Validity of prediction equations for evaluating aerobic fitness in cystic fibrosis

O. W. Tomlinson[1, 2], A. R. Barker[1], J. Trott[2], N. J. Withers[2], P. J. Oades[2], C. A. Williams[1, 2]

1. Children's Health and Exercise Research Centre, Sport and Health Science, University of Exeter, Exeter, United Kingdom
2. Royal Devon and Exeter NHS Foundation Trust Hospital, Exeter, United Kingdom

Objective: Annual cardiopulmonary exercise testing (CPET) is recommended for patients with cystic fibrosis (CF) to objectively evaluate aerobic fitness (represented by maximal oxygen uptake [VO_{2max}]). Numerous prediction equations (PrEq) are used to compare and normalise VO_{2max}. However, their validity and error is unknown in CF and therefore this was examined in this study using commonly used PrEq for VO_{2max}.
Methods: A valid and reliable CPET protocol on a cycle ergometer verified VO_{2max} in 89 patients (53 male/36 female, 9-69 years) with CF. VO_{2max} was predicted from seven PrEq, including three endorsed by the European CF Society Exercise Working Group (Jones 1985, Orenstein 1993, Werkman 2014). Verified and predicted VO_{2max} were correlated and paired-samples *t*-test established differences between values. Bland-Altman plot analyses established mean bias (absolute and %) and limits of agreement (LoA) for each PrEq relative to verified VO_{2max}. Paired-samples *t*-test also identified differences between VO_{2max} values derived from each PrEq.
Results: Each predicted VO_{2max} ($L \cdot min^{-1}$) significantly correlated ($r = 0.49 – 0.95$, $p < 0.01$ for all) with verified VO_{2max}. Ranges between predicted and verified VO_{2max} were: mean difference = 0.10 – 1.87 $L \cdot min^{-1}$, LoA = 0.61 – 1.27 $L \cdot min^{-1}$, mean error = 17 – 35%. VO_{2max} predicted from 6 of 7 PrEq was significantly different to verified VO_{2max} ($p < 0.01$) and the final PrEq neared significance ($p = 0.08$). Mean difference between predicted VO_{2max} values ranged from 1 – 33%$_{predicted}$ ($p < 0.01 – 0.66$).
Conclusion: A large range of error is evident between verified and predicted VO_{2max} values which has important implications for clinical interpretation of VO_{2max}. Use of PrEq should either be abandoned due to high error rates, or interpreted with caution, and comprehensive standardisation of PrEq for VO_{2max} in CF is needed. Future PrEq should incorporate clinical factors pertinent to CF (e.g. FEV_1, infection and pancreatic status).