Title of Research: Cross-Validation of Single-Stage Treadmill Tests for Predicting Aerobic Fitness in Adolescents with Type I Diabetes

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Introduction/Purpose:
High aerobic fitness is associated with better disease management in individuals with type 1 diabetes mellitus (T1DM). The criterion measure of aerobic fitness is a maximal test using indirect calorimetry. However, the Ebbeling and Nemeth protocols were developed to predict maximal oxygen consumption (VO2max) using submaximal work rates, without measuring oxygen consumption. The Ebbeling equation has been validated in adults against maximal testing using indirect calorimetry (R2=0.86, SEE=4.85 ml/kg/min), and the Nemeth equation has been validated in obese children (R2=0.75, SEE=3.36 ml/kg/min). Neither has been validated in adolescents with T1DM. The purpose was to cross-validate the Ebbeling and Nemeth equations to predict VO2max in adolescents with T1DM.

Experimental Design:
Adolescents with T1DM (n=10 males, 10 females) completed a progressive treadmill walking test to volitional fatigue. Indirect calorimetry measured O2 uptake and CO2 production. After a warm-up, participants completed one 4 min stage at a self-selected speed between 2.0 and 4.5 mph and 5% grade (Ebbeling/Nemeth protocol). Speed was increased by 0.5 mph for 2 min, after which grade was increased by 2% each min until exhaustion. Volitional fatigue was defined as meeting 2 of the following: heart rate ≥200 beats per min; respiratory exchange ratio >1.0; or ≤2 ml/kg/min change in VO2 in the final min. Predicted VO2max values were calculated using the Ebbeling and Nemeth regression equations and compared to observed VO2max. Spearman correlation coefficients, 95% confidence intervals, coefficients of determination (R2), standard error of the estimate (SEE), and total error (TE) were calculated.

Results:
The mean observed, Ebbeling prediction, and Nemeth prediction of VO2max were 47.0, 42.4, and 43.5 ml/kg/min, respectively. The association between the Ebbeling prediction and the observed VO2max was r=0.92 (95% CI=0.81, 0.97), R2=0.81, and TE=6.47 ml/kg/min. The association between the Nemeth prediction and the observed VO2max was r=0.77 (95% CI=0.50, 0.90), R2=0.66, and TE=5.57 ml/kg/min.

Conclusions:
Aerobic fitness can be accurately predicted with a submaximal, single-stage treadmill protocol that does not require indirect calorimetry. The Nemeth regression equation is a better fit than the Ebbeling for adolescents with T1DM.