The effect of physical activity on the dynamics of myocardial bioelectrical activity in students

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Abstract

Objective of the study is to investigate the effect of the nature of physical activity on the dynamics of myocardial bioelectrical activity in students at an agricultural university.

Methods and structure of the study. A total of 62 students from an agricultural university were examined, from whom two groups were identified based on their levels of physical activity: Group A comprised students who continued to practise selected sports (25 individuals), and Group B comprised students who had stopped practising sport after their third year (41 individuals). The study of myocardial bioelectrical activity in students at an agricultural university was carried out using the results of the standard method for interpreting electrocardiograms. All parameters were recorded three times at each stage of the study: at rest, after a graded physical exercise test, and during the recovery period. A two-stage 'step test' on a 40 cm high step, based on the method of Y.S. Weinbaum, was used as the submaximal graded exercise test. All data obtained from the functional study were analysed using the method of variational statistics.

Results and conclusions. Resting ECG data indicated an improvement in cardiovascular function among students participating in selected sports compared with those who had stopped practising sport. This was reflected in a prolongation of the cardiac cycle by 35.7 beats per minute, and the presence of a high percentage of moderate (68%) and marked (32%) sinus arrhythmia, indicating an increase in cardiac functional reserves among students who engaged in physical exercise throughout their time at university.

Informative indicators for assessing the bioelectrical activity of the students' myocardium under different types of physical activity include: the severity of sinus arrhythmia (ΔRR=0.25–0.50 s), the characteristics of RR intervals, QT intervals and the amplitudes of the P_{II}, R_{II}, T_{II} waves and the total voltage of the R waves in standard electrocardiogram leads.

Keywords: *physical activity, students, bioelectrical activity of the myocardium.*

Introduction. One of the key areas of modern sports science is the study of how the body adapts and improves its physiological functions to achieve optimal performance under various conditions of physical activity.

Numerous works by domestic and foreign authors present the main theoretical approaches to researching adaptation, expanding the range of compensatory capabilities, and increasing the level of functional reserves in students' bodies at different stages of life [3, 15, 16].

Of particular importance is the initial stage of study in the first and second years, which is characterised by a complex period of adaptation for students to the new university environment [10]. One of the conditions for the success of these adaptive changes depends on the organisation of an optimal exercise regime, which contributes to the enhancement of the functional capabilities of the students' major physiological systems [8, 9] .

As students' fitness levels increase, powerful cholinergic reactions develop, one consequence of which is negative chronotropic effects causing a slowing of the heart rate [1, 2]. Due to increased tone in the vagal innervation centres, bradycardia is observed in student athletes. In trained individuals, isotonic cardiac hyperfunction is observed during physical exertion, arising from an increase in cardiac output and the amplitude of heart contractions. Moderate myocardial hypertrophy, combined with some dilation of the heart chambers, is energetically the most economical, as it contributes to increased cardiac efficiency. Such hyperfunction, and therefore hypertrophy, is characterised as 'physiological' [4, 11, 14].

Objective of the study is to investigate the effect of the nature of physical activity on the dynamics of myocardial bioelectrical activity in students at an agricultural university.

Methods and structure of the study. Dynamic studies were conducted among students at the K.A. Timiryazev Russian State Agrarian University – Moscow Agricultural Academy. A total of 62 students were examined, from whom two groups of senior students differing in terms of physical activity were identified: Group A – students who continued to practise selected sports (25 individuals) and Group B – students who had stopped practising sport after their third year (41 individuals).

ECG recordings were made in 12 standard leads (I, II, III – augmented unipolar limb leads aVR, aVL, aVF, unipolar chest leads according to Wilson V_1–V_6).

The study of myocardial bioelectrical activity in students at an agricultural university was conducted using the generally accepted method for interpreting electrocardiograms, including the determination of heart rate, the position of the electrical axis and the electrical position of the heart, the amplitude, shape and direction of the P, Q, R, S and T waves, and the duration of the PQ, QRS and and QT intervals. All parameters were recorded three times at each stage of the study: at rest, after a graded exercise test, and during the recovery period.

A two-stage 'step test' on a 40 cm high step, based on the method of Y.S. Weinbaum, was used as the submaximal graded exercise test. This made it possible not only to assess the adequacy of the responses of the ECG parameters under study following physical exertion, but also to determine the level of the body's physical working capacity during various types of physical activity.

All data obtained from the functional study were analysed using the method of variational statistics, with calculation of the arithmetic mean and the standard deviation. The significance level (P) was determined.

Results of the study and discussion. Analysis of the ECG parameters revealed that, on average, both the interval and amplitude data for the majority of the students examined during the initial period of their university studies were within physiological norms [6, 7].

The electrocardiographic data of the students examined during their fourth year of study are presented in Tables 1 and 2. Studies have shown that senior students in Group A, who continued to engage in

Table 1. Changes in students' ECG interval parameters during their time at university (M±m)

Indicators		Stages of the study	Second year – Stage II (n=66)	Fourth year (n=62)			P IV-A	P IV-B
				Group A	Group B	P A-B		
RR		Rest	0,87±0,01	0,98±0,03	0,81±0,03	0,001	0,001	0,11
		Physical activity	0,53±0,02	0,56±0,03	0,42±0,02	0,001		0,001
		Recovery period	0,71±0,01	0,78±0,02	0,61±0,05	0,003	0,003	0,05
HR		Rest	71,2±1,04	61,2±4,36	74,0±3,52	0,001	0,01	0,001
		Physical activity	118,8±1,83	107,1±3,90	142,8±5,55	0,001	0,06	0,01
		Recovery period	85,6±2,12	76,9±4,07	98,3±4,20	0,32	0,11	0
PQ		Rest	0,15±0,002	0,16±0,006	0,15±0,008	0,32	0,11	0
		Physical activity	0,14±0,005	0,15±0,005	0,15±0,016	0	0,16	0,55
		Recovery period	0,15±0,003	0,16±0,007	0,15±0,005	0,24	0,20	0
QRS		Rest	0,09±0,002	0,09±0,004	0,08±0,006	0,17	0	0,11
		Physical activity	0,09±0,002	0,09±0,006	0,08±0,005	0,24	0	0,11
		Recovery period	0,09±0,004	0,09±0,004	0,08±0,005	0,12	0	0,11
QT	Actual	Rest	0,37±0,005	0,40±0,009	0,38±0,008	0,10	0,006	0,28
		Physical activity	0,31±0,002	0,32±0,010	0,28±0,009	0,006	0,32	0,002
		Recovery period	0,35±0,003	0,35±0,014	0,34±0,010	0,55	0	0,06
	Target	Rest	0,36±0,002	0,39±0,012	0,35±0,007	0,007	0,016	0,016
		Physical activity	0,28±0,003	0,31±0,009	0,25±0,008	0,001	0,003	0,001
		Recovery period	0,33±0,004	0,34±0,007	0,30±0,010	0,003	0,23	0,007
L∞QRS		Rest	71,3±3,58	75,2±5,68	72,3±4,92	0,69	0,55	0,84
		Physical activity	76,6±2,95	77,7±5,61	74,3±5,27	0,69	0,84	0,69
		Recovery period	73,0±2,48	74,2±4,84	73,2±7,06	0,92	0,84	0,92

regular physical exercise either independently or through sports clubs, exhibited statistically significant changes in ECG parameters, indicating an overall improvement in cardiovascular function, compared with students in Group B, who had stopped regular exercise after their third year.

Evidence of improved cardiac function and mobilisation of the heart's functional reserves was provided by a prolongation of the resting heart cycle (RR interval), attributable to vagal tone, and a more appropriate response in heart rate following graded exercise, averaging 107.1 bpm in group A compared with 142.8 bpm in group B. This, together with a more rapid recovery of ECG data, generally indicated an improvement in the quality of the deployment of reserve adaptive mechanisms in senior students who continued to engage in physical exercise. An individual analysis of the degree of sinus arrhythmia showed that in students in Group A, in the majority of cases (68%), the difference in the RR interval (ΔRR) ranged from 0.21 to 0.35 s, corresponding to a moderate degree of sinus arrhythmia. A pronounced degree of sinus arrhythmia (ΔRR = 0.36–0.50 s) was observed in 32% of cases, indicating a rational parasympathetic influence on the activity of the sinus node. No cases of severe sinus arrhythmia (ΔRR ≥ 0.50 s) were noted in group A. However, in Group B, cases of severe arrhythmia were observed (ΔRR = 0.65–0.75 s) in conjunction with repolarisation processes, a reduction in total RR voltage, T_6 syndrome and other changes, indicating the negative impact of limited physical activity during the final period of university study. This was also evidenced by other ECG parameters: mean values of the electrical systole (QT interval), which in students of Group B exceeded normal values both at rest and after physical exertion, particularly during the recovery period (T_{11} by 6–13%).

An analysis of the amplitude parameters of the electrocardiograms of final-year students revealed that in Group A, against the backdrop of increasing fitness levels, positive changes were observed, manifested as an increase in the amplitude of the RII, R and TII waves, alongside a slight decrease in the amplitude of the average PII wave. The changes observed in Group A are associated with the development of physiological myocardial hypertrophy, caused by the continuation of regular physical exercise during university studies [5, 8, 12, 13].

At the same time, in Group B, a significant reduc-

Table 2. Changes in students' ECG amplitude parameters during their time at university (M±m)

Indicators	Stages of the study	Second year – Stage II (n=66)	Fourth year (n=62)			P IV-A	P IV-B
			Group A	Group B	P		
PII	Rest	1,42±0,05	1,36±0,10	2,32±0,15	0,001	0,62	0,001
	Physical activity	2,04±0,10	2,05±0,18	3,42±0,15	0,001	0,92	0,001
	Recovery period	1,65±0,06	1,60±0,13	2,83±0,14	0,001	0,69	0,001
RII	Rest	11,7±0,62	13,5±0,88	9,4±0,84	0,002	0,09	0,03
	Physical activity	13,0±0,44	15,2±0,90	14,1±0,89	0,37	0,03	0,28
	Recovery period	12,2±0,71	14,2±0,72	10,3±0,93	0,002	0,05	0,09
ΣR	Rest	25,3±1,45	28,7±1,75	23,4±1,50	0,03	0,14	0,37
	Physical activity	27,2±1,33	31,3±1,56	26,5±1,79	0,05	0,05	0,76
	Recovery period	26,3±1,39	27,1±1,72	22,2±1,81	0,05	0,69	0,08
SII	Rest	1,07±0,14	1,50±0,53	1,35±0,48	0,84	0,43	0,55
	Physical activity	1,98±0,22	2,04±0,59	1,90±0,67	0,84	0,92	0,92
	Recovery period	1,63±0,17	1,75±0,35	1,62±0,44	0,84	0,76	0,92
TII	Rest	4,44±0,19	5,41±0,38	2,55±0,41	0,001	0,02	0,001
	Physical activity	4,75±0,20	5,84±0,28	3,54±0,30	0,001	0,003	0,001
	Recovery period	4,37±0,22	5,63±0,43	2,07±0,54	0,001	0,012	0,001
TV_2	Rest	3,34±0,27	3,37±0,65	3,03±0,40	0,62	0,92	0,48
	Physical activity	3,53±0,43	3,51±0,51	3,41±0,67	0,92	0,92	0,84
	Recovery period	3,31±0,32	3,39±0,55	3,30±0,49	0,92	0,92	0,92
TV_5	Rest	6,02±0,30	6,20±0,36	4,53±0,50	0,009	0,69	0,012
	Physical activity	5,56±0,36	5,61±0,58	4,03±0,53	0,05	0,92	0,02
	Recovery period	5,47±0,25	5,53±0,63	4,22±0,44	0,10	0,92	0,016

tion in the amplitude of the ECG waves in question was observed, which, in the presence of an enlarged P_{11} wave, indicated an overall deterioration in the bioelectrical activity of the myocardium in these students.

Conclusions. Resting ECG data indicated an overall improvement in cardiovascular function among students in Group A compared with those in Group B. This was reflected in a prolongation of the cardiac cycle by 35.7 beats per minute, a high proportion of cases with moderate (68%) and marked (32%) sinus arrhythmia, which indicated an increase in cardiac functional reserves among students who engaged in physical exercise throughout their time at university.

Thus, informative indicators for assessing the bioelectrical activity of the students' myocardium under different types of physical activity are: the degree of severity of sinus arrhythmia (ΔRR=0.25–0.50 s), the characteristics of RR intervals, QT intervals and the amplitudes of the Pii, Rii, Tii waves, and the total voltage of the R waves in standard electrocardiogram leads.

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