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Submaximal Fitness Test in Team Sports: A Systematic Review and Meta-Analysis of Exercise Heart Rate Measurement Properties

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INTRODUCTION:
Submaximal Fitness Tests (SMFT) are a pragmatic approach for evaluating athlete's physiological state, due to their time-efficient nature, low physiological burden and relative ease of administration in team-sports settings. Whilst a variety of outcome measures can be collected during SMFT, exercise heart rate (HRex) is the most popular. Understanding the measurement properties of HRex can support the interpretation of data and assist in decision-making regarding athlete's current physiological state and training effects. The aims of our systematic review and meta-analysis were to: 1) establish meta-analytic estimates of SMFT HRex reliability and convergent validity; and 2) examine the moderating influence of athlete and protocol characteristics on the magnitude of these measurement properties.
METHODS:
We conducted a systematic literature search with MEDLINE, Scopus and Web of Science databases for studies published up until January 2022 since records began. Studies were considered for inclusion when included team-sports athletes and the reliability and/or convergent validity of SMFT HRex was investigated. Reliability statistics included the group mean difference (MD), typical error of measurement (TE) and intraclass correlation coefficient (ICC) derived from test-retest(s) designs. Pearson's correlation coefficient (r) describing the relationship between SMFT HRex and a criterion measure of endurance performance was used as the statistic for convergent validity. Mixed-effects, multilevel hierarchical models, combined with robust variance estimate tests were performed to obtain pooled measurement property estimates, effect heterogeneity, and meta-regression of modifying effects.
RESULTS:
The electronic search yielded 21 reliability (29 samples) and 20 convergent validity (29 samples) studies that met the inclusion criteria. Reliability meta-analysis indicated good absolute (MD = 0.5 [95% CI: 0.1 to 0.9] and TE = 1.6 [1.4 to 1.9] % points), and high relative (ICC = 0.88 [0.84 to 0.91]) reliability. Convergent validity meta-analysis indicated an inverse, large relationship (r = –0.58 [–0.62 to –0.54]) between SMFT HRex and endurance tests performance. Meta-regression analyses suggested no meaningful influence of SMFT protocol or athlete characteristics on reliability or convergent validity estimates.
CONCLUSION:
Submaximal Fitness Test HRex is a reliable and valid proxy indicator of endurance performance in team-sport athletes. Athlete and SMFT protocol characteristics do not appear to have a meaningful effect on these measurement properties. Practitioners may implement SMFT HRex for monitoring athlete's physiological state by using our applied implications to guide the interpretation of data in practice. Future research should examine the utility of SMFT HRex to track within-athlete changes in aerobic capacity, as well as any further possible effects of SMFT protocols design elements or HRex analytical methods on measurement properties.

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