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Predictive potential of cardiovascular risk factors and their associations with arterial stiffness in people of European and Korean ethnic groups

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Aim. To compare the effect of cardiovascular risk factors on aortic stiffness in people of European and East Asian ethnic groups.

Material and methods. A total of 266 patients aged 18-60 years of European (n=133) and Korean (n=133) ethnic groups were examined. Clinical assessment was carried, Also, following blood parameters was evaluated: total cholesterol (TC), low- (LDL-C) and high- (HDL-C) density lipoprotein cholesterol, apolipoproteins A (apo-A) and B (apo-B), triglycerides (TG), uric acid, creatinine, glucose, adiponectin, resistin. The aortic pulse wave velocity (PWV) and central blood pressure (CBP) were determined using a Tensiomed arteriograph (Hungary). The study design included 3 stages. The first stage included statistical analysis using Mann-Whitney, χ^2, Fisher tests, while the second one – determination of weighing coefficients of individual risk factors on aortic PWV. The third stage consists of verification of the relationship between ethnicity and aortic PWV using multivariate logistic regression and stochastic gradient boosting (SGB).

Results. In Europeans, the median values of growth, body mass index (BMI), waist circumference (WC) and waist-to-height ratio were significantly higher, while the levels of apo-B, TC, HDL-C, LDL-C, TG was significantly lower than in Asians. Koreans had higher blood concentrations of UA, creatinine, glucose, while the resistin concentration was 1,8 times lower. Among Europeans, the odds ratio of developing hypertension (HTN) was significantly higher. The level of aortic PWV in people of different ethnic groups did not differ significantly. Univariate logistic regression showed a dominant influence of age, CPP and waist-to-height ratio on aortic PWV. A less noticeable significant relationship with aortic PWV had HTN, female sex, BMI, levels of systolic, diastolic and pulse BP. Multivariate logistic regression and SGB showed the maximum prediction accuracy when 5 predictors were combined in one model: age, height, HTN, LDL-C, and ethnicity. Comparable accuracy was demonstrated by a model where glucose level was used instead of LDL-C. The results indicate a nonlinear relationship between the ethnic factor and aortic PWV. Its predictive potential was realized only in combination with functional and metabolic status parameters of patients. In Koreans, the threshold values of these factors can be significantly higher than in Europeans.

Conclusion. Developed using modern machine learning technologies, the assessment aortic PWV models taking into account the ethnic factor can be a useful tool for processing and analyzing data in predictive studies.

Keywords: cardiovascular risk, ethnicity, aortic stiffness, machine learning, mathematical models.

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According to the World Health Organization, cardiovascular diseases continue to be the leading cause of disability and premature mortality of the population, even in the context of a coronavirus disease 2019 (COVID-19) pandemic [1, 2]. It is known that the majority of cardiovascular events are associated with cardiovascular remodelling, the subclinical manifestations of which remain undiagnosed for many years. Currently, the issues of cardiovascular risk (CVR) personification and its prognostic assessment are relevant [3]. An important but insufficiently studied aspect of this approach is phenotypic and genetic characteristics of specific individuals, including their ethnicity [3-5]. The data obtained indicate that the traditional CVR factors in different ethnic groups have their own specifics [6]. In the context of current demographic situation when various ethnic groups are not fully tied to their habitats, the issues of ethnicity-related personified CVR assessment acquire special relevance. European and American experts have developed adjustment factor or additional points to the traditionally used CVR scores in first-generation immigrants living in the European Union and the United States [7, 8]. There is available data from specific studies indicating differences in the implementation of traditional risk factors (RFs), most often, hypertension (HTN), in individuals of different ethnic groups living in the Russian Federation [5, 9]. The effect of RF sum is reflected in the target organ damage, which in the early, preclinical stages can be described by some markers, among which excessive aortic stiffness occupies a special place [10, 11]. Increased stiffness of the aorta and large arteries is one of the integral vascular remodelling indicators, which determines the development of vascular events, including in young people [7, 8, 10]. At the same time, the use of arterial stiffness as the only predictor of CVR models based on logistic regression (LR) showed insufficient predictive value. As a number of studies shows, the use of modern machine learning (ML) technologies makes it possible to increase the efficiency of predicting adverse cardiovascular events.

The aim was to compare the effect of cardiovascular risk factors on aortic stiffness in people of European and East Asian ethnic groups.

Material and methods

The study involved 266 people (men, 130; women, 136) aged 18-60, living in the Primorsky Krai and the Sakhalin Oblast. The first group included 133 subjects (mean age, 40,3 years; 95% confidence interval (CI) [38,6; 42]) of European (Slavic) ethnicity, and the second — 133 subjects (mean age, 40,1 years; 95% CI [38,9; 41,1]) of East Asian (Korean) ethnicity (second and third-generation immigrants). The study included patients followed up in outpatient clinics, which signed informed consent. The exclusion criteria were age over 60 years, obesity, symptomatic HTN, arrhythmias, acute disease, and exacerbated chronic disease. The study design was approved by the interdisciplinary ethics committee of the Pacific State Medical University (Vladivostok, Russia). All patients signed written informed consent. The study protocol included 61 characteristics obtained using anthropometric, clinical, and investigational examination methods. All patients were measured for height, body weight, waist circumference (WC), and body mass index (BMI). The study took into account data on sex, smoking status, HTN, and family history. There were following laboratory parameters characterizing the clinical and metabolic status of subjects: total cholesterol (TC), high- and low-density lipoprotein cholesterol (HDL-C and LDL-C), apolipoprotein A (apoA), apolipoprotein B (apoB), uric acid (UA), triglycerides (TG), C-reactive protein (CRP), glucose, adiponectin, and resistin. Arterial stiffness parameters were determined by non-invasive angiography (TensioClinic TL1, TensioMed, Hungary). We also studied aortic pulse wave velocity (APWV), systolic (SBP) and diastolic (DBP) blood pressure on the radial artery, pulse pressure (PP), central aortic blood pressure (CAP), and heart rate. APWV was considered as a continuous or categorical dichotomous (APWV >10 m/s corresponds to an increased level) dependent variable. The input traits were a subgroup of potential predictors and were presented as continuous and categorical variables. Methods of statistical analysis and ML were used for data processing and analysis. The first ones included

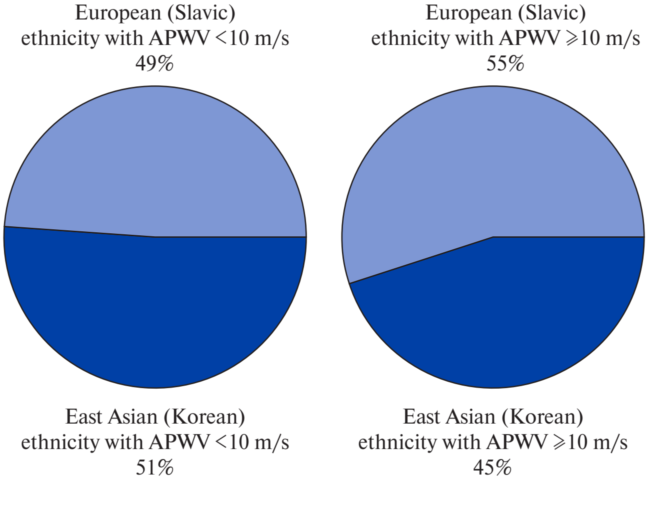

Figure 1. The ratio of persons from different ethnic groups with normal and increased arterial stiffness.
Abbreviation: APWV — aortic pulse wave velocity.

Table 1

Clinical, anthropometric, functional, and metabolic parameters in individuals of different ethnic groups

Parameter	Europeans, n=133	Koreans, n=133	OR, 95% CI	p-value
Age, years	42 [39; 44]	40 [39; 42]		0,75
Male sex, n	64 (48,9%)	66 (51,1%)	0,81 [0,5; 1,3]	0,46
Height, cm	173 [170; 176]	166 [164; 170]		<0,00001
Weight, kg	80 [75; 85]	68 [64; 74]		<0,00001
BMI, CU	26,4 [25,5; 27,8]	24,6 [23,5; 26]		0,00041
WC, cm	89 [85; 93]	82 [80; 86]		0,00018
WHtR, CU	51,7 [49,1; 53,6]	50 [47,9; 51,1]		0,037
UA, mmol/L	0,34 [0,32; 0,41]	0,43 [0,39; 0,55]		0,00024
apoA, g/l	1,8 [1,58; 1,96]	1,6 [1,53; 1,73]		0,15
apoB, g/l	0,85 [0,79; 0,9]	1,075 [0,97; 1,16]		<0,00001
LDL-C, mmol/L	3,57 [3,27; 3,89]	3,925 [3,63; 4,26]		0,037
HDL-C, mmol/L	1,22 [1,11; 1,34]	1,395 [1,24; 1,69]		0,0032
TG, mmol/L	1,45 [1,19; 1,61]	1,77 [1,5; 2,1]		0,026
Total cholesterol, mmol/L	5,47 [5,06; 5,83]	6,34 [6,06; 6,65]		<0,00001
Creatinine, μmol/L	74,45 [70,4; 77,7]	99,6 [91; 107,2]		<0,00001
CRP, mg/L	0,945 [0,67; 1,56]	1,6 [1,2; 2,3]		0,126
Glucose, mmol/L	5,13 [5; 5,23]	6,67 [6,44; 7,15]		<0,00001
Resistin, pg/ml	5,1 [5; 5,3]	2,8 [2,5; 3,7]		0,000054
Adiponectin, pg/ml	5,8 [5,36; 6]	5,08 [3,55; 6,5]		0,43
HTN, n (%)	74 (55,6%)	42 (31,6%)	2,7 [1,6; 4,5]	0,000127
SBP, mm Hg	132 [129; 136]	124 [120; 130]		0,0026
DBP, mm Hg	80 [77; 83]	77 [75; 80]		0,136
CAP, mm Hg	120,6 [115,3; 125]	115,4 [110,25; 122,7]		0,5
PP, mm Hg	51 [39; 53]	45 [43; 47]		0,00054
Heart rate, bpm	71 [68; 72]	71 [70; 72]		0,7
APWV (continuous), m/s	7,69 [7,45; 8,15]	7,55 [7,17; 8,05]		0,43
APWV ⩾10, n (%)	27 (20,3%)	22 (16,5%)	1,3 [0,7; 2,4]	0,53

Note: OR was calculated only for categorical factors.

Abbreviations: HTN — hypertension, apoA — apolipoprotein A, apoB — apolipoprotein B, DBP — diastolic blood pressure, CI — confidence interval, BMI — body mass index, UA — uric acid, OR — odds ratio, WC — waist circumference, TC — total cholesterol, PP — pulse pressure, SBP — systolic blood pressure, APWV — aortic pulse wave velocity, CRP — C-reactive protein, TG — triglycerides, HDL-C — high-density lipoprotein cholesterol, LDL-C — cholesterol low density lipoproteins, CAP — central aortic pressure, HR — heart rate.

descriptive statistics (median (Me), 95% CI), Spearman correlation analysis, Chi-squared, Fisher, Mann-Whitney tests, and univariate weighted LR. The second ones involved following ML techniques: multivariate LR, stochastic gradient boosting (SGB). Statistical significance was confirmed by a p-value <0,05. The development of multivariate LR models was carried out using only one of the correlated variables in their structure to eliminate the multicollinearity. The accuracy of the models was assessed by three quality metrics: area under the ROC curve, sensitivity, and specificity. The models were developed on a training sample (3/4 patients) and verified on a test sample (1/4). Cross-validation was performed with averaging quality metrics at least 100 times over randomly selected data. When developing the LR and SGB models, the Korean ethnicity was coded "1", and the European one — "0".

The study design included 3 phases. At the first, statistical analysis was used, with the help of which intergroup comparisons were carried out. For continuous variables, the Mann-Whitney test was used, since a preliminary assessment of distribution normality by the Shapiro-Wilk test showed a negative result. The chi-square test was used to compare categorical variables, and Fisher's exact test — to assess the odds ratio (OR) with a 95% CI. Comparisons were made for groups with different ethnicity (Europeans and Koreans), as well as for subjects with normal and

Table 2

Assessment of the effect of CVR factors on APWV in the general population

Parameter	APWV <10 m/s, n=217	APWV ⩾10 m/s, n=49	OR, 95% CI	p-value
Age	39 [38; 41]	47 [45; 47]		<0,0001
Male sex	129 (59,4%)	14 (28,5%)		
Female sex	88 (40,6%)	35 (71,4%)	3,6 [1,9; 7,4]	0,00017
Height	171,5 [170; 173]	164 [163; 167]		0,00017
WC	84 [82; 87]	89,5 [82; 95]		0,24
BMI	25,36	26,15		0,034
WHtR	50 [48,8; 51,1]	52,4 [49,1; 57,4]		0,012
UA	0,39 [0,36; 0,43]	0,34 [0,31; 0,46]		0,53
ApoA	1,7 [1,59; 1,77]	1,64 [1,21; 2,34]		0,76
ApoB	0,92 [0,86; 0,97]	0,92 [0,68; 0,98]		0,54
LDL-C	3,79 [3,42; 3,99]	3,55 [3; 4,37]		0,69
HDL-C	1,28 [1,2; 1,41]	1,26 [0,95; 1,52]		0,21
TG	1,6 [1,42; 1,74]	1,4 [1,1; 2,67]		0,83
Cholesterol	5,92 [5,61; 6,17]	5,55 [4,9; 6,21]		0,12
Creatinine	83,4 [77,4; 90,1]	74,9 [68,7; 89]		0,1
CRB	1,12 [0,91; 1,6]	2,6 [0,42; 7,97]		0,11
Glucose	5,625 [5,44; 5,82]	5 [4,9; 6,2]		0,064
Resistin	4,7 [3,9; 5]	4,78 [2,25; 5,5]		0,88
Adiponectin	5,7 [5,3; 6]	5,68 [4,7; 6,4]		0,79
HTN	77 (35,5%)	39 (79,6%)	7 [3,4; 15,6]	<0,0001
SPB	128 [123; 131]	138 [126; 145]		0,014
DBP	77 [76; 80]	83 [79; 90]		0,01
PP	47 [46; 50]	51 [47; 58]		0,04
CAP	116,2 [111,8; 120,2]	136,5 [121; 155,4]		0,00016
Heart rate	71 [70; 72]	70 [68; 72]		0,24

Abbreviations: HTN — hypertension, apoA — apolipoprotein A, apoB — apolipoprotein B, DBP — diastolic blood pressure, CI — confidence interval, BMI — body mass index, UA — uric acid, OR — odds ratio, WC — waist circumference, TC — total cholesterol, PP — pulse pressure, SBP — systolic blood pressure, APWV — aortic pulse wave velocity, CRP — C-reactive protein, TG — triglycerides, HDL-C — high-density lipoprotein cholesterol, LDL-C — cholesterol low density lipoproteins, CAP — central aortic pressure, HR — heart rate.

increased APWV. At the second phase, according to normalized characteristics, using univariate LR, weights were determined that corresponded to the significance of effect of specific CVR factors on APWV in the general population and in ethnic groups. At the third phase, multivariate models based on LR and SGB were developed, the structure of which was step by step supplemented with potential predictors of increased arterial stiffness. With an increase in the quality metrics, the factor was considered as a predictor of vascular remodelling. Data processing and analysis were performed in R in the R-studio environment and in Python using the XGBoost and TensorFlow packages.

Results

At the first phase, we analyzed possible differences in demographic, anthropometric, clinical, and investigational parameters between the two ethnic groups (Table 1).

It was found that ethnic groups did not significantly differ in age and sex composition. The median values of anthropometric parameters (height, weight, BMI, WC and waist-to-height ratio (WHtR)) were significantly higher in Europeans. In this group, such lipid profile parameters as apoB, TC, HDL-C, LDL-C, TGs were significantly lower than in the comparison group. The Koreans had a higher blood concentration of UA, creatinine, glucose, while the resistin level was 1,8 times lower than in Europeans. At the same time, CRP and adiponectin levels in the comparison groups did not differ. HTN with a higher SBP and PP levels was significantly more common in the European group. Compared to Koreans, Europeans had a significantly higher risk of HTN (OR, 2,7 [1,6; 4,5]) (Table 1). At

Table 3

Weighting coefficients of univariate LR models for assessing APWV in the general population

Predictive factor	Weighting coefficient	p-value
Age	6,1	<0,0001
Ethnic group	-0,25	0,43
Female sex	1,3	0,00017
Height	-3,4	0,0007
BMI	2,18	0,013
WHtR	3	0,0046
HTN	2	<0,0001
SBP	2,4	0,0055
DBP	2,1	0,016
PP	1,4	0,055
CAP	4,3	<0,0001
Creatinine	-2,4	0,11
GFR	0,32	0,89
Glucose	-2,8	0,28
UA	-0,82	0,66
HDL-C	-1,7	0,16
LDL-C	-0,67	0,6
TC	-0,34	0,077

Note: (-) — inverse dependence of APWV on this factor.

Abbreviations: HTN — hypertension, DBP — diastolic blood pressure, BMI — body mass index, UA — uric acid, WC — waist circumference, TC — total cholesterol, PP — pulse pressure, SBP — systolic blood pressure, GFR — glomerular filtration rate, APWV — aortic pulse wave velocity, HDL-C — high density lipoprotein cholesterol, LDL-C — low density lipoprotein cholesterol, CAP — central aortic pressure.

Table 4

Weighting coefficients of univariate LR models in assessing the predictive potential of CVR factors in European and Korean ethnic groups

Predictive factor	Europeans		Koreans	
	Weighting coefficient	p-value	Weighting coefficient	p-value
Age	6	0,00002	4,1	0,0018
Female sex	1,2	0,0087	1,6	0,006
Height	-4,87	0,00073	-2,2	0,043
BMI	2,6	0,023	0,65	0,5
WHtR	2,9	0,023	1,33	0,22
HTN	2,68	0,00043	1,65	0,0008
SBP	2,4	0,0055	3	0,00003
DBP	2,1	0,016	3,7	<0,00001
PP	1,4	0,055	0,85	0,25
CAP	4,3	0,00003	5	<0,00001
LDL-C	0,04	0,8	0,06	0,9

Abbreviations: HTN — hypertension, DBP — diastolic blood pressure, BMI — body mass index, WC — waist circumference, PP — pulse pressure, SBP — systolic blood pressure, LDL-C — low-density lipoprotein cholesterol, CAP — central aortic pressure.

the same time, the APWV in individuals of different ethnic groups did not differ significantly (OR, 0,78 [0,41; 1,46], p=0,53) (Figure 1).

Analysis of RF effect on the increase in APWV was carried out for dichotomous variable (Table 2). The results of comparing CVR among the general

Table 5

Quality of multivariate LR and SGB models for predicting APWV in the general population

№	Predictive factor	Logistic regression			Stochastic gradient boosting		
		AUC	Sensitivity, %	Specificity, %	AUC	Sensitivity, %	Specificity, %
1	Age	0,763±0,06	74,4±11	67,2±7	77,3±6	73,1±11	67,2±8
2	Age + female sex	0,802±0,06	67,8±14	72±7	79,6±6	70,5±15	69,4±9
3	Age + female sex + ethnicity	0,796±0,06	67,5±13	71,9±7	79,3±6	69,5±15	69,5±9
4	Age + height	0,787±0,06	75,6±10	68,4±6	0,794±0,06	70,2±11	70,6±7
5	Age + height + ethnicity	0,778±0,06	72,8±11	70,1±6	0,792±0,06	68,8±11	70,4±7
6	Age + height + female sex	0,793±0,06	68,9±12	70,7±6	0,796±0,06	69,3±0,12	71±7
7	Age + height + female sex + ethnicity	0,786±0,06	68,5±12	71,2±6	0,792±0,06	68,5±12	71,2±7
8	Age + height + CAP	0,804±0,09	73,6±17	80,9±7	0,757±0,08	63,7±16	79,4±7
9	Age + height + HTN	0,827±0,06	77,4±11	73,4±6	0,82±0,06	78,8±11	72,2±6
10	Age + height + HTN + ethnicity	0,823±0,06	77,3±11	74,1±6	0,817±0,06	78,1±12	72,4±6
11	Age + height + HTN + LDL-C	0,833±0,09	78,8±17	75±9	0,785±0,09	76±16	74,6±10
12	Age + height + HTN + LDL-C + ethnicity	0,867±0,08	80,3±13	85,5±7	0,843±0,08	81,2±15	76,8±7
13	Age + height + HTN + glucose	0,818±0,09	79±16	72,9±9	0,809±0,09	74,6±19	73,9±8
14	Age + Height + HTN + glucose + ethnicity	0,857±0,08	86,4±14	78,4±8	0,846±0,09	80,7±17	76±8

Note: the averaged quality metrics values were obtained on test samples.

Abbreviations: HTN — hypertension, LDL-C — low-density lipoprotein cholesterol, CAP — central aortic pressure, AUC — area under the ROC curve.

population with APWV <10 m/s and APWV ⩾10 m/s showed that aortic stiffness increase is significantly associated only with age, female sex (OR, 3,6 [1,9; 7,4], p=0,00017), anthropometric parameters (height, BMI, WHtR), HTN (OR, 7 [3,4; 15,6], p<0,0001), the level of SBP, DBP, PP and CAP.

To verify the possible interrelationships of CVR factors with aortic stiffness, based on univariate LR, we constructed models for assessing APWV with the calculation of weighting coefficients that allow us to clarify the predictive value of potential predictors. This approach significantly expands the potential of processing and analyzing data due to a more detailed classification of CVR factors' effect on the resulting variable (Table 3).

Evaluation of the weighting coefficients of univariate regression models made it possible to identify CVR factors that had significant relationships with APWV. The age (6,1), CAP (4,3), and WHtR (3) had a direct dominant effect on APWV. An intense inverse relationship was recorded between the height of subjects and arterial stiffness (-3,4). Factors such as HTN, female sex, SBP, DBP, PP, and BMI had a less pronounced, but reliable direct relationship with APWV. At the same time, the effect of ethnicity and metabolic parameters on arterial stiffness was not significant.

For a more accurate assessment of ethnicity-APWV relationships, we have developed univariate LR models separately for each ethnic group (Table 4).

The analysis of weighting coefficients in the comparison groups showed that anthropometric parameters (WHtR and BMI) have a significant effect on APWV only in the European population. In this group of subjects, the dependence of arterial stiffness on age, height, and HTN was more noticeable. Among Koreans, sex (female), as well as SBP and DBP had a more intense relationship with APWV.

At the next phase, we developed multivariate LR and SGB models and performed their cross-validation on 100 random samples. The main quality metrics was obtained: area under the ROC curve, sensitivity and specificity (Table 5).

It was found that in all the models developed, the age of subjects was used as the basic predictor, the high predictive potential of which was also proved at the previous phases (Tables 2-4). The step-by-step inclusion of additional factors in their structure with the subsequent validation of models on test samples showed that the most accurate of them are models 12 and 14, which included the ethnic factor. Analysis of models 1-9 showed that age, female sex, height, CAP and HTN are "self-sufficient" predictors of

Table 6

Weighting coefficients of multivariate LR models with the ethnicity inclusion

Predictive factor	Weighting coefficient/p-value		
Parameter	Model 10	Model 12	Model 14
Age	0,085/0,00056	0,104/0,047	0,084/0,037
Height	-0,073/0,00017	-0,043/0,05	-0,057/0,04
HTN	1,38/0,00005	1,8/0,0065	1,6/0,011
Ethnicity	-0,206/0,44	-3,3/0,016	-3,38/0,011
LDL-C	-	0,168/0,6	-
Glucose	-	-	0,07/0,21

Note: during analysis, Koreans were coded 1, Europeans — 0.
Abbreviations: HTN — hypertension, LDL-C — low-density lipoprotein cholesterol.

arterial stiffness and do not depend on ethnicity. This conclusion was made based on quality metrics obtained for different types of models (LR and SGB), the accuracy of which increased when height or sex were included in their structure and did not change significantly when these factors were combined with ethnicity (models 1-7). It should be noted that sex and height have comparable predictive value, and their combination in one model increases the predictive quality. The presence of HTN was more significant than the CAP, but they both increased the prediction accuracy "without the help" of ethnicity (models 8-9). The maximum rise in quality metrics was recorded when 5 predictors were combined: age, height, HTN, LDL-C, and ethnicity (model 12). Comparable accuracy was demonstrated by a model in which the LDL-C was replaced by serum glucose (model 14). The data obtained indicate a nonlinear relationship between the ethnic factor and APWV. Its predictive potential was realized only when combined with functional and metabolic status parameters of the subjects.

For a more detailed assessment of influence vector of the ethnicity on APWV, we analyzed the weighting coefficients of the models with ethnic factor (Table 6).

Negative weighting coefficients for the selected ethnicity coding (models 12, 14) indicate that an increase in the serum concentration of glucose and LDL_C in Europeans is a RF of increased arterial stiffness. At the same time, among Koreans, these factors were not associated with the risk of increased APWV. It can be assumed that in this cohort of subjects, the realization of pathogenic potential of CVR factors is carried out at their higher threshold values (Table 1).

Discussion

The level of CVR in practice is most often assessed using integral scales. At the same time, the prognostic significance of classical scales and other systems for CVR stratification actively discussed [3, 12, 13]. Most experts note the need to search for novel biological markers that would make it possible to personalize the CVR assessment in an earlier age patients. Of particular interest are the approaches associated with integral CVR parameters, which reflect the RF sum effect on the organism throughout life, including the phenotypic and genetic characteristics of a person. Markers of cardiovascular remodelling and, first of all, parameters of aortic and large arterial stiffness occupy an important place in CVR reclassification. Parameters of arterial or aortic stiffness are recognized as independent predictors of all-cause and cardiovascular mortality, even more significant than CVR factors such as blood pressure or blood cholesterol [10, 11]. An increase in aortic stiffness due to impaired elasticity is considered one of the manifestations of natural aging in humans and CVR escalation [11]. In recent years, research has been intensified using ML to develop prognostic models that assess the CVR [14, 15]. At the same time, there are not enough works on assessing the ethnicity influence on the integral CVR indicators, despite the fact that ethnicity is recognized as a promising factor in CVR reclassification [3, 13].

In the present study, using the developed models, we obtained new data on the probability of CVR factor realization in individuals of the European and Korean ethnic groups. According to our data, the median APWV values in these cohorts did not differ significantly with each other. However, the analysis of weighting coefficients of univariate LR models revealed differences in influence of individual CVR factors on arterial stiffness. Models based on LR and SGB made it possible to verify the high predictive potential of age, female sex, height, HTN and CAP for assessing increased arterial stiffness regardless of ethnicity. Also, the fact that the patient had HTN was more significant than the CAP level, but both of these factors increased the accuracy of the prognosis. At the same time, according to our data, the serum levels of LDL-C and glucose demonstrated predictive value for vascular remodelling only in conjunction with ethnicity, which was confirmed by modelling.

Study limitations. The study limitations includes the inadequate sample size and the need to expand the methods for processing and analyzing data, including using artificial neural networks.

Conclusion

Currently, the topical direction of preventive cardiology is the improvement and adaptation of the well-known CVR stratification scores with the studying novel predictors, including ethnicity [3, 4, 12]. At the same time, it should be noted that for a full revision of classical scales, data are still insufficient, and therefore it is necessary to perform studies with a larger number of representatives of different ethnicity. The data obtained in this study on the influence of individual RFs and their combinations on the risk of increased arterial stiffness in individuals of the European and East Asian races complement the already known information. The analysis indicate that the threshold values of metabolic factors (LDL-C and glucose) associated with increased arterial stiffness in Koreans, compared with the Europeans, may be significantly higher. This hypothesis was confirmed by comparing biochemical parameters in the comparison groups and modelling the aortic stiffness level with stepwise inclusion of potential predictors.

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