THE UNIVERSITY OF ALABAMA KINESIOLOGY

ACCURACY OF THE METABOLIC RUNNING EQUATION FOR ESTIMATING VO$_2$MAX IN MALE RECREATIONAL RUNNERS: A COMPARISON OF TWO GRADED EXERCISE TEST PROTOCOLS

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Introduction

- The accuracy of metabolic running equations for estimating VO$_2$max may vary depending on the graded exercise test (GXT) protocol used (Myers et al., 1991)
- Differences in protocol structure, such as stage duration, speed, and incline, can influence metabolic demand and affect prediction accuracy (Foster et al., 1986)
- The ACSM metabolic running equation is commonly used to estimate VO$_2$max from treadmill workload, but limited research has evaluated its accuracy across different GXT protocols in recreational athletes (American College of Sports Medicine, 2021; Lang et al., 2018)
- Purpose: To evaluate the accuracy of the ACSM metabolic running equation for estimating VO$_2$max during two treadmill GXT protocols in adult male recreational runners

Methods

- A convenience sample of nine recreationally active male runners participated (age = 22.6 ± 5.4 yrs, height = 163.8 ± 6.4 cm, weight = 83.8 ± 10.8 kg)
- Each subject completed two randomized treadmill GXT protocols: Astrand and vVO$_2$max
- Final treadmill work rate at exhaustion was used to estimate VO$_2$max using the ACSM metabolic running equation: VO$_2$max = 3.5 + (speed × 0.2) + (speed × grade × 0.9) (American College of Sports Medicine, 2021).
- Estimated VO$_2$max values were compared to directly measured VO$_2$max collected using a metabolic cart with breath-by-breath gas analysis.

Results

Figure 1. ACSM Metabolic Equation was significantly different than measured VO2max in "speed-based" GXT protocol.
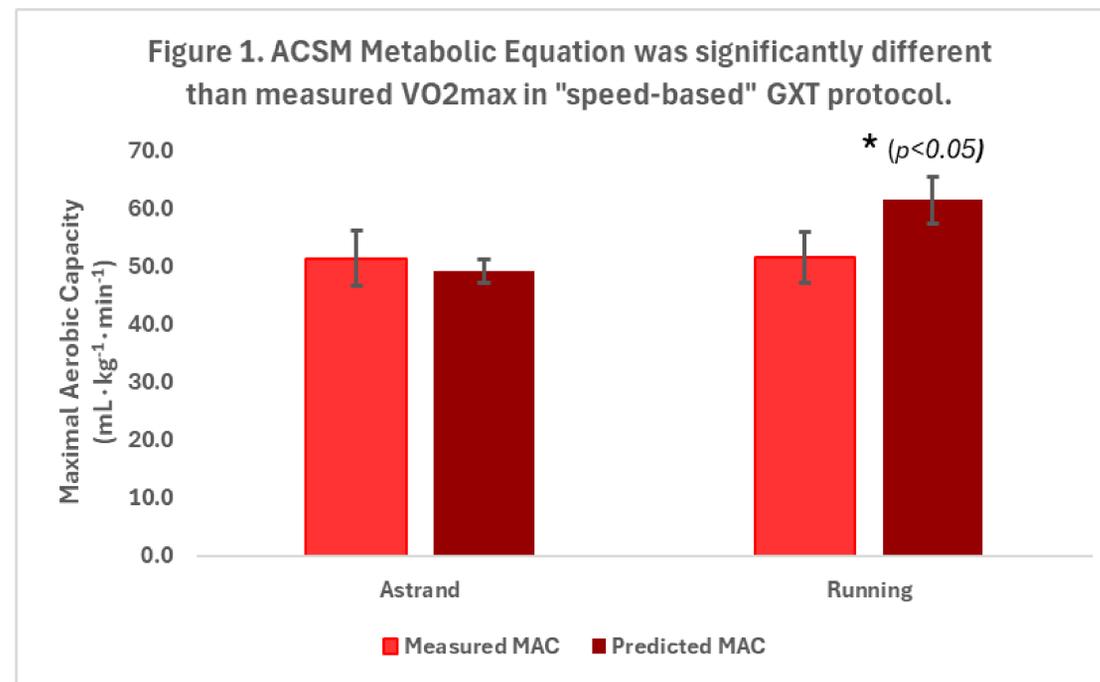
Table 1. Differences between measured and estimated VO$_2$max for two different GXT Protocols.

	Astrand	Running
Measured VO$_2$max	51.40 ± 4.69	51.55 ± 4.39
Estimated VO$_2$max	49.10 ± 2.01	61.43 ± 3.96 *

*Significantly different ($p < 0.05$)
Values are listed as means ± standard deviation.

ACSM Metabolic Equation

Predicted VO$_2$max = 3.5 + (speed [m·min^{-1}] × 0.2) + (speed [m·min^{-1}] × grade [fraction] × 0.9).

Conclusions

- Average predicted VO$_2$max values were more accurate during the Astrand protocol compared to the vVO$_2$max protocol.
- The vVO$_2$max protocol resulted in significant overestimations of VO$_2$max, indicating reduced accuracy of the ACSM metabolic running equation under those conditions.
- These results suggest that GXT protocol design, specifically whether progression is based on grade versus speed, may influence prediction error.
- Despite the overestimation in the vVO$_2$max protocol, the relatively small standard error of estimate (SEE) and limits of agreement (LOA) suggest a correction factor could improve accuracy.
- The ACSM metabolic running equation may be better suited for protocols with grade-based progression rather than speed-based maximal protocols.

Practical Applications

- Practitioners should consider the influence of GXT protocol design when using metabolic running equations to estimate VO$_2$max.
- The Astrand protocol may yield more accurate estimates due to its steady-state structure.
- The vVO$_2$max protocol may require a correction factor to improve the precision of VO$_2$max predictions.
- Understanding these differences can help guide more reliable assessments of aerobic fitness in recreational runners.