Clinically significant subjective features of highly qualified athletes with different types of cardiac rhythm regulation

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of the article

The aim of the study is to identify the characteristic subjective features of highly qualified athletes with different types of cardiac rhythm regulation.

Materials and methods. 202 highly qualified male athletes aged 22.6 ± 2.8 years and engaged in acyclic sports were examined. According to the designed survey protocol, all athletes were interviewed using a specifically designed questionnaire, which included 4 questions pools, each of them characterized certain components of athletes' subjective assessment of their condition and attitude to it during the previous week, as well as studies using spiroarteriocardiorhythmography (SACR).

Results. The SACR study allowed to divide athletes, taking into account heart rate variability (HRV) parameters, into 4 groups according to the types of their cardiac rhythm regulation. Subjective signs that might have clinical significance in the development of cardiovascular overexertion were uncomfortable sensations in the heart, feeling of interruption in the heart work, perspiration at rest, headache after sleep, perspiration at low loads, feeling of fatigue after sleep and night perspiration. Uncomfortable sensations in the heart occurred frequently in 1 % of cases and periodically in 15.3 % of cases, and feeling of interruption in the heart work occurred frequently in 0.5 % of cases and periodically in 14.9 % of cases. These indications were typical of people with cardiac rhythm regulations type I and II. In type III the least number of clinically significant features was noted. In type IV the number of significant features was less than in types I and II; however, this is nonsignificant. Probable differences in the features of perspiration at rest were noticed in athletes with type IV in comparison with type III.

Conclusions. Subjective indications can be employed to verify the regulatory features of the cardiovascular system, which are associated with the centralization of effects. Questionnaires can be useful in differentiating states of overexertion according to parasympathetic type and a state of high training level in type IV cardiac rhythm regulation.

Key words: data collection, medical history taking, heart rate, athlete.

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Клінічно значущі суб'єктивні ознаки висококваліфікованих спортсменів із різними типами регуляції серцевого ритму

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Мета роботи – визначити характерні суб'єктивні ознаки висококваліфікованих спортсменів із різними типами регуляції серцевого ритму.

Матеріали та методи. Обстежили 202 висококваліфікованих спортсменів чоловічої статі віком 22,6 ± 2,8 року, які займаються ациклічними видами спорту. Усіх спортсменів згідно з протоколом обстеження опитали, використовуючи анкету, яку розробили. Опитувальник складається з 4 блоків запитань, кожен із них характеризував певні складові суб'єктивного оцінювання власного стану та ставлення до нього протягом попереднього тижня. Крім того, всім обстеженим виконали спіроартеріокардіоритмографію (САКР).

Результати. САКР дослідження дало можливість диференціювати спортсменів з урахуванням параметрів варіабельності серцевого ритму (ВСР) на 4 групи за типами регуляції серцевого ритму. Суб'єктивні ознаки, які можуть мати клінічне значення у разі розвитку перенапружень серцево-судинної системи: неприємні відчуття в ділянці серця, відчуття перебоїв у роботі серця, пітливість у стані спокою, головний біль після сну, пітливість під час незначних навантажень, наявність відчуття втоми після сну та пітливість у нічний період. Часті неприємні відчуття в ділянці серця відзначили 1 % респондентів, періодичні – 15,3 %; часте відчуття перебоїв у роботі серця – 0,5 % опитаних, періодичне – 14,9 %. Ці ознаки характерні для I та II типів регуляції серцевого ритму. При III типі виявили найменшу кількість клінічно значущих ознак. При IV типі кількість значущих ознак була меншою, ніж при I та II типах, але невірогідно. Вірогідними у спортсменів із IV типом, порівнюючи зі спортсменами з III типом, були відмінності за ознакою пітливості у спокої.

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Висновки. За суб'єктивними ознаками можна визначити регуляторні особливості серцево-судинної системи, що пов'язані з централізацією впливів. Анкетування може бути корисним для диференціації станів перенапруження за парасимпатичним типом та станом високої тренованості при IV типі регуляції серцевого ритму.

Ключові слова: збір даних, збір анамнезу, серцевий ритм, спортсмени.

Актуальні питання фармацевтичної і медичної науки та практики. 2021. Т. 14, № 1(35). 84–92

Клинически значимые субъективные признаки высококвалифицированных спортсменов с различными типами регуляции сердечного ритма

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Цель работы – определить характерные субъективные признаки высококвалифицированных спортсменов с различными типами регуляции сердечного ритма.

Материалы и методы. Обследовали 202 высококвалифицированных спортсменов мужского пола в возрасте 22,6 ± 2,8 года, которые занимаются ациклическими видами спорта. Все спортсмены согласно протоколу обследования прошли опрос с использованием разработанной нами анкеты, которая была сформирована из 4 блоков вопросов, каждый из них характеризовал определенные составляющие субъективной оценки собственного состояния и отношение к нему в течение предыдущей недели. Кроме того, всем обследованным проведена спироартериокардиоритмография (САКР).

Результаты. САКР-исследование позволило дифференцировать спортсменов с учетом параметров вариабельности сердечного ритма (ВСР) на 4 группы по типам регуляции сердечного ритма. Субъективные признаки, которые могут иметь клиническое значение при развитии перенапряжений сердечно-сосудистой системы: неприятные ощущения в области сердца, ощущение перебоев в работе сердца, потливость в состоянии покоя, головная боль после сна, потливость при незначительных нагрузках, наличие ощущения усталости после сна и потливость в ночное время. Частые неприятные ощущения в области сердца отметили 1 % респондентов, периодически – 15,3 %; частое ощущение перебоев в работе сердца – 0,5 % обследованных, периодически – 14,9 %. Эти признаки характерны для I и II типов регуляции сердечного ритма. При III типе отмечено наименьшее количество клинически значимых признаков. При IV типе количество значимых признаков было меньше, чем при I и II типах, но недостоверно. Достоверными у спортсменов с IV типом в сравнении со спортсменами с III типом были отличия по признаку потливости в покое.

Выводы. По субъективным признакам можно определить регуляторные особенности сердечно-сосудистой системы, связанные с централизацией влияний. Анкетирование может быть полезным при дифференциации состояний перенапряжения по парасимпатическому типу и состоянием высокой тренированности при IV типе регуляции сердечного ритма.

Ключевые слова: сбор данных, сбор анамнеза, сердечный ритм, спортсмены.

Актуальные вопросы фармацевтической и медицинской науки и практики. 2021. Т. 14, № 1(35). С. 84–92

The problem of routine monitoring of athletes is related to the individual assessment of the effect of training and competitive loads, as well as recovery after them [1–4]. It is important to consider not only objective but also subjective features that would allow to standardize a comprehensive assessment of athletes' condition [1–3,5,6].

At the level of determining the physiological parameters that reflect the body's response to exercise, according to changes in energy supply [7–9], in cardiovascular [1–14], respiratory [15,16], sensorimotor systems [17–19], in metabolic processes [20–22], accompanied by changes in the immune response [20], endocrine regulation [23], methods of determining the subjective assessment of load perception, as well as psychophysical changes in the athlete's body are essential [24–26]. Some authors emphasize certain advantages of their use in the training process [27].

In recent years, a significant number of questionnaires and their modifications, providing a meticulous assessment of the effect of sports, as well as external factors on the recovery of an athlete, have appeared [6,28]. Their use in determining or regulating non-functional overstrain has been tested [29–33].

Within microcycles, it is proposed to use the Acute Recovery and Stress Quick (ARSQ), which has 8 scales for assessing physical, mental, emotional and general recovery, as well as stress [29,30]. A short version (SRSS) is also used; it is suitable for multiple measurements at short intervals, for example, in experimental conditions to evaluate recovery strategies [31], as well as in long-term monitoring [32]. The developers emphasize that the effectiveness of questionnaires depends on the responsibility and diligence of athletes, so it is important to ensure the confidentiality, proper use and estimation of data provided by athletes [34,35]. When examining a large number of athletes, the survey allows to quickly and economically collect data on their condition, especially after intense training or competition. This helps develop and adjust individual training schemes, taking into account the characteristics of the sport, as well as the psychophysiological state of athletes after competitions or training. At the same time, it is emphasized that survey data will be the most informative in combination with possible physiological research methods [6,36,37].

The method of spiroarteriocardiorhythmography (SACR) [38] has been tested by us in numerous field studies of athletes [39–42]. This allowed us to use the mentioned method in a comprehensive monitoring survey of athletes during the pre-competition period of the annual training cycle in combination with questionnaires.

Aim

The purpose of the work is to identify typical subjective characteristics of highly qualified athletes with different types of cardiac rhythm regulation.

Table 1. Criteria for determining the types of cardiac rhythm regulation according to N. I. Shlyk

Type of regulation	Group	Criteria	
		SI, conventional units	VLF, мс^2
Predominance of central regulation	I	>100	>240
	II	>100	<240
Predominance of autonomous regulation	III	25–100	>240
	IV	<25	VLF>500, TP>8000–10000

Materials and methods

Using spiroarteriocardiorhythmography (SACR), 202 highly qualified male athletes aged 22.6 ± 2.8 years and engaged in acyclic sports, namely various martial arts (karate, taekwondo, kickboxing, boxing, judo, sambo, wrestling) and sport games (water polo, football), were examined. Their experience of sports training was 10.3 ± 3.1 years. All studies were conducted in the pre-competition period. The SACR study was performed in the morning, on an empty stomach, in a sitting position. Registration lasted for 2 minutes. Before SACR study, questionnaires, morphometric examinations, and standard methods of measuring arterial systolic (SPB) and diastolic pressure (DPB) were performed [43].

According to the developed survey protocol, all athletes were interviewed using a specifically designed questionnaire, which included 4 questions pools. Each of them characterized certain components of athletes' subjective estimation of their own condition and attitude to it during the previous week. Each question was evaluated on a three-point scale, which provided an opportunity to characterize various features as non-occurring (scoring "0" points), occurring periodically (scoring "1" point) or often (scoring "2" points).

The first pool included questions that characterized the subjective signs of the general condition of an athlete at the time of the examination: psycho-emotional state, appetite, body weight dynamics, the presence of cardiovascular system complaints, headache, sweating and more. The second pool included questions related to characteristics and sensations during and after sleep, such as falling asleep, dreaming, waking up, the presence of fatigue after waking up, sweating in sleep, and so on. The third pool included questions related to sensations and manifestations during training loads. The fourth pool of questions was formed to understand the attitude of athletes to the recovery procedures used in the training process. However, the analysis of the results of the latter was not conducted in this study.

The type of autonomous regulation of the cardiac rhythm of athletes was determined according to the approach proposed by N. I. Shlyck [44,45], which grounds the classification of HRV on the data with the definition of TP (ms^2), SI (c. u.) and VLF (ms^2). There are 4 Types of autonomic regulation of cardiac rhythm: Type I shows moderate stress, Type II shows a decrease in the functional state of regulatory systems, the development of fatigue, Type III shows the optimal state of regulation, Type IV shows overstrain of autonomic regulation, or high fitness.

The principles of types classification, taking into account the above mentioned criteria, are presented in *Table 1.*

Statistical analysis of the physiological study results was performed to determine the differences between the groups using Mann–Whitney test. Subjective parameters were analyzed using the percentile method.

Results

According to the survey of athletes, the information on the peculiarities of classes and recreation organization in the pre-competition period was provided. It was related to the number of trainings (per week) – 6.0 ± 2.2, the average duration of one training (min.) – 121.0 ± 24.0, the average duration of training (min. per week) – 726 ± 314 and the average duration of sleep (hours) – 7.8 ± 1.1.

Analyzing the survey data in the whole group of athletes (*Table 2*), we will focus on the questions of each pool. According to the answers to the question about the general condition, it should be noted that in the vast majority of athletes, negative symptoms associated with discomfort in the heart, a feeling of heart failure, sweating at rest are not frequent, but occur periodically in 13.9–15.8 % of cases. Very rarely (up to 5 %) athletes report loss of appetite, variability in body weight, headache, and persistent reluctance to train. Feelings of lethargy, apathy, lack of vigor are within the expected range (5.0–5.9 %), while 8.9 % of athletes report frequent irritability and 12.9 % of them report increased excitability. Periodically, the above symptoms are observed between 21.8 % (for loss of appetite) and 57.9 % (for a feeling of increased excitability). The exception is the question on the feeling of reduced efficiency, which appears periodically in 72.8 % of cases. And only 11.4 % of athletes report it as frequent.

Analyzing the answers to the questions pool "Sleep", it should be noted that frequent sleep disorders in the studied group of athletes are quite rare (up to 5 %). However, a number of athletes (7.9 %) often report the presence of shallow sleep, and a certain number (5 %) often have a feeling of fatigue after sleep. This sign is most often defined by athletes as recurrent (48.5 % of cases). Slightly less often (35.6 % of cases), athletes notice periodically occurring poor sleep. All other subjective signs of recurrent sleep disorders occur in 10.0 % to 25.0 % of cases, which can be considered as expected. Among the characteristics of this question pool, there are the answers about poor sleep, the presence of a feeling of fatigue after sleep, as well as shallow sleep.

Table 2. The distribution of answers to the questionnaire by pools and their average scores in the studied group of athletes, n (%)

Question pools	no (0)	periodically (1)	often (2)
Question pool 1: "General condition"			
Impaired appetite	151 (74.8)	44 (21.8)	7 (3.5)
Weight loss	116 (57.4)	81 (40.1)	5 (2.5)
Headache regardless of external conditions	155 (76.7)	44 (21.8)	3 (1.5)
Unpleasant sensations in the heart	169 (83.7)	31 (15.3)	2 (1.0)
Feeling of heart failure	171 (84.7)	30 (14.9)	1 (0.5)
Feeling of reduced efficiency	32 (15.8)	147 (72.8)	23 (11.4)
Feeling vigor	115 (56.9)	75 (37.1)	12 (5.9)
Feeling of increased excitability	59 (29.2)	117 (57.9)	26 (12.9)
Irritability	78 (38.6)	106 (52.5)	18 (8.9)
Feelings of lethargy	80 (39.6)	111 (55.0)	11 (5.4)
Apathy, mood swings	120 (59.4)	69 (34.2)	13 (6.4)
Persistent reluctance to train	146 (72.3)	47 (23.3)	9 (4.5)
Sweating at rest	163 (80.7)	30 (14.9)	9 (4.5)
Question pool 2: "Sleep"			
Perspiration at night	160 (79.2)	39 (19.3)	3 (1.5)
Poor sleep	124 (61.4)	72 (35.6)	6 (3.0)
Shallow sleep	149 (73.8)	37 (18.3)	16 (7.9)
Terrible dreams / Nightmares	174 (86.1)	22 (10.9)	6 (3.0)
Frequent waking up	146 (72.3)	50 (24.8)	6 (3.0)
Feeling of fatigue after sleep	94 (46.5)	98 (48.5)	10 (5.0)
Headache after sleep	179 (88.6)	18 (8.9)	5 (2.5)
Question pool 3: "Training"			
Intense sweating during exercise	64 (31.7)	82 (40.6)	56 (27.7)
Sweating at low loads	68 (33.7)	103 (51.0)	31 (15.3)
High efficiency	134 (66.3)	57 (28.2)	11 (5.4)
Feeling of heaviness in working muscles	52 (26.0)	130 (65.0)	18 (9.0)
Lack of feeling of ease at walking	84 (41.6)	76 (37.6)	42 (20.8)
Feeling of fatigue of the day after training	72 (35.6)	116 (57.4)	14 (6.9)
Slow entry into work	118 (58.4)	64 (31.7)	20 (9.9)
Feeling of heaviness during training	62 (30.7)	126 (62.4)	14 (6.9)
Fear of performing complex exercises	150 (74.3)	37 (18.3)	15 (7.4)

Most of the subjective feelings of athletes are related to training, which is quite expected. Among the signs that may have a functional burden, there are intense perspiration during exercise (27.7 % – frequent, 40.6 % – periodic), sweating at low loads (15.3 % – frequent, 51.0 % – periodic). Other signs are usual for fitness trainings; however, they can have diagnostic value when the frequency of their occurrence is increased: feeling of heaviness in working muscles (9.0 % of cases), lack of feeling of ease at walking (20.8 % of cases), feeling of fatigue for the rest of the day after training (6.9 % of cases), as well as a feeling of heaviness during training (6.9 % of cases).

Certainly, an increase in the frequency of the above mentioned symptoms may indicate the development of overstrain of the cardiovascular system and musculoskeletal system, as well as overtraining of athletes.

Examination of athletes using SACR allowed to differentiate them (taking into account the parameters of HRV) into 4 groups according to the types of cardiac rhythm regulation. *Table 3* shows their distribution and average data that indicate their clear verification.

Characterizing athletes with different types of regulation, attention should be paid to morphometric and routine integrated indicators (*Table 4*), which differ significantly in Type IV. They show significantly lower body mass index (BMI, $kg \cdot m^{-2}$), chest circumference (cm) and higher vital index (VI, $kg \cdot ml^{-1}$), compared with other athletes. A similar difference is shown by the integral parameters of autonomic tone (vegetative index), economization of the cardiovascular system (Robinson index) and physical performance (according to the level of functional state (LFS) by Pirogova). Athletes of Type III (optimal) regulation considerably differ from athletes belonging to Type I and II according to the mentioned integral parameters. However, they do not differ significantly in morphometric parameters. At the same time, morphometric and standard integrated indicators of athletes with Type I and II regulation are generally similar.

An important component of determining the functional overstrain is the characterization of the subjective characteristics of the athlete, which can be combined with the development of such states. A significant number of publications in this regard show a fairly high efficiency in assessing the current state of the athlete [46].

Taking into account the aim of the work, related to the assessment of subjective symptoms in athletes with different types of cardiac rhythm regulation, we analyzed the answers to questions that may have clinical significance (*Table 5*).

The presented data demonstrate that each of the types of regulatory cardiac rhythm is accompanied by a number of subjective features that may have clinical significance. The least number of such manifestations are observed in Type III, the most – in Type II. Comparing the data of registration of subjective traits in athletes with different types of regulation, it should be noted that this study surveyed athletes in the pre-competition period of the training process, which did not allow us to track the dynamics of changes in cardiac rhythm regulation in individual athletes. However, the simultaneity and combination of testing allowed to more fully characterize the conditions that develop in athletes under the influence of physical activity.

First of all, the subjective characteristics of athletes, which are rare in the studied group, deserve attention. Unpleasant sensations in the heart and sensations of interruptions are quite

Table 3. Average values of HRV indicators, which were the basis for the differentiation of athletes by types of cardiac rhythm regulation

Type of regulation	n	TP, ms^2	VLF, ms^2	SI, c.u.
I type	42	2490 (1632; 3844)	610 (331; 1406)	143.4 (122.9; 214.5)
II type	28	1475 (1163; 2314)	161 (144; 188)	222.1 (150.8; 282.8)
III type	88	5686 (4186; 12679)	770 (471; 1600)	57.7 (38.5; 70.3)
IV type	44	18540 (12645; 26392)	1490 (992; 2061)	17.4 (13.3; 19.9)

Table 4. Comparative characteristics of morphometric and routine parameters of athletes with different types of cardiac rhythm regulation, M (Q1; Q3)

Indicators	I type	II type	III type	IV type
Body mass, kg	75.0 (62.0; 84.0)	75.0 (70.0; 87.0)	73.0 (64.0; 79.5)	70.7 (58.5; 82.5)
Body length, cm	181 (169; 188)	181 (172; 190)	175 (170; 186)	175 (170; 185)
BMI, kg·m^{-2}	23.1 (21.1; 25.2)	22.2 (21.4; 26.7)	22.5 (20.9; 24.7)	20.9 (20.0; 26.2)
HR, m^{-1}	70.3 (62.9; 74.4)	66.2 (62.5; 71.8)	59.2 (54.0; 65.4)	54.1 (49.9; 61.2)
SBP, mmHg	120 (110; 130)	120 (116; 130)	120 (110; 130)	110 (106; 120)
DBP, mmHg	76 (70; 80)	76 (70; 80)	72 (64; 80)	70 (68; 80)
PBP, mmHg	50 (40; 54)	54 (40; 60)	42 (40; 50)	40 (35; 47)
Vegetative index	-0.08 (-0.19; 0.06)	-0.11 (-0.22; 0.01)	-0.23 (-0.33; -0.07)	-0.34 (-0.57; -0.18)
Robinson index	82.4 (69.6; 94.8)	79.4 (77.4; 94.1)	72.0 (62.4; 79.4)	61.5 (56.5; 71.0)
Baevsky`s AP	2.26 (1.88; 2.40)	2.21 (2.06; 2.27)	2.01 (1.82; 2.19)	1.89 (1.72; 2.02)
LFS by Pirogova	0.67 (0.55; 0.78)	0.69 (0.63; 0.70)	0.75 (0.68; 0.83)	0.81 (0.75; 0.90)

Table 5. The comparison of distributions of clinically significant subjective features of athletes with different types of regulatory support of the cardiovascular system

		I type			II type			III type			IV type		
		no (0)	periodically (1)	often (2)	no (0)	periodically (1)	often (2)	no (0)	periodically (1)	often (2)	no (0)	periodically (1)	often (2)
Uncomfortable sensations in the heart	n	31	10	1	17	10	1	82	6	0	39	5	0
	%	73.8	23.8	2.4	60.7	35.7	3.6	93.2	6.8	0.0	88.6	11.4	0.0
Feeling of interruption in the heart work	n	31	11	0	17	11	0	80	7	1	43	1	0
	%	73.8	26.2	0.0	60.7	39.3	0.0	90.9	8.0	1.1	97.7	2.3	0.0
Sweating at rest	n	31	8	3	19	6	3	81	7	0	32	9	3
	%	73.8	19.0	7.1	67.9	21.4	10.7	92.0	8.0	0.0	72.7	20.5	6.8
Sweating at night	n	30	11	1	21	5	2	75	13	0	34	10	0
	%	71.4	26.2	2.4	75.0	17.9	7.1	85.2	14.8	0.0	77.3	22.7	0.0
The feeling of fatigue after sleep	n	21	18	3	11	14	3	40	45	3	22	21	1
	%	50.0	42.9	7.1	39.3	50.0	10.7	45.5	51.1	3.4	50.0	47.7	2.3
Headache after sleep	n	39	2	1	21	6	1	76	9	3	43	1	0
	%	92.9	4.8	2.4	75.0	21.4	3.6	86.4	10.2	3.4	97.7	2.3	0.0
Sweating at low loads	n	2	26	14	2	19	7	45	38	5	19	20	5
	%	4.8	61.9	33.3	7.1	67.9	25.0	51.1	43.2	5.7	43.2	45.5	11.4

typical of the Types of regulation I and II, which are observed in the centralization of cardiac rhythm regulation. In Type I, they occur periodically and often in every fourth athlete (23.8 % and 2.4 %, respectively). They are slightly more often in Type II: in 35.7 % and 3.6 % of cases, respectively. However, they are also periodically registered in Types III and IV: in 6.8 % and 11.4 % of cases. On the other hand, they often occur in only 2 athletes (1 %) of the entire group studied.

The subjective sign associated with the feeling of interruptions in the heart is mainly found in athletes of Type I and II regulation (periodically in 26.2 % and 39.3 %). In Types III and IV it is rare (9.1 % and 2.3 %). However, it was detected as frequent in one of the athletes belonging to Type III. It is quite informative that despite a significant sinus arrhythmia, no sensations in work of interruption were fixed among athletes of Type IV.

Other features of the options for centralization (Types I and II) and autonomy (Types III and IV) of cardiovascular regulation are not significantly related. However, with optimal (Type III) regulatory support, sweating at rest is the least often (8 %). In other types, it occurs from 26.1 % to 32.1 % of cases. At the same time, with excessive influence of the sympathetic division (Type II) it is often in 10.7 % of cases, and with excessive vagotonic impact (Type IV) – in 6.8 %, which does not clearly differentiate these groups. Sweating at night is the least often, in 14.8 % of cases, periodically occurs in athletes of Type III. In others it ranges from 22.7 % to 28.6 %, which also does not allow to characterize as specific for any of the Types.

Athletes of Type II complain of sleep fatigue more often – 50.0 % periodically and 10.7 % often. However, in other Types it occurs in 50.0 % to 54.4 % of athletes and is less often – from 2.3 % in type IV to 7.1 % in Type I. The symptom associated with post-sleep headache is in some way different. Most often (in every fourth athlete) it is observed in Type II. It is rarely fixed (2.3 %) in Type IV. On the other hand, it occurs in every seventh athlete with optimal (Type III) regulation. A sign of sweating at low loads, which is registered in the vast majority of athletes (95.2 % and 92.9 % of cases, respectively) was quite characteristic for Types I and II. However, with the autonomy of regulation (Types III and IV), it is also often and is observed in half (48.9 %) and more (56.9 %) of athletes.

Discussion

The analysis of subjective signs that characterize the general condition, sleep and feelings during training revealed that most changes in athlete's feelings determine the nature of the adaptive reactions of the body that occur in the training process. Symptoms that are rare and may be of clinical significance in the development of cardiovascular overstrain have been identified. These included: uncomfortable sensations in the heart, a feeling of heart failure, sweating at rest, headache after sleep, sweating at low loads, the presence of fatigue after sleep, night sweats.

They are quite rare in athletes. Exceptions are the signs that characterize the presence of fatigue after sleep and the activity of the activation of autonomous mechanisms of thermoregulation, as well as autonomic dysregulation (according to sweating).

Discomfort in the heart is a non-specific symptom that can occur in various conditions related to heart function, such as myocardial ischemia with excessive stretching of the heart chambers, which can occur with increasing end-diastolic size, a number of inflammatory diseases of different layers of the heart, aortic lesions, etc. [47–50]. These sensations can also have reflexive nature and be associated with the condition of the spine or excessive activation of the branches of the sympathetic ANS [51–53]. Despite the fact that this feature is quite rare in the surveyed group of athletes (often in 1 % of cases and periodically in 15.3 % of cases), it deserved a meticulous analysis, which showed its significant predominance in the centralization of regulatory effects on heart rate. However, in some cases, it can occur with the predominance of autonomous influences.

Feeling of heart failure is also a non-specific symptom; however, it has a clear connection with heart function, namely arrhythmia. This feature in the studied group of athletes is also quite rare (often in 0.5 % of cases and periodically in 14.9 % of cases). Its presence, as a rule, may indicate the appearance of an extrasystolic form of arrhythmia, and, most likely, ventricular [47,49]. However, it can be variably present as sinus node weakness, when one or more heart contractions may occur [54]. Other forms of arrhythmic disorders usually have a more stable course. The same forms such as sinus arrhythmia, which is characteristic of athletes, or atrial extrasystole, usually do not cause subjective sensations. Thus, in athletes belonging to Type IV, who have very pronounced sinus arrhythmia, the feeling of interruption in work was noted in only 2.3 % and only periodically.

Sweating at rest in the absence of other symptoms is a sign of adjustment of thermoregulatory processes and stress of the autonomic nervous system in ensuring metabolism. In the whole group of surveyed athletes, this symptom is often present in 4.5 % of cases, and periodically – in 14.9 % of cases. Taking into account the type of cardiac rhythm regulation, it was the least often (in 8 % of cases) in optimal (Type III), most often in 32.1 % and 27.3 % of cases in autonomic dysregulation of the sympathetic and parasympathetic type, respectively. Quite rarely it occurred in Type I (26.1 % of cases).

Headache after sleep is a very important sign of impaired cerebral blood flow during sleep and failure to restore neck muscle tone, which also has autonomous determinants [54]. In general, among athletes, it occurs frequently and periodically in 11.4 % of cases. However, it may also indicate deterioration in the regulation of systemic circulation and be accompanied by an increase (more often) or a decrease (less often) in blood pressure. Most often, it shows the predominance of sympathicotonic effects in every fourth athlete. Rarely (2.3 %) it is observed with a predominance of vagotonic effects.

A rather important sign of the presence of autonomic dysregulation is night sweats, when a number of anabolic

processes, aimed at restoring the structures and functions of the body after daytime stress of catabolic mechanisms associated with life, take place [22]. Usually, sweating during sleep is accompanied by lytic processes of thermoregulation, which implement the return of accumulated heat, as in case of a number of inflammatory diseases [23]. In athletes, sweating during sleep can characterize the processes of hypothalamic-pituitary and autonomic dysfunction and indicate the tension of adaptive mechanisms in the body [10]. In our study, night sweats occur frequently and periodically in one of five athletes (only 20.8 % of cases).

Signs of fatigue after sleep and sweating at low physical loads have a certain pre-nosological significance. These symptoms are quite common: in 53.5 % and 66.3 %, respectively. The presence of fatigue after sleep is a characteristic sign of insufficient recovery, but it can occur with excessive stress of the previous day, when the body has little time to fully recover, and the presence of sweating at low physical loads, usually characterizes the stress of adaptive mechanisms [10]. Certainly, these signs are significant with frequent registration.

Conclusion

Subjective features can be used to verify the regulatory features of the cardiovascular system, which are associated with the centralization of effects (for the majority of signs). However, their intertype individual differentiation is difficult. On the other hand, the autonomy of influences can be determined as a manifestation of optimal regulatory support (Type III) only in the absence of most subjective features, and not always. An even bigger problem is the definition of Type IV, which is differentiated from Type III, only on the basis of sweating at rest (27.3 % vs. 8 %), which is not a clear subjective feature, although it can help distinguish between states of high fitness and overexertion according to parasympathetic type.

So, taking into account the types of heart rate regulation, the questionnaire can be helpful in determining the condition of the athlete. It is most likely that it can be effective in differentiating states of overstrain by parasympathetic type and state of high fitness.

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