LASER BASED RESPIRATORY GAS MEASUREMENT
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INTRODUCTION
Most common method to evaluate maximal oxygen uptake (VO2max) is to measure respiratory gas exchange during exercise with the open circuit spirometry. Accurate determination of VO2max requires fractional concentrations of oxygen (FEO2), carbon dioxide (FECO2) and ventilation (VE) to be measured simultaneously. Modern respiratory gas analyzers are most commonly equipped with infrared sensor for CO2 measurement and either galvanic fuel cell, electrochemical cell or paramagnetic measurement method for O2 detection. Generally all these measurements have been done by using several different methods (2). By using same diode laser based measurement method both O2 and CO2 measurements can be combined. Highly selective measurements are possible because tunable diode laser’s narrow emission line can be adjusted to the measured gas absorption range. In theory, better measurement accuracy and stability, more rapid scans, faster measurements, smaller and cheaper equipments and less need for calibration and maintenance are possible to achieve with the diode laser technique. Diode laser technique offers several benefits for the equipment development like small size and power consumption, good efficiency and possibility to make measurements from small amount of sample. Purpose of this study was to determine the applicability of diode laser technique in respiratory gas measurements.

METHODS
Two identical respiratory gas analyzers (Medikro 919 ergospirometer) were connected parallel and 11 healthy human subjects (age 27-52 year) performed maximal cycle ergometer exercise with the gas exchange measured simultaneously by the two analyzers. One analyzer was modified to use diode laser based oxygen measurement and the reference one used original paramagnetic method. Altogether 560 measurement points (averaged over 30s) and 470 breath-by-breath results were analyzed. Results were analyzed by using Pearson correlation coefficient and paired t-test. Bland-Altman tests were used to compare reliability between methods (1).

RESULTS
True O2 correlated significantly (true O2: $R^2 = 0.995$ p<0.001) between the analyzers. Bland-Altman analysis shown small variation between the methods (true O2: B-A = 0.21 (+0.35 – +0.08)). Analyzed CO2 and VE results confirmed functionality of the methods (true CO2: $R^2 = 0.994$ p<0.001) (true CO2: B-A = -0.05 (0.05 – -0.15)) and correspondingly (VE: $R^2 = 0.997$ p<0.001) (VE: B-A = 0.36 (+2.16 – -1.44)).

CONCLUSION
Diode laser based O2 -measurement correlated very well with the paramagnetic one used as a reference analyzer. Based on the present results a diode laser seems to be a suitable technique for analyzing respiratory gases. More research, however, is still required for the determination of the O2 and CO2 measurements combination as well as for the equipment development.

REFERENCES

Keywords: Running, Methodology, Gas Exchange