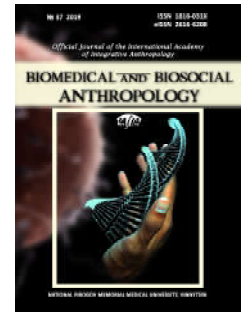




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Relationships of heart rate variability parameters with indicators of external body structure in highly qualified juvenile mesomorph volleyball players

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Determining the maladaptation and adaptive capabilities of the body, in particular the cardiovascular system of volleyball player is currently advanced in sports medicine. The aim of the work is to establish correlations between cardiointervalographic indicators and parameters of external body structure in volleyball players of mesomorphic somatotype of juvenile. The study involved 24 volleyball players aged 17 to 21 with a high level of sportsmanship and more than 3 years of experience. We conducted a study of heart rate variability on the cardiac computer diagnostic complex "OPTW" according to the recommendations of the European and North American Cardiac Association (1996). Indicators of autonomic homeostasis according to Baevsky, variation pulsometry, statistical and spectral cardiointervalographic parameters were determined. Anthropometry was performed by the method of Bunak (1941), somatotypological study - by the calculated modification of the method of Heath-Carter (1990), determination of the component composition of body weight by the method of Matejko (1992), correlation analysis by the method of Spearman was performed in the package "STATISTICA 5.5". Mesomorphic volleyball players were found to have the highest number and strength of reliable correlations with anthropo-somatotypological parameters, most of which were inverse and medium strength. Statistical, spectral parameters of heart rate variability and indicators of autonomic homeostasis with indicators of external body structure had few significant correlations. The girth of the hand in mesomorphic constitution volleyball players was statistically significantly related to the value of all statistical parameters and indicators of autonomic homeostasis by the method of Baevsky. According to the results of correlation analysis, we can assume that in volleyball players of mesomorphic somatotype with increasing the size of the mesomorphic component of somatotype, longitudinal, circumferential sizes and diameters of chest, arm, leg, neck will increase the impact on heart rate variability of the parasympathetic autonomic system.

Keywords: correlation, cardiointervalographic parameters, anthropometric dimensions, mesomorphic somatotype, volleyball players.

Introduction

One of the most developed sports is volleyball. Almost every country has more than one volleyball team, which is constantly trying to reach the championship of the world's leading teams [1, 6, 7]. Coaches of volleyball teams make a titanic effort every day to achieve prizes and are forced to develop and improve the training regime of their teams [2, 14, 15, 16, 17]. It is the use of modern electrophysiological examinations of every volleyball athlete in combination with his constitutional features that may be the secret to success. The introduction of new technologies in determining the maladaptation and adaptive capabilities of the volleyball player's body is currently advanced in sports

medicine [7, 10, 18]. Increasingly common in scientific articles and studies on the physiology of athletes is such a non-invasive method of examination as cardiointervalography [7, 8, 12]. This technique allows you to quickly and clearly show the adaptive picture of each athlete [3]. This method of diagnosis creates a perspective in the individual training process in the detection of signs of overstrain of the mechanisms of adaptation, thereby improving the results of the team as a whole [1, 9, 17, 22]. Printed literature, which describes this technique for determining heart rate variability, is not numerous among volleyball players [18, 23, 24], and especially little

information on the study of constitutional features, anthropometric indicators in combination with cardiointervalographic data, which determines the scientific novelty of this research.

The aim of the work is to establish correlations between cardiointervalographic indicators and parameters of external body structure in volleyball players of mesomorphic somatotype of juvenile age.

Materials and methods

We conducted a comprehensive survey of highly qualified (from the first adult category to masters of sports) athletes aged 17 to 21 years, who played volleyball for more than three years. Anthropometric study was performed by the method of Bunak [4], determination of the component composition of body weight - by the method of Matejko [11], somatotypological study - by Heath-Carter [5]. 24 volleyball players with mesomorphic somatotype were selected.

Determination of heart rate variability in volleyball players was performed on a computer diagnostic system "OPTW", considering the recommendations of the European and North American Cardiac Association [13]. Four groups of indicators were determined: *statistical* (SDNN - standard quadratic deviation of the length of normal R-R intervals, RMSSD - square root of the sum of squares of the difference between the values of consecutive pairs of normal R-R intervals, PNN50 - the percentage of pairs of consecutive normal R-R intervals differing by more than 50 ms of the total number of consecutive pairs of intervals); *variation pulsometry* (mode, mode amplitude, average, minimum and maximum value of R-R intervals, variation range); *spectral* (total recording power in all bands, power in very low frequencies, power in low frequencies, power in high frequencies, power ratio in the bands of low and high frequencies); *indicators of vegetative homeostasis*, which were determined by the method of Baevsky (vegetative rhythm and stress indices of regulatory systems and autonomic balance).

The analysis of the relationships between cardiointervalographic parameters and constitutional characteristics was performed in the package "STATISTICA 5.5" (licensed № AXXR910A374605FA) using the non-parametric Spearman method.

Results

After correlation analysis have been done, it was found that most indicators of variation heart rate with anthropometric body parameters in mesomorphic somatotype volleyball players had a small number of medium and strong reliable correlations. It was found that the *mode* had fewer reliable direct correlations (only with the height of the trochanteric point ($r=0.40$, $p=0.050$), folds on the thigh ($r=0.41$, $p=0.048$) and on the crus ($r=0.68$, $p=0.001$)) and a greater number of inverse correlations of medium and strong force, in particular: with the width of the distal epiphysis of the thigh ($r=-0.40$, $p=0.050$), the girth of

the shoulder in a relaxed state ($r=-0.62$, $p=0.001$), neck ($r=-0.55$, $p=0.006$), chest on exhalation ($r=-0.52$, $p=0.010$), chest at rest ($r=-0.41$, $p=0.048$), transverse mid-chest diameter ($r=-0.43$, $p=0.037$), anterior-posterior mid-thoracic diameter ($r=-0.72$, $p=0.001$), thickness of skin and fat folds on the chest ($r=-0.41$, $p=0.049$), mesomorphic component of the somatotype ($r=-0.49$, $p=0.015$).

The amplitude of mode in volleyball players had a small number of reliable, mostly inverse, correlations of medium strength with the height of the upper thoracic point ($r=-0.46$, $p=0.024$), the width of the distal epiphysis of the forearm ($r=-0.40$, $p=0.050$), neck circumference ($r=0.59$, $p=0.002$) and hand circumference ($r=-0.54$, $p=0.006$).

It was found that the average value of the R-R interval in mesomorphic volleyball players also had a small number of strong and medium feedback, in particular with the girth of the shoulder in the unstressed state ($r=-0.45$, $p=0.027$), the girth of the foot ($r=-0.46$, $p=0.022$), anterior-posterior mid-thoracic diameter ($r=-0.63$, $p=0.001$), the thickness of the skin and fat folds on the thigh ($r=-0.56$, $p=0.005$).

Among mesomorphic volleyball players, the index of the maximum value of the R-R interval had significant average feedback with the girth of the foot ($r=-0.45$, $p=0.026$), anterior-posterior mid-thoracic diameter ($r=-0.50$, $p=0.014$) and direct correlations with the girth of the hand ($r=0.46$, $p=0.023$), the thickness of the skin and fat folds on the posterior surface of the shoulder ($r=0.49$, $p=0.014$). And the minimum value of the R-R interval had both feedback and direct correlations, in most cases they were of medium strength. Feedback was found for the shoulder girth in the unstressed state ($r=-0.59$, $p=0.003$), neck girth ($r=-0.40$, $p=0.050$), anterior-posterior mid-thoracic diameter ($r=-0.50$, $p=0.013$), mesomorphic component of the somatotype ($r=-0.41$, $p=0.044$); and direct correlations - with the height of the trochanteric point ($r=0.46$, $p=0.023$), the thickness of the skin and fat folds on the posterior surface of the shoulder ($r=0.52$, $p=0.010$), on the anterior surface of the shoulder ($r=0.61$, $p=0.002$), on the forearm ($r=0.45$, $p=0.028$), on the crus ($r=0.66$, $p=0.001$), endomorphic component of the somatotype ($r=0.42$, $p=0.039$), fat mass according to Matejko ($r=0.47$, $p=0.021$). The variation scope in the external body structure had only significant correlations with neck girth ($r=-0.47$, $p=0.020$) and hand girth ($r=0.47$, $p=0.020$).

The statistical indicator of heart rate variability SDNN significantly moderately directly correlated only with the girth of the hand ($r=0.42$, $p=0.039$). RMSSD indicator had significant direct correlations with the height of the upper thoracic point ($r=0.52$, $p=0.010$), the width of the distal epiphysis of the shoulder ($r=0.41$, $p=0.049$), forearm ($r=0.53$, $p=0.008$), girth of the hand ($r=0.44$, $p=0.032$) and inverse significant correlations with neck girth ($r=-0.55$, $p=0.005$). PNN50 indicator had significant inverse correlations with neck girth ($r=-0.48$, $p=0.017$) and hand girth ($r=-0.66$, $p=0.001$).

Most of the spectral indicators of heart rate variability in

mesomorphic somatotype volleyball players did not have numerous reliable correlations with anthropometric and somatotypological parameters.

The total recording power in all ranges had one direct and two reliable feedback: with the height of the trochanteric point ($r=0.40$, $p=0.049$), the girth of the shoulder in the unstressed state ($r=-0.40$, $p=0.050$) and the neck ($r=-0.40$, $p=0.050$). *The spectral index, which reflects the power at very low frequencies*, had reliable feedback of medium strength with the girth of the shoulder in a tense state ($r=-0.40$, $p=0.050$), neck ($r=-0.51$, $p=0.011$), intertrochanteric distance ($r=-0.41$, $p=0.046$).

It was found that *the power in the low frequency range* in mesomorphic volleyball players had significant correlations only with the anterior-posterior mid-thoracic diameter ($r=-0.51$, $p=0.010$) and shoulder width ($r=0.62$, $p=0.001$).

Power in the high frequency range had several significant direct relationships with body length ($r=0.46$, $p=0.025$), body surface area ($r=0.45$, $p=0.027$), shoulder height ($r=0.46$, $p=0.025$), finger point ($r=0.40$, $p=0.050$) and trochanteric ($r=0.41$, $p=0.047$) points and one feedback with the shoulder girth in the unstressed state ($r=-0.40$, $p=0.050$).

The power ratio in the low and high frequencies had significant relationships with the shoulder girth in the tense state ($r=-0.40$, $p=0.050$) and with the width of the shoulders ($r=0.41$, $p=0.045$).

Indicators of the relationship between vegetative homeostasis according to the Baeovsky method had few reliable correlations with the constitutional parameters of the body. Thus, the *stress index* had inverse significant mean correlations with the height of the upper thoracic point ($r=-0.40$, $p=0.050$), the width of the distal epiphysis of the shoulder ($r=-0.42$, $p=0.039$), forearm ($r=-0.44$, $p=0.030$), the girth of the hand ($r=-0.43$, $p=0.035$). *The autonomic balance index* was significantly correlated only with the girth of the hand ($r=-0.41$, $p=0.046$).

The vegetative indicator of rhythm had the largest number of reliable correlations with the indicators of the external structure of the body. For this indicator, the inverse of the average strength correlations with the height of the upper thoracic point ($r=-0.43$, $p=0.037$), the width of the distal epiphysis of the forearm ($r=-0.40$, $p=0.050$), the girth of the hand ($r=-0.47$, $p=0.020$) and straight - with neck circumference ($r=0.61$, $p=0.002$), transverse mid-thoracic diameter ($r=0.50$, $p=0.029$) and anterior-posterior mid-thoracic diameter ($r=0.46$, $p=0.022$) were found.

Discussion

Establishing relationships between heart rate variability and somatometric parameters makes it possible from the standpoint of integrative anthropology [11] to substantiate the peculiarities of the regulation of cardiac activity in individuals of a certain somatotype [21]. Analyzing the features of correlations between cardiointervalographic parameters and indicators of external body structure in mesomorphic volleyball players, it is necessary to note the

smaller number and strength of the identified reliable relationships, in contrast to the group of fighters who also belonged to this somatotype, as noted in our previous studies [24]. In addition, it was found that volleyball players of mesomorphic somatotype had more numerous correlations between variations of heart rate and spectral parameters of heart rate variability and indicators of external body structure than athletes, who also belonged to this constitutional type [20].

Thus, according to the results of our data, it is necessary to pay attention to the fact that in volleyball players of mesomorphic constitutional type the indicators of variation pulsometry, in comparison with other groups of cardiointervalographic parameters, have the greatest number and strength of reliable correlations with anthropometric sizes and components of somatotype and body weight. In particular, the mode of youth volleyball players is associated with 12 constitutional parameters, which is 24.5 % of all anthropo-somatotypological indicators that were identified in our study. Of these from the total number: the average power feedbacks were 14.3 %, direct - 4.1 %, strong feedback - 4.1 %, strong direct - 2.0 %. Since mode depends on the dominant influence of the sinus node [25], we can predict that in volleyball players with increasing size of the mesomorphic component of the somatotype, girth size and diameter of the chest, neck and shoulder girth, epiphysis width of the lower extremity (because with the distal epiphysis the revealed feedback of average force ($r=-0.35$), though unreliable) will decrease influence on variability of a heart rhythm of sympathetic department of an autonomic nervous system. At the same time, the increase in fat deposition on the segments of the lower limb and the height of the acetabulum point will, on the contrary, lead to a more pronounced influence of the central contour of the autonomic nervous system [22, 23]. In general, it is interesting to note that the number and strength of correlations between mode and parameters of external body structure in highly qualified athletes of different sports differs significantly. Thus, in mesomorph athletes this indicator is practically unrelated to anthropometric characteristics [20], and in wrestlers it is interrelated with most of the constitutional parameters (63.3 %) [24]. In mesomorphic-type volleyball players, the amplitude of mode had significant average correlations with only 8.2 % of anthropo-somatotypological indicators, inverse correlations prevail (6.1 %). The mean R-R interval, which reflects the balance of parasympathetic and sympathetic influences [23], had a small number of reliable relationships of medium strength: with the reverse direction 4.1 %, direct - 2.0 %. And only 2.0 % of constitutional parameters with this cardiointervalographic indicator had strong inverse correlations. The maximum value of the R-R interval in this group of athletes correlated with only 4.1 % of anthropometric indicators. The minimum value of the R-R interval had stronger and more significant correlations with the indicators of the external structure of the body. Thus,

the return and direct correlations of medium strength were 8.2 %, and strong direct correlations were 4.1 %.

Statistical indicators of heart rate variability in adolescent volleyball players had a small number of reliable direct correlations. Of these, the standard deviation of the R-R intervals and the percentage of pairs of consecutive normal R-R intervals that differed by more than 50 ms from the total number of consecutive pairs of intervals were associated with 2.0 % of external body composition. The square root of the sum of the squares of the difference in the values of successive pairs of normal R-R intervals correlated with 8.2 % of body size, with predominating direct correlations.

According to the spectral indicators of heart rate variability in mesomorph volleyball players, there was no difference between feedback and direct correlations. Among correlations dominate medium strength. Most spectral parameters are related to two or three anthropometric dimensions. Only the recording power in the high frequency range was related to 12.2 % of the external body structure. This spectral index reflects the activity of the parasympathetic part of the autonomic nervous system [22, 25], so in volleyball players of mesomorphic somatotype increase in longitudinal body size will be accompanied by more pronounced opportunities for a rational type of adaptation of the cardiovascular system to exercise.

The relationships of indicators of autonomic homeostasis by the method of Baevsky in volleyball players of mesomorphic somatotype did not differ in strength and quantity from the spectral and statistical parameters of heart rate variability. Thus, the voltage index of regulatory systems had only medium power feedback with 8.2 % of anthropometric dimensions. Increasing the massiveness of the upper extremity will lead to a decrease in the value of this indicator, and hence the activity of the mechanisms of

sympathetic regulation [23]. The index of vegetative balance had a reliable feedback only with the girth of the hand, it is noteworthy that this anthropometric indicator is associated with all parameters of autonomic homeostasis by the method of Baevsky. The vegetative rhythm index had the largest number and strength of correlations.

The obtained results substantiate the possibility of using step-by-step regression analysis for the development of individual cardiointervalographic parameters in mesomorphic somatotype volleyball players depending on the peculiarities of their body structure.

Conclusions

1. It was found that in juvenile age volleyball players who belonged to the mesomorphic somatotype, the indicators of variation pulsometry had the highest number and strength ($r=0.40-0.72$) correlations with anthropo-somatotypological characteristics. Mode had the most reliable connections (24.5 % of all possible).

2. Among the statistical indicators of heart rate variability, the square root of the sum of squares of the difference between the values of consecutive pairs of normal R-R intervals with constitutional parameters had the largest number of statistically significant correlations. All statistics had significant correlations with hand girth.

3. Most spectral indicators are interrelated with single anthropometric dimensions. Only the recording power in the high frequency range was related to 12.2 % of the external body structure indicators.

4. In the group of indicators of vegetative homeostasis according to the method of Baevsky in volleyball players of mesomorphic somatotype, the vegetative rhythm index had the largest number (12.2 %) and strength ($r=0.40-0.61$) of correlations. All indicators of this group had significant correlations with the girth of the hand.

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ВЗАЄМОЗВ'ЯЗКИ ПАРАМЕТРІВ ВАРІАБЕЛЬНОСТІ СЕРЦЕВОГО РИТМУ З ПОКАЗНИКАМИ ЗОВНІШНЬОЇ БУДОВИ ТІЛА У ВИСОКОКВАЛІФІКОВАНИХ ВОЛЕЙБОЛІСТІВ-МЕЗОМОРФІВ ЮНАЦЬКОГО ВІКУ

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Визначення дезадаптаційних та пристосувальних можливостей організму, зокрема серцево-судинної системи, волейболіста є на теперішній час передовим у спортивній медицині. Мета роботи - встановити зв'язки між кардіоінтервалографічними показниками та параметрами зовнішньої будови тіла у волейболістів мезоморфного соматотипу юнацького віку. У дослідженні взяли участь 24 волейболісти у віці від 17 до 21 року з високим рівнем спортивної майстерності і стажем більше 3 років. Нами було проведено дослідження варіабельності серцевого ритму на кардіологічному комп'ютерному діагностичному комплексі "ОРТМ" за рекомендаціями Європейської та Північноамериканської кардіологічної асоціації (1996). Визначали показники вегетативного гомеостазу за Басєвським, варіаційної пульсометрії, статистичні та спектральні кардіоінтервалографічні показники. Антропометрію проводили за методом Бунака (1941), соматотипологічне дослідження - за розрахунковою модифікацією метода Heath-Carter (1990), визначення компонентного складу маси тіла за методом Матейко (1992), кореляційний аналіз за методом Спірмена проведено у пакеті "STATISTICA 5.5". Встановлено, що у волейболістів мезоморфів показники варіаційної пульсометрії мали з антропо-соматотипологічними параметрами найбільшу кількість та силу достовірних зв'язків, більшість з яких були зворотні, середньої сили. Статистичні, спектральні параметри варіабельності серцевого ритму та показники вегетативного гомеостазу з показниками зовнішньої будови тіла мали нечисельні достовірні кореляції. Обхват кисті у волейболістів мезоморфного конституціонального типу статистично значуще був пов'язаний з величиною усіх статистичних параметрів і показників вегетативного гомеостазу за методом Басєвського. За результатами кореляційного аналізу можемо припустити, що у волейболістів мезоморфного соматотипу при збільшенні величини мезоморфного компоненту соматотипу, поздовжніх, обхватних розмірів і діаметрів грудної клітки, верхньої кінцівки, нижньої кінцівки, ший буде збільшуватися вплив на варіабельність серцевого ритму парасимпатичного відділу автономної нервової системи.

Ключові слова: кореляція, кардіоінтервалографічні показники, антропометричні розміри, мезоморфний соматотип, волейболісти.

ВЗАИМОСВЯЗИ ПАРАМЕТРОВ ВАРІАБЕЛЬНОСТИ СЕРДЕЧНОГО РИТМА С ПОКАЗАТЕЛЯМИ ВНЕШНЕГО ТЕЛОСЛОЖЕНИЯ У ВИСОКОКВАЛІФІЦІРОВАННИХ ВОЛЕЙБОЛИСТОВ-МЕЗОМОРФОВ ЮНОШЕСКОГО ВОЗРАСТА

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Определение дезадаптационных и приспособительных возможностей организма, в частности сердечно-сосудистой системы, волейболиста есть в настоящее время передовым в спортивной медицине. Цель работы - установить связи между кардиоинтервалографическими показателями и параметрами внешнего телосложения у волейболистов

мезоморфного соматотипа юношеского возраста. В исследовании участвовали 24 волейболиста в возрасте от 17 до 21 года с высоким уровнем спортивного мастерства и стажем больше 3 лет. Нами было проведенное исследование variability сердечного ритма на кардиологическом компьютерном диагностическом комплексе "ОРТМ" по рекомендациям Европейской и Североамериканской кардиологической ассоциации (1996). Определяли показатели вегетативного гомеостаза по Баяевскому, вариационной пульсометрии, статистические и спектральные кардиоинтервалографические показатели. Антропометрию проводили по методу Бунака (1941), соматотипологическое исследования - по расчетной модификации метода Heath-Carter (1990), определение компонентного состава массы тела по методу Матейко (1992), корреляционный анализ по методу Спирмена проведен в пакете "STATISTICA 5.5". Установлено, что у волейболистов мезоморфов показатели вариационной пульсометрии имели с антропо-соматотипологическими параметрами наибольшее количество и силу достоверных связей, большинство из которых были обратные, средней силы. Статистические, спектральные параметры variability сердечного ритма и показатели вегетативного гомеостаза с показателями внешнего телосложения имели немногочисленные достоверные корреляции. Обхват кисти у волейболистов мезоморфного конституционального типа статистически значимо был связан с величиной всех статистических параметров и показателей вегетативного гомеостаза по методу Баяевского. По результатам корреляционного анализа можем допустить, что у волейболистов мезоморфного соматотипа при увеличении величины мезоморфного компонента соматотипа, продольных, обхватных размеров и диаметров грудной клетки, верхней конечности, нижней конечности, шеи будет увеличиваться влияние на variability сердечного ритма парасимпатического отдела автономной нервной системы.

Ключевые слова: *корреляция, кардиоинтервалографические показатели, антропометрические размеры, мезоморфный соматотип, волейболисты.*
