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COMPARATIVE ESTIMATION OF INFORMATIVENESS OF LEUCOCYTARY INDEX OF ADAPTATION BY GARKAVI AND BY POPOVYCH

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We compared the informativeness of two well-known indices quantitative measure of general adaptation reactions offered Garkavi L.H. et al. (1977) and Popovych I.L. et al. (2000). An examination of 20 healthy men found that index of adaptation by Popovyc that takes into account the relative content in leucocytogram of lymphocytes and deviations of monocytes, eosinophils and bacilonucleary neutrophils, moderately or significantly correlated with the neuroendocrine-immune complex, whereas links them index of adaptation by Garkavi as the ratio of lymphocytes/segmented neutrophils are weak or absent.

Keywords: *general adaptation reactions, neuroendocrine-immune complex, indices of adaptation by Garkavi and by Popovyc.*

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ПОРІВНЯЛЬНА ОЦІНКА ІНФОРМАТИВНОСТІ ЛЕЙКОЦИТАРНОГО ІНДЕКСУ АДАПТАЦІЇ ЗА ГАРКАВІ І ЗА ПОПОВИЧЕМ

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Нами проведене порівняння інформативності двох відомих індексів кількісної міри стану загальної адаптаційної реакції організму, запропонованих Гаркави Л.Х. и др. (1977) та Поповичем І.Л. та ін. (2000). При обстеженні 20 практично здорових чоловіків виявлено, що індекс адаптації Поповича, який враховує як відносний вміст у лейкоцитограмі лімфоцитів, так і відхилення від норми вмісту моноцитів, еозинофілів і паличкоядерних нейтрофілів, помірно або значно корелює з параметрами нейроендокринно-імунного комплексу. Натомість зв'язки з ними індексу адаптації Гаркаві як відношення лімфоцити/сегментоядерні нейтрофіли слабкі або відсутні.

Ключові слова: *загальні адаптаційні реакції організму, нейроендокринно-імунний комплекс, індекси адаптації Гаркаві та Поповича.*

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СРАВНИТЕЛЬНАЯ ОЦЕНКА ИНФОРМАТИВНОСТИ ЛЕЙКОЦИТАРНОГО ИНДЕКСА АДАПТАЦИИ ЗА ГАРКАВИ И ЗА ПОПОВИЧЕМ

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Нами проведено сравнение информативности двух известных индексов количественной меры состояния общей адаптационной реакции организма, предложенных Гаркави Л. Х. и др. (1977) и Поповичем И.Л. и др. (2000). При обследовании 20 практически здоровых мужчин выявлено, что индекс адаптации Поповича, который учитывает как относительное содержание в лейкоцитограмме лимфоцитов, так и отклонение от нормы содержания моноцитов, эозинофилов и палочкоядерных нейтрофилов, умеренно или значительно коррелирует с параметрами нейроэндокринно-иммунного комплекса. В то же время связи с ними индекса адаптации Гаркави как отношения лимфоциты/сегментоядерные нейтрофилы слабые или отсутствуют.

Ключевые слова: *общие адаптационные реакции организма, нейроэндокринно-имунный комплекс, индексы адаптации Гаркави и Поповича.*

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INTRODUCTION

The conception of **general adaptation reactions** of organism (GARO), created by Garkavi L.Kh., Kvakina E.B. and Ukolova M.A. in 1977 on the base of Selye H. classic conception of stress and developed then by them [2,3], and also by Radchenko O.M. [10], sufficiently successfully used in medicine and valeology for the estimation of general condicion of organism. According to this conception, GARO of **training** and **quiet** and **heightened activation** of **high levels of reactivity** (HLR, harmonious) represent different gradations of health, but the same GARO of **low levels of reactivity** (LLR, disharmonious) and **stress** of HLR (eustress) characterize the premorbide states of organism, and heterospecific nosotropic basis of illness are stress of LLR (distress) and reaction of **superactivation**. Comparative estimation of the state of the looked after groups of persons and his dynamics under act of pathogenic or sanogenic factors the authors of conception and their numerous followers give after frequentness of separate GARO, id est an estimation has **qualitative** or semiquantitative character only. The input of index of adaptation as relation lymphocytes/segmentonuclear neutrophyles (L/SNN) quite not decides problems of **quantitative** estimation of the state of adaptation, in fact, after their table [3, p. 361], ranges of **quality** different GARO is crossing. In particular, ranges of L/SNN-ratio reactions of training of HLR and LLR present accordingly 0,27÷0,52 and 0,26÷1,17, reactions of the quiet activation: 0,45÷0,64 and 0,44÷1,43, heightened activation: 0,57÷1,12 and 0,57÷3,0. For the decision of problem Popovych I.L. et al. [4,7,8] on results comparative researches of parameters of immunity, hemostase and metabolism and them cross-correlation connections with the parameters of leucocytogram for persons with different GARO fundamentally other index of adaptation, which takes into account the range of both lymphocytosis and other elements of leucocytogram, was offered. A maximal point (7) was appropriated GARO of the quiet activation (QA) of HLR, which appeared the first after a grade. Quantification other GARO it was conducted after a formula:

$IAP=7\bullet\Phi^{(1-R)/2}$, where

Φ is a number of Fibonacci (1,618)

R is a grade of GARO.

On this scale the second after the grade of GARO of heightened activation (HA) of HLR is appraised in 5,5 p, GARO of training (T) of HLR in 4,3 p, GARO of the QA of LLR in 2,67 p, GARO of T of LLR in 2,1 p, GARO of HA of LLR in 1,65 p, and reaction of superactination - in 1,3 p.

At the same time, the qualitative-quantitative scale of Bayevskyi R.M. [1] uses for the estimation of the state of adaptation a mass appeal, built on the basis of parameters of hart rate variability. Last, in turn, at a construction scales of Popovych I.L. et al. [8] not taken into account. Going out expounded, we put before itself **aim**: conduct a comparative estimation based on neuro-endocrine and immune parameters of informativity of leucocytary index of adaptation by Garkavi and by Popovych.

MATERIAL AND RESEARCH METHODS

Under a observations were 20 practically healthy volunteers - men by age 26-54 years. In the morning in basale terms at first ECG recorded hardware-software complex "КардіоЛаб+ВСР" (ХАІ-МЕДИКА, Kharkiv, Ukraine) in standard lead II. For further analysis the following parameters heart rate variability (HRV) were selected. Temporal parameters (Time Domain Methods): the standart deviation of all NN intervals (SDNN), the square root of the mean of the sum of the squares of differences between adjacent NN intervals (RMSSD), the percent of interval differences of successive NN intervals greater then 50 ms (pNN_{50}) [11]; heart rate (HR), moda (Mo), the amplitude of moda (AMo), variational sweep (MxDMn) [1]. Spectral parameters (Frequency Domain Methods): power spectral density (PSD) components of HRV - high-frequency (HF, range 0,4÷0,15 Hz), low-frequency (LF, range 0,15÷0,04 Hz), very low-frequency (VLF, range 0,04÷0,015 Hz) and ultra low-frequency (ULF, range 0,015÷0,003 Hz). Expectant as classical indexes: LF/HF, LFnu=100%•LF/(LF+HF) and stress index Bayevskyi (SI=AMo/2•Mo•MxDMn) and regulatory systems activity index Bayevskyi [1].

Whereupon took from an ulnar vein the test of blood for determination of plasma levels of main adaptive hormones: cortisol, triiodo-thyronine and testosterone - by the ELISA method with the use of analyzer of "Tecan" (Oesterreich) and corresponding sets of reagents of JSC "Алкор Био" (St-Pb., RF [5]) and sodium and potassium (by the method of flaming photometry on the device of ПФМ У 4.2), with the purpose of estimation of mineralocorticoid activity after Na/K-ratio. After it volunteers filled a questionnaire with the purpose of estimation of level of the trait and reactive anxiety [9].

In the same portion of blood determined the parameters of phagocytose by neutrophyles of museum culture of Staphylococcus aureus and counted up leucocytogram, on the basis of which determined the type

of GARO, indexes of adaptation by Garkavi [3] and by Popovych [8], index of strain (tension) of leucocytogram by Popovych [8] and entropy of leucocytogram [7,14].

In quality the marker of general health level determined the index of electronegativity of kernels of buccal epithelium method of intracellular electrophorese on a device "Біотест" (State University, Kharkiv), according to the instruction [6].

Digital material it is traited by the methods of cross-correlation and canonical analyses [7,13], using the package of softwares "Statistica 5.5".

RESULTS

On the first stage of analysis the looked after contingent was divided into two clusters of GARO: high levels of reactivity (HLR) and low levels of reactivity (LLR). Because the looked after men were practically healthy, in 65% them fully expectant it is established harmonious GARO as markers of health. At the same time, for the 35% persons GARO appeared disharmonious, that testifies to the premorbidian state, predefined, presumably, by chronic psycho-emotional tension. By a quantitative measure last it is possible to count index of strain of leucocytogram by Popovych (tabl. 1), which at GARO of LLR in 4,75 time higher, than at GARO of HLR. It combines with lesser in 2,2 time index of adaptation by Popovych. Between these indexes the expected considerable negative correlation (Fig. 1) is educed, in fact exactly she represents essence of conception of GARO by Popovych. At this contingent the strain of leucocytogram is a consequence, mainly, monocytose.

Table 1. Comparative description of parameters of лейкоцитограми of different clusters of GARO

Parameters of leucocytogram	HLR (n=13)	LLR (n=7)
Clusterforming		
Index of adaptation by Popovych, units	4,72 ±0,28	2,13 ±0,16*
Index of adaptation by Popovych, ln units	1,54 ±0,05	0,74 ±0,07*
Index of strain of leucocytogram by Popovych, units	0,04 ±0,01	0,19 ±0,04*
Others		
Lymphocytes, %	25,9 ±0,6	30,0 ±2,4
Segmentonucleary neutrophyles, %	61,7 ±0,6	54,3 ±3,0*
Index of adaptation by Garkavi (Lf/SNN), units	0,42 ±0,01	0,58 ±0,09
Bacillonucleary neutrophyles, %	3,8 ±0,2	3,0 ±0,2*
Eosinophyles, %	3,3 ±0,1	3,9 ±0,5
Monocytes, %	5,4 ±0,3	8,9 ±0,3*
Entropy of leucocytogram	0,645 ±0,006	0,699 ±0,016*

Note. Significantly of difference between parameters marked *

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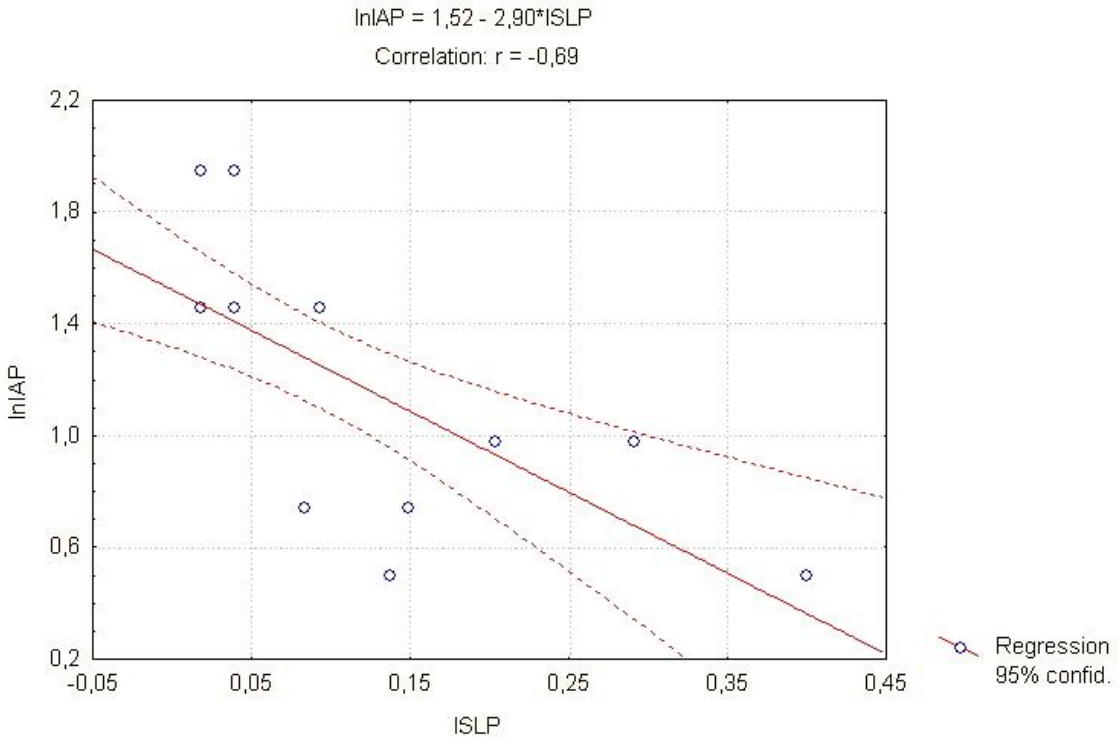

Fig. 1. Correlationship between index of strain of leucocytogram by Popovych (ISLP) (axis of X) and index of adaptation by Popovych (axis of Y)

Alternative index of adaptation by Garkavi, despite logic of conception of GARO, appeared at LLR even some higher, than at HLR. About the mathematical tactlessness of this index as a quality measure of the state of adaptation testifies also him considerable negative correlation from index of adaptation by Popovych (Fig. 2) and considerable positive correlation from index of strain of leucocytogram by Popovych (Fig. 3).

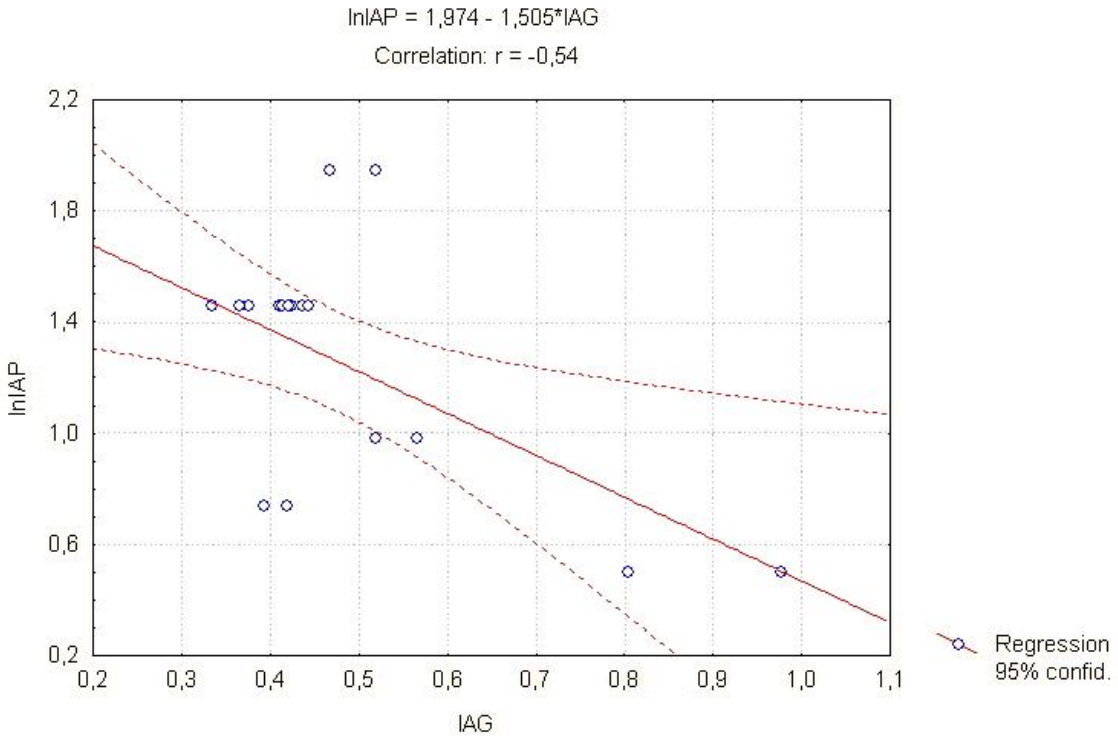

Fig. 2. Correlationship between index of adaptation by Garkavi (IAG) (axis of X) and index of adaptation by Popovych (IAP) (axis of Y)

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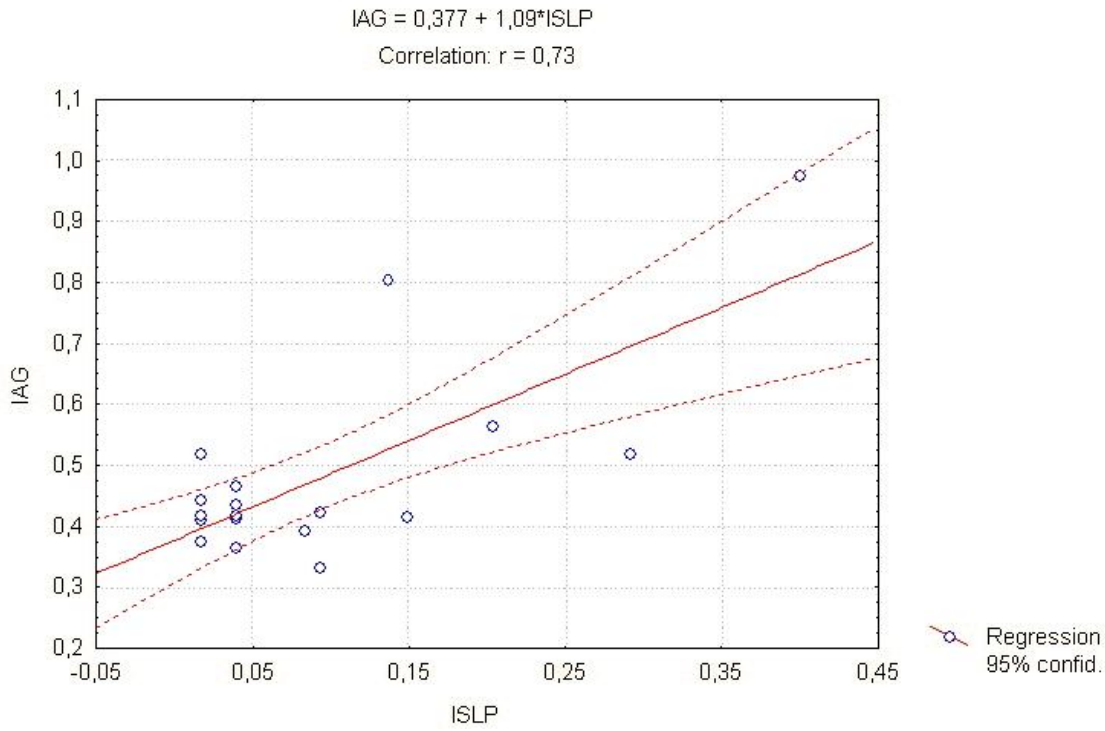

Fig. 3. Correlationship between index of strain of leucocytogram by Popovych (ISLP) (axis of X) and index of adaptation by Garkavi (axis of Y)

It is first educed by us, that GARO of LLR is characterized significantly more than GARO of LLR, entropy of leucocytogram. Interestingly, that coefficient of correlation between entropy of leucocytogram and lnIAP (Fig. 4) exactly the same, as well as between of ISLP and lnIAP (Fig. 3). Thus, entropy (chaos) of leucocytogram it is also possible to examine as a quantitative measure of disharmony of GARO.

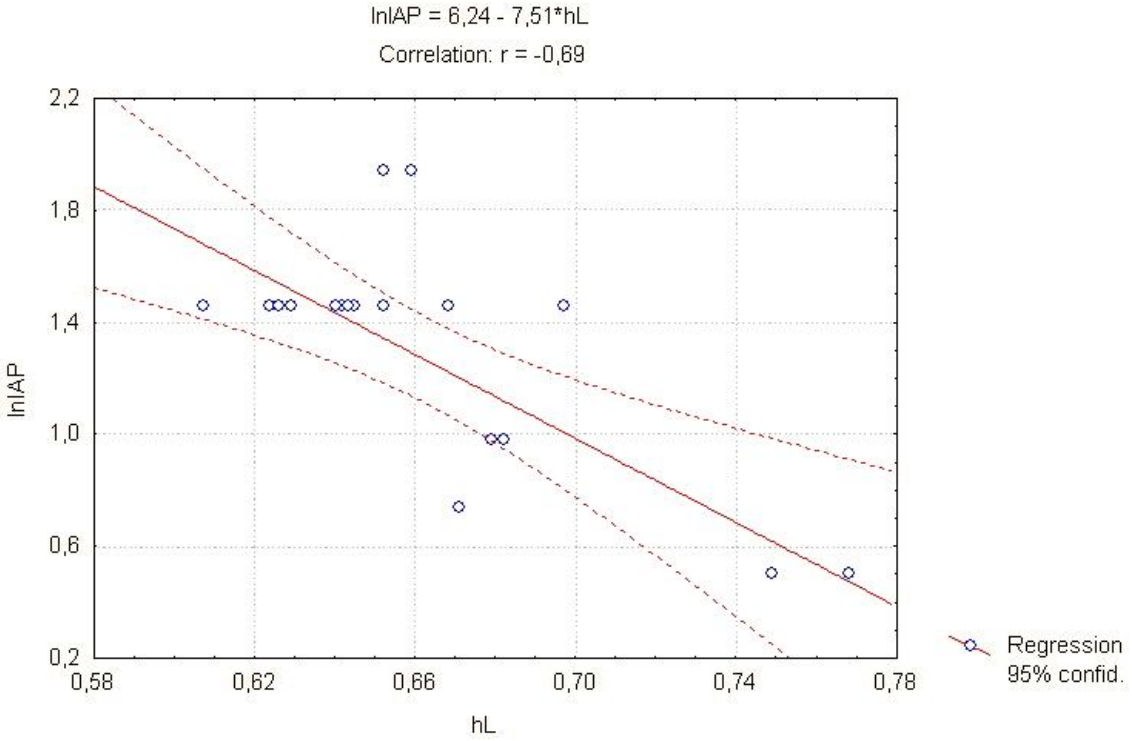

Fig. 4. Correlationship between enropy of leucocytogram (hL) (axis of X) and index of adaptation by Popovych (axis of Y)

But index of adaptation by Garkavi, again despite logic, correlates from entropy of leucocytogram positively and strongly (Fig. 5).

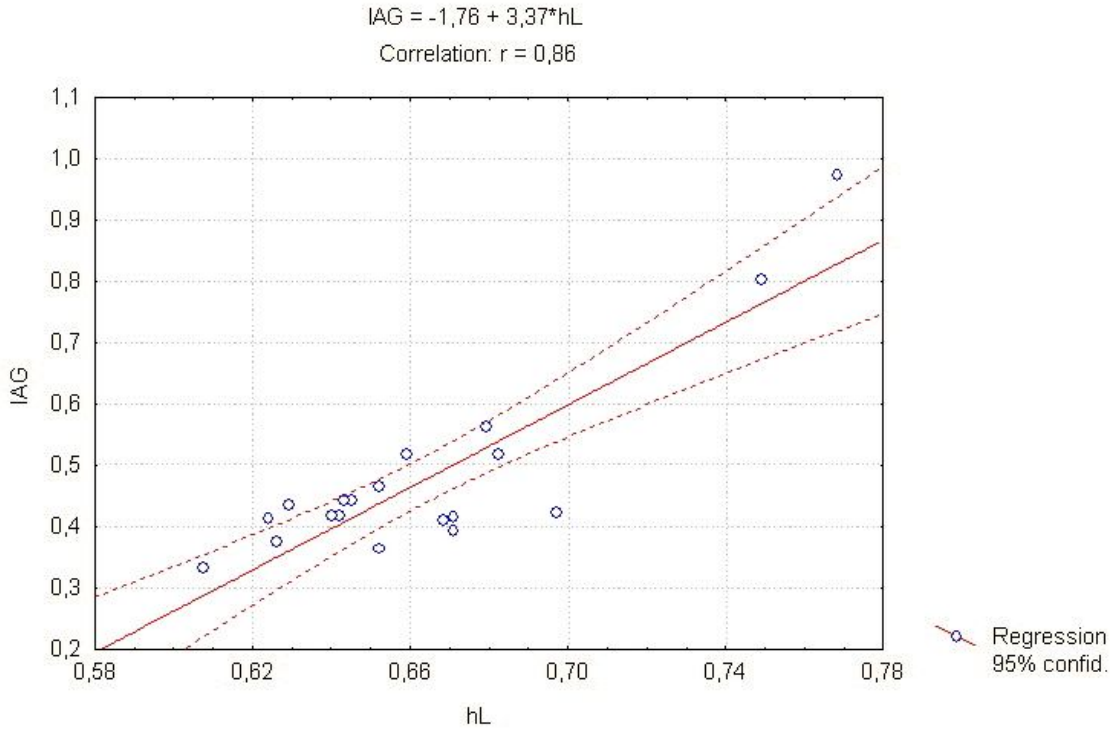

Fig. 5. Correlationship between enropy of leucocytogram (hL) (axis of X) and index of adaptation by Garkavi (axis of Y)

At the comparative analysis of temporal parameters of HRV it is educed (table 2) that GARO of LLR is characterized by higher, than GARO of HLR, levels correlates of sympathic tone: hart rate (+23%) and of AMo (+74%), but lesser levels correlates of parasympathic tone: Mo (-21%), MxDMn (-41%), HRV TI (-43%), SDNN (-52%) of and of RMSSD (-62%). It testifies to the sympathotonic change of vegetative homoeostasis at disharmonious GARO, by quantitative expression of which higher in three times of sympatho-vagal balance index and on 31% stress index of Bayevskyi (SIB).

Table 2. Comparative description of temporal parameters of HRV of different clusters of adaptation

Parameters	HLR (n=13)	LLR (n=7)
HR, beats/min	60,9 ±2,2	75,0 ±1,5*
Mo, ms	988 ±34	779 ±18*
AMo, %	38 ±4	66 ±7*
MxDMn, ms	244 ±18	144 ±24*
Sympatho-vagal balance index (10^3•AMo/MxDMn)	193 ±49	584 ±151*
Stress index Bayevskyi, units	107 ±34	381 ±102*
Stress index Bayevskyi, ln units	4,36 ±0,20	5,73 ±0,27*
HRV TI, units	12,9 ±1,2	7,4 ±1,2*
SDNN, ms	58 ±6	28 ±4*
RMSSD, ms	47 ±8	18 ±3*

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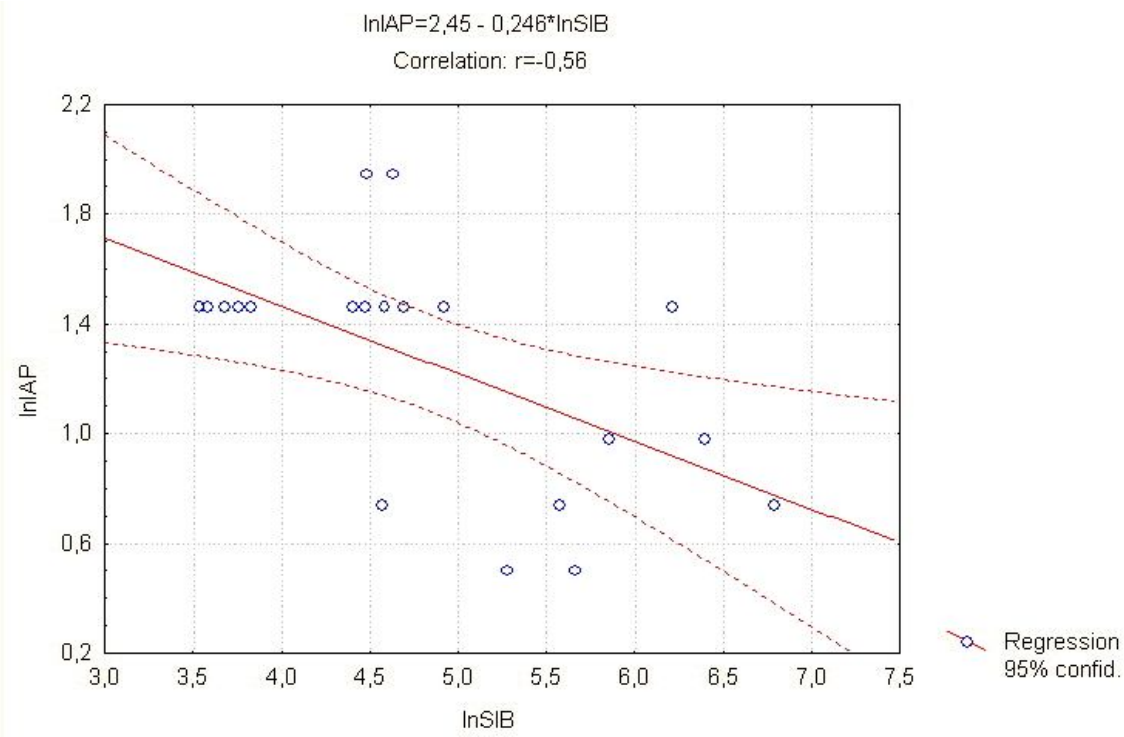

Fig. 6. Correlationship between stress index Bayevskyi of HRV (SIB) (axis of X) and index of adaptation by Popovych (axis of Y)

We are first educe considerable negative correlation between lnSIB and lnIAP (Fig. 6), while correlation of between lnSIB and IAG very weak (r=0,27).

Interestingly, that saided touches the same measure and such accessible parameter as hart rate: r=-0,58 for lnIAP (Fig. 7) and 0,31 for IAG.

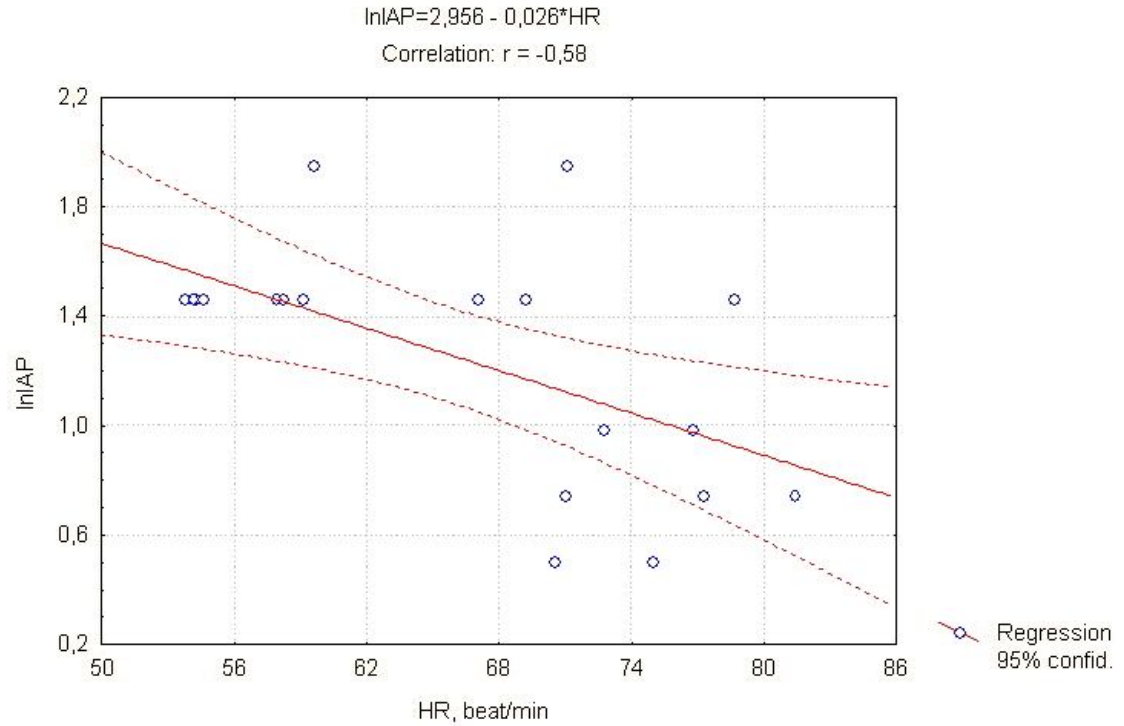

Fig. 7. Correlationship between heart rate (HR) (axis of X) and index of adaptation by Popovych (axis of Y)

Less informing is SDNN (r=0,58 and -0,25), AMo (r=-0,52 and 0,18), MxDMn (r=0,52 and -0,32), RMSSD (r=0,44 and -0,26), HRV TI (r=0,44 and -0,28).

Concerning spectral parameters of HRV it is educed (table 3) that GARO of LLR is characterized by below, than GARO of HLR, PSD of separate components and, naturally, total PSD of HRV.

Table 3. Comparative description of spectral parameters of HRV of different clusters of adaptation

Parameters	HLR (n=13)	LLR (n=7)
Total PSD of HRV, ms^2	3665 ±618	841 ±261*
PSD **HF** component of HRV, ms^2	1159 ±421	145 ±63*
PSD **LF** component of HRV, ms^2	942 ±160	346 ±134*
PSD **VLF** component of HRV, ms^2	1281 ±314	313 ±86*
PSD **ULF** component of HRV, ms^2	284 ±98	35 ±12*
Sympatho-vagal balance index (LF/HF)	2,2 ±0,7	3,7 ±1,0
LFnu, [100•LF/(LF+HF)], %	58 ±5	72 ±5
Regulatory systems activity index Bayevskyi, units	2,6 ±0,55	5,2 ±1,1*

Thus exactly total of PSD of HRV closer in all correlates from lnIAP (Fig.8).

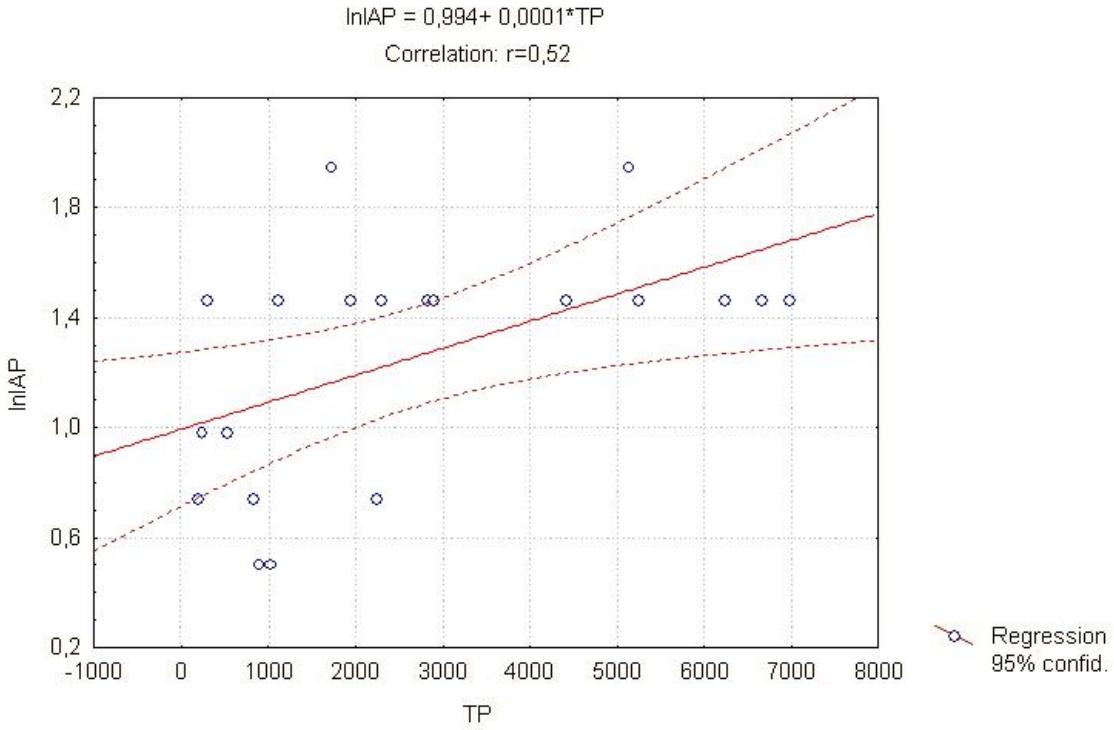

Fig. 8. Correlationship between total power spectrum density of HRV (TP) (axis of X) and index of adaptation by Popovych (axis of Y)

PSD of separate components is constrained from lnIAP more poorly (r=0,49; 0,41; 0,31 and 0,29 for LF, VLF, HF and ULF respectively). But IAG correlates from total of PSD of HRV poorly (r=-0,26). An analogical situation is observed in relation to separate components of spectrum of HRV. It is known about considerable connections between the parameters of HRV and electroencephalogram [12]. From here the ground of supposition swims out about influence on the state of adaptation from the side of CNS.

The additional testifying to the sympathotonic change of vegetative homoeostasis at disharmonious GARO is them higher, though insignificant, classic indexes LF/HF and LFnu. These indexes mildly negatively correlate from lnIAP (r=-0,38 and -0,35 respectively). But IAG correlates from LF/HF and Lfnu opposite character (r=0,48 and 0,41 respectively).

Another integral parameter - regulatory systems activity index of Bayevskyi - at GARO of LLR appeared twice as high, than at GARO of HLR. Thus frequentness of the normal states of regulatory systems (1÷3 points) presents 28% versus 77%, but the states of tension of regulatory systems (4÷7 points) - 43% versus

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23%, and the states of blowing off adaptation (8÷10 points) - 29% versus 0% at GARO of LLR and HLR respectively. On the whole moderate negative correlation takes place between regulatory systems activity index of Bayevskyi and lnIAP (r=-0, 36), but not IAG (r=0,08).

Momentously, that between index of strain of leucocytogram by Popovych and stress index of Bayevskyi exist considerable positive correlation (Fig. 9). It fills with a term "strain" physiology sense. Both parameters of strain/stress in common determine level of adaptation on 53% (Fig.10).

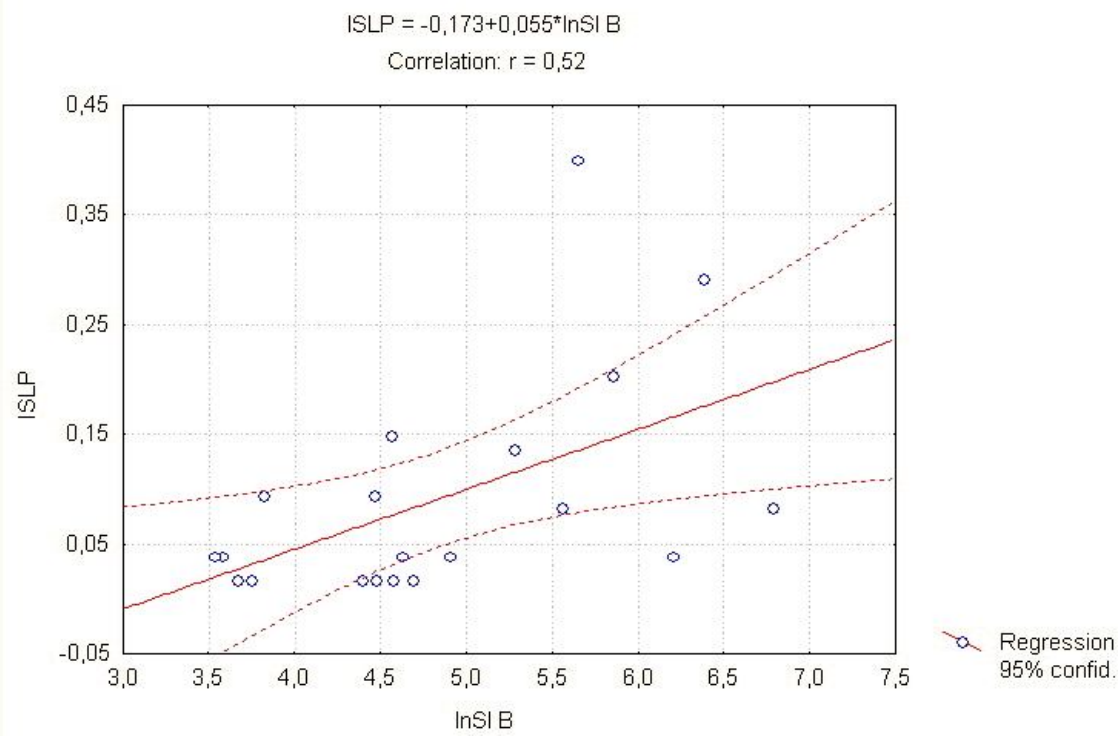
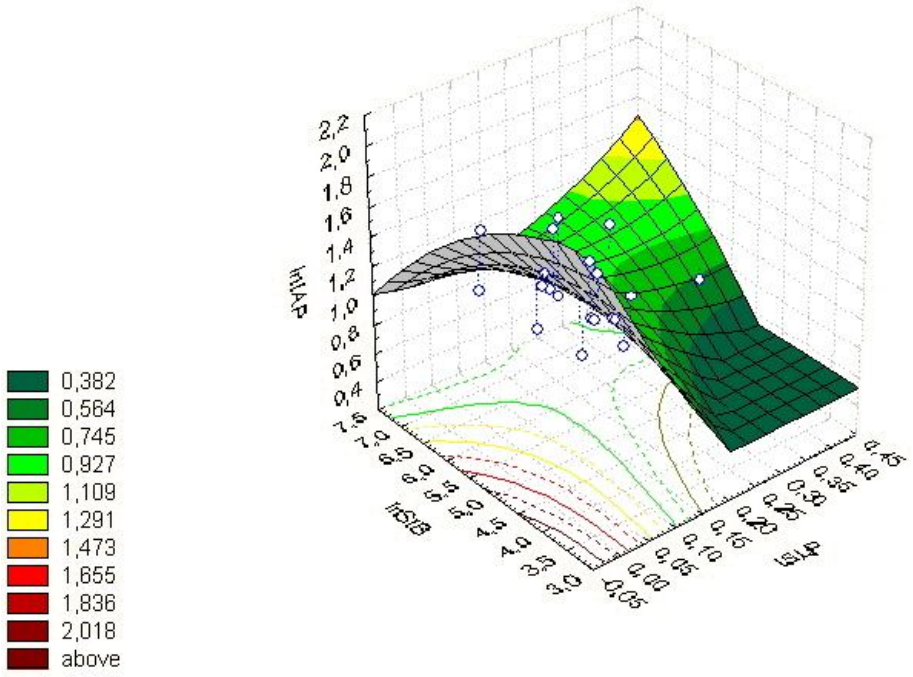


Fig. 9. Correlationship between stress index Bayevskyi (axis of X) and index of strain of leucocytogram by Popovych (axis of Y)



lnIAP=2,05-2,31•ISLP-0,12•lnSIB; R=0,73; $F_{(2,2)}$=9,7; p=0,002

Fig. 10. Correlationship between index of strain of leucocytogram by Popovych (axis of X), stress index Bayevskyi (axis of Y) and index of adaptation by Popovych (axis of Z)

Among the registered (table 4) parameters of phagocytose by neutrophyles of culture of Staphylococcus aureus a substantial difference between harmonious and disharmonious GARO is educed concerning exactly to the completeness of phagocytose (index of killing) as a marker of antibacterial defence of organism, but neither activity nor intensity of phagocytose.

Table 4. Comparative description of parameters of phagocytose and endocrine status of different clusters of adaptation

Parameters	HLR (n=13)	LLR (n=7)
Index of phagocytose of neutrophyles, %	85,8 ±0,7	86,6 ±1,0
Microbian number of neutrophyles, microbas/phagocyte	11,9 ±0,7	13,7 ±0,8
Index of killing of neutrophyles, %	49,4 ±2,6	34,7 ±4,4*
Cortisol, nM/l	477 ±56	725 ±104*
Triiod-thyronine, nM/l	2,04 ±0,09	1,93 ±0,13
Testosterone, nM/l	25 ±2	28 ±3
Mineralocorticoid activity (plasma Na/K-ratio)	41,4 ±1,0	42,8 ±3,5
Sodium, mM/l	136 ±1	133 ±1*
Potassium, mM/l	3,3 ±0,1	3,2 ±0,2

We are confirm educed previously [4,8] positive connection between index of bactericidity of neutrophyles and index of adaptation by Popovych (Fig. 11). The last is determined by compatible influence by IKN and SIB on 46% (Fig. 12).

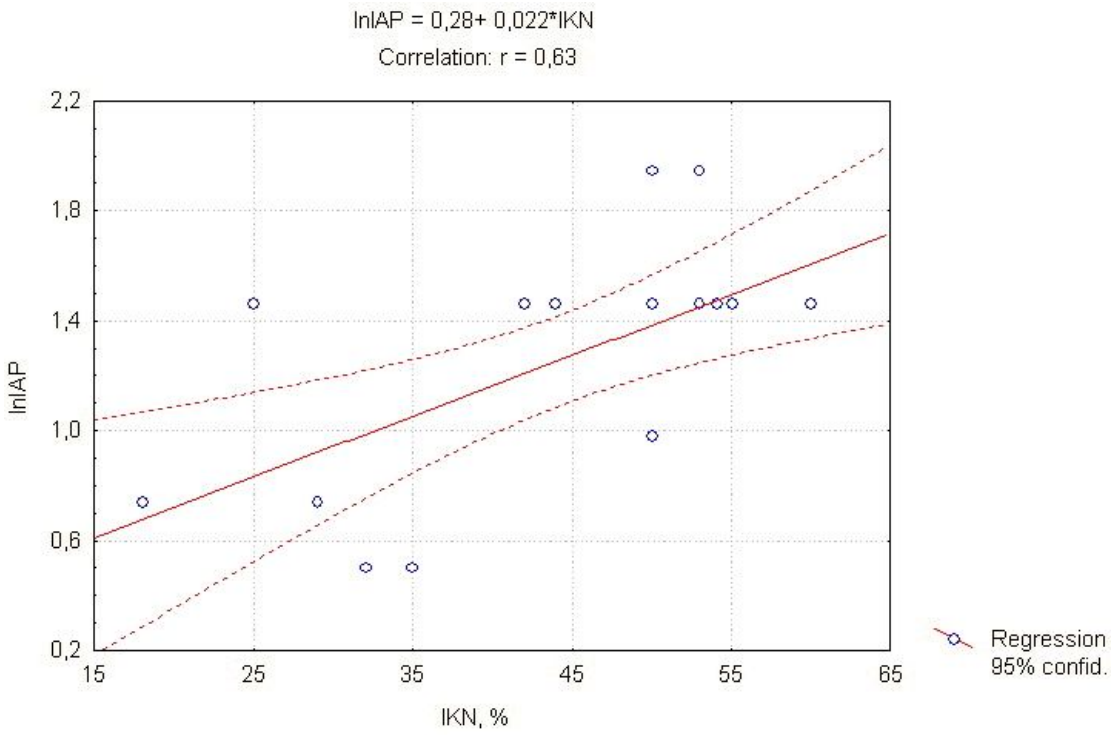


Fig. 11. Correlationship between index of killing of neutrophyles (IKN) (axis of X) and index of adaptation by Popovych (axis of Y)

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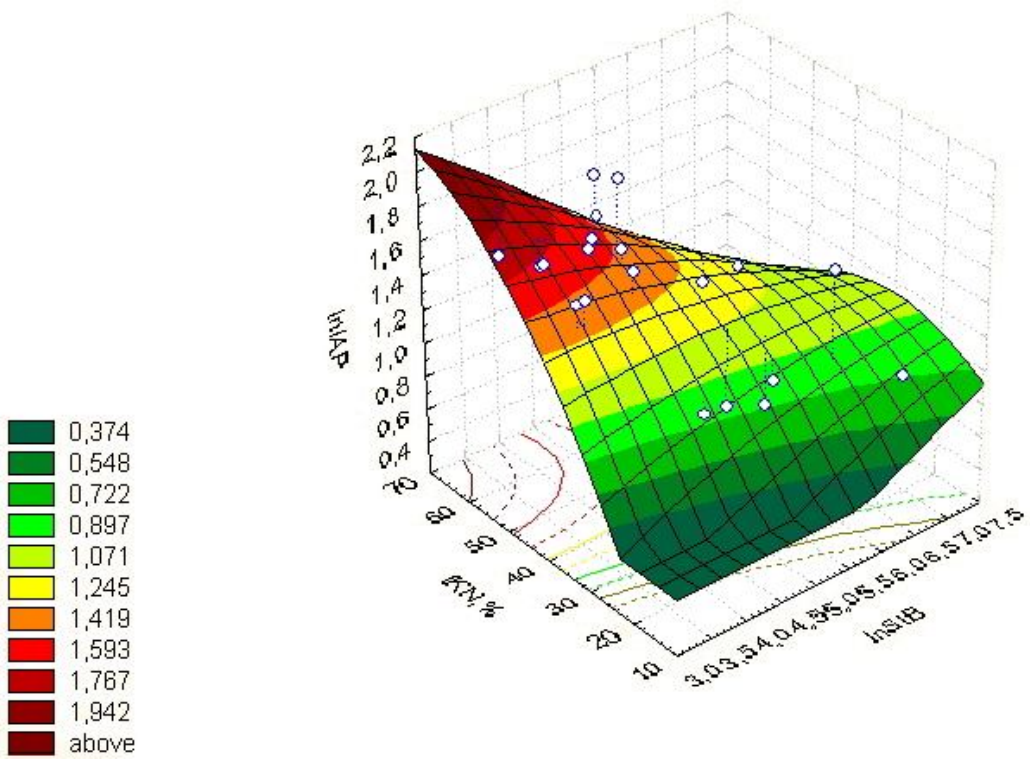
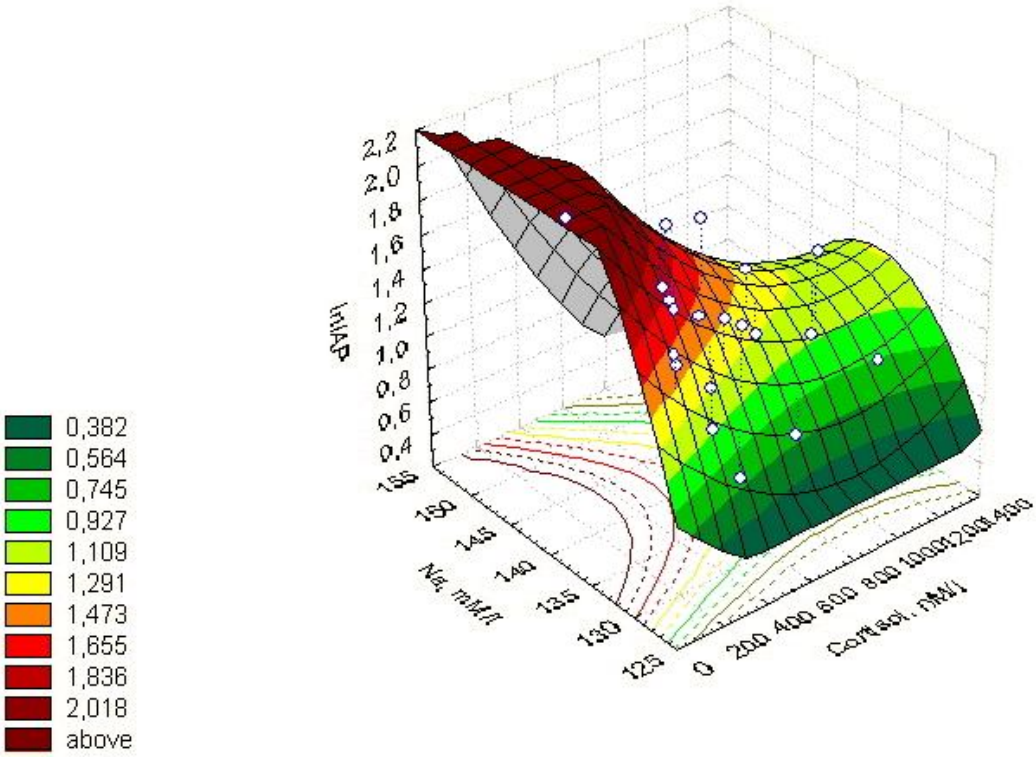


lnIAP=1,17-0,13•lnSIB+0,016•IKN; R=0,68; $F_{(2,2)}$=7,7; p=0,006

Fig. 12. Correlationship between stress index Bayevskyi (axis of X), index of killing of neutrophyles (axis of Y) and index of adaptation by Popovych (axis of Z)

But IAG quite not correlates from index of killing (r=-0,16), but with is constrained activity (r=-0,30) and intensivity (r=0,44) of phagocytose.



lnIAP=-2,93-0,0007•Cort+0,034•Na; R=0,55; $F_{(2,2)}$=3,7; p=0,046

Fig. 13. Correlationship between plasma levels of cortisol (axis of X), sodium (axis of Y) and index of adaptation by Popovych (axis of Z)

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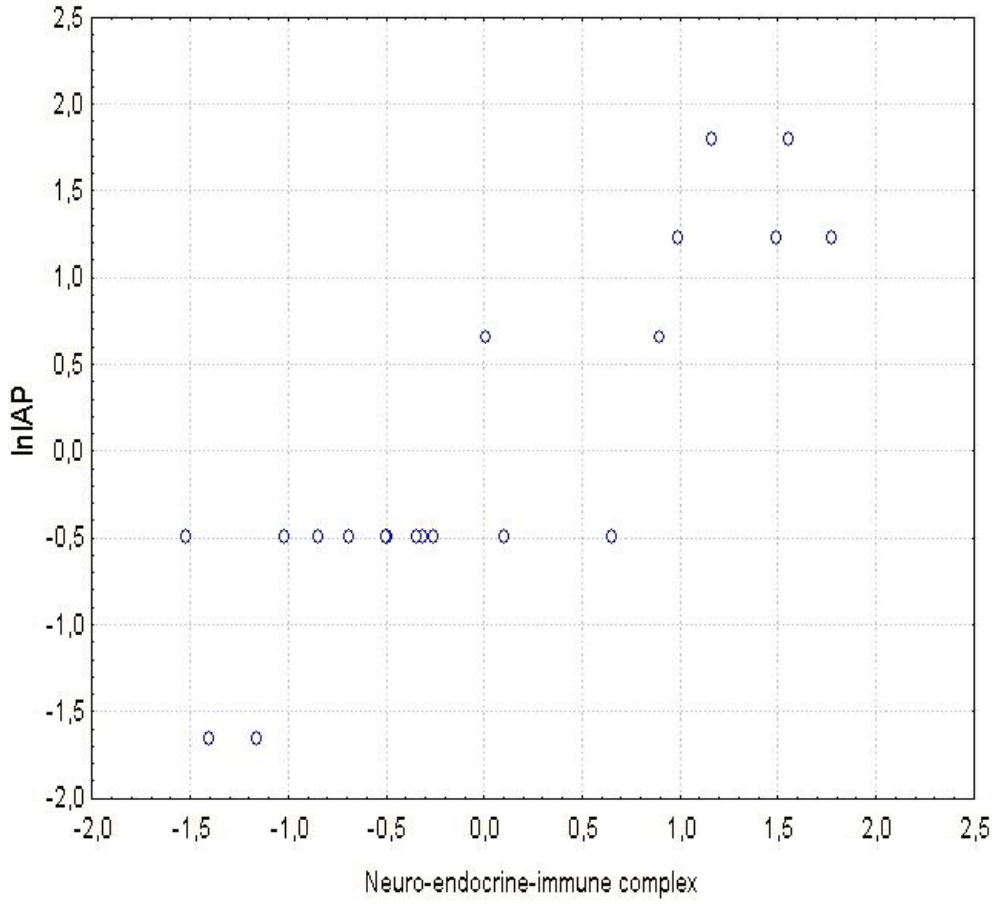
Coming back to table 4 see that GARO of LLR is characterized in one and a half times higher, than GARO of HLR plasma level of cortisol. It is not educed in relation to other hormonal and electrolyte parameters of differences. At the same time, it is educed connections between lnIAP and cortisol (r=-0,41), testosterone (r=-0,36), sodium (r=0,35). But IAG does not correlate with these parameters (r=0,11; 0,14 and -0,24 respectively). Cortisol and sodium together determines the level of adaptation on 30% (Fig.13).

It is in addition, educed by us, that normalised on age index of electronegativeness of kernels of buccal epithelium (IENN) at GARO of LLR presents 100±2% versus 104±2% at GARO of HLR. This parameter positively correlates from index of adaptation by Popovych (r=0,42), that comports with an idea about him as the marker of general health level [6]. But IAG correlates from IENN negatively (r=-0,32).

Beyond expectation, suggested by data of literature [3,10], we did not succeed to educe differences between harmonious and disharmonious GARO after the levels of anxiety (44±3 point versus 47±2 point for trait anxiety and 31±2 point versus 28±2 point for reactive anxiety).

Seven parameters of neuroendocrine-immune complex, selected after pair coefficients correlations, in an aggregate determines index of adaptation by Popovych on 77% (Fig. 14).



lnIAP=-0,085•lnSIB + 4•10^{-5}•TP + 0,01•IKN - 0,0005•Cort - 0,007•Na – 0,02•Test + 0,0018•IENN - 1,07

lnIAP=-0,218•lnSIB + 0,249•TP + 0,335•IKN - 0,347•Cort - 0,090•Na – 0,492•Test + 0,295•IENN

R=0,88; R^2=0,77; $F_{(7,1)}$=5,6; $\chi^2_{(7)}$=21; p=0,005

Fig. 14. Canonical correlationship between parameters of neuro-endocrine-immune complex (axis of X) and index of adaptation by Popovych (axis of Y)

On Fig.15 12 parameters, the sizes of which at GARO of HLR are higher, than at GARO of LLR, are collected, and on Fig.16 9 parameters, the sizes of which at GARO of HLR are below, than at GARO of LLR, are collected.

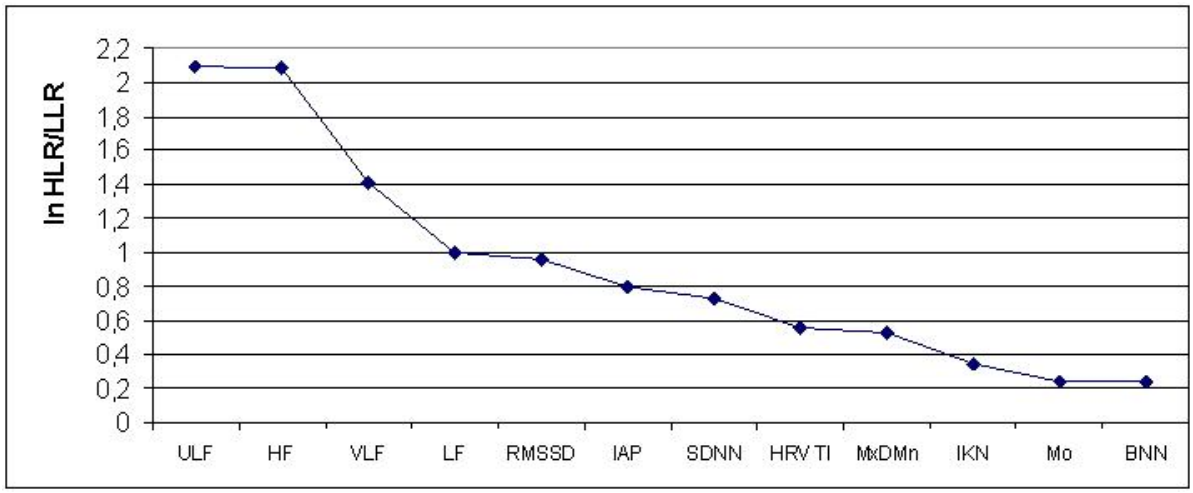


Fig.15. Parameters, the sizes of which at GARO of high levels of reactivity (HLR) are higher, than at GARO of low levels of reactivity (LLR)

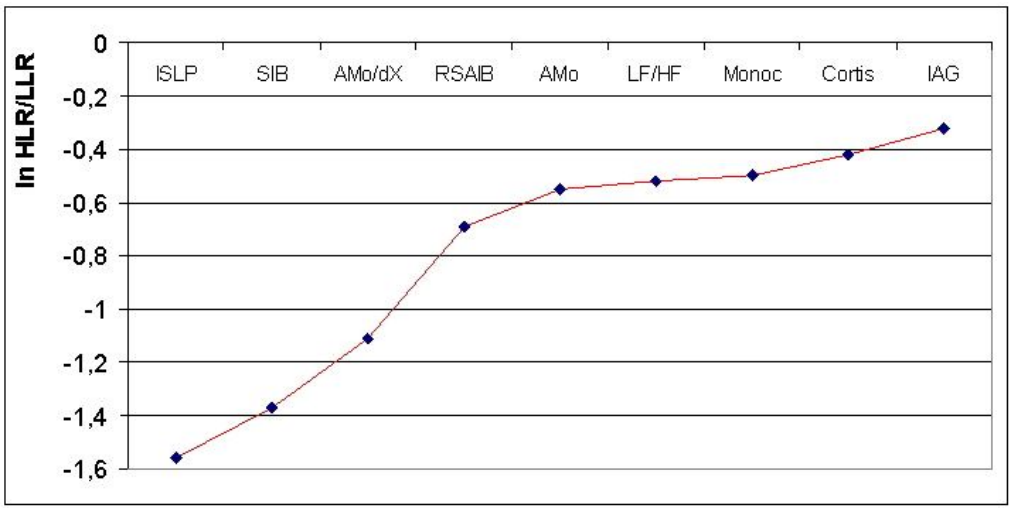


Fig. 16. Parameters, the sizes of which at GARO of high levels of reactivity (HLR) are below, than at GARO of low levels of reactivity (LLR)

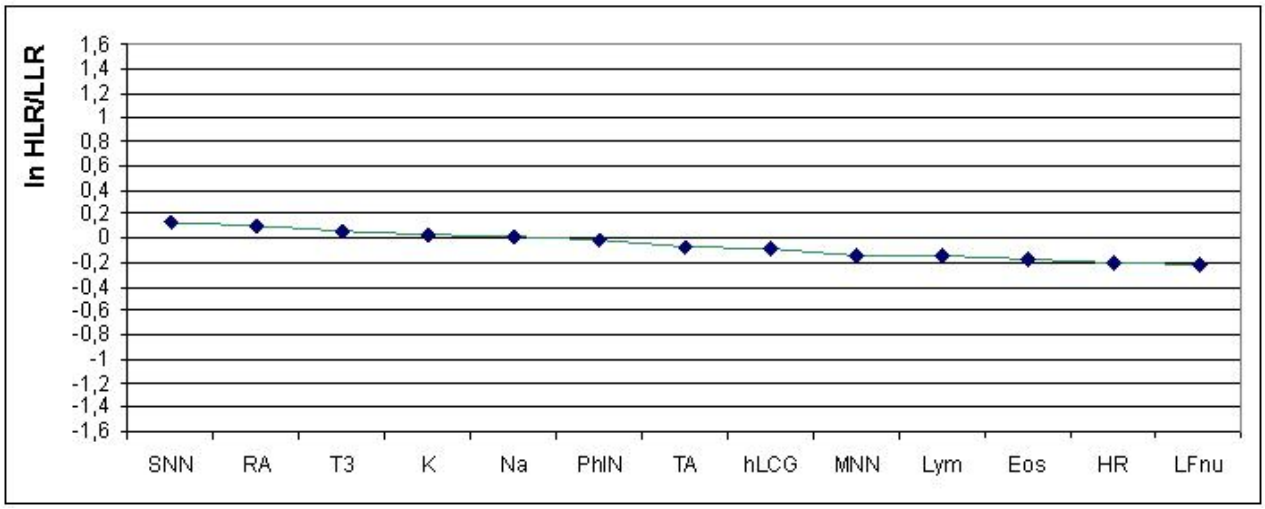


Fig. 17. Parameters the sizes of which at GARO of HLR and LLR do not differ substantially

Other registered parameters substantially do not differ at harmonious and disharmonious GARO (Fig.17).

Application of method of discriminant analysis allows to educe exactly those parameters (except index of adaptation by Popovych) after the aggregate of which harmonious and disharmonious GARO can be

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recognized, id est discriminated. Stress index of Bayevskyi, entropy of leucocytogram, cortisolemia and two markers of vagal tone appeared such identification (characteristic) parameters (table 5).

Table 5. Results of discriminant analysis of parameters, characteristic for GARO of high and low levels of reactivity

Canonical variables	Parameters of Wilks' statistics			Coefficients for canonical variables		Coefficients for classification functions		Mean of canonical variables±standart error	
	Λ	F	p<	Raw	Structu-ral	HLR (n=13)	LLR (n=7)	HLR (n=13)	LLR (n=7)
Stress index, ln	0,53	16,0	10^{-3}	2,169	0,41	132,6	142,6	4,36±0,20	5,73±0,27
Entropy of LCG	0,20	21,3	10^{-5}	26,96	0,39	1177,5	1301,8	0,645±0,006	0,699±0,016
Cortisol, nM/l	0,32	18,0	10^{-4}	0,0037	0,22	0,046	0,063	477±58	724±104
HRV TI, un.	0,16	15,0	10^{-4}	0,2589	-0,30	24,46	25,65	12,9±1,2	7,4±1,2
VLF HRV, ms^2	0,17	18,0	10^{-4}	-0,0007	-0,22	-0,020	-0,024	1281±314	313±86
	Constant			-32,6		-824,5	-978,8	Mean of root±standart error	
Squared Mahalanobis distance between clusters: 23,6; F=14,7; $p<10^{-4}$ Canonical correlation r*=0,92; Wilks' Λ=0,16; $\chi^2_{(5)}=29$; $p<10^{-4}$								-1,61 ±0,28	+3,00 ±0,37

The discriminant information is condensed in single canonical root, which, judging after structural coefficients for canonical variables, straight representes stress index of Bayevskyi, entropy of leucocytogram and cortisolemia, but by inversely modus representes markers of vagal tone. On Fig. 18 are visualized the individual unstardardized canonical scores of root for men with harmonic and disharmonic GARO, calculated by individual values of canonical variables, raw coefficients for canonical variables and constant of discriminant function. Evidently, that GARO of HLR is characterized, without exceptions, lesser values of ndividual unstardardized canonical scores of root, than GARO of LLR. It represents both more lesser levels of stress index Bayevskyi, entropy of leucocytogram, cortisolemia and higher levels of vagal tone. By the calculation of values of classification functions after its coefficients and constant it is possible in the future on the basis of discriminant variables faultlessly to take the inspected person to GARO of HLR or LLR.

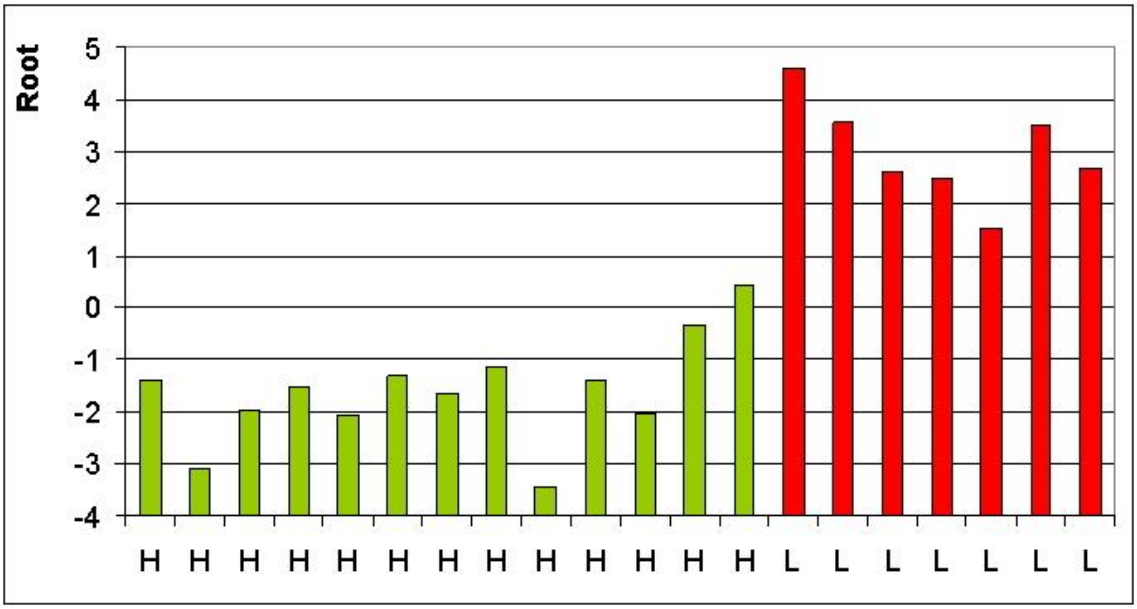

Fig. 18. Unstandardized canonical scores of root for men with GARO of HLR (H) and LLR (L)

The method of discriminant analyses allows also to educe the parameters of leucocytogram, identification for different types of GARO (table 6). Identification information is condensated in 4 roots, however noteworthy only two from them: root 1 contains 53% of discriminant possibilities, and root 2 yet 43%, while on other roots is only 4%.

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Table 6. Results of discriminant analysis of parameters of leucocytogram, identification for different types of GARO

N_Λ r	Discriminant variables	GARO param-s	T L (3)	T H (11)	QA L (2)	QA H (2)	HA L (2)	Wilks' statistics	
1. **-0,66** -0,60	Index of adaptation by Garkavi (Lf/SNN), un.	X±m	0,40±0,01	0,41±0,01	0,54±0,02	0,49±0,03	0,89±0,09	Λ	0,066
		RCCDF1	-133,1	-133,1	-133,1	-133,1	-133,1	F	53,0
		RCCDF2	96,8	96,8	96,8	96,8	96,8	p	$<10^{-6}$
		CoeCF	-11979	-11290	-12987	-11515	-10555		
3. **-0,50** -0,49	Lymphocytes, %	X±m	24,3±0,3	25,3±0,5	30,0±1,0	29,0±1,0	38,5±1,5	Λ	0,005
		RCCDF1	3,17	3,17	3,17	3,17	3,17	F	18,2
		RCCDF2	-3,12	-3,12	-3,12	-3,12	-3,12	p	$<10^{-6}$
		CoeCF	339,3	320,3	369,3	328,0	308,2		
5. **-0,33** -0,07	Eosinophyles, %	X±m	3,7±0,3	3,3±0,1	2,5±0,5	3,5±0,5	5,5±0,5	Λ	0,001
		RCCDF1	1,20	1,20	1,20	1,20	1,20	F	12,8
		RCCDF2	-1,36	-1,36	-1,36	-1,36	-1,36	p	$<10^{-6}$
		CoeCF	177,2	166,2	185,6	169,9	163,6		
4. **-0,12** -0,41	Index of strain of leucocytogram by Popovych, un.	X±m	0,10±0,02	0,04±0,01	0,25±0,04	0,03±0,01	0,27±0,13	Λ	0,002
		RCCDF1	27,8	27,8	27,8	27,8	27,8	F	15,2
		RCCDF2	-17,4	-17,4	-17,4	-17,4	-17,4	p	$<10^{-6}$
		CoeCF	1955	1840	2171	1870	1663		
2. **-0,02** -0,40	Monocytes, %	X±m	8,3±0,3	5,6±0,4	9,5±0,5	4,5±0,5	9,0±1,0	Λ	0,020
		RCCDF1	0,80	0,80	0,80	0,80	0,80	F	21,4
		RCCDF2	-1,52	-1,52	-1,52	-1,52	-1,52	p	$<10^{-6}$
		CoeCF	128,4	119,5	139,0	121,9	121,7		
		ConDF1	-35,1	-35,1	-35,1	-35,1	-35,1		
		ConDF2	55,4	55,4	55,4	55,4	55,4		
		ConCF	-2690	-2388	-3189	-2522	-2460		
		Root 1	+2,59	+0,21	+5,42	-0,14	-10,3		
		Root 2	-1,15	+2,46	-7,93	+0,52	-4,35		

1. N_Λ - ordinal nomber of discriminant variables.
2. r – correlation variables – canonical roots (**Root 1** and Root 2)
3. X±m - means of discriminant variables±standart errors.
4. RCCDF – raw coefficients for canonical discriminant functions (canonical variables).
5. CoeCF - coefficients for classification functions.
6. ConDF – constants for discriminant functions.
7. ConCF - constants for classification functions.
8. Root – means of canonical roots of discriminant variables.

Fig. 19. Very successfully (though cleanly by chance mathematically) visualises high and low levels of reactivity of GARO, that shows up in localization of individual points along the axis of root 2, which presents inversely index of strain of leucocytogram by Popovych and monocytose. Pays attention on itself absence of differences after IAG between GARO of HLR and LLR.

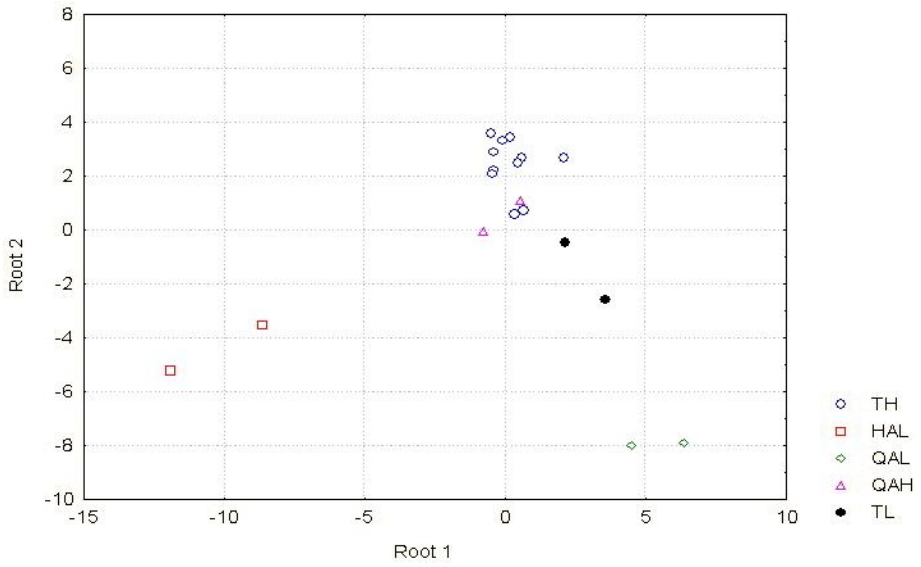

Fig. 19. Unstandardized canonical scores of root 1 and root 2 of parameters of leucocytogram for men with various recorded GARO

On results of discriminant analysis of all registered parameters it is inclused in a model, except distinguished on the previous stage of 5 parameters of leucocytogram, also 7 parameters which represent the

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state of adrenal cortex, testes, autonomic regulation and phagocytose and can be considered identification for each of 5 types of GARO (table 7 and of Fig. 20).

Table 7. Results of discriminant analysis of parameters, identification for different types of GARO

N_{Λ} r	Discriminant variables	GARO param-s	T L (3)	T H (11)	QA L (2)	QA H (2)	HA L (2)	Wilks' statistics	
1.	Index of adaptation by Garkavi (Lf/SNN), un.	X±m	0,40±0,01	0,41±0,01	0,54±0,02	0,49±0,03	0,89±0,09	Λ	0,066032
		RCCDF1	142,9	142,9	142,9	142,9	142,9	F	53,0
		RCCDF2	264,0	264,0	264,0	264,0	264,0	p	$<10^{-6}$
		CoeCF	-56228	-56611	-65376	-56232	-57034		
2.	Monocytes, %	X±m	8,3±0,3	5,6±0,4	9,5±0,5	4,5±0,5	9,0±1,0	Λ	0,019787
		RCCDF1	-1,11	-1,11	-1,11	-1,11	-1,11	F	21,4
		RCCDF2	-1,26	-1,26	-1,26	-1,26	-1,26	p	$<10^{-6}$
		CoeCF	312	318	373	318	335		
3.	Lymphocytes, %	X±m	24,3±0,3	25,3±0,5	30,0±1,0	29,0±1,0	38,5±1,5	Λ	0,005199
		RCCDF1	-4,04	-4,04	-4,04	-4,04	-4,04	F	18,2
		RCCDF2	-6,80	-6,80	-6,80	-6,80	-6,80	p	$<10^{-6}$
		CoeCF	1498	1510	1747	1503	1536		
4.	Index of strain of leucocytogram by Popovych, un.	X±m	0,10±0,02	0,04±0,01	0,25±0,04	0,03±0,01	0,27±0,13	Λ	0,002116
		RCCDF1	-137	-137	-137	-137	-137	F	15,2
		RCCDF2	-73,2	-73,2	-73,2	-73,2	-73,2	p	$<10^{-6}$
		CoeCF	26343	28683	33446	28004	20172		
5.	Plasma cortisol, nM/l	X±m	884±230	477±69	611±171	473±59	598±158	Λ	0,001090
		RCCDF1	0,019	0,019	0,019	0,019	0,019	F	12,8
		RCCDF2	0,004	0,004	0,004	0,004	0,004	p	$<10^{-6}$
		CoeCF	-2,7	-3,1	-3,6	-3,0	-3,3		
6.	Eosinophyles, %	X±m	3,7±0,3	3,3±0,1	2,5±0,5	3,5±0,5	5,5±0,5	Λ	0,000532
		RCCDF1	1,69	1,69	1,69	1,69	1,69	F	11,6
		RCCDF2	-3,46	-3,46	-3,46	-3,46	-3,46	p	$<10^{-6}$
		CoeCF	397	314	344	328	274		
7.	Index of killing of neutrophyles, %	X±m	25±4	49±3	50±0	52±1	34±2	Λ	0,000230
		RCCDF1	-0,455	-0,455	-0,455	-0,455	-0,455	F	11,1
		RCCDF2	0,091	0,091	0,091	0,091	0,091	p	$<10^{-6}$
		CoeCF	35,6	47,5	56,7	45,4	54,4		
8.	Index of phagocytose of neutrophyles, %	X±m	88±1	87±1	88±1	84±3	83±1	Λ	0,000114
		RCCDF1	-1,52	-1,52	-1,52	-1,52	-1,52	F	10,4
		RCCDF2	-0,53	-0,53	-0,53	-0,53	-0,53	p	$<10^{-6}$
		CoeCF	258	290	337	281	306		
9.	Mineralocorticoid activity (Na/K-ratio)	X±m	49±7	41±1	39±2	41±1	38±0,2	Λ	0,000062
		RCCDF1	1,02	1,02	1,02	1,02	1,02	F	9,5
		RCCDF2	-0,02	-0,02	-0,02	-0,02	-0,02	p	$<10^{-6}$
		CoeCF	-109	-133	-157	-128	-148		
10.	Sympatho-vagal balance index (LF/HF)	X±m	2,6±0,9	2,1±0,8	1,8±0,2	2,4±0,9	7,3±1,2	Λ	0,000028
		RCCDF1	-3,51	-3,51	-3,51	-3,51	-3,51	F	9,1
		RCCDF2	0,54	0,54	0,54	0,54	0,54	p	$<10^{-6}$
		CoeCF	313	399	474	383	458		
11.	Stress index Bayevskyi, ln un.	X±m	5,64±0,64	4,33±0,24	6,12±0,27	4,55±0,07	5,47±0,19	Λ	0,000002
		RCCDF1	6,73	6,73	6,73	6,73	6,73	F	13,7
		RCCDF2	-2,43	-2,43	-2,43	-2,43	-2,43	p	$<10^{-6}$
		CoeCF	-377	-559	-676	-529	-679		
12.	Plasma testosterone, nM/l	X±m	29±6	27±2	23±0,1	16±1	33±6	Λ	0,000001
		RCCDF1	-0,124	-0,124	-0,124	-0,124	-0,124	F	13,0
		RCCDF2	-0,094	-0,094	-0,094	-0,094	-0,094	p	$<10^{-6}$
		CoeCF	28,3	29,9	34,8	29,0	31,5		
		ConDF1	134,4	134,4	134,4	134,4	134,4		
		ConDF2	140,0	140,0	140,0	140,0	140,0		
		ConCF	-18011	-19290	-25788	-18727	-20640		
		Root 1	+22,5	+0,5	-24,5	+4,5	-16,5		
		Root 2	-7,1	+2,4	-16,7	+2,9	+11,4		

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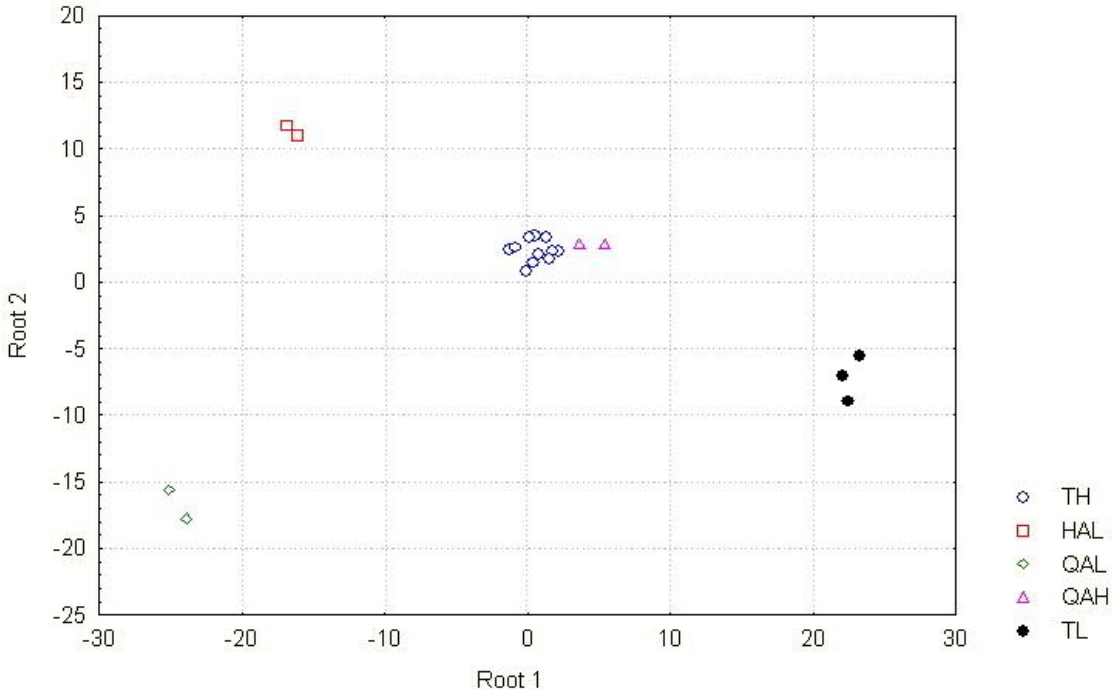

Fig. 20. Unstandardized canonical scores of root 1 and root 2 of parameters of leucocytogram and neuroendocrine-immune complex for men with various recorded GARO

Among the contingent looked after by us it did not appear persons from GARO of heightened activation of HLR (HAH) and superactivation (SA). However their parameters it is possible enough exactly to calculate after equalizations of multiple regression. It is possible also to visualize centroides of these GARO on the plane of root 1 and root 2 (Fig. 21).

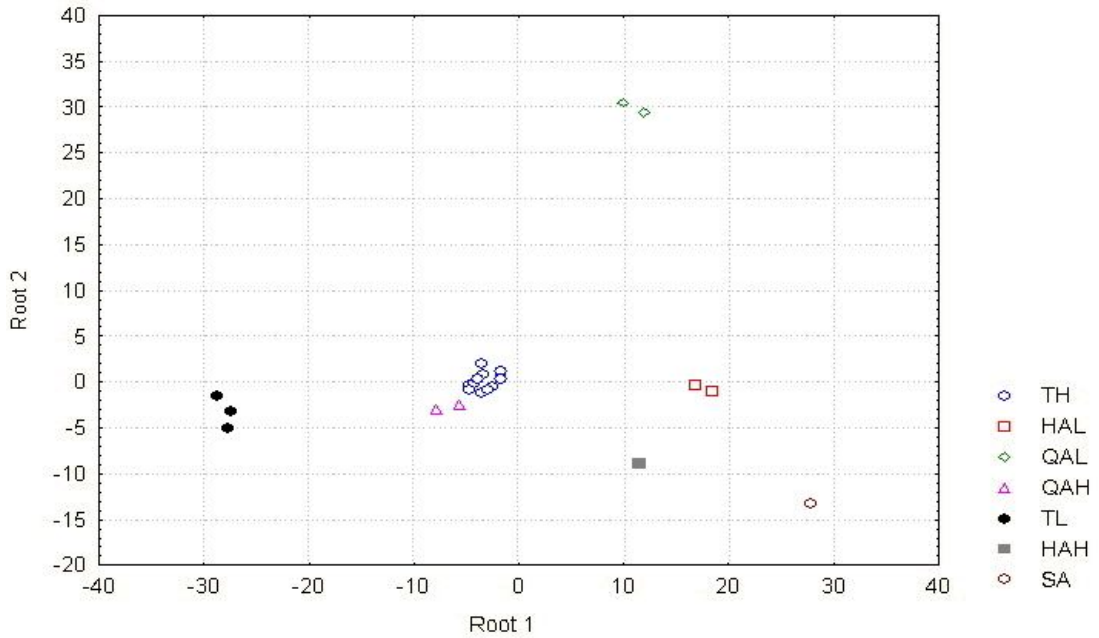

Fig. 21. Unstandardized canonical scores of root 1 and root 2 of parameters of leucocytogram and neuroendocrine-immune complex for men with various recorded and existing (HAH and SA) GARO

CONCLUSION

An examination of 20 healthy men found that index of adaptation by Popovych that takes into account the relative content in leucocytogram of lymphocytes and abnormal contents of monocytes, eosinophils and neutrophils, moderately or significantly correlated with the neuroendocrine-immune complex, whereas links them index of adaptation by Garkavi as the ratio of lymphocytes/segmented neutrophils are weak or absent.

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ACCORDANCE TO ETHICS STANDARDS

Tests in patients are conducted in accordance with positions of Helsinki Declaration 1975, revised and complemented in 2002, and directive of National Committee on ethics of scientific researches. During realization of tests from all participants the informed consent is got and used all measures for providing of anonymity of participants.

For all authors (L.G. Barylyak, R.V. Malyuchkova, O.K. Tolstanov, O.B. Tymochko, R.F. Hryvnak, M.R. Uhryn) any conflict of interests is absent.

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ACCORDANCE TO ETHICS STANDARDS

Tests in patients are conducted in accordance with positions of Helsinki Declaration 1975, revised and complemented in 2002, and directive of National Committee on ethics of scientific researches. During realization of tests from all participants the informed consent is got and used all measures for providing of anonymity of participants.

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