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***Indexes of central haemodynamics and heart rhythm variability at the  
persons with different level of physical efficiency***

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**Wskaźniki hemodynamiczne i zmienność pracy serca u osób o zróżnicowanej  
wydolności fizycznej**

Numerous studies showed that haemodynamics and heart rhythm variability (HRV) among the sportsmen and the persons, who had not taken up sports, both in the state of rest and exercise differed substantially [1]. Especially a lot of publications are devoted to the influence of aerobic training on the cardiovascular system [5, 6]. At the same time cardiovascular system features and HRV are investigated insufficiently among the people who do not exercise regularly having different level of physical efficiency [4]. These differences may be caused by both the life conditions and the genetic factors [7].

Therefore the research goal was to study the cardiovascular system features among the healthy young men with a different level of PWC170.

**MATERIALS AND METHODS**

109 healthy young men aged 17-23 took part in the study. 5-minute registrations of electrocardiogram, differential thorax reopletizmogram with a bioamplifier RA5-01, pneumogram with a piezoelectric sensor located in front of the nostrils were carried out in the morning (from 8 to 11 o'clock) after 15-minute rest in the lying position. The signals were transformed through ADC ADC-1280, registered on HDD of the computer, and then were analyzed using the Bioscan program [1]. The similar records were carried out during the exercise with the power of 1 W/kg performed on the cycle ergometer TX-1 (HKS, Germany). Arterial pressure was measured with Korotkov's method. The average arterial pressure (APav) was calculated with Hikem's formula. The systolic blood volume was calculated according to the signals of differentiated impedance reogram as to the all realizations for 5 minutes [2]. The body surface was counted according to Du Boua's formula for the calculation of stroke index (SI) and cardiac index (CI). The statistical and spectral analysis of cardiointervalogram and spirointervalogram was conducted in the program "CASPICO". The following descriptions were thus determined: M – an average value of the R-R intervals; SDNN – an average square error of cardio cycle duration; rMSSD – square root from an average one of size difference squares of successive R-R interval pairs, Mosp – moda of spirointerval mass. The estimation of heart rhythm wave structure was carried out according to the median spectrogram. The median spectrogram was built as follows: The individual spectrograms were divided into 50 windows 0,01Hz wide, in which spectrum power was determined. According to the individual data the table was built and the spectrum power median was determined in every window. The diagram was built according to these medians. The estimation of the selection central tendency was made according to the median as index distribution was not normal. A physical efficiency was estimated with the test PWC170, which was performed according to a standard procedure on cycle ergometer TX-1 (HKS, Germany). For leveling anthropometric parameter influence on this index its level was estimated in the relative units per kilogram of body weight. Authenticity of differences between various group indexes and under different influences was determined ac-

ording to H-criterium Kruskal-Wallis ANOVA median test in the program Statistica for Windows 5.0.

## RESULTS

The analysis of PWC170/kg index distribution in the investigated selection showed that three groups of persons with a different level of physical capacity may be chosen. The persons with indexes less than 14 kgm/min\*kg were related to the group with a low efficiency (21 persons), from 14 to 19 kgm/min\*kg – middle (56 persons), more than 19 kgm/min\*kg – high efficiency (32 persons).

In the state of rest (tabl.1) there was the reliable decline of an average arterial pressure with the growth of physical capacity. Duration of cardio- and spiointervals was increased too. These changes can be explained by greater tone of parasympatic part of the autonomic nervous system (ANS) at the men with higher efficiency level.

Tabl.1. Central haemodynamics and HRV indexes in the state of rest

	Level of capacity		
	Low	Middle	High
APav (mm of Hg)	93.33*	90.0+	87.5^
SI (ml/m <sup>2</sup> )	29.29	28.57	32.19
CI (ml/hv.*m <sup>2</sup> )	1930	1879	1852
M (ms)	871*	927	975^
SDNN (ms)	56.34	68.92	57.87
rMSSD (ms)	50.0	66.0	49.5
Mosp (ms)	3625	3625+	4125^

Note: \* - p<0.05 between groups with low and middle capacity; + - p<0.05 between groups with middle and high capacity; ^ - p<0.05 between groups with high and low capacity

With the growth of capacity a stroke index had a tendency to increase, and cardiac index – to reduction, that can indicate the greater economy of heart work in the state of rest in persons with a high efficiency.

At the same time such indexes of HRV as SDNN and rMSSD did not differ significantly in the different groups, though there was a tendency to increase in the group with a middle level PWC170/kg.

The analysis of the wave structure of heart rhythm variability with a median spectrogram (fig. 1) showed that indeed the persons with the middle level of physical capacity had authentically higher spectrum power in an area 0,08-0,12 Hz, and top power in the range of high frequencies differed in persons with middle and high capacity levels.

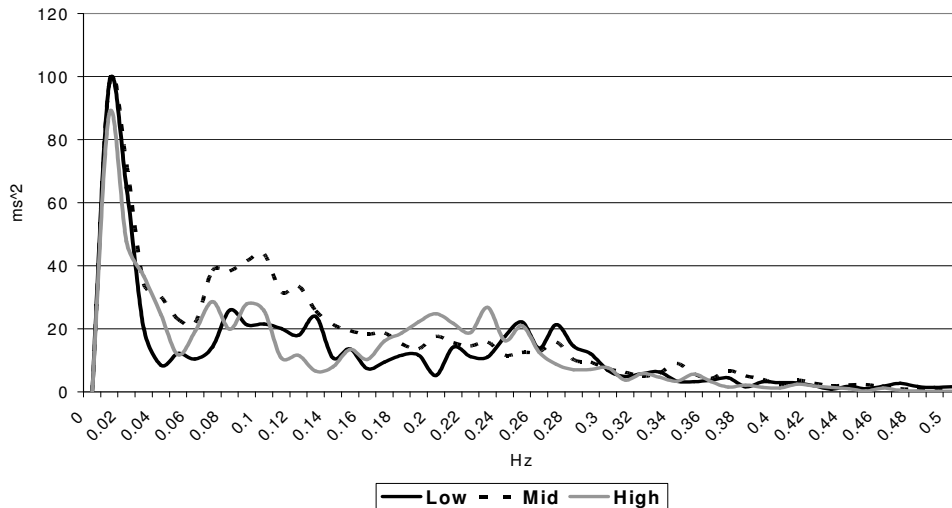


Fig.1. Median spectrogram at the persons with different capacity level in the state of rest

The noted features can be explained by greater activity of ANS sympathetic part in persons with middle efficiency, because the waves of heart rhythm spectrogram in this frequency are determined by this factor. The difference in the HRV wave structure in persons with middle and high efficiency in the range of high frequencies is explained by different duration of spiroycycle in them.

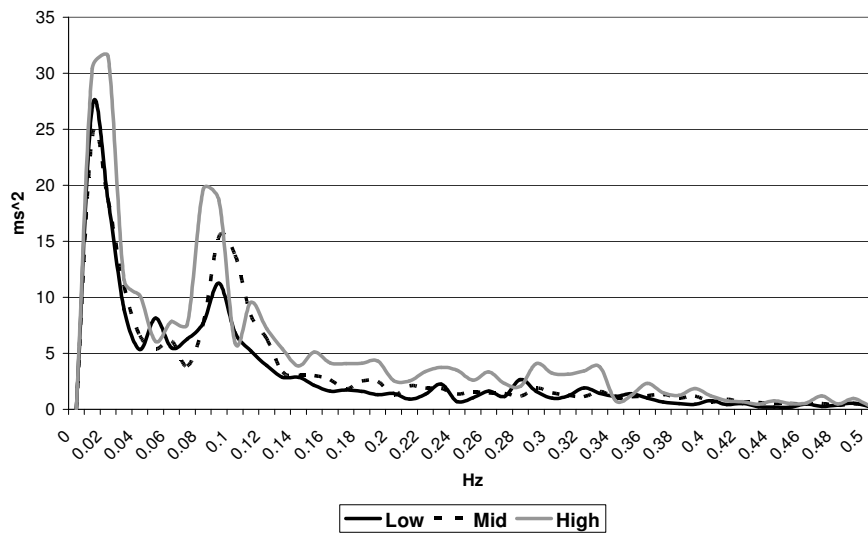
Thus the persons with a different level PWC170/kg in the state of rest have substantial differences both in the work of cardiovascular system and in the wave structure of cardiac rhythm.

APav is identical in all groups during dosed physical work (1 Wt/kg), CI is somewhat higher, though unreliably, in the persons with low efficiency (tabl.2). Differences in HRV between them are more substantial. So M increases with the growth of efficiency level. SDNN and rMSSD is significantly higher at the persons with high efficiency. It can indicate greater reserve possibilities at them.

**Tabl.2. Central haemodynamic and HRV indexes at physical exercise**

	Level of capacity		
	Low	Low	Low
APav (mm of Hg)	96,67	100	100
SI (ml/m <sup>2</sup> )	34,04	32,44	35,23
CI (ml/min*m <sup>2</sup> )	3685	3334	3440
M (ms)	546*	595+	645^
SDNN (ms)	24,12	26,40+	33,62^
rMSSD (ms)	13,50	20,0	24,0^
Mosp (ms)	3125	2875	3125

The analysis of cardiac rhythm wave structure (Fig. 2) showed that the men with middle and high efficiency had higher spectrum power in the area of 0,08-0,11 Hz. Besides the persons with high capacity had higher power spectrum in the area of high frequencies (>0.15 Hz).



**Fig.2. Median spectrogram at the persons with different capacity level with physical loading**

### CONCLUSIONS

Thus the indexes of heart rhythm variability are the most prospective in the estimation of the human body reactivity to dosed physical loading. The indexes of central haemodynamics are more adequate for the estimation of the body functional condition in the state of rest.

## LITERATURE

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## SUMMARY

The indexes of central haemodynamics, heart rhythm variability and physical efficiency of 109 healthy young men, who had not taken up sports, were evaluated. The indexes of heart rhythm variability were discovered to be the most prospective in the estimation of a human organism reactivity for dosed physical exercise. The central haemodynamics indexes were more adequate for human organism estimation in the state of rest.

## STRESZCZENIE

Autorzy oceniali ośrodkowe wskaźniki hemodynamiczne, zmienność rytmu serca i wydolność fizyczną u 109 zdrowych młodych ludzi, którzy nie uprawiają sportu. Stwierdzono, że w ocenie reakcji organizmu na dawkowany wysiłek fizyczny najbardziej przydatne są wskaźniki zmienności rytmu serca. Ośrodkowe wskaźniki hemodynamiczne były dokładniejsze w ocenie reakcji organizmu w stanie spoczynku.