AGREEMENT BETWEEN A LIVE MOTON TRACKING SYTEM AND VIDEO ANNOTATION SOFTWARE FOR MONITORING BARBELL VELOCITY AND POWER DURING A HIGH INTENSITY FUNCTIONAL TRAINING WORKOUT

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INTRODUCTION

High-intensity functional training (HIFT) involves vigorous multimodal circuit training with auto-regulated rest periods (4,5). Performance is typically gauged by how quickly work is completed, and thusly, dependent on finding the fastest sustainable pace for each exercise prescribed within a workout.

Objectively finding and precisely tracking ideal pacing is nearly impossible without technological assistance (5). The gold standard method, three-dimensional (3D) motion tracking systems (MTS) using high-speed cameras, is costly and restrictive (e.g., wearing sensors). Meanwhile, cheap and readily-available methods (i.e., pairing lower-quality cameras [e.g., camera phone] with video annotation software [VAS]) to quantify kinetics can be overly tedious for variable accuracy. Recent advances in less expensive, sensor-less MTS might offer a middle-ground solution. Though criterion-related validity has been established between various 3D MTS (6,7), the technologies may still be limited to specific exercises and at times, can fail to detect repetitions (1).

Data loss might be avoided by having VAS serve as back-up for when repetitions are not detected in real time. However, currently, VAS has only been validated against the gold standard (3). Agreement between VAS and sensor-less MTS must still be established.

PURPOSE

To determine agreement between video annotation software (VAS) and 3D motion tracking system (MTS) for monitoring barbell velocity and power during a 5-minute HIFT workout.

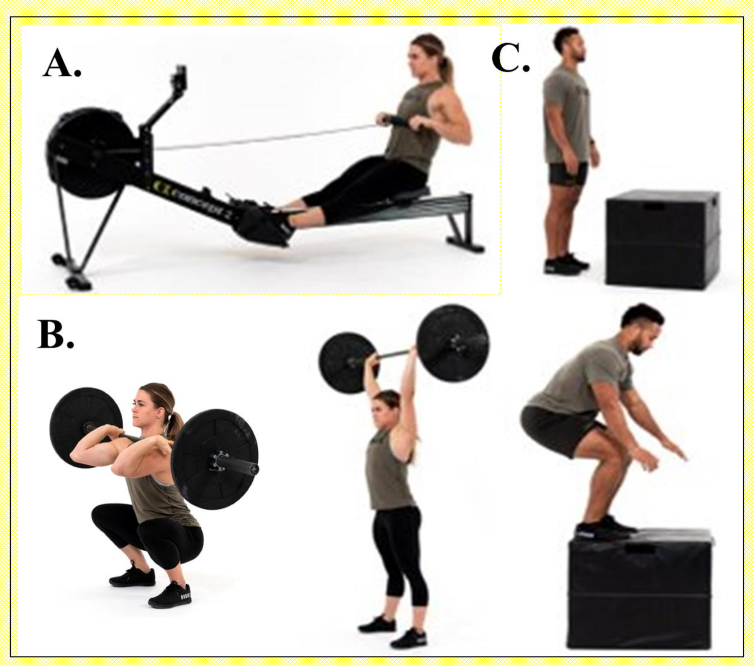
METHODS

A sub-sample of seven men (n=7: 29±7 years, 173±9 cm, 83±17 kg) with HIFT experience (≥2 years) were selected from a larger investigation examining the effect of a pre-workout supplement on HIFT performance.

The parent study had participants randomly complete 5- and 15-minute versions of a HIFT workout (Figure 1) after consuming a pre-workout supplement or placebo over 4 weeks.

Figure 1. Workout Design

All trials consisted of the same circuit of A) 9-calorie rowing, B) six barbell thrusters at 95 lbs. (43.1 kg), and three 24-in box jumps, repeated for 'as many repetitions as possible' (AMRAP) within 5 or 15 minutes. Movement standards [adapted from (1)] were verified by a certified strength and conditioning specialist during all trials.



All barbell thruster repetitions were recorded by a 3.5-megapixel Surface™ 3 tablet camera (Microsoft Corp., Redmond, WA) at 1920x1080p/30 fps, as well as MTS (PERCH, Catalyft Labs, Inc., Cambridge, MA, USA), from standardized positions.

Estimates of mean concentric barbell velocity (V) and power (P) were provided by MTS and quantified using VAS (Kinovea v.0.9.5, Free Software Foundation, Inc., Boston, MA, USA) from all recordings.

Random sample of 219 complete sets (~68%) were selected from all 5-minute trials and used to assess agreement between VAS and MTS.

RESULTS

- **Paired samples t-tests:** Significant ($p < 0.001$) differences between MTS (V = 1.21 ± 0.16 m·s^{-1}; P = 510 ± 69 W) and VAS (V = 1.48 ± 0.33 m·s^{-1}; P = 626 ± 135 W)
- **Pearson correlations:** Significant ($p < 0.001$) relationships between MTS and VAS for V (r = 0.36) and P (r = 0.40) (see Figure 2), as well as between averages of and differences between devices for V (r = -0.64) and P (r = -0.63) (see Figure 3) with coefficients of variation at 114% and 107%, respectively.

Figure 2. Relationships between mean concentric barbell A) velocity and B) power collected by MTS and VAS.

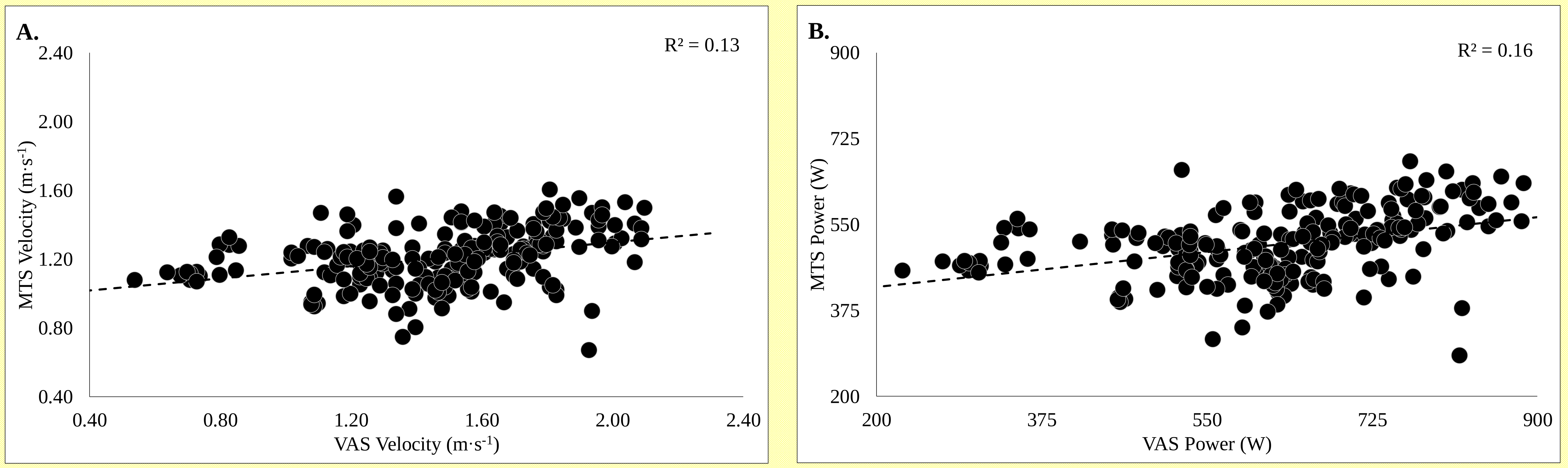
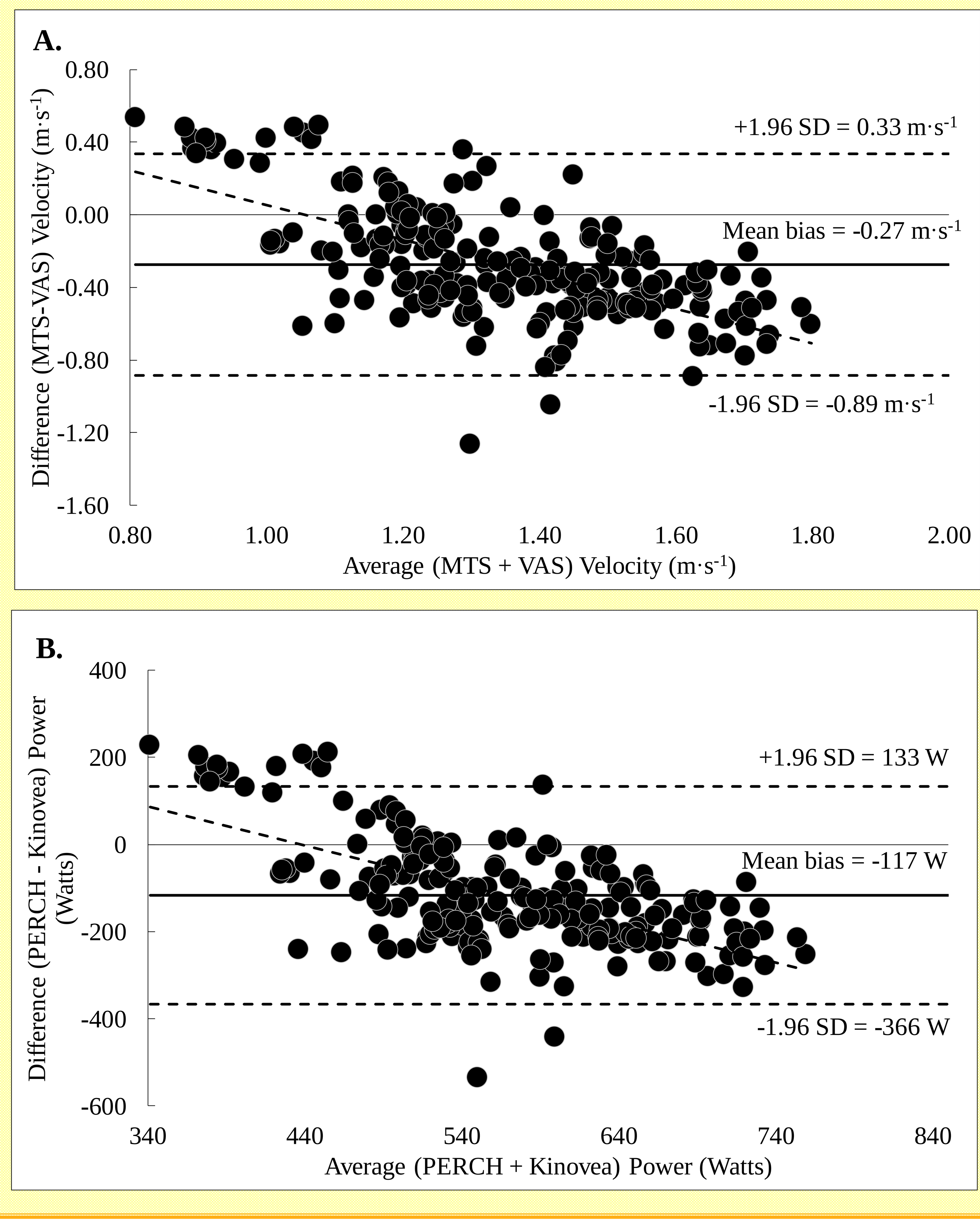


Figure 3. Bland-Altman plots of agreement between MTS and VAS for measuring mean concentric barbell A) velocity and B) power.



CONCLUSIONS

Although significant relationships between raw scores were quantified by MTS and VAS, their agreement lacked overall validity. Compared to MTS, VAS overestimated V and P, and differences were exacerbated with faster or more powerful repetitions. The lack of agreement and exaggerated differences might be explained by differences in technological sophistication (e.g., camera quality) and/or user error (i.e., researcher reliability).

Nevertheless, these findings are consistent with previous comparisons between VAS and gold-standard MTS (3). VAS significantly overestimated eccentric and concentric velocity during back squat and bench press.

PRACTICAL APPLICATIONS

Simultaneous utilization of MTS and VAS, with the latter serving as back-up for undetected repetitions, would not be a practical solution for tracking barbell thruster kinetics during a HIFT workout. However, other studies found that the PERCH MTS was determined to be reliable in tracking velocity during various high-intensity movements, such as thrusters, back squats, and deadlifts, (6,7). Agreement between devices is subject to change based on complexity of the exercise movement and technical mastery by the subject.

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