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ANALYSIS OF REGRESSIVE MODELS OF HEART RATE VARIABILITY INDICATORS DEPENDING OF BODY ORGANIZATION, AGE AND HAND STRENGTH OF HEALTHY MALE AND FEMALE INDIVIDUALS OF EUCINETIC HEMODYNAMICS TYPE

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Using the regression analysis technique, we have built the individual models of heart rate variability indicators (HRV) based on the individual features of constitutional parameters of the body, age and hand strength with determination coefficients R2 less than 0.5 in practically healthy Podillia young men and women of eucinetic hemodynamics type. It was found that R2 determination coefficients of young men in 17 completed models ranged from 0.136 to 0.478, while in young women, R2 determination coefficients of 17 completed models ranged from 0.095 to 0.342. The models of young men most commonly covered the width of distal epiphyses of long tubular bones of the limbs (30.9%, mostly upper limbs), body circumference dimensions (15.7%, mainly at account of limbs) and body diameters (12.6%, mostly sagittal and transverse mid-thoracic size of the chest and pelvic measurement (Distancia cristarum)); and models of young women - age (35.3%), body weight components (13.7%, mainly at account of body muscle mass by Matiegka), width of distal epiphyses of long tubular bones of the limbs (at account of the lower extremities) and the hand strength (at account of the right hand) (11.8% each).

Key words: practically healthy young men and women, heart rate variability, hemodynamics types, anthropometry, regressive models.

Cardiointervalography is practically important examination method, as it is used as a screening test in mass health examinations for identification of patients with subclinical and clinical forms of diseases, for assessment of initial vegetative tonus, vegetative reactivity and activity, and prediction of functional state (body durability) for vocational selection and determination of professional suitability [5]. It was proved that the variability of hemodynamic reactions might be preconditioned by individual-typological features of blood circulation regulation, based on the relationship between cardiac and vascular mechanisms, supporting the hemodynamic homeostasis. Moreover, the constitutional features of the cardiovascular system depended not only on the morphological characteristics, but also on certain differences in functional systems, playing an essential role subject to the state of vegetative regulation [11]. That is why, the scientists face the necessity to identify and mathematically substantiate appropriate heart rate variability indicators (HRV) not only for individuals of different constitutional types, but also in the groups distinguished by physiological components of the general constitution, in particular, in individuals of different hemodynamics types.

Research purpose - to analyze the regression models of normative individual HRV indicators depending on the individual features of the structure and size of a human body, age and hand strength of young men and women of eucinetic hemodynamics type.

Material and methods. We conducted complex clinical-laboratory, psychohygienic, psychophysiological and anthropogenic examination of young urban population of the Podillia region of Ukraine at the Research Center of Pyrohov Memorial Vinnytsia National Medical University. As a result, we enrolled 129 healthy 16-20 year-old young women according to the age periodization of human ontogenesis, adopted by VII All-Union Conference on the Problems of Age Morphology, Physiology and Biochemistry of the Academy of Pedagogical Sciences of the USSR in 1965. To determine the type of hemodynamics, young men and women were subjected to a 15-second tetrapolar thoracic rheogram synchronized with phonocardiography and electrocardiogram. The type of blood circulation was determined against the heart index values [18]. 64 practically healthy young men and 78 young women of eucinetic hemodynamics type were being recorded rhythmograms during 5 minutes in the progress of electrocardiography in the second standard lead followed by computer processing of the results. In parallel with the electrocardiography, a pneumogram was recorded using a nasal thermistor. The cardiac rhythm data were analyzed using a computer program of a certified cardiological diagnostic complex [10]. The variational pulsometry, statistical and spectral HRV indicators were evaluated according to the recommendations of the European and North American Cardiology Association (1996) against the results of processing the obtained results. We assessed the following parameters of variational pulsometry: the mode (Mo, ms) - a value of the most common R-R interval (corresponds to a maximum histogram); a mode amplitude (AMo,%) – a number of R-R intervals corresponding to the mode value represented in % of the sample size; average R-R interval (NNM, ms); minimum R-R interval (Min, ms) (abnormal R-R intervals were excluded); maximum R-R interval (Max, ms) (abnormal R-R intervals were excluded); variation range (VR, ms), calculated as a difference between Max and Min values. Among the HRV statistical indicators the following were determined: the standard deviation of the length of normal R-R intervals (SDNN, ms); square root of the sum of squares of the differences of the values of successive pairs of normal R-R intervals (RMSSD, ms); and the percentage of a number of pairs of successive normal R-R intervals that differ from the total number of pairs of consecutive intervals by more than 50 ms (PNN50,%). Using the appropriate formulas, we calculated the indicators of autonomic homeostasis by Baevsky method, namely: vegetative equilibrium index (IVR = AMO/VR); the index of regulatory systems tension (IN = AMo/(2 x VR x Mo)); and vegetative rhythm indicator (VPR = 1/(Mo x VR)). During the HRV spectral analysis, we defined the following frequency ranges: very low frequency (VLF, 0.003-0.04 Hz), low frequency (LF, 0.04-0.15 Hz) and high frequency (HF, 0.15-0.4 Hz) ranges. For each range, we determined both the signal strength and the contribution of each oscillatory component to the total power of spectrum (FO). We considered the power ratio in the low and high frequency bands (LF/HF). The anthropometric examination of young men was conducted in accordance with the V. Bunak scheme. [1]. The antropometric somatotype was defined using J. Carter and B. Heath method [3]. The component body weight was determined according to the methodology by J. Matiegka [9]. The strength of right and left hands was measured with the help of a dynamometer. To establish individual HRV indicators depending on individual anthropo-somatotypological characteristics, age and hand strength of young men and women of different hemodynamics types, we used the method of stepwise regressive analysis of the STATISTICA 5.5 licensed statistical package.

Results and its discussion. Notably that no models of HRV indicators with R2 determination coefficients higher than 0.50 were built for both young men and women of eucinetic hemodynamics type.

The analysis of completed models for young men of eucinetic hemodynamics type revealed that: ● among completed models (all 17), R2 determination coefficients ranged from 0.136 (NNM) to 0.478 (VPR); ● R2 determination coefficient preconditioned the admissible dependable variable for the group of HRV statistical indicators - from 31.6% to 42.3%; for the group of variational pulsometry parameters - from 13.6% to 41.5%; for the group of autonomic homeostasis indicators by Baevsky method - from 43.8% to 47.8%; for the group of HRV spectral indicators - from 19.9% to 36.7%; ● usually, the models covered the following predictors: in the general group of HRV indicators - the width of distal epiphyses of long limb tubular bones (30.9%, mostly upper limbs), body circumference dimensions (15.7%, mainly at account of limbs), and body diameters (12.6%, mostly sagittal and transverse mid-thoracic size of the chest and pelvic measurement (Distancia cristarum)); separately among the statistical HRV indicators - the width of distal epiphyses of long limb bones (41.7%) and body circumference dimensions (17.8%); separately among the variational pulsometry parameters - the width of distal epiphyses of long tubular bones of the extremities (29.2%), body diameters (16.7%), and body circumference dimensions (15.6%); separately among the indicators of autonomic homeostasis by Baevsky method - the width of distal epiphyses of long limb bones (58.3%), body dimensions (15.6%), and components of body mass composition (11.1%); separately among of the HRV spectral indicators - longitudinal body dimensions (12.0%), body diameters and thickness of skin-and-fat folds (by 11.1% each), and the width of distal epiphyses of long limb bones (10.0%); ● among the individual indicators, the most common for the models were the width of distal epiphysis of forearm (11.5%), hip circumference (10.4%), upper arm circumference in the lower third (9.4%), foot circumference (8.3%) and sagittal size of the chest and circumference of the shin in the upper third (by 5.4% each); ● the following groups of indicators were not a part of the models as predictors: in the general group of HRV indicators – general body dimensions, hand strength and age; separately among the statistical HRV indicators - additional somatotype components and the body mass composition indices; separately among the parameters of variational pulsometry - additional somatotype components; separately among indicators of autonomic homeostasis by Baevsky method - additionally longitudinal body dimensions and somatotype components; separately among the HRV spectral indicators – additional body mass component indicators.

The analysis of completed models in young women of eucinetic hemodynamics type revealed: ● among completed models (totally 17), R2 determination coefficients ranged from 0.095 (RMSSD) to 0.342 (LF); ● R2 determination coefficient preconditioned the admissible dependent variable in the group of variational pulsometry parameters - from 9.5% to 19.4%; in the group of HRV statistical indicators - from 13.1% to 29.9%; in the group of autonomic homeostasis indicators by Baevsky method - from 24.7% to 29.3%; in the group of HRV spectral indicators - from 11.8% to 34.2%; ● the following predictors were the most common for the following models: in the general group of HRV indicators - age (35.3%), body composition indicators (13.7%, mainly at account of the body muscle mass by Matiegka), width of distal epiphyses of long tubular bones of the extremities (at account of the lower extremities) and the hand strength (at account of the right hand) (by 11,8% each); separately among the HRV statistical indicators - the body circumference dimensions (13.3%) and the body mass composition indicators (11.1%); separately among the variational pulsometry parameters - age (50.0%), the body mass composition indicators (11.1%) and body diameters (10.4%); separately among the autonomic homeostasis indicators by Baevsky method - age (100%), the hand strength (50.0%), width of distal epiphyses of long limb bones (16.7%), body diameters (12.5%) and body mass composition indicators (11.1%); separately among the HRV spectral indicators - longitudinal body dimensions, the width of distal epiphyses of long limb bones, and the body mass composition indicators (20.0% each), and the body circumference dimensions (10.7%); ● the following individual indicators were the most common for the models: circumference of the forearm in the lower third (11.5%), the width of distal epiphyses of long limb bones and age (both 7.7%), the height of acetabular anthropometric point and the body muscle mass component by Matiegka (6.4% each); ● the following groups of indicators were not a part of the models as predictors: in the general group of HRV indicators - none; separately among the statistical HRV indicators - general body dimensions, width of distal epiphyses of long limb bones, thickness of skin and fat folds, somatotype components, hand strength and age; separately among the variational pulsometry parameters - only general body dimensions; separately among autonomic homeostasis indicators by Baevsky method – general body dimensions, thickness of skin and fat folds, and somatotype components; separately among the spectral HRV indicators – the hand strength and age. With optimal vegetative regulation, in fact, in individuals with hypo- and eukinetic type of hemodynamics, cardiac rhythm control occurs with a minimum participation of higher levels, and in case of non-optimal - activation of increasingly high levels of management is necessary (centralization of management) that occurs in people with hyperkinetic type of hemodynamics [7]. In turn, the depletion of adaptive capabilities manifests itself in the emergence of a large number of correlations between functional indicators, and with the optimal vegetative provision with the adaptation of increased activity, their number, on the contrary, decreases [13]. All types of hemodynamics, according to scientists [8, 15], are variants of the reberence values norm and differ not only by features of blood circulation indices, but also mechanisms of neurohumoral regulation. The discovery of intra-systemic (intragroup) features of interconnections in all three groups in a number of studies [4, 17] indicates the originality of the «response» of a certain group of HRV indicators to the predominance of the activity of a particular system in providing a certain specific function. Differences in the number of links between functional and anthropo-somatotypological indicators show the deep dependence of structural transformations of the blood circulation apparatus inherent in a certain hemodynamic type and mechanisms of regulation of its function, as well as on the development of other physiological systems: neurovegetative, endocrine, urinary, metabolic functions of the organism [2, 14]. Regression analysis is one of the most optimal methods for estimating multiple bonds in biomedical research [20]. In contrast to the correlation analysis, regression analysis - not only indicates the existence of dependence between an independent variable and one or more dependent variables, but also allows determining this dependence quantitatively [20]. According to the publications, young women present with more distinct functional and morphological differentiation in hemodynamic types with approximately same percentage of representatives thereof [12, 19]. Therefore, reliable HRV models with a determination coefficient greater than 0.5 were built only for young women of extreme hypo- and hyperkinetic types [16]. In young men, the stability of hemodynamics and regulation mechanisms suggested of more intensive progress in body formation, which determined the optimal level of blood circulation, expressed in a lesser degree of its centralization and a higher level of vagotonia or eutonia, both in hypo- and eukinetic hemodynamics types [6]. This explains the construction of HRV models with a determination coefficient less than 0.5 in young men of the above-mentioned hemodynamics types [16].

Conclusion

1. We built 17 HRV indicator models for young men of eucinetic hemodynamics type with the accuracy of sign description ranging from 0.136 (NNM) to 0.478 (VPR). We also built 17 HRV indicator models for young women of eucinetic hemodynamics type with the accuracy of sign description ranging only from 0.095 (RMSSD) to 0.342 (LF).

2. The HRV indicators, which were the most common to the models: in young men of a hypokinetic type of hemodynamics – width of distal epiphyses of long tubular bones of the extremities (30.9 %, mostly at account of the lower extremities), the body circumference dimensions (15.7 %, mostly at account of the extremities), and body diameters (12.6 %, mostly sagittal and transverse mid-thoracic size of the chest and pelvic measurement (Distancia cristarum)); in young women of hypokinetic hemodynamics type – age (35.3 %), the body mass composition indicators (13.7 %, mostly at account of body muscle mass component by Matiegka), width of distal epiphyses of long tubular bones of the extremities (at account of lower extremities) and the hand strength (at account of right hand) (11.8 % each). The bindings enable early detection of the pathology and provide differential diagnostics of various cardiovascular diseases in adolescent patients and suggest of the expediency of further introduction of the data obtained into clinical practice.

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Реферати

АНАЛІЗ РЕГРЕСІЙНИХ МОДЕЛЕЙ ПОКАЗНИКІВ ВАРІАБЕЛЬНОСТІ СЕРЦЕВОГО РИТМУ В ЗАЛЕЖНОСТІ ВІД ОСОБЛИВОСТЕЙ БУДОВИ ТІЛА, ВІКУ ТА СИЛИ СТИСКАННЯ КИСТЕЙ ЗДОРОВИХ ЮНАКІВ І ДІВЧАТ З ЕУКІНЕТИЧНИМ ТИПОМ ГЕМОДИНАМІКИ

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Використовуючи метод регресійного аналізу, ми побудували індивідуальні моделі показників варіабельності серцевого ритму (ВСР) на основі індивідуальних особливостей конституційних параметрів тіла, віку і сили рук з коефіцієнтами визначення R2 менше 0,5 у практично здорових юнаків і дівчат Поділля з еукінетичним типом гемодинаміки. Було виявлено, що коефіцієнти визначення R2 у юнаків в 17 завершених моделях варіювалися від 0,136 до 0,478, тоді як у дівчат коефіцієнти визначення R2 у 17 завершених моделей варіювалися від 0,095 до 0,342. Моделі юнаків найчастіше покривали ширину дистальних епіфізів довгих трубчастих кісток кінцівок (30,9%, головним чином верхніх кінцівок), розміри окружності тіла (15,7%, головним чином за рахунок кінцівок) і діаметрів тіла (12,6%, в основному сагиттальний і поперечний середній розмір грудей і таза (Distancia cristarum)); і моделі дівчат (35,3%), компоненти маси тіла (13,7%, головним чином, за рахунок м'язової маси тіла по Матейко), ширина дистальних епіфізів довгих трубчастих кісток кінцівок (з урахуванням нижніх кінцівок) і сила рук (з урахуванням правої руки) (по 11,8%).

Ключові слова: практично здорові юнаки та дівчата, варіабельність серцевого ритму, типи гемодинаміки, антропометрія, регресійні моделі.

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АНАЛИЗ РЕГРЕССИОННОЙ МОДЕЛИ ПОКАЗАТЕЛЕЙ ВАРИАБЕЛЬНОСТИ СЕРДЕЧНОГО РИТМА В ЗАВИСИМОСТИ ОТ ОСОБЕННОСТИ СТРОЕНИЯ ТЕЛА, ВОЗРАСТА И СИЛЫ СЖИМАНИЯ КИСТЕЙ ЗДОРОВЫХ ЮНОШЕЙ И ДЕВУШЕК С ЭУКИНЕТИЧЕСКИМ ТИПОМ ГЕМОДИНАМИКИ

Сергета И. В., Ковальчук В. В., Дмитренко С. В., Даценко Г.В., Очеретная О. Л.

Используя метод регрессионного анализа, мы построили индивидуальные модели показателей вариабельности сердечного ритма (ВСР) на основе индивидуальных особенностей конституциональных параметров тела, возраста и силы рук с коэффициентами определения R2 менее 0,5 у практически здоровых юношей и девушек Подолья с эукинетическим типом гемодинамики. Было обнаружено, что коэффициенты определения R2 у юношей в 17 завершенных моделях варьировались от 0,136 до 0,478, тогда как у девушек коэффициенты опре-деления R2 у 17 завершенных моделей варьировались от 0,095 до 0,342. Модели юношей чаще всего покрывали ширину ди-стальных эпифизов длинных трубчатых костей конечностей (30,9%, главным образом верхних конечностей), размеры ок-ружности тела (15,7%, главным образом за счет конечностей) и диаметров тела (12,6%, в основном сагиттальный и поперечный средний размер груди и таза (Distancia cristarum)); и модели девушек (35,3%), компоненты массы тела (13,7%, главным обра-зом, за счет мышечной массы тела по Матейко), ширина дис.-тальных эпифизов длинных трубчатых костей конечностей (с учетом нижних конечностей) и сила рук (с учетом правой руки) (по 11,8%).

Ключевые слова: практически здоровые юноши и девушки, вариабельность сердечного ритма, типы гемодинамики, антропометрия, регрессионные модели.

Рецензент Гунас І.В.