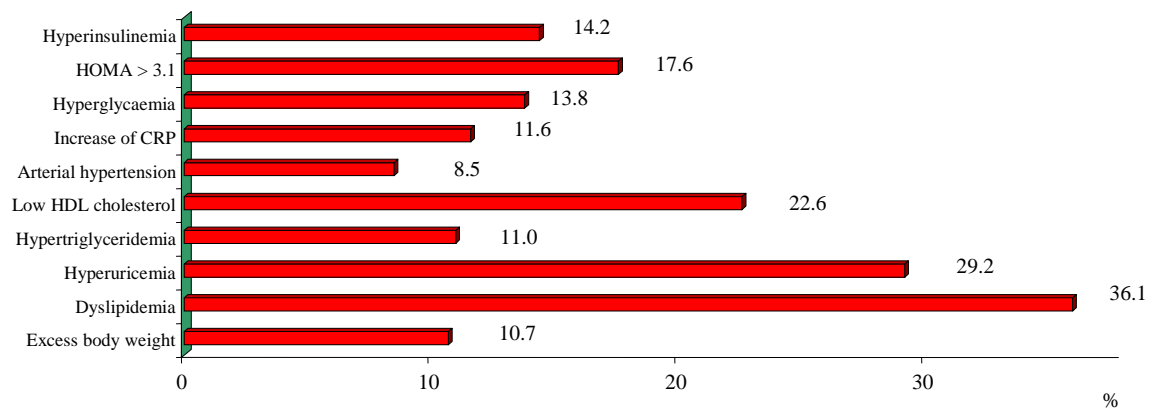


Fig. 2. Incidence of metabolic disorders that form the metabolic syndrome among children and adolescents (n = 319)



Note. HOMA — Homeostasis Model Assessment of Insulin Resistance, CRP — C-reactive protein, HDL cholesterol — high-density lipoprotein cholesterol.

FINANCING SOURCE

Part of the study was carried out with financial support from the grant of the Russian Foundation for the Humanities 13-06-00733a 2013.

CONFLICT OF INTERESTS

Not declared.

ORCID

Svetlana I. Malyavskaya <http://orcid.org/0000-0003-2521-0824>

Andrej V. Lebedev <http://orcid.org/0000-0003-1865-6748>

Galina N. Kostrova <http://orcid.org/0000-0002-3132-6439>