USING KINETIC ISOMETRIC MID-THIGH PULL VARIABLES TO PREDICT D-I MALE SPRINTERS' 60M PERFORMANCE

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The purpose of the study was to determine the relationship of isometric mid-thigh pull kinetic variables including: peak force (PF), instantaneous force at 50, 90, 200 and 250 milliseconds (F@50, 90, 200 and 250 ms) rate of force development (RFD@ 50, 90, 200 and 250 ms) and impulse at 50, 90, 200, and 250 ms (IP @ 50, 90, 200 and 250 ms) to college male sprinters' 60 m running performance. Eleven NCAA Division I male sprinters participated in the study that included two testing sessions. The first session included sprint testing and the second session included isometric mid-thigh pull strength assessment. The results from current study indicated that explosive force production variables (F@ 50 ms, RFD @ 50 and 90 ms, IP @ 90 and 200 ms) showed strong correlations with 60 m running time and maximal running velocity; while the MPF was not related to sprint variables.

KEYWORDS: sprint, peak force, explosive force production, rate of force development

INTRODUCTION: Strength is the ability to produce force (Stone, Sands, Carlock and Callan et al., 2004). Force is a vector quantity, thus, strength could have a direction and magnitude (Stone et al. 2004). Evaluation of skeletal muscle strength can be analyzed by force-time curves of isometric and dynamic muscle actions (Haff, Carlock, Hartman, Kilgore, Kawamoi, Jackson, Morris et al 2005). Variables that have been previously considered as important factors for sport performance include: peak force (PF), rate of force development (RFD), power output (PO) and impulse (IP) (Stone et al., 2004. Haff et al., 2005).

Sprinting is a cyclical movement. From a physical perspective, in order to achieve better sprint performances the ability of explosive force production and higher RFD during the limited time to overcome inertia of body mass is required (Tillin, Pain and Folland, 2013). Thus, numerous sport scientists and coaches have used various testing protocols to explore and measure sprinters' ability to generate explosive force (Mero, Luhtanen, Vitasalo and Komi 1981; Wilson, Lyttle, Ostrowski and Murphy., 1995; Chunha, Fernades, Valamatos and Valamatos. et al. 2007; Bissas and Havenetidis 2008; Requena, Badillo, Villareal and Ereline et al. 2009; West, Owen, Jones and Bracken et al. 2011; Tillin et al. 2013).

Among the various forms of testing, isometric force production measurements have been used quite often by researchers for assessing neuromuscular function in the field of sport science. Findings from Mero et al. (1981) indicated that PF was strongly related to sprinters' maximal running velocity in 100 m sprints. Wilson et al. (1995) did not find any relationship between single joint isometric force production characteristics and 30 m sprint performance. Chuanha et al. (2007) confirmed Mero's findings that PF was correlated to sprinting performance in young athletes during the 60 m sprint. The same study also indicated that RFD was correlated to 60 m sprinting time, maximal running velocity and PF. Somewhat contradictory, Bissas et al. (2008) did not find that PF was related to 60 m sprinting performance and maximal running velocity for trained athletes. However, the time to 60% of peak force correlated to maximal running velocity for trained athletes. Requena et al. (2009) also reported no correlation between isometric force production variables and 15 m sprint performance in male soccer players.

After analyzing 39 professional rugby players, West et al. (2011) indicated PF relative to body weight was negatively correlated to 10 m sprint time. In addition, the authors also found that force at 100 milliseconds (ms) and peak rate of force development (PRFD) was negatively correlated to 10 m sprint time. The most current study from Tillin et al. (2013) reported that normalized peak force ≤ 100 ms was correlated to 5 m and 20 m sprint time for rugby players.

The lack of uniformity in results of the previously mentioned studies may be due to differences in participant backgrounds (e.g. non-athletes, field athletes, and sprinters, single vs. multi-joint) and methodology. As a result, questions remain in regards to the relationship of PF and sprint performance; as well as if isometric force assessments can predict dynamic movements effectively.

Thus, the purpose of the study was to determine the relationship of isometric mid-thigh pull kinetic variables (PF, instantaneous force at 50, 90, 200 and 250 ms [F@50, 90, 200 and 250 ms], RFD and IP @ 50, 90, 200 and 250 ms) and Division I male sprinters' running performance variables (60 m running time and maximal running velocity).

METHODS: Subjects participating in the current study included eleven Division-I male sprinters on the East Tennessee State University track and field team. All subjects read and signed university approved informed consent documents before participating in any testing.

Testing was completed on two separate testing sessions with at least 48 hours apart between testing sessions. The first session included the 60 m sprint test, while the second session included strength testing measured by an isometric mid-thigh pull.

During the 60 m sprint testing session: two sprints from standing position were performed by each participant on an indoor 70 m long synthetic track with a lane width of 1.2 m. Before 60 m sprint testing, the participants had sufficient time to warm up, which consisted of dynamic stretching. Afterward, two maximal effort 60 m sprint trials were measured. A 10 minute rest period between trails was given for participants to eliminate effects of fatigue. The sprint times were measured by an electronic timing gate system (Brower system, UT, US). Electronic timing gates were placed at 10 m intervals from the start line for 60 m. The results from timing gate system was used to calculate maximal running velocity (V-max) and overall 60 m running time (T 60).The best running time of the two trials was used for further analysis.

Evaluation of strength was completed with a maximal effort multi-joint isometric contraction, an isometric mid-thigh pull (IMTP). The strength assessments were done in a customized power rack and kinetic values were collected via a dual force plate setup (two separate 91 cm x 45.5 cm force plates, Roughdeck HP, Rice Lake, WI). Data were sampled at 1,000 Hz. The protocol, apparatus and positioning were previously described by Haff and colleagues (1997).

Trials were considered successful as long as no countermovement of greater than 200 N was observed. In an effort to ensure maximum force and rate of force development, athletes were coached to "pull as fast and as hard as possible". These commands were based on our previous experience and previous research indicating that the use of these instructions produces optimal results for maximal force and RFD (Stone 2004). Subjects were given 2–3 minutes rest between each trial.

A customized LabVIEW program (Version 12.0, National Instruments Co., Austin, TX, USA) was used to both collect and analyze kinetic data obtained during the strength assessment.

Kinetic data obtained in the IMTP were: MPF; RFD@50, @90, @200 and 250 ms), instantaneous force at 50, 90, 200 and 250ms (F@50, F@90, and F@250), and impulse at 50, 90, 200 and 250ms (IP@50, IP@90, IP@200 and IP@250). The 2 best trials (based on peak force) were averaged and used in the data analyses.

Descriptive statistical analyses were conducted and relationships between variables were evaluated using Pearson product-moment correlation coefficients.

RESULTS: Descriptive statistics of sprint and isometric mid-thigh pull variables were shown in table 1. The correlation statistics showed that F@50 ms was strongly and inversely correlated to 60 m sprint time ($r= -0.54$, $p<0.05$); F@50 ms and F@90 ms was strongly correlated to V-max (r=0.577, p<0.05; r=6.86, p<0.01); RFD@50 ms and RFD@90 ms correlated to V-max (r=0.605, p<0.05; r=0.742, p<0.01 respectively); IP@90 ms and IP200 ms were strongly correlated to V-max (r=6.03, p<0.05; r=0.547, p<0.05). PF and scaled PF did not show statistically significant correlation to any sprint variables.

Table 1. Descriptive Statistics

Variables	Mean	±S D
PF	3029.83	517.34
F@50	1307.02	181.38
F@90	1696.78	352.68
F@200	2451.95	402.88
F@250	2641.81	432.18
RFD50	6131.10	3602.08
RFD90	7736.78	3739.78
RFD200	7257.43	2043.96
RFD250	6565.37	1706.51
IP@50	55.41	4.99
IP@90	115.91	15.73
IP@200	339.20	64.66
IP@250	465.19	90.02
T 60	7.05	0.30
V-max	9.60	0.44

Table 2. Correlation coefficient matrix between sprint variables and kinetic isometric mid-thigh pull variables.

	MPF	F@50	F@90	RFD50	RFD90	IP@90	IP@200
T 60	0.4	-0.382	-0.27	-0.540*	-0.373	-0.085	-0.287
V-max	-0.174	0.577*	0.686**	0.605*	0.742**	0.603*	0.547*

*. Correlation is significant at the 0.05 level.

**. Correlation is significant at the 0.01 level.

DISCUSSION: The aim of the current study was to determine the relationship of isometric force production characteristics to D-I male sprinters' sprinting performance variables. The current study agrees with previous studies (Chuanha et al., 2007; Bissas and Havenetidis, 2008; West et al., 2011; Tillin et al., 2013) that RFD showed statistically significant correlations to sprinting time and maximal running velocity. During sprinting, ground contact time is less than 100 ms, therefore those sprinters who could produce larger forces on the ground during that short period of time may have better 60 m sprint performance. One important finding in the current investigation was correlation of IP@ 90 ms and IP@ 200 ms to maximal sprint velocity could supports this assumption. Harris, Cronin Hopkins and Hansen (2008) also reported that impulse relative to body mass negatively correlated to 30 and 40 meter sprint time. Thus, impulse might be an important indicator for sprinters' performance. Further study is needed to confirm this.

Contrary to previously reported data from Mero et al. (1981) and Chuanha et al. (2007), MPF did not statistically correlate to 60 m sprint variables in the current study. These conflicting results may be due to differences in participant training and competition backgrounds and testing protocol differences between studies. For example, sprinters competing at higher levels of competition may exhibit a greater relationship to peak force characteristics compared to the participants in the current study.

CONCLUSION: The current study demonstrates that isometric force production characteristics (F@ 50 ms, F@ 90 ms, RFD 50 ms, RFD 90 ms, IP 90 ms and IP 200 ms), assessed from the mid-thigh pull position, are related to D-I male sprinters' 60 m sprinting performance. Sport scientists and coaches should focus on the development of sprinters' ability to produce explosive force through training and monitoring. Further study might investigate the relationship of isometric mid-thigh pull force production characteristics to sprint performance in sprinters with different competition levels (elite vs. non-elite), as well as the role of maximum strength in sprinters' performance at different competition levels.

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