PREDICTING THE RISK OF LEFT VENTRICULAR HYPERTROPHY IN CHILDREN AND ADOLOLESCENTS EITH ARTERIAL HYPERTENTION BASED ON 24-HOUR BLOOD PRESSURE MONITORING AND METABOLIC INDICATORS

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Abstract: Objective: To investigate the significance of 24-hr ambulatory blood pressure monitoring (ABPM) data and metabolism indicators, as well their correlation in predicting the risk of left ventricular hypertrophy (LVH) in children and adolescents with arterial hypertension (AH).
Methods: We studied 118 children and adolescents, M±m 15.51±0.25 yrs, Boys/Girls – 104/14, with AH: 60 stable, 40 labile, 18 prehypertension (high-normal blood pressure), and a control group of 13 normotensive children, M±m 15,19±0,41 yrs, Boys/Girls – 10/3. All patients underwent a comprehensive anamnestic, clinical, laboratory, and instrumental examination, including 24-hr ABPM; indicators were standardized by gender and age. On Doppler echocardiography (echoCG), the left ventricular myocardial mass index (LVMI) was calculated. Lipid spectrum parameters were determined by biochemical method, venous blood glycemia by GOD-PAP, blood serum basal immunoreactive insulin by ELISA methods, insulin resistance (IR) by HOMA parameters calculation. Statistical processing was performed using the package of statistical analysis software STATISTICA.
Results: Of a range of metabolism indicators, BMI, TG level, LDL/HDL ratio, HOMA index, 24-hr DBP index, and the stable character of AH identified as the most significant factors in predicting the risk of LVH in hypertensive children. All multivariate models of logistic regressions, which include BMI, can predict the probability of LVH with an accuracy of 79.7-84.7%, sensitivity - 57.5-77.5%, specificity - 86.4-91.0%.
Conclusions: Obtained satisfactory concordance of the actual data with predictive models' results indicate the possibility of their use to predict the risk of LVH in children and adolescents with AH.

Keywords: Arterial hypertension, blood pressure monitoring, left ventricular hypertrophy, children

INTRODUCTION The current worldwide epidemic of cardiovascular disease has, on its basis, far not least, the increasing prevalence of arterial hypertension (AH) in children and adolescents [1,2,3]. Over the past three decades, AH remains the single most important preventable cause of premature death [4,5,6]. So it is highly essential to identify hypertensive children with a high risk of target organ damage [4,7,8,9,10]. Due to the high adaptive and compensatory characteristics of the pediatric patient organism, the clinical manifestations of the developing disease may be subtle and lag behind the appearance of pathological morphological changes, which can be detected only with additional instrumental studies [11,12,13,14]. To solve this problem is necessary to have accessible and reliable diagnostic criteria predicting the risk of AH's potentially fatal sequelae that will allow timely and appropriate treatment and preventive measures.

Our study aimed to identify risk factors associated with left ventricular hypertrophy (LVH) and investigate the significance of 24-hr ambulatory blood pressure monitoring (ABPM) data and metabolism indicators and their correlation in predicting the risk of LVH in children and adolescents with hypertension (AH).

MATERIAL AND METHODS

Study Group

A comprehensive study of 118 non-treated children and adolescents of 12–17 years old, mean age 15.51±0.25 yrs, boys – 104, girls – 14, diagnosed AH - 60 with stable AH, 40 with labile AH, and 18 with prehypertension (high-normal blood pressure) - was carried out. The control group consisted of 13 children with normotension: mean age 15,19±0,41 yrs, boys – 10, girls – 3. All children belonged to the Caucasian race and were residents of a

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large industrial city of Ukraine, a low-income eastern European country.

To establish the diagnosis of AH and determine its clinical and pathogenetic forms, all children underwent 24-hour ambulatory blood pressure monitoring ABPM using a Cardiotens-01 recorder from MEDITECH (Hungary) with brachial cuff by the child's age.

When analyzing the ABPM data, the following quantitative parameters assessed for 24 hours: the average daily, maximum, and minimum values of blood pressure (BP) - systolic (SBP), diastolic (DBP), mean arterial pressure (MAP), pulse BP (PBP), heart rate (HR), load indices related to increased systolic and diastolic BP in the daytime and at night [15,16].

Stable AH was diagnosed when the average daily BP was above the 95th percentile, the hypertension time index was more than 50%. Labile AH was determined when the hypertension time index was from 25% to 50%, but the average daily BP was below the 95th percentile. Prehypertension (high-normal blood pressure) was defined when average daily BP was between the 90th and 95th percentile [3,17,18].

Doppler echocardiography performed using the Megas apparatus (Italy) according to the standard technique to determine the presence of target organ damage (LVH) in children with AH. The left ventricular myocardial mass index (LVMI) was calculated as the ratio of the left ventricular myocardial mass (LVM) to growth in the 2.7 degrees [17]. In pediatric practice, the criterion for LVH is LVMI ($g/m^{2,7}$) more than 95th percentile by gender [7,17,19,20].

Values of the lipid spectrum parameters of the venous blood serum taken after 12 hours of fasting were determined by the biochemical method. In girls, blood sampling was performed in the first phase of the menstrual cycle. The content of total cholesterol (TC), levels of low-density lipoprotein cholesterol (LDL-C), very low-density lipoprotein cholesterol (VLDL-C), high-density lipoprotein cholesterol (HDL-C), and triglycerides (TG) were determined. The ratios of lipid fractions: TC / HDL, LDL / HDL, TG / HDL and the difference between TC and HDL, which reflect the risk of cardiovascular disease in adults, were also evaluated. Lipid and lipoprotein levels above the 95th percentile for the appropriate age and sex in adolescents 12-18 years of age were considered elevated, and levels between the 90th and 94th percentiles were considered marginal.

Anthropometric indicators assessed the children's physical development: body weight and height, waist circumference (WC), and body mass index (BMI).
The GOD-PAP method's glucose level in venous blood was determined using a Glucose liquid color kit (Human, Germany) on a Mikrolab-200 photometer.

The quantitative level of basal immunoreactive insulin was determined in the blood serum by the enzyme-linked immunosorbent assay method (ELISA) and the DRG insulin ELISA kit (Germany). Hyperinsulinemia was diagnosed when the insulin level increased above the reference value of 25 μU/mL.

Indirect indicators assessed insulin resistance (IR): the level of basal insulinemia and the homeostatic model of IR with the calculation of HOMA parameters [21,22]. The criterion for high IR was a HOMA-IR level of more than 3.6.

Statistical Analysis Statistical processing of the results performed using the licensed package of statistical analysis software STATISTICA v. 6.1 (Statsoft Inc., USA), SN AJAR909E415822FA.

The Student's (t) and Mann-Whitney (U) tests were used to assess the significance of differences in terms of quantitative characteristics, for qualitative characteristics - the chi-square test of agreement (χ^2), including Yates' correction, and Fisher's exact test. Multiple comparisons of several observation groups carried out using the nonparametric Kruskal-Wallis test (H) and two-way analysis of variance (ANOVA / MANOVA) with an assessment of the strength of influence (K^2) of individual factors on the significant trait. To quantify the relationship between personal characteristics, we used correlation analysis with the calculation of Spearman correlation coefficients (r) and the coefficient of connectivity (φ) [23].

In the study, we used the odds ratio (OR) to assess the relative risk of a particular event (LVH development, AH formation, IR, etc.), which was calculated by the formula:

$$OR = \frac{a \cdot d}{c \cdot b}, \qquad (1)$$

a is the number of cases with an effect in the main group, ***b*** is the number of cases with an effect in the comparison group, ***c*** is the absence of an effect in the main group, and ***d*** is the absence of an effect in the comparison group.
If the OR value is 0 to 1, it corresponds to the risk reduction or equal to 1 - no effect, above 1 - increased risk.

95% confidence intervals (95% CI) for the OR indicator calculated using the formula:

$$95\%\text{CI} = \frac{ad}{bc}\exp\left[\pm 1{,}96\sqrt{\left(\frac{1}{a}+\frac{1}{b}+\frac{1}{c}+\frac{1}{d}\right)}\right], \quad (2)$$

where *a, b, c, d* – designations correspond to the formula 1.

To quantify the influence of risk factors on the likelihood of LVH formation in children with AH, we used the logistic regression method.
In general terms, the logistic regression equation written as:

$$p = \frac{e^z}{1+e^z} \quad (3)$$

$$z = b_0 + b_1 \cdot x + \ldots b_i \cdot x_i \quad (4)$$

where x_i – factor values,
b_i – regression coefficients,
p – the probability of LVH formation [23].

RESULTS Correlation analysis determined the relationship between LVH, hemodynamic and non-hemodynamic factors, such as AH, BMI, dyslipidemia, IR (***Table 1***).

To quantify the influence of risk factors on the likelihood of LVH formation in children with AH, we used constructing a logistic regression (formulas 3, 4). The criterion for assigning a patient to a high-risk group for developing LVH was the calculated probability (*p*) of more than 0.5. At *p* less than or equal to 0.5, low risk predicted. In the first stage, univariate models were built to predict the risk of LVH formation in children with AH for each factor separately. The obtained indicators of relative risk (ORs) were analyzed above when describing the factors. Only those risk factors that had significant associations with LVH were selected to construct regression models as potential predictors of the formation of LVH in children with AH. The main results of the regression analysis presented in ***Table 2***.

As seen from ***Table 2***, the most significant factor in forming LVH in children with AH is the indicator characterizing body weight - BMI (OR = 10.69). This dependence well illustrated by the graph of the logistic function (***Figure 1***).

We observed the same patterns in the analysis of other indicators characterizing body weight in children with AH - WC, WHR (waist/hip ratio), actual body weight, and birth weight ratio.

Regression equations were constructed to predict the individual risk of LVH formation in children with AH based on actual values that allow calculating the likelihood of LVH for specific values of the indicator in a patient, taking into account age and gender. Described models based on the limiting levels of signs. The data are shown in ***Table 3***.

The main indicators of daily monitoring of BP in children were identified, considering correlation analysis (***Table 1***). They had significant associations with LVH, namely, 24-hr DBP index, mean daily DBP, mean daily pulse BP, mean daily HR, the variability of SBP, and DBP at night. For them, univariant logistic regressions were also built (***Table 4***).

Thus, in a case of insufficient DBP decrease in children at night (24-hr DBP index), the likelihood of LVH formation increases from *p* = 0.36 in dipper DBP to *p* = 0.51 non-dipper DBP and *p* = 0.66 in night-peaker DBP. We observed the same patterns in low variability of SBP and DBP at night, heart rate during the day. A positive correlation between the mean daily pulse BP and LVH is manifested in an increase in the likelihood of LVH formation from *p* = 0.21 in the mean daily DBP equal to 50 mm Hg, *p* = 0.62 in the mean daily DBP equal to 80 mm Hg.

Univariate models testing of the effectiveness of predicting the risk of LVH formation showed that the coincidence of the expected results with actual data for the development of LVH (sensitivity) ranges from 0% (hereditary burden of cardiovascular diseases - CVD, dyslipidemia, etc.) to 55.0 - 65.2% (BMI, WC, WHR) and for the absence of this complication (specificity) - from 70% to 100% (***Table 5***). Keeping this in mind, multivariate logistic regressions were constructed to improve the forecast efficiency, considering the separate and joint influence of the considered risk factors.

The general view of multivariate logistic regression represents in formulas 3, 4. The construction of a mathematical model is carried out by sequential inclusion in those indicators (risk factors) that significantly contribute to predicting the likelihood of LVH formation in children with AH. The corresponding contribution of the factor assessed by the degree of importance of the regression coefficient b_i (P <0.30) and the calculated odds

Index	Spearman correlation coefficient	Index	Spearman correlation coefficient
BMI	r = 0.52 P<0.001	Caro index of insulin sensitivity	r = -0.30 P = 0.012
Actual body weight / birthweight ratio	r = 0.32 P = 0.001	24-hr index of DBP	r = -0.21 P = 0.022
WC	r = 0.42 P<0.001	Mean 24-hr DBP	r = -0.20 P = 0.029
WHR (waist/hip ratio)	r = 0.47 P = 0.005	Mean daily DBP	r = -0.26 P = 0.004
LDL / HDL	r = 0.19 P = 0.041	Maximal 24-hr DBP	r = -0.22 P = 0.019
TG / HDL	r = 0.24 P = 0.010	Maximal daily DBP	r = -0.20 P = 0.026
TC / HDL	r = 0.25 P = 0.007	Mean daily BP	r = -0.22 P = 0.014
Basal insulin level	r = 0.30 P = 0.012	Mean 24-hr HR	r = -0.20 P = 0.034
IR index HOMA-IR	r = 0.29 P = 0.016	Mean daily HR	r = -0.25 P = 0.007
Mean 24-hr pulse BP	r = 0.19 P = 0.040	Nighttime SBP variability	r = -0.20 P = 0.032
Mean daily pulse BP	r = 0.21 P = 0.020	Nighttime DBP variability	r = -0.22 P = 0.019
HDL	r = -0.34 P< 0.001	Mean 24-hr HR variability	r = -0.19 P = 0.039

Table 1. Relationship between the left ventricular myocardial mass index and various other risk factors.

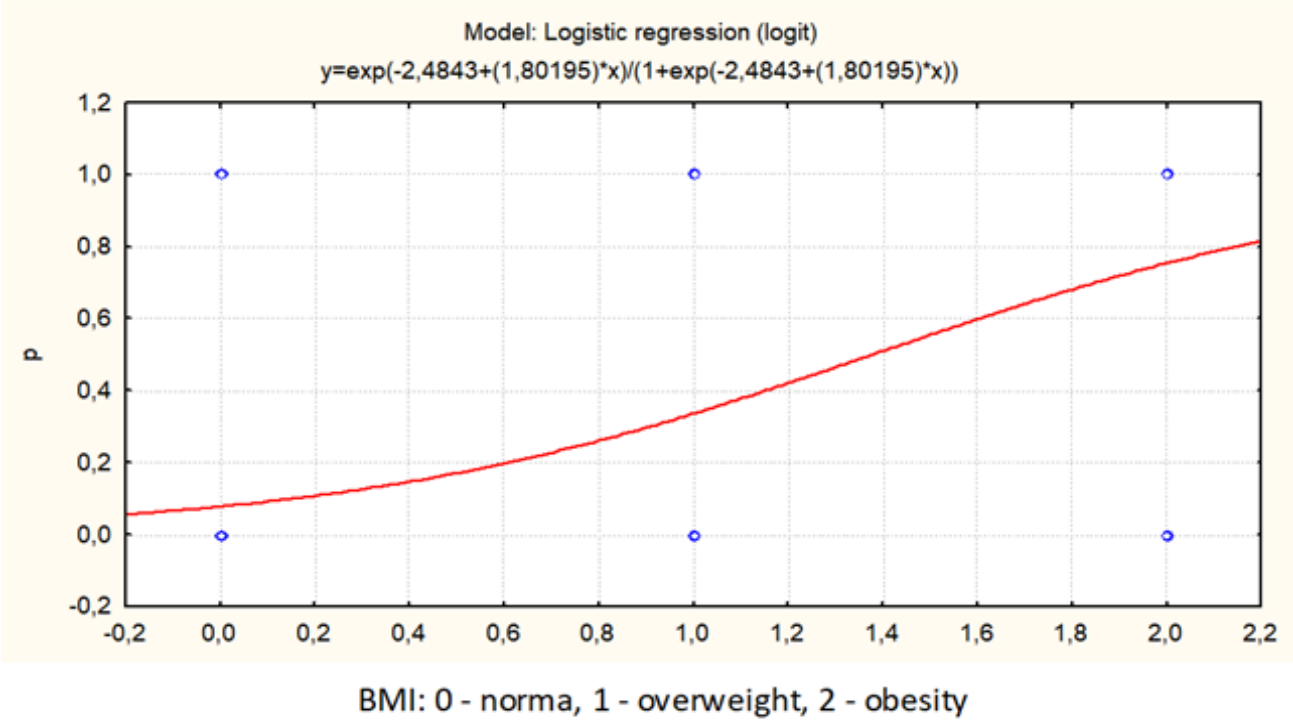

Figure 1. Graph of the risk of LVH formation in children with AH, depending on the value of BMI.

Indicator	Gradation of the indicator	Coefficients		Adequacy of the model by χ^2	Predicted probability p
		Constant (b0)	b1		
BMI	0 - norma 1 - overweight 2 - obesity	-2.484	1.802	χ^2=39.8; P<0.001	0.08 0.34 0.75
WC	0 - norma 1 - >94 cm (boys) >80 cm (girls)	-1.174	1.174	χ^2=8.65; P<0.003	0.24 0.50
WHR	1 - norma 2 - >0.9 (boys) >0.85 (girls)	-5.534	2.826	χ^2=9.50; P<0.002	0.06 0.53
Bodyweight/birthweight	Values, including: = 15 = 25 = 35	-3.591	0.127	χ^2=11.21; P<0.001	0,16 0,40 0,70
TG	1 -<1,45 mmol/L 2 – 1.45-1.7 3 ->1.7	-1.871	0.807	$\chi^{2=}$10.77; P<0.001	0.26 0.44 0.63
HDL	1 -≤1.03 mmol/L 0 - >1.03	-0.956	1.099	χ^2=6.10; P<0.014	0.28 0.54
VLDL	1 -<0.70 mmol/L 2 – 0.70-0.78 3 - >0.78	-1.639	0.708	χ^2=6.71; P<0.001	0.28 0.44 0.62
TC / HDL	1 - < 2 2 - 2-4 3 - > 4	-2.798	0.984	χ^2=5.4; P<0.020	0.14 0.30 0.54
LDL / HDL	1 - < 2 2 - 2-2.99 3 - 3-4.99 4 - ≥ 5	-1.747	0.707	χ^2=5.73; P<0.017	0.26 0.42 0.59 0.75
Dyslipidemia	0 - no 1 - yes	-1,124	0.782	χ^2=3.83; P<0.050	0.25 0.42
IR index HOMA-IR	1- <2.77 2 – 2.77-3.59 3 - ≥ 3.6	-2.257	0.669	χ^2=4.22; P<0.040	0.17 0.29 0.44
Insulin level	1 -<20 μU/mL 2 - 20-24 3 - ≥ 25	-1.650	0,582	χ^2=3.88; P<0.049	0.26 0.38 0.52
Hereditary burden of CVD	0 - no 1 - yes	-1.007	0.793	χ^2=4.02; P<0.045	0.27 0.48
Smoking	0- does not smoke 1 - smokes	-1.281	1.114	χ^2=4.25; P<0.039	0.22 0.46

Table 2. Indicators of univariate logistic regressions for LVH formation risk in children with AH, depending on the main risk factors.

ratio (OR) consistent with all the features included in the model. As in the case of the univariant model, the multivariate model's adequacy is assessed by criterion χ^2, as well as by the so-called disagreement coefficient (DIS). The latter's size indicates the ratio between correctly and incorrectly classified actual data by the constructed model. The effectiveness of the forecasting model was estimated by the parameters of sensitivity (SE), specificity (SP), and inerrancy (accuracy) of the prognosis (AC) [21].

Analysis of univariate models showed that the risk of LVH formation in children with AH was significantly (p<0.05-0.001) associated with indicators characterizing the presence of abdominal excess body weight or obesity (BMI, WC, the ratio of actual body weight to birthweight), indicators of lipid (TG, HDL, VLDL, and their ratios) and carbohydrate metabolism (blood insulin level, HOMA-IR, IR index), hereditary burden by CVD, as well as ABPM indicators characterizing AH (24-hr index of DBP, mean daily pulse BP, mean daily HR, nighttime SBP variability, nighttime DBP variability).

Given the significant correlation between the indicators characterizing body weight, only one of them, BMI, was included in the model, which had the highest OR = 10.69 in the univariate models (***Table 3***). As shown above

Risk factor	Coefficients				OR*	Adequacy of the model by χ^2	Model efficiency indicators
	Constant (b0)	b1	b2	b3			
BMI (kg/m^2)	-8,049	-0,141	0,422	0,4	10,84	χ^2=40,98 P<0,001	SE=55,0% SP=89,7%
WC (cm)	-7,097	-0,142	0,785	0,09	4,98	χ^2=27,79 P<0,001	SE=45,0% SP=85,9%
WHR	-9,242	0	-0,357	10	4,41	χ^2=7,05 P<0,029	SE=15,0% SP=96,2%
TG (mmol/L)	-0,528	-0,073	0	0,908	3,88	χ^2=6,35 P<0,042	SE=17,5% SP=93,6%
HDL (mmol/L)	3,837	-0,041	-0,716	-2,388	3,67	χ^2=12,99 P<0,005	SE=32,5% SP=87,2%
VLDL (mmol/L)	-0,535	-0,072	0	1,958	3,88	χ^2=6,21 P<0,045	SE=17,5% SP=93,6%
TC/ HDL	-0,742	-0,066	-0,820	0,589	4,20	χ^2=10,59 P<0,014	SE=22,5% SP=92,3%
LDL/ HDL	-1,681	0	0	0,525	4,36	χ^2=5,49 P<0,019	SE=15,0% SP=94,9%
TG/ HDL	0,044	-0,078	-0,458	1,119	3,35	χ^2=10,15 P<0,017	SE=25,6% SP=90,7%
IR index HOMA-IR	-2,149	0,012	0	0,272	3,33	χ^2=6,53 P<0,038	SE=25,0% SP=90,9%
Insulin level (μU/mL)	-2,315	0,014	0	0,0659	3,90	χ^2=6,99 P<0,030	SE=33,3% SP=88,6%

Footnotes: 1. * - Age and gender consistent odds ratio for risk factor;
2. b1 – the coefficient for age; b2 coefficient for gender; b3 – the coefficient for the relevant risk factor;
3. The risk factor and age (years) acquire specific meanings; the gender of the child coded: 1 - male, 2 - female;
4. SE - *sensitivity*, *SP - specificity*.

Table 3. Indicators of logistic regressions for assessing LVH formation risk in children with AH, depending on the main risk factors, age, and gender of children.

Indicator	Gradation of the indicator	Coefficients		OR	Adequacy of the model by χ^2	Predicted probability p
		Constant (b0)	b1			
24-hr DBP index	0 - < 0% 1 - 0-9.9% 2 - 10-20% 3 - > 20%	0.644	-0.601	1.70	χ^2=4.86 P<0.028	0.66 0.51 0.36 0.24
Mean daily DBP	Values, incl. = 50 mm Hg = 65 mm Hg = 75 mm Hg	6.19	-0.095	2.55	χ^2=8.78; P<0.003	0.81 0.51 0.28
Mean daily pulse BP	Values, incl. =50 mm Hg =60 mm Hg =80 mm Hg	-4.329	0.060	3.92	χ^2=5.86; P<0.016	0.21 0.33 0.62
Mean daily HR	Values, incl. = 60 beats / min = 75 beats / min = 90 beats / min	3.956	-0.055	1.45	χ^2=7.0; P<0.008	0.66 0.46 0.27
Nighttime SBP variability	Values, incl. =4 mm Hg =10 mm Hg =15 mm Hg	0.931	-0.157	1.17	χ^2=5.37; P<0,020	0.58 0.35 0.19
Nighttime DBP variability	Values, incl. =4 mm Hg =10 mm Hg =15 mm Hg	1.076	-0.212	1.54	χ^2=6.68; P<0.009	0.56 0.26 0.11
Mean 24-hr HR variability	Values, incl. =5 beats / min =10 beats / min =15 beats / min	1.301	-0.135	1.15	χ^2=5.17; P<0.023	0.65 0.49 0.33

Table 4. Indicators of univariate logistic regressions for the risk of LVH formation in children with AH according to the daily monitoring of BP.

predicting the risk of LVH formation in children with AH based on this factor alone provides 78% predictive accuracy (***Table 5***).

Among the factors characterizing lipid metabolism, TG indicators, and the LDL / HDL ratio were prognostically significant. In combination with BMI (model 1), they increase the maximum likelihood of LVH formation (with the worst values of indicators) from p = 0.75 to 0.952, and predictive accuracy from 78% to 80.5% (***Table 4***). It should be noted that the agreed OR in the multivariate model for these indicators is 1.55 for TG, 1.70 for LDL / HDL, and 5.37 for BMI. In one-dimensional models (***Table 3***), ORs were 4.21, 4.36, and 10.69, respectively.

The insulin resistance index HOMA IR (OR = 2.28) became a prognostically significant carbohydrate metabolism indicator. The addition of it to model 1 (model 2) insignificantly increased the probability of an unfavorable prognosis to p = 0.973 and the predictive accuracy to 80.9%.

As shown above, distinct ABPM indicators are highly informative for predicting the risk of LVH in children with

Indicator	Gradation of the indicator	Number of observations (n)	Efficiency indicators (%)			
			SE	SP	AC	FN/FP
BMI	0 - norma 1 - overweight 2 - obesity	118	55.0	89.7	78.0	45.0/10.3
WC	0 - norma 1 - >94 cm (boys) >80 cm (girls)	118	57.5	70.5	66.1	42.5/29.5
WHR	1 - norma 2 - >0,9 (boys) >0,85 (girls)	33	65.2	90.0	72.7	34.8/10.0
Bodyweight/birthweight	Values	95	27.3	95.2	71.6	72.7/4.8
TG	1 -<1,45 mmol/L 2 – 1.45-1.7 3 ->1.7	118	32.5	89.7	70.3	67.5/10.3
HDL	1 -≤1,03 mmol/L 0 - >1,03	118	37.5	83.3	67,8	62.5/16.7
VLDL	1 -<0.70 mmol/L 2 – 0.70-0.78 3 - >0.78	118	22.5	92.3	68.6	77.5/7.7
TC/ HDL	1 – < 2 2 - 2-4 3 – > 4	118	27.5	85.9	66.1	72.5/14.1
LDL/ HDL	1 – < 2 2 - 2-2.99 3 – 3-4.99 4 – > 5	118	17.5	96.2	69.5	82.5/3.8
Dyslipidemia	0 - no 1 - yes	118	0.0	100	66,1	100/0.0
IR index HOMA-IR	1- <2.77 2 – 2.77-3.59 3 - ≥ 3.6	70	0.0	100	64.3	100/0.0
Insulin level	1 - < 20 µU/mL 2 – 20-24 3 – ≥ 25	70	40.0	80.0	65.7	60.0/20.0
Hereditary burden of CVD	0 - no 1 - yes	118	0.0	100	66.1	100/0.0
Smoking	0- does not smoke 1 - smokes	70	0.0	100	70.0	100/0.0
24-hr DBP index	0 – < 0% 1 – 0-9,9% 2 – 10-20% 3 – > 20%	118	20.0	87.2	64.4	80.0/12.8
Mean daily DBP	Values (mm Hg)	118	17.5	92.3	66.9	8.5/7.7
Mean daily BP	Values (mm Hg)	118	12.5	92.3	65.3	87.5/7.7
Mean daily pulse BP	Values (mm Hg)	118	17.5	94.9	68.6	82.5/5.1
Mean daily HR	Values (mm Hg)	118	12.5	91.0	64.4	87.5/9.0
Nighttime SBP variability	Values (mm Hg)	118	5.0	100	67.8	95.0/0.0
Nighttime DBP ariability	Values (mm Hg)	118	15.0	89.7	64.4	85.0/10.3
Mean 24-hr HR variability	Values (mm Hg)	118	7.5	98.7	67.8	92.5/1.3

SE - sensitivity, SP - specificity, AC – inerrancy (accuracy), FP – false-positive, FN – false-negative test results

Table 5. Indicators of the effectiveness of predicting the risk of LVH formation in children with AH by univariate logistic regressions.

Model No	Factor (indicator) parameters				Predicted probability of LVH (p)	Adequacy of the model by χ^2	Efficiency indicators of the model
	Name	Gradatio	Regression coefficient	Agreed OR			
1	Constant BMI TG LDL/HDL	- * * *	-3.82 1.68 0.44 0.53	- 5.37 1.55 1.70	p_{min} = 0.055 p_{max} = 0.952	χ^2 = 44.8; P<0.001 DIS = 14.2	SE = 65.0%; SP=88.5% AC=80.5%
2	Constant BMI TG LDL/HDL IR index HOMA-IR	- * * * *	-4.557 1.922 0.839 0.662 0.824	- 6.83 2.31 1.94 2.28	p_{min} = 0.020 p_{max} = 0.973	χ^2 = 31.3; P<0.001 DIS = 15.4	SE=70.8%; SP=86.4% AC=80.9%
3	Constant BMI 24-Hr DBP index	- * **	-0.585 2.005 -0.989	- 7.42 0.37	p_{min} = 0.028 p_{max} = 0.968	χ^2 = 47.6; P<0.001 DIS = 20.4	SE = 70.0%; SP=89.7% AC=83.1%
4	Constant BMI IR index HOMA-IR Hr DBP index	- * * **	-0.700 2.125 0.196 -1.258	- 8.37 1.22 0.28	p_{min} = 0.014 p_{max} = 0.984	χ^2 =.31.5;P<0.001 DIS = 25.3	SE=76.0%; SP=88.9% AC=84.3%
5	Constant BMI TG LDL/HDL 24-hr DBP index	- * * * **	-1.930 1.866 0.433 0.487 -0.931	- 6.46 1.54 1.63 0.39	p_{min} = 0.022 p_{max} = 0.994	χ^2 = 5.5; P<0.001 DIS = 13.7	SE=57.5%; SP=91.0% AC=79.7%
6	Constant BMI TG 24-hr DBP index AH stab.	- * * ** #	-1.287 1.871 0.450 -0.964 0.253	- 6.49 1.57 0.38 1.29	p_{min} = 0,023 p_{max}= 0,983	χ^2 = 50.0; P<0.001 DIS=26.7	SE=77,5%; SP=88.5% AC=84.7%
7	Constant TG LDL/HDL 24-hr DBP index AH stab.	- * * ** #	-1.655 0.708 0.553 -0.571 0.610	- 2.03 1.74 0.57 1.84	p_{min} = 0.109 p_{max} = 0.964	χ^2 = 20.38 P<0,001 DIS = 4.1	SE=37.5%; SP=87.2% AC=70.3%

1. * - gradations of the indicator are given in ***Table 2***
2. ** - gradations of the indicator are given in ***Table 4***
3. # - gradations of the indicator AH stab.: 0 – a labile form of hypertension or prehypertension, 1 – a stable form of hypertension.
4. DIS – disagreement coefficient, which characterizes the quality of classification.
5. p_{min} (p_{max}) – the probability of LVH formation at combinations of the best (worst) values of factors.

Table 6. Indicators of multivariate logistic regressions for assessing the likelihood of LVH formation in children with hypertension.

AH. Based on mathematical modeling results, only the 24-hr index of DBP was included in the model. The contribution to predicting all ABPM indicators, based on which the univariate models were built, was either insignificant (due to the correlation with taken into account indicators), or less than the contribution of the 24-hr index of DBP.

The analysis showed an insufficient decrease in DBP in children at night (night-peaker or non-dipper DBP) combined with obesity (model 3) increases the likelihood of LVH formation to p = 0.968. This model's efficiency indicators are better than in previous cases (models 1, 2) - the sensitivity is 70%, the specificity is 89.7%, and the inerrancy (accuracy) is 83.1%.

In a combination of high BMI, HOMA IR levels with a low 24-hr index of DBP values (model 4), the probability of an unfavorable prognosis increases to p = 0.984.

Multiple correlations of metabolic disorders (negative changes in BMI, TG, LDL / HDL) and insufficient decrease in DBP at night with the formation of LVH (model 5) increases the likelihood of this complication to p = 0.994. However, it should be noted that the constructed model has high specificity (91.0%) and low sensitivity (57.5%), that is, in almost half of the patients (42.5%), the test results according to the model will be false-negative. Conversely, a false positive prognosis can be expected in no more than 9% of cases.

Considering the high incidence of LVH in children with a stable clinical form of AH, we introduced the index of AH stabilization into the model. This indicator took two values: 1 - a stable form of AH and 0 - labile AH or prehypertension. The probability of the worst prediction of LVH according to model 6, which included this indicator, as well as the previously described indicators of BMI, TG, 24-hr index of DBP, is p = 0.983. Model efficiency indicators are satisfactory.

It should be noted that in all models 1-6, the BMI indicator was included, which, in comparison with other indicators, has a high value of the agreed OR - from 5.37 in model 1 to 8.37 in model 4, which indicates its high informative value for predicting the likelihood of LVH formation in children with AH. To confirm this fact, we built model 7, which included TG indicators, LDL / HDL, 24-hr index of DBP, and clinical hemodynamic forms of hypertension. With the worst values of these indicators (TG > 1.7 mmol/L, LDL / HDL ≥ 5, 24-hr index of DBP < 0%; stable form of AH), the likelihood of developing LVH is p = 0.964. At the same values, but with 24-hr index of DBP - non-dipper, p = 0.938. Simultaneously, model 7 (excluding BMI) can correctly predict the presence of LVH only in 37.5% of cases. It has low sensitivity, in contrast to model 6, the sensitivity of which is 77.5%. The coefficient of disagreement, characterizing the classification's correctness, for model 6 is 6.5 times higher - 26.7 versus 4.1 (***Table 4***).

DISCUSSION & CONCLUSION Thus, multivariate logistic regression analysis made it possible to identify BMI, TG, LDL / HDL ratio, HOMA index, 24-hr DBP index, and AH's stable character as significant factors in predicting the risk of LVH in children with AH.

Analysis of the effectiveness of multivariate models showed that all logistic regressions, including BMI, can predict the probability of LVH in children with AH (an accuracy of 79.7-84.7%, sensitivity - 57.5-77.5%, specificity - 86.4-91.0%). Obtained satisfactory concordance of the actual data with predictive models indicates the possibility of their use to predict the risk of LVH in children with AH.

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