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Assessment of the accuracy of prediction of the maximal oxygen uptake based on submaximal exercises in the former elite rowers and paddlers

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The aim of the present study was to assess the usefulness of the Astrand-Rhyming and extrapolation methods as well as modifications thereof for prediction of the maximal oxygen uptake (VO₂max) in the former elite rowers and paddlers, i.e. the representatives of sports requiring high endurance capacity and strength. For the assessment, results obtained in 52 former athletes aged between 30 and 67 years were used. The subjects performed the incremental exercise test on a cycle ergometer until volitional exhaustion. VO₂max was determined directly and its predicted values were also calculated based on the following parameters: the heart rate (HR) during a submaximal exercise at the given oxygen uptake (A-R1) or power output (A-R2) using the Astrand-Rhyming nomogram as well as modification of these methods (A-R3 and A-R4) in which the obtained results were multiplied by the additional age-related coefficient calculated from the linear regression of the subjects' age relative to the quotient of the measured and predicted VO₂max values; the relationship between the oxygen uptake and heart rate at a submaximal exercise extrapolated to the age-predicted values of HRmax calculated according to the formulas: HRmax = 220 – age (Extrp.1), HRmax = 220 – 0.9•age (Extrp.2), and HRmax = 197.4 – 0.435•age (Extrp.3); the latter formula was based on the linear regression of HRmax relative to the subjects' age in the examined group. Accuracy of the prediction of VO₂max was estimated based on the following indices: the difference between VO₂max determined directly and indirectly (MD), the correlation coefficient (r) between these values, the standard estimation error (SEE), and the total error (TE). The results indicate that modifications of the A-R1, A-R2, and Extrp.1 methods significantly increased the accuracy of the VO₂max prediction with A-R3 and Extrp.2 being the most efficient. In the A-R3 compared to the A-R1 method significant decreases of MD (1.6% vs. 13.9%) and TE (6.5 vs. 8.2) were detected even though r (0.70 vs. 0.71) did not change and SEE rose insignificantly (6.4 vs. 5.7). In the Extrp.2 compared to the Extrp.1 method, decreases of MD (3.4% vs. 6.8%) and TE (4.5 vs. 5.2) were also detected, whereas r (0.84 vs. 0.83) and SEE (4.2 vs. 4.4) remained unchanged. Overall, our results demonstrate that VO₂max can be relatively precisely estimated in the former paddlers and rowers based on the heart rate at submaximal exercises. Apparently, a significant increase in the accuracy of the VO₂max prediction following modification of the widely used methods is partly due to the age-related slower decrease of HRmax in the former athletes compared to that found in people not engaged professionally in sports and/or in the former athletes from other sports.

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