

NORMATIVE PEAK FORCE VALUES FROM ISOMETRIC MIDTHIGH ASSESSMENTS AND RELATIONSHIPS WITH MUSCULAR STRENGTH IN FIREFIGHTERS

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ABSTRACT

BACKGROUND

The isometric midhigh pull (IMTP) is an assessment used to evaluate lower body peak force, with minimal risk of injury and few technical requirements. Limited information is available regarding IMTP normative values for tactical populations and their relationship to muscular strength measures.

PURPOSE

The purpose was to produce percentile rankings for IMTP assessments in career firefighters and examine relationships between measures of muscular strength and aerobic performance.

METHODS

Eighty-five firefighters (women, n=4; age: 37.0 ± 8.9 yr.; height: 1.80 ± 0.07 cm; body mass: 91.8 ± 14.1 kg; BF%: 20.7 ± 7.3 %) completed an IMTP test to assess lower-body peak force. For the IMTP, firefighters pulled upward as forcefully as possible on a stationary bar located at mid-thigh level, standing on bilateral force platforms. Bar height was adjusted to initial knee and hip angles of 125° and 145°, respectively. Three maximal effort attempts (no straps allowed) were completed, with 2 minutes of rest in between attempts. Peak forces for the three attempts were averaged. On a separate day, a sub-cohort of firefighters (n=39) completed a battery of tests including body composition assessment, upper and lower body maximal strength, and muscular endurance testing. Five-Repetition Maximum (5RM) determination on the bench press (BP), back squat (BS), and hex bar deadlift (Hex DL) exercises were performed using standard protocols and used to estimate one-repetition maximum (1RM). Repetitions to Failure (RTF) were assessed for BP (45.3 kg), bent-over dumbbell row (20.4 kg) and Hex DL (61.2 kg), and BS (61.2 kg). Relationships between peak force from the IMTP and additional measures of performance were evaluated.

RESULTS

Percentile rankings for IMTP were 2037 N (Poor), 2721 N (Below Average), 3052 N (Average), 3252 N (Above Average), and 3670 N (Very Good) for the 5th, 25th, 50th, 75th and 95th percentiles, respectively. Strong relationships were observed for IMTP peak force and Hex DL 1RM (r=0.662), p<0.01. Moderate relationships were observed between IMTP peak force and BS 1RM (r=0.501), and Hex DL RTF (r=0.429), p<0.01. Peak force was positively associated with height (r=0.434), weight (r=0.504), body mass index (r=0.283), and fat-free mass (r=0.588), p<0.01.

CONCLUSIONS

IMTP peak force is strongly associated with Hex bar DL 1RM, and moderately associated with BS 1RM and Hex DL RTF. Taller, heavier, and individuals with more fat-free mass produced more force.

PRACTICAL APPLICATIONS

The current percentile rankings can be used to characterize peak force derived from the IMTP among tactical populations. The IMTP may offer an alternative method of evaluating lower body strength, using a less technical and safer movement compared to other more dynamic measures of lower body strength.

OBJECTIVES

PURPOSE

The purpose was to produce percentile rankings for IMTP assessments in career firefighters and examine relationships between measures of muscular strength and aerobic performance.

Baseline Characteristics

Eighty-five firefighters (women, n=4; age: 37.0 ± 8.9 yr.; height: 1.80 ± 0.07 cm; body mass: 91.8 ± 14.1 kg; BF%: 20.7 ± 7.3 %)

METHODS

Firefighters completed an IMTP test to assess lower-body peak force. For the IMTP, firefighters pulled upward as forcefully as possible on a stationary bar located at mid-thigh level, standing on bilateral force platforms. Bar height was adjusted to initial knee and hip angles of 125° and 145°, respectively (1,2).

Three maximal effort attempts (no straps allowed) were completed, with 2 minutes of rest in between attempts. Peak forces for the three attempts were averaged.

On a separate day, a sub-cohort of firefighters (n=39) completed a battery of tests including body composition assessment, upper and lower body maximal strength, and muscular endurance testing.

Five-Repetition Maximum (5RM) determination on the bench press (BP), back squat (BS), and hex bar deadlift (Hex DL) exercises were performed using standard protocols and used to estimate one-repetition maximum (1RM).

Repetitions to Failure (RTF) were assessed for BP (45.3 kg), bent-over dumbbell row (20.4 kg) and Hex DL (61.2 kg), and BS (61.2 kg).

Statistical Analysis

Relationships between peak force from the IMTP and additional measures of performance were evaluated. Correlation coefficients were defined as very weak: <0.20; weak: 0.20–0.39; moderate: 0.40–0.59; strong: 0.60–0.79; and very strong: >0.80.

RESULTS

- Strong relationships were observed for IMTP peak force and Hex DL 1RM (r=0.662), p<0.01.
- Moderate relationships were observed between IMTP peak force and BS 1RM (r=0.501), and Hex DL RTF (r=0.429), p<0.01.
- Peak force was positively associated with height (r=0.434), weight (r=0.504), body mass index (r=0.283), and fat-free mass (r=0.588), p<0.01.

RESULTS

Table 1. Summary of Fitness Testing Battery.

	Mean ± SD
Peak Force (N)	2954 ± 484
Bench Press 1RM (kg)	98.4 ± 26.4
Back Squat 1RM (kg)	117.1 ± 35.6
Hex Deadlift 1RM (kg)	143.0 ± 33.4
Dumbbell Row RTF (N)	43.4 ± 21.6
Bench Press RTF (N)	34.1 ± 17.1
Hex Deadlift RTF (N)	54.3 ± 23.1
Back Squat RTF (N)	36.3 ± 16.7

Data presented as Mean ± SD. N = Newtons; 1RM = 1 repetition maximum; RTF = repetitions to failure.

Table 2. Percentile rankings for isometric midhigh pull.

Percentile	Value	Classification
5 th	2037 N	Poor
25 th	2721 N	Below Average
50 th	3052 N	Average
75 th	3252 N	Above Average
95 th	3670 N	Very Good

N = Newtons.

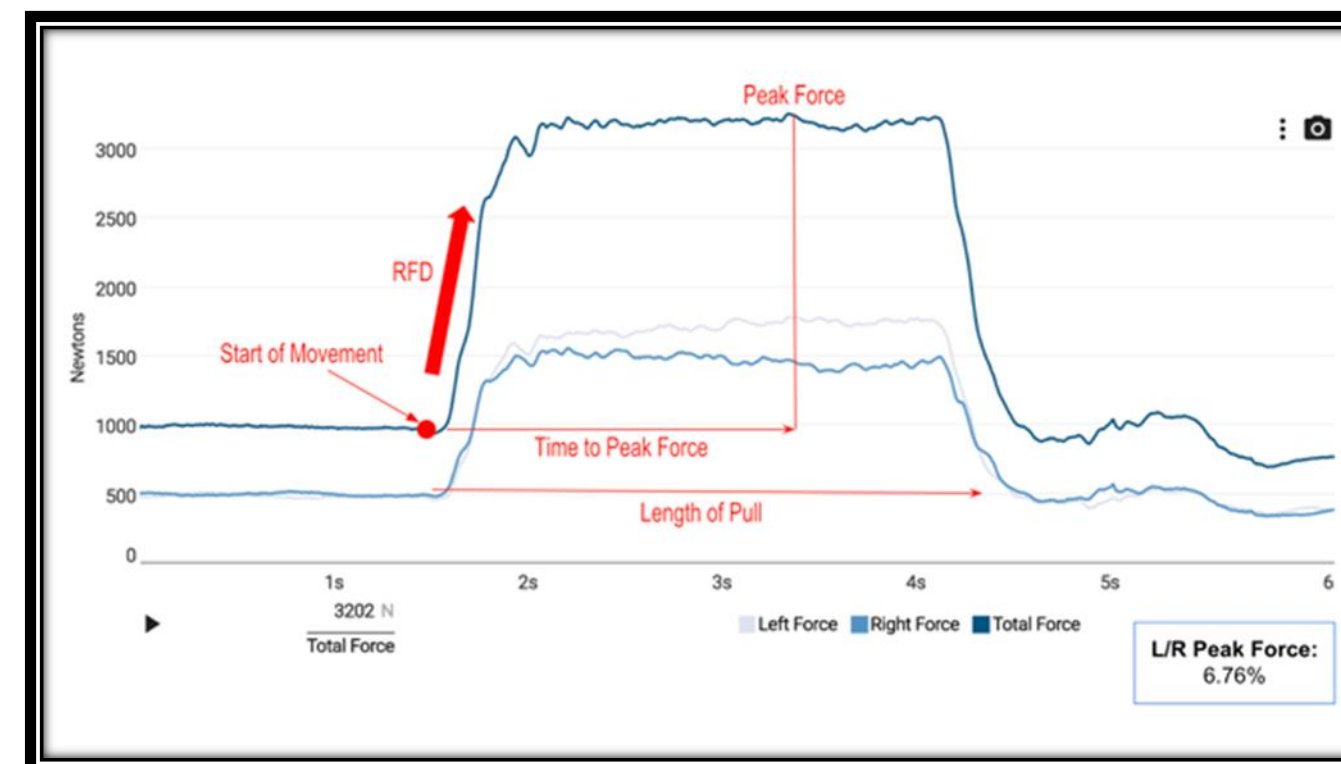


Figure 1. Force production profile for isometric midhigh pull.



DISCUSSION

- Previous research has identified relationships between measures of lower body strength and occupational performance in firefighters (3).
- The isometric mid-thigh pull (IMTP) is commonly used to assess an athlete's force generation ability and has been demonstrated to be highly reliable and is simple and relatively quick to perform. The data that can be determined from the force-time curves generated by the test, have been shown to be closely related to performance capacities in a variety of dynamic athletic tasks.
- However, less is known about the utility of this test in firefighters and how it may be associated with measures of lower body strength.
- Results from the current study indicate that IMTP peak force is strongly associated with Hex bar DL 1RM, and moderately associated with BS 1RM and Hex DL RTF in structural firefighters.
- Taller, heavier, and individuals with more fat-free mass produced more force.

CONCLUSIONS

- The IMTP may offer an alternative method of evaluating lower body strength, using a less technical and safer movement compared to other more dynamic measures of lower body strength.
- The current percentile rankings can be used to characterize peak force derived from the IMTP among tactical populations.
- Future work should examine the most effective training strategies for improving lower body strength and power in firefighters, as well as relationships between strength and risk of injury for this tactical population (4).

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