Applications of the running 3-min all-out exercise test: an update

Abstract
The running 3 min all out Exercise Test (3MT) was first used to provide a comprehensive performance assessment of distance runners. Subsequent research has increased the scope of training programs to include a variety of sports utilizing both continuous and non-continuous running (i.e. soccer, rugby). Use of the shuttle running 3MT also has applications for tactical occupations (i.e., law enforcement, military) that require accelerating/decelerating and changing directions. Additionally, with tactical occupations, the use of a running 3MT with an adjustment equation can predict a decline in performance with a specific load from tactical/gear protective. The objective of this review is to provide a brief update on such new applications for the running 3MT.

Keywords: Critical speed, high intensity interval training, maximal steady-state, performance modeling

Abbreviations: 3MT, 3-min all-out exercise test; CS, critical speed; D', curvature constant of the speed-time relationship; t<sub>LIM</sub>, time-limit for sustaining a given running speed and traveling a given distance

Introduction
The running 3-min all-out exercise test (3MT) estimates the parameters of critical speed (CS) and the curvature constant of the speed-time relationship (D'; pronounced D-prime). Critical speed is presumed to represent a mechanical measure of the maximal aerobic steady state, demarcating the heavy and severe exercise domains. Exercise in the severe domain relies upon the continual, time-dependent depletion of phosphocreatine, the time-dependent rise in blood lactate and evokes a slow component of oxygen uptake that can culminate with attainment of the maximum oxygen uptake at and just prior to the time of exhaustion (t<sub>LIM</sub>). The higher the D', the longer distance a person can travel running at speeds exceeding CS before reaching t<sub>LIM</sub>. By using the parameters of CS and D', the sport scientist can predict the time or speed one can run different distances (note: typically distances spanning 1,000 to 5,000 m).

The running 3MT has enormous potential for developing racing strategy and is a useful field test for monitoring changes in both endurance and high-intensity exercise capacity. Although much is written about the utility of the 3MT to indirectly measure physiological mechanisms governing CS and D', less is known about the utility of 3MT for tactical running situations. The purpose of this review is to provide on update on running 3MT and to discuss developments for the test beyond continuous running events.

Discussion
The running 3MT involves having the subject run at high-intensity speeds sufficient to exhaust all of D' within a 150 sec duration, whereby the speed of the remaining 30 sec will be equivalent to CS. The subject should be directed to build up their speed progressively to avoid a muscular injury (e.g. strained hamstring) and then maintain that speed for as long as they can. The timing of the 3MT can be performed using global positioning system (GPS) technology, video recorded times for specified waypoints, or by manually recording split times at specified waypoints. The latter two timing methods are conducive for indoor running, whereas outdoor GPS monitoring allows for testing a large number of subjects in a short period of time (i.e., an entire sports team tested in less than 30 min). The speed of the initial 150 sec (S<sub>150</sub>) is then used to derive D' using: D'=(S<sub>150</sub>-CS) 150sec. As a concern for pacing exists, we recommend calculating the slope of speed relative to time during last 30 sec of the test (Figure 1).

Figure 1. Example shuttle running 3-min all-out exercise test. Take notice of the more apparent acceleration and deceleration curves during the initial test. The slope is reported to confirm a nadir of speed relative to time (note: the closer the value to zero, the better).

Individualized distance-time and speed-time curves can be derived using data from the running 3MT. The solid lines in Figure 2 depict the t<sub>LIM</sub> associated with running 1000, 3000 and 5000m (left panel) for a representative subject with a CS of 4 m/s and a D' of 180 m along with the corresponding speeds of those performances (right panel). The dashed lines in Figure 2 depicts adjusted t<sub>LIM</sub> for 60% fractional utilization of D' that could be used for high intensity interval training (HIIT). For practical purposes, HIIT bouts utilizing 60% and 80% D' can be performed for 4-5 and 3 sets, respectively, for 90 to 300 sec per interval and a 1:1 and 1:1.5 work: rest ratio, respectively.
The 3MT also is a valid tool for prescribing shuttle running HIIT. The above-mentioned studies illustrate the utility of the 3MT and the CS concept. The prescriptions for HIIT are very practical and job-specific for a tactical population (e.g., accelerating/decelerating, changing direction, performing with a load to simulate foot pursuits, tactical movements on the battlefield). Such prescriptions and training regimes not only may increase performance but survivability.

Conclusion
The running 3MT was developed as a surrogate measure determining CS and D’, two parameters that can be used to predict \( t_{\text{180}} \) associated with various distances and speeds (Figure 2, solid lines). The 3MT also have been used to derive HIIT times (Figure 2, dashed line) and evaluate training-induced adaptations. Recent studies have validated use of the 3MT for predicting shuttle running performance along with running with tactical load. Future investigations are necessary to validate the use the 3MT to prescribe HIIT for non-continuous running and/or running with a tactical load. Such advances promise to expand the use of the CS concept to a wider range of applications and populations.

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Conflict of interest
Author declares there is no conflict of interest in publishing the article.

References


