Fajda Oleksandra I., Hrinchenko Borys V., Snihur Oleh V., Barylyak Liliya G., Zukow Walery. What Kerdoe's Vegetative Index really reflects? Journal of Education, Health and Sport. 2015;5(12):279-288. ISSN 2391-8306. DOI http://dx.doi.org/10.5281/zenodo.35421
http://ojs.ukw.edu.pl/index.php/johs/article/view/2015%3B5%2812%29%3A279-288
http://pbn.nauka.gov.pl/works/681547
Formerly Journal of Health Sciences. ISSN 1429-9623 / 2300-665X. Archives 2011–2014
http://journal.rsw.edu.pl/index.php/JHS/issue/archive

Deklaracja.
Specyfika i zawartość merytoryczna czasopisma nie ulega zmianie.
Zgodnie z informacją MNiSW z dnia 2 czerwca 2014 r., że w roku 2014 nie będzie przeprowadzana ocena czasopism naukowych; czasopismo o zmienionym tytule otrzymuje tyle samo punktów co na wykazie czasopism naukowych z dnia 31 grudnia 2014 r.
The journal has had 5 points in Ministry of Science and Higher Education of Poland parametric evaluation. Part B item 1089. (31.12.2014).

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 10.11.2015. Revised 25.11.2015. Accepted: 14.12.2015.

WHAT KERDOE'S VEGETATIVE INDEX REALLY REFLECTS?

Oleksandra I. Fajda[1], Borys V. Hrinchenko[1], Oleh V. Snihur[1], Liliya G. Barylyak[2,3], Walery Zukow[4]

[1]JSC „Dnipro-Beskyd", Truskavets', Ukraine alexavka7@gmail.com; verdo
[2]JSC " Truskavets'kurort", Truskavets', Ukraine
[3]Laboratory of Experimental Balneology, OO Bohomolets' Institute of Physiology NAS, Truskavets'-Kyiv i.popovych@ukr.net
[4]Faculty of Physical Education, Health and Tourism, Kazimierz Wielki University, Bydgoszcz, Poland w.zukow@ukw.edu.pl

Abstracts

Background. Index I Kerdö, the author proposed back in 1966, ie before the era HRV, to quantify the autonomic tone continues to be widely used. We set a goal to analyze the relationships Kerdö's Vegetative Index (KVI) with parameters of HRV and EEG, as well as with Mineralocorticoide, Calcitonin and Parathyrin Activities. **Methods.** In basal conditions in men, patients with chronic pyelonephritis and cholecystitis in remission, recorded Blood Pressure and Heart Rate ("Omron-4MI", Netherland), HRV ("Cardiolab+VSR", KhAI Medica, Ukraine) and EEG ("NeuroCom Standard", KhAI Medica, Ukraine). In urine determining the concentration of Phosphates, Calcium, Potassium and Sodium. **Results.** No correlation ascertained between KVI and LF/HF Ratio (r=-0,18) and Baevskiy's Vegetative Index (r=0,17). However, KVI weakly correlated with Power Spectrum Density (PSD) LF (r=-0,35), (VLF+LF)/HF Ratio (r=-0,32) and Baevskiy's Stress Index (r=0,32) as well as with Parathytin Activity (r=0,33), estimated by Urina Phosphates/Calcium Ratio. Medium strength correlation (r=0,56) found between KVI and Baevskiy's Activity Regulatory Systems Index in Orthostase. However, the strongest correlations of KVI proved with Amplitude of α-Rhythm Ongoiging EEG (r=0,57) and PSD P4-α (r=0,65). Canonical correlation between KVI, on the one hand, and the parameters of EEG, HRV and Parathyrin Activity, on the other hand, was very strong: R=0,933; R^2=0,870; Adjusted R^2=0,758; $F_{(18)}$=7,8; $\chi^2_{(18)}$=62; $p<10^{-5}$. **Conclusion.** Kerdö's Vegetative Index reflects above all Amplitude of α-Rhythm EEG and its Power Spectrum Density in Parietal and Central loci, less options HRV, but is not marker of sympatho-vagal balance.

Keywords: Kerdö's Vegetative Index, HRV, EEG, correlations.

Abbreviations

AMo/ΔX Ratio	Bayevskiy's Vegetative Balance Index.
AMo/2•ΔX•Mo Ratio	Bayevskiy's Stress Index.
ANS	Autonomic nervous system.
EEG	Electroencephalogram.
HFnu	Normalized power in HF band, a derived index that is computed by dividing HF by some suitable denominator representing the total relevant power, as discussed in the text.
HF power	Power in the High Frequency band of the HRV spectrum, often between 0.15–0.40 Hz, often reported in units of milliseconds-squared.
HRV	Heart rate variability (usually measured as summaries of heart period variability).
KVI	Kerdö's Vegetative Index.
LF/HF Ratio	Spectral HRV index HRV sympatho-vagal balance represents Ratio HRV computed as (LF/HF).
LFnu	Normalized power in LF band, a derived index that is computed by dividing LF by some suitable denominator representing the total relevant power, as discussed in the text.
LF power	Power in the Low Frequency band of the HRV spectrum, often between 0.04 – 0.15 Hz, often reported in units of milliseconds-squared.
PSD	Power Spectrum Density in Parietal and Central loci.
PSNS	Autonomic parasympathetic nervous system.
SA	Node Sino-atrial pacemaker node of the heart.
SNS	Autonomic sympathetic nervous system.
VLF power	Power in the Low Frequency band of the HRV spectrum, often with band limits strictly greater than 0.00 Hz and less than 0.04 Hz, often reported in units of milliseconds-squared.

INRODUCTION

Index I Kerdö, the author proposed back in 1966 [4], ie before the era HRV [1], to quantify the autonomic tone, continues to be widely used. However, in previous studies of School Truskavets' Spa [2,6,7,8,11,12] was found only a weak correlation Kerdö's Vegetative Index (KVI) with parameters of HRV, characterizing autonomic tone. On the other hand, we have established the existence of the relationship between the parameters of HRV and Ongoiging EEG as in healthy men [10] and in patients with chronic pyelonephritis [9]. So we set a goal, the last contingent of people to analyze the relations KVI parameters of HRV and EEG, as well as with Mineralocorticoide, Calcitonin and Parathyrin Activities.

MATERIAL AND METHODS

We examined 43 volunteer men (30÷66 old) treated at the Truskavets' spa accord to the diagnosis of chronic pyelonephritis and cholecystitis in remission. In the morning on an empty stomach recorded Blood Pressure and Heart Rate ("Omron-4MI", Netherland) to calculate Kerdö's Vegetative Index (KVI) [4], electrocardiogram in II lead to assess the parameters of HRV [1] (software and hardware complex "KardioLab+HRV" production "KhAI-MEDICA" Kharkiv) and background EEG in 16 monopolar leads (software and hardware complex "NeuroCom" the same production) [9,10]. In the urine collected during the day, determined concentration of Phosphates, Calcium, Potassium and Sodium. Used unified methods [3].

Results processed by methods of cross-correlation and canonical analyses, using the software package "Statistica 5.5".

RESULTS AND DISCUSSION

The value Heart Rate is in the range 50÷100 beats/min, Diastolic Blood Pressure: 60÷115 mm Hg, it gives KVI in the range -59÷22 units (Fig. 1), covering the states vagotonia, eutonia and sympathicotonia.

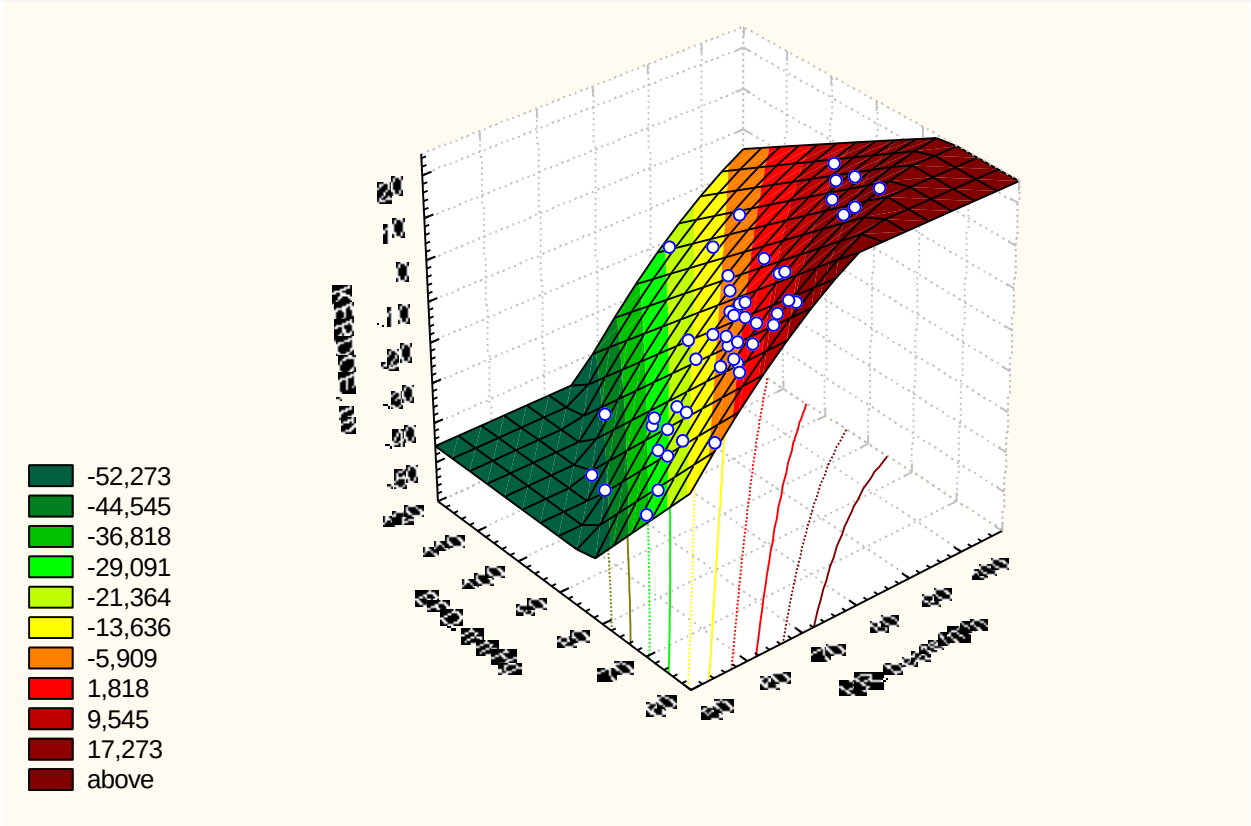

Fig. 1. Relationships between Heart Rate (X-line), Diastolic Blood Pressure (Y-line) and Kerdoe's Vegetative Index (Z-line)

Conventionally, that sympatho-vagal balance represents LF/HF Ratio HRV. Beyond expectation we found out only very weak, besides negative, correlation between LF/HF Ratio and KVI (Fig.2).

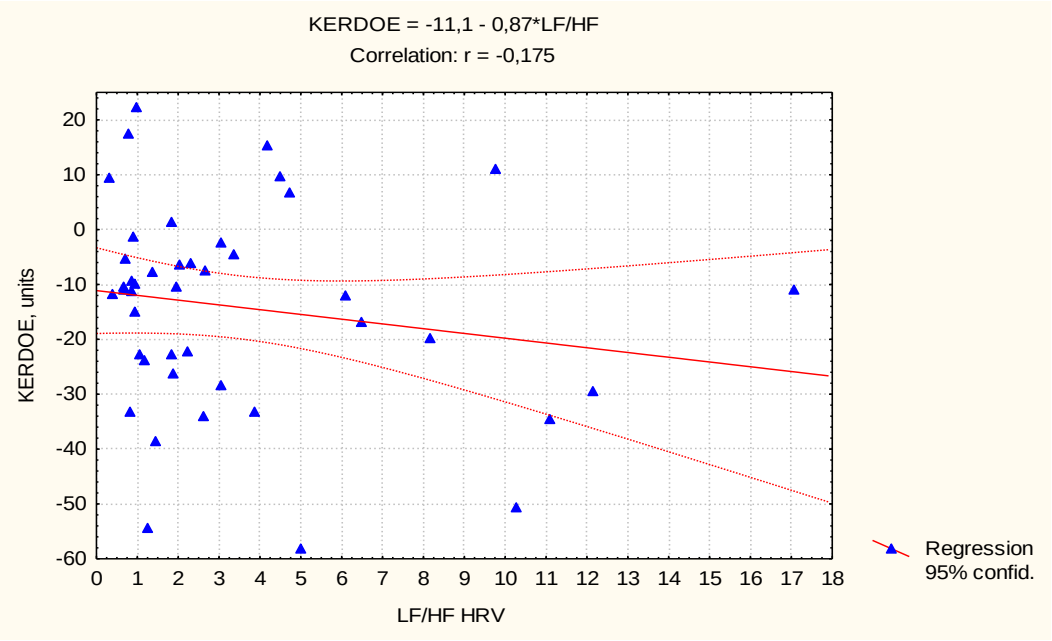

Fig. 2. Correlation between LF/HF Ratio (X-line) and Kerdoe's Vegetative Index (Y-line)

Bayevskiy's Vegetative Balance Index as AMo/ΔX Ratio correlates with KVI also very weak (Fig.3).

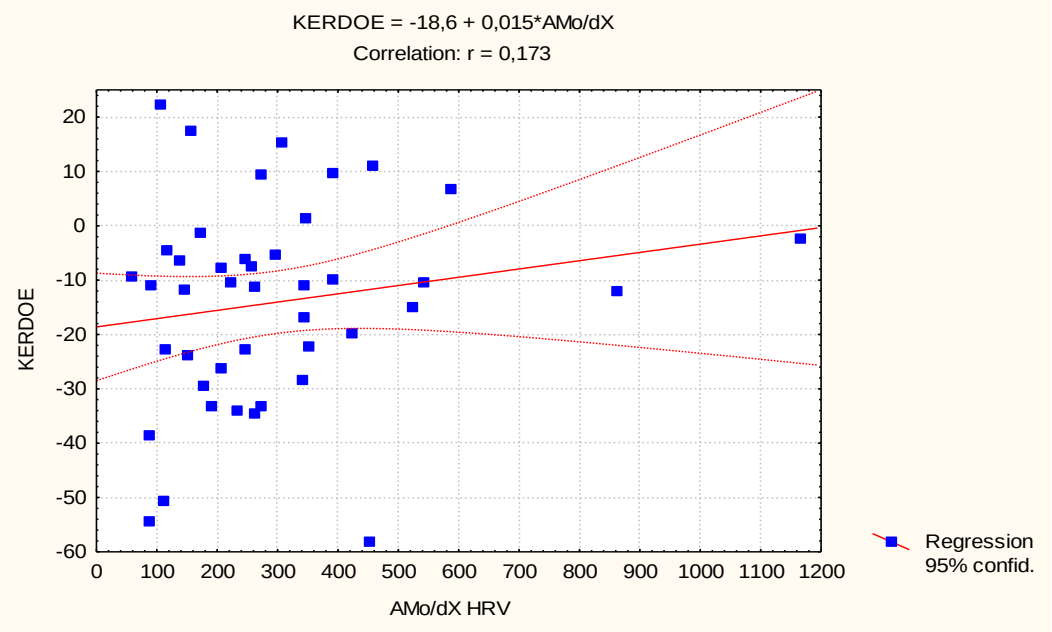

Fig. 3. Correlation between Bayevskiy's Vegetative Balance Index (X-line) and Kerdoe's Vegetative Index (Y-line)

But Bayevskiy's Stress Index as AMo/2•ΔX•Mo Ratio correlates with KVI already significantly moderato (Fig. 4), due to Mo, which closely correlates with HR.

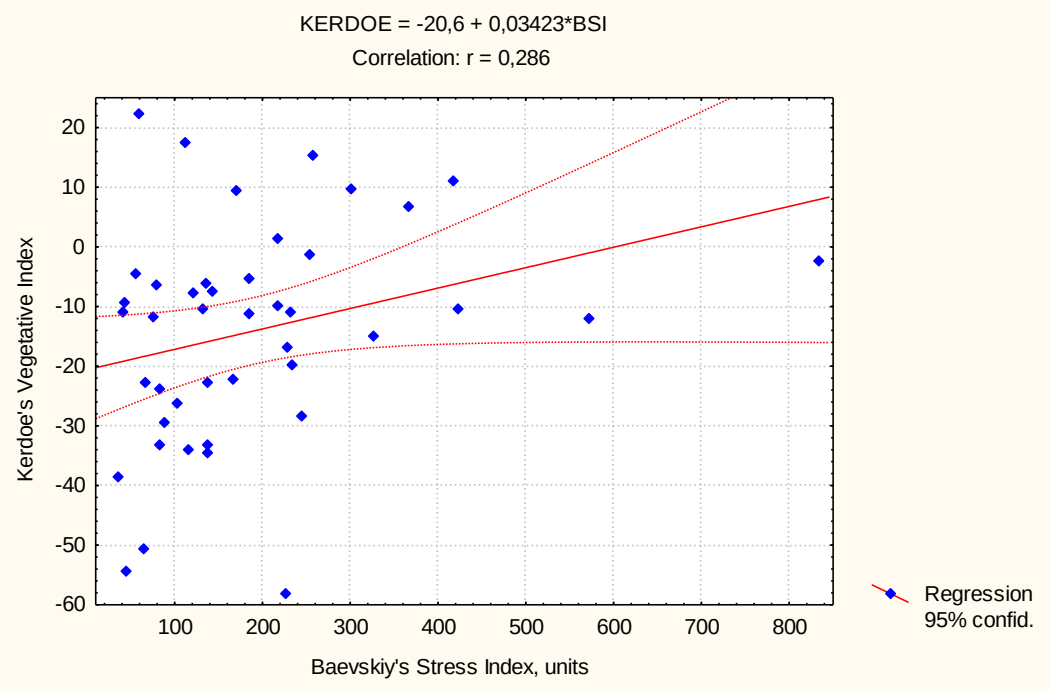

Fig. 4. Correlation between Bayevskiy's Stress Index (X-line) and Kerdoe's Vegetative Index (Y-line)

Natural logarhythm of Bayevskiy's Stress Index correlates with KVI a bit stronger (Fig. 5). It was found out the analogical size of coefficient of correlation before [11].

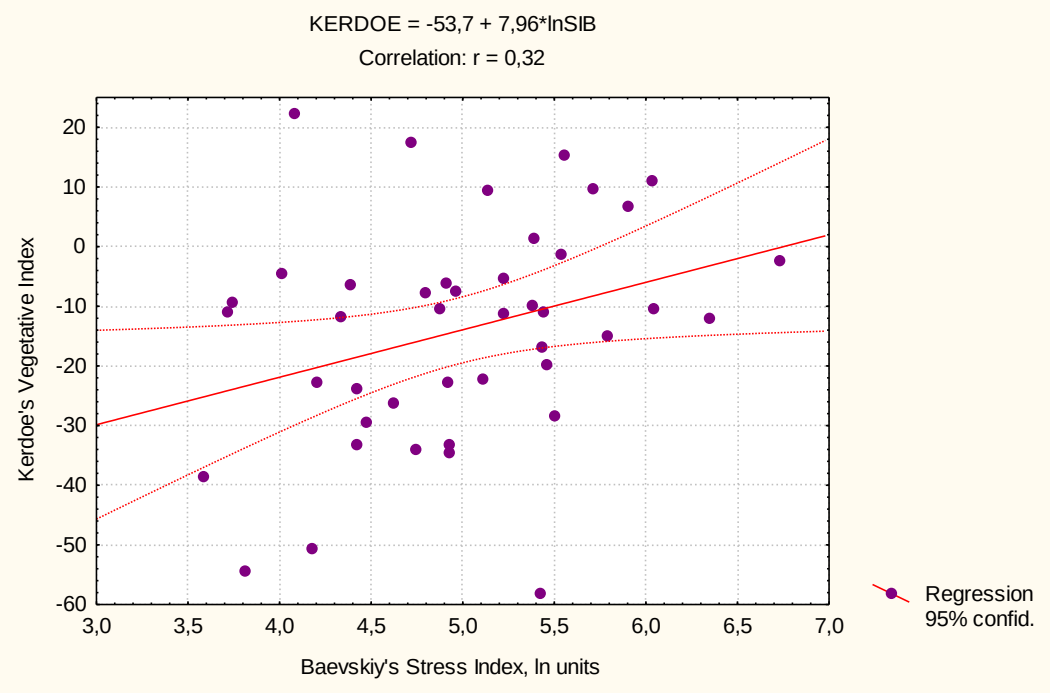

Fig. 5. Correlation between natural logarhythm of Bayevskiy's Stress Index (X-line) and Kerdoe's Vegetative Index (Y-line)

At the same time, KVI weakly but significantly correlated with Power Spectrum Density (PSD) LF (r=-0,35) and (VLF+LF)/HF Ratio (r=-0,32).

Medium strength correlation found between KVI and Baevskiy's Activity Regulatory Systems Index in Orthostase (Fig. 6). Analogical size of coefficient of correlation of KVI proved with Amplitude of α-Rhythm Ongoiging EEG (Fig. 7) and PSD P4-α (Fig. 8).

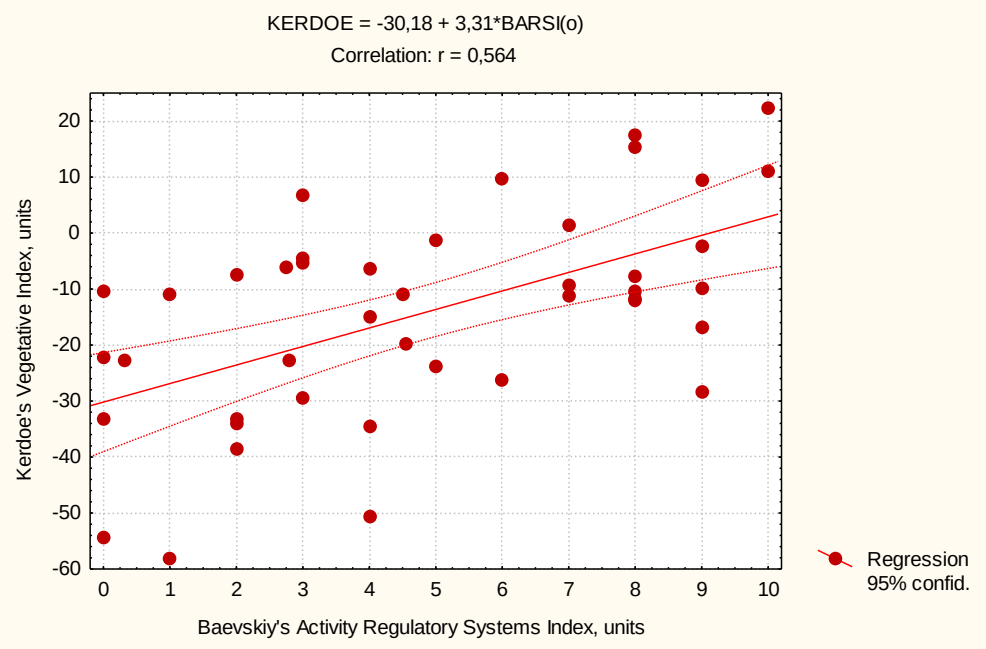

Fig. 6. Correlation between Bayevskiy's Activity Regulatory Systems Index (in orthostase) (X-line) and Kerdoe's Vegetative Index (Y-line)

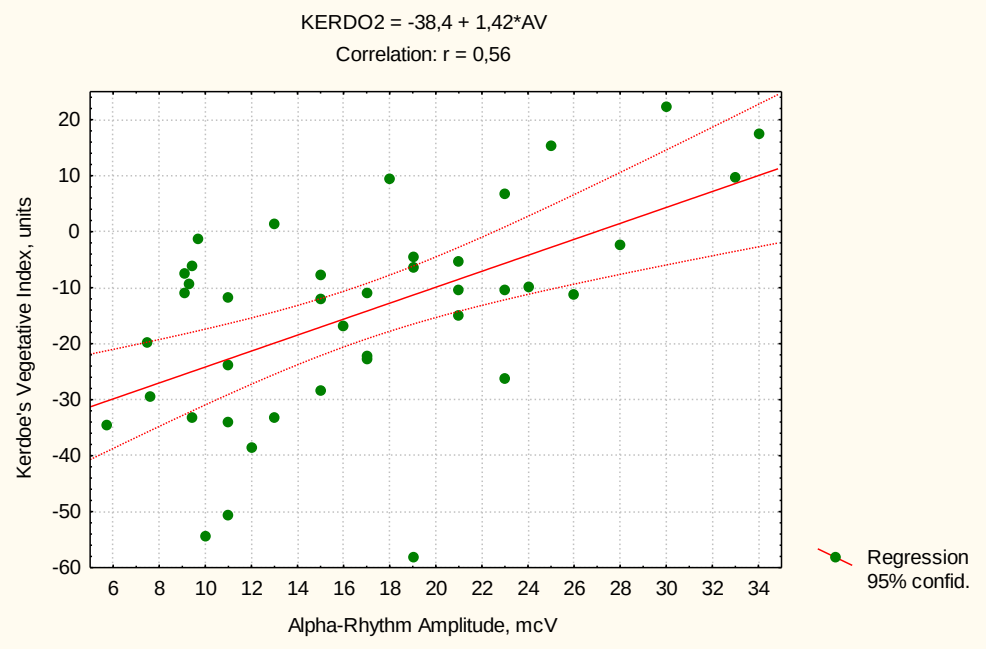

Fig. 7. Correlation between α-Rhythm Amplitude (X-line) and Kerdoe's Vegetative Index (Y-line)

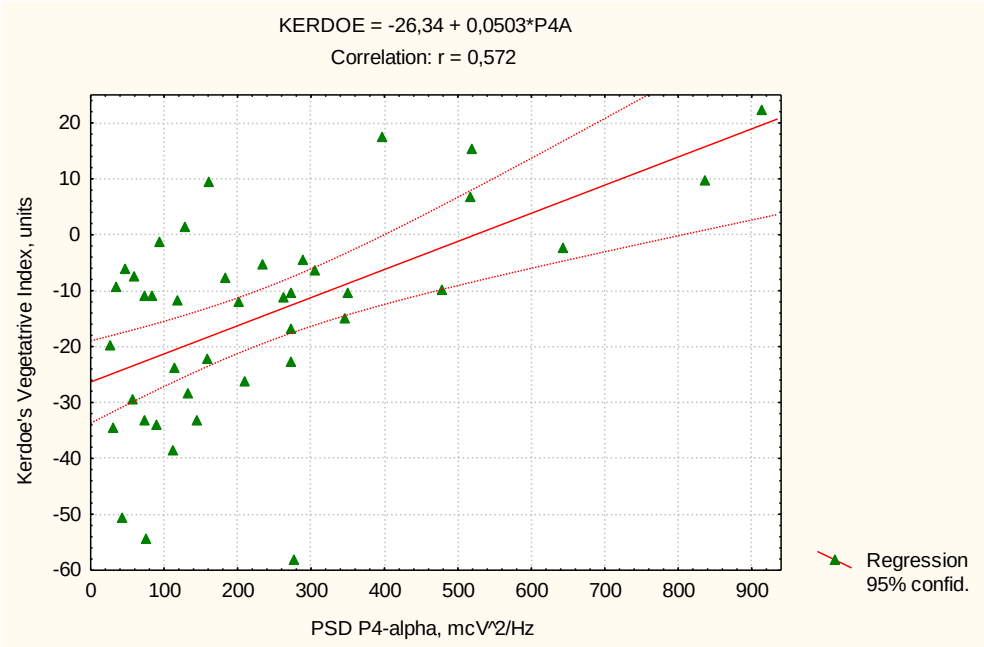

Fig. 8. Correlation between PSD α-Rhythm in locus P4 (X-line) and Kerdoe's Vegetative Index (Y-line)

Both parameters are taken together predetermine a size KVI on 49% (Fig. 9, Table 1).

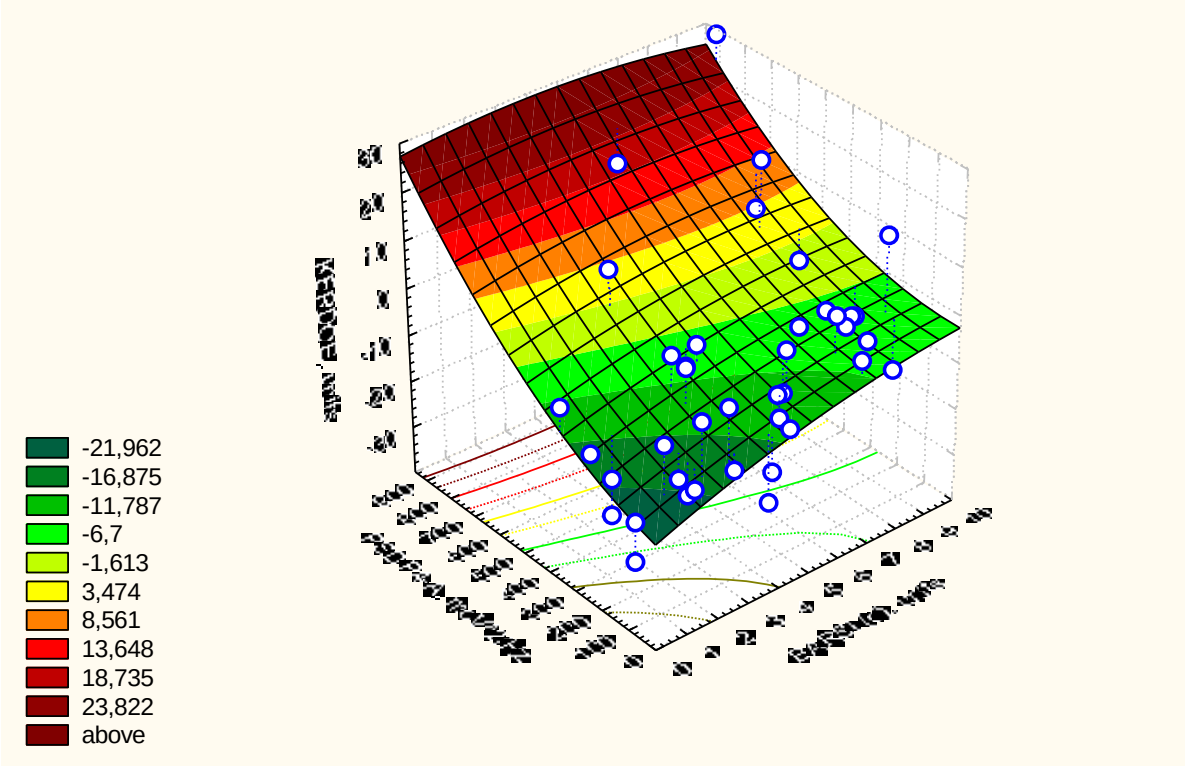

Fig. 9. Relationships between Bayevskiy's Activity Regulatory Systems Index in orthostase (X-line), PSD α-Rhythm in locus P4 (Y-line) and Kerdoe's Vegetative Index (Z-line)

Table 1. Regression Summary for Dependent Variable: KVI

R=0,717; R^2=0,514; Adjusted R^2=0,488; $F_{(2,4)}$=19,6; $p<10^{-5}$; Std. Error of estimate: 9,9.

		Beta	St. Err. of Beta	B	St. Err. of B	$t_{(37)}$	p-level
Intercpt	r			-26,1	3,024	-8,64	10^{-6}
PSD P4-α	0,65	,535	,123	,035	,008	4,33	10^{-3}
BARSI(o)	0,52	,318	,123	1,424	,554	2,57	,014

In addition, found out substantial positive correlation KVI with Index α-Rhythm EEG and its Power Spectrum Density in various loci as well as θ-Rhythm in locus O2 and δ-Rhythm in locus C4, while negative correlation with PSD β-Rhythm in loci P3 and O2. Separate attention is deserved by correlation KVI with Parathytin Activity, estimated by Urina Phosphates/Calcium Ratio (Table 2).

Table 2. Regression Summary for Dependent Variable: KVI

R=0,933; R^2=0,870; Adjusted R^2=0,758; $F_{(18)}$=7,8; $\chi^2_{(18)}$=62; $p<10^{-5}$; Std. Error of estimate: 6,8.

n=40		Beta	SE of Beta	B	SE of B	$t_{(21)}$	p-level
Intercpt	r			-33,8	10,7	-3,15	,005
PSD P4-α	**0,65**	3,527	0,540	0,2326	0,0356	6,54	10^{-5}
PSD C4-α	**0,57**	-2,383	0,508	-0,3015	0,0643	-4,69	10^{-4}
PSD P3-α	**0,54**	-1,382	0,368	-0,0845	0,0225	-3,76	,001
BARSI (in orthost.)	**0,52**	0315	0,107	1,4105	0,4780	2,95	,008
PSD F7-α	**0,47**	0,957	0,296	0,4057	0,1254	3,24	,004
PSD O2-α	**0,46**	-1,615	0,321	-0,1346	0,0267	-5,04	10^{-4}
PSD T6-α	**0,44**	-0,508	0,206	-0,1652	0,0670	-2,47	,022
Index α-Rhythm	**0,43**	0,603	0,203	0,3123	0,1053	2,97	,007
PSD O1-α	**0,42**	1,821	0,375	0,1383	0,0285	4,85	10^{-4}
PSD Fp1-α	**0,42**	-3,409	0,836	-0,7697	0,1887	-4,08	,001
PSD Fp2-α	**0,40**	3,618	0,798	0,7752	0,1711	4,53	10^{-4}
PSD P4-α, %	**0,35**	-0,466	0,163	-0,4049	0,1419	-2,85	,009
PSD O2-θ	**0,35**	-1,103	0,246	-0,7133	0,1591	-4,48	10^{-4}
PSD C4-δ	**0,32**	0,629	0,171	0,1359	0,0369	3,68	,001
Parathyrin Activity	**0,33**	0,510	0,140	12,28	3,36	3,66	,001
(VLF+LF)/HF	**-0,32**	-0,333	0,097	-0,6067	0,1769	-3,43	,003
PSD P3-β, %	**-0,33**	0,673	0,176	0,7649	0,2000	3,82	,001
PSD O2-β, %	**-0,43**	-0,633	0,180	-0,5229	0,1490	-3,51	,002

The transferred parameters predetermine a size KVI on 76% (Table 2, Fig. 10).

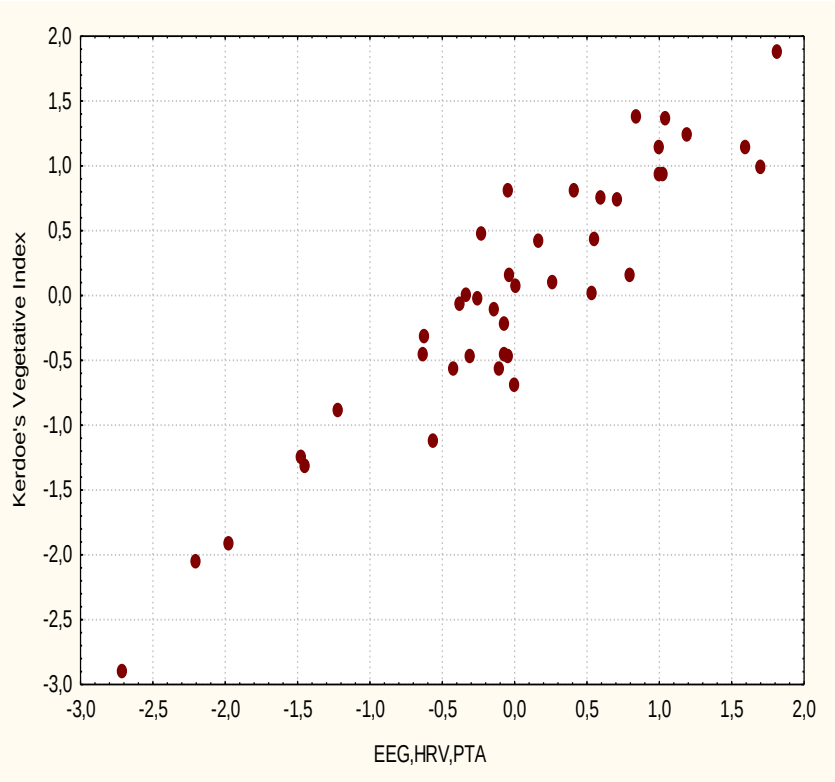

Fig. 10. Canonical correlation between parameters EEG, HRV and Parathyrin Activity (X-line) and Kerdoe's Vegetative Index (Y-line)

The got results are given by grounds for a conclusion that Kerdö's Vegetative Index reflects above all Amplitude of α-Rhythm EEG and its Power Spectrum Density in Parietal and Central loci, less options HRV, but is not marker of sympatho-vagal balance.

References

1. Baevskiy RM, Ivanov GG. Heart Rate Variability: theoretical aspects and possibilities of clinical application [in Russian]. Ultrazvukovaya i funktsionalnaya diagnostika. 2001; 3: 106-127.
2. Barylyak LG, Kruhliy YuZ, Zukow W, Yanchiy OR, Popovych IL. Indicators, distinctive for women with different ovarian status and different responses streslimiting effect of bioactive water Naftussya spa Truskavets'. Journal of Education, Health and Sport. 2015; 5(3): 247-258.
3. Goryachkovskiy AM. Clinical Biochemistry [in Russian]. Odesa: Astroprint. 1998. 608 p.
4. Kerdö I. An index for evaluation of vegetatine tonus calculated from the data of blood circulation [in German: Ein aus Daten der Blutzirkulation kalkulierter Index zur Beurteilung der vegetativen Tonuslage]. Acta Neurovegetativa (Wien). 1966; 29(2): 250-268.
5. Khramov YuA, Veber VR. Vegetative Implementation and Hemodynamics by Hypertonic Disease [in Russian]. Novosibirsk: Nauka. 1985. 129 p.
6. Kostyuk PG, Popovych IL, Ivassivka SV (editors). Chornobyl', Adaptive and Defensive Systems, Rehabilitation [in Ukrainian]. Kyiv: Computerpress. 2006. 348 p.
7. Popovych IL. Stresslimiting Adaptogene Mechanism of Biological and Curative Activity of Water Naftussya [in Ukrainian]. Kyiv: Computerpress. 2011. 300 p.
8. Popovych IL, Barylyak LG. Influence of course using of bioactive water Naftussya on stress level at women with endocrine and gynecological pathology [in Ukrainian]. Medical Hydrology and Rehabilitation. 2009; 7(3): 100-118.

9. Popovych IL, Kozyavkina OV, Kozyavkina NV, Korolyshyn TA, Lukovych YuS, Barylyak LG. Correlation between Indices of the Heart Rate Variability and Parameters of Ongoing EEG in Patients Suffering from Chronic Renal Pathology. Neurophysiology. 2014; 46(2): 139-148.
10. Popovych IL, Lukovych YuS, Korolyshyn TA, Barylyak LG, Kovalska LB, Zukow W. Relationship between the parameters heart rate variability and background EEG activity in healthy men. Journal of Health Sciences. 2013; 3(4): 217-240.
11. Prokopovych LN, Kit YI, Pogranychna IV, Popovych AI, Savchyn LI, Kozlovs'ka DV, Bilins'ka SN, Hayevs'ka LD, Popovych MV, Kindrakevych GV. The immediate vegetotropic reactions on application of ozokerite and its prognose [in Ukrainian]. Medical Hydrology and Rehabilitation. 2005; 3(3): 4-9.
12. Vis'tak HI. The relationships between vegetotropic and endocrine, immunotropic and clinical effects of bioactive water Naftussya at women with hyperplasia of the thyroid gland [in Ukrainian]. Medical Hydrology and Rehabilitation. 2012; 10(2): 37-66.