HEART RATE VARIABILITY AND EXERCISE INTENSITY: ESTIMATION OF MAXIMAL HEART RATE IN MIDDLE-AGED AND OLDER MEN FOR SUBMAXIMAL AEROBIC FITNESS TESTING
Karavirta Laura, Tulppo Mikko P., Nyman Kai, Laaksonen David E., Pullinen Teemu, Laukkanen Rajja, Kinnunen Hannu, Häkkinen Arja, Häkkinen Keijo (University of Jyväskylä, Merikoski Rehabilitation and Research Center, Oulu and Division of Cardiology, Department of Medicine, University of Oulu, Central Hospital, Jyväskylä, Department of Medicine, Kuopio University Hospital, Polar Electro Oy, Kempele, University of Jyväskylä and Central Hospital, Jyväskylä, Finland)

Introduction. One of the essential factors causing error in the prediction of maximal oxygen uptake (VO2max) in submaximal tests is the extrapolation of the exhaustion point based on age-predicted maximal heart rate (HRmax). The decrease observed in different variables of heart rate variability (HRV) when exercise intensity is increased (Stejskal et al. 2001) could provide one possibility for a more accurate HRmax estimation. This study examined the consistency of the HRV profile during graded exercise for the estimation of HRmax and thus to enhance the validity of submaximal exercise testing in middle-aged and older men.

Methods. After medical examination the subjects with no background of regular physical activity performed a maximal graded exercise test by bicycle ergometer. The initial exercise intensity was 50 W and increased by 20 W every 2nd minute until exhaustion. Oxygen uptake (SensorMedics Vmax229) and R-R intervals by heart rate monitors (Polar S810i) were measured continuously. Each test load until 150 W (with < 15 % of noise) was analyzed separately for high frequency power (HF) and the standard deviation of the instantaneous beat-to-beat R-R interval variability (SD1) by Polar precision performance SW software. A cubic function was fitted to the relative HF and SD1 against the relative heart rate (HR/HRmax). Thereafter, the heart rate at which HF diminished to 70, 60, 50 and 40 % of the HF level at 50 W (100 %) were searched from the graph (HR HF-70, HR HF-50, respectively). The same was done for SD1. If the 100 % level of HF/SD1 did not occur at 50 W the subject’s data was discarded.

Results. HRV data of 74 subjects was accepted for further analysis (mean age 55 ± SD 7 years, body mass 82 ± 11 kg, and VO2max 33.1 ± 5.1 ml/kg/min). SD1 and HF decreased significantly between the consecutive exercise intensities. SD1 and HF decreased from the values of 6.5 ± 3.9 ms and 36 ± 49 ms2 at 50 W to 1.8 ± 0.6 ms and 3 ± 3 ms2 at 150 W, respectively. Correlation coefficients between HRmax and HR at which SD1 or HF declined to 70, 60, 50 or 40 % were 0.50-0.53 (p < .001) for HF and 0.43-0.50 for SD1 (p < .001). The correlation between HRmax and age (r = 0.50, p<.001) than that of HRmax and age (r = -0.36, p<.01). The regression analysis showed that the most accurate estimation was attained, when age and HR HF-50 were used in the prediction equation: HRmax = 160.633 – 0.603 (age) + 0.441 (HR HF-50) (SEE = 9.8 bpm), where as the SEE was 11.6 bpm in the equation based on age only.

Conclusion. The declining profile of HRV during incremental cycling test seems to provide a useful tool for prediction of HRmax in submaximal aerobic fitness testing, since the age leads to a less accurate estimation. However, more research is needed to reveal the most suitable HRV analysis method and individualized testing protocol for populations of different age and training status.

References
Keywords: Testing, Endurance Performance, Heart Rate Variability