Mechanical efficiency and pulmonary gas exchange variables in graded test

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Introduction
Mechanical efficiency is one of the main factors of exercise performance. VO2 – power output relationship [2] is important to understand more physiological basis of mechanical efficiency. Following this idea the aim of the present study was to analyze the correlation between pulmonary gas exchange and power output variables measured in graded test and mechanical efficiency in submaximal steady-rate test.

Methods
The study was done with seven male athletes – university students (Mean ± SD) age 21 ± 1.41, body mass 74 ± 8.7 kg, height 180 ± 8.7 cm, BMI 22 ± 1.9 in two exercise tests on Monark ergometer (60 revolutions per minute). The subjects performed a graded test to exhaustion started at 60 W, with 30 W increments every 60 s and in a week a 5-minute submaximal steady-rate test at intensity 30% Wmax determined individually. The variables W, W.kg⁻¹.min⁻¹, VO2, VO2.ml.kg⁻¹.min⁻¹, VCO2, VE, RER, Exc.CO2, HR, VO2/HR were measured. Pulmonary gas exchange parameters were registered by Oxycon breath-by-breath system. Sport Tester PE-3000 was used for HR monitoring. Submaximal test intensity was defined as a percentage of VO2max attained in progressive test for each subject. Chemical energy expenditure and mechanical energy of steady-rate load were computed. Mechanical efficiency was calculated and averaged of four minutes (without 1st minute of the 5-minute submaximal test because of O2 deficit)

Results
Peak variable values of the maximal test were summarized in table 1. From the graphic analysis done individually for each subject it was found: Exc. CO2 from 0.25 L.min⁻¹ to 0.39 L.min⁻¹, VO2 plateau in 4 cases and absence in 3 cases [1], abrupt VE increase during last one-two minutes of the exhaustive test. Comparing the two tests showed that the intensity of submaximal test as a percentage of VO2max in all subjects was bellow the anaerobic threshold. The mean value of mechanical efficiency was 17.29 ± 2.59. Spearman’s correlation between parameters was given in table 2.

Discussion/Conclusion
Nonparametric correlation analysis showed strong relationship between VO2 max, VCO2 max, VE max, VO2/HR max and the “anaerobic” variable Exc.CO2 max. The same variables correlated with height, body mass and W max, except no correlation between VE max and W max, Exc.CO2 max and height. BMI, W.kg⁻¹.min⁻¹, VO2.ml.kg⁻¹.min⁻¹, HR didn't have any significant correlations. It should be taken into account the absence of relationship between VO2 max and HR max but very strong “functional” correlation (1.000**) there was between VO2 max and VO2/HR max. It wasn’t found in our previous study [3] dependence between the aerobic capacity (VO2 max) and mechanical efficiency acceleration computed from the anaerobic threshold up to RER 1 in graded test with longer steps. The present protocols were different but confirmed the same result. The correlation structure revealed high coefficients for ME and body mass (.775*), W max (.982**), Exc.CO2 max (.857*). Previous and present data of ME give the reason to consider not only peak values but also the physiological changes occurred from the onset up to exhaustion in graded test. It could be concluded from these findings that the mechanical efficiency doesn’t predict directly aerobic power (capacity) but it is a reliable criterion for exercise performance of the athletes.

References