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ORIGINAL ARTICLE

Reliability and various of isometric force production on regional upper body arm muscle-joint complex

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ABSTRACT

The various variations of isometric force promote on regional muscles peak and average force. Considered hypothesis and aim approaches of study were for investigate of Hill model (1938) upper body muscle force to the indicating muscle-tendon joint sections. Based on isometric force measurements, dynamic indicators were measured to time dependent peak and average force. New handheld dynamometer measurements were tested on 14 region arm muscle and joint line for; the twenty-six women age 16 to 18, with *Activforce* methods (*Activforce* 2, Australia) used in upper body range of motion applied isometric muscle force activations. It that concluded on maximal isometric test protocols tested on peak (long time) and average (short time) force. The various regional activities showed that very good reliability indicators and extremely strong effect size. Peak and average force test protocols reported on low risk ratio of the coefficient variance on peak force; CV (0.21-0.37) – effect size (d = 2.67-4.59), average force; CV (0.22-0.35) – effect size (d = 2.79-4.39) (p < .05). Different joint range of motion arm movements were produced isometric peak and average of maximal torque using of time dependent handheld dynamometer indicators indicated potential isometric force. Avaible study noted *Activforce* handheld dynamometer currently used for this study and research investigate, therefore, isometric force measurements are popular method must be used in peak and average force detection to promote reliable force and exercise condition.

Keywords: Sport medicine, Isometric force, Joint range of motion, Arm muscle, Peak force, Average force.

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INTRODUCTION

Hill (1938) equated force model on muscle activated to isolated muscle conditions. In coordinated, the force activations for isolated muscle preparations; force (F) involved in muscles create joint angular moment (r); -(Moment = r x F) about compartment extremities of joint, it these changes as force ratio of regional muscles by rotated range of motion (Hebert et al., 2015). As Hill (1938), mechanic force production model, is of one muscle-tendon section processes to range of motion and angular joint motion able primer compartment muscle actions. In contrast to force models, specific postural muscles were located in arm of joint section are produce various joint moment with maximum tork, therefore proximal and distal region nearest produce isometric force actions for elevate exactly potential maximum force as horizontal lines consist of abduction, adduction, in generally flexion, and extension (Hill, 1938).

It that is to isometric force testing of muscle, progress processes are tested on dynamic indicator protocols including setting-up of peak force, indeed time dependent measurements promote muscle arm moment torque, one of these tests are handheld dynamometer used to time dependent point of muscle isometric force production (Jan Nijhof & Gabriel, 2006). An isometric test approach is testing potential muscle neural force activation promote indeed maximum force i.e., to maximum explosive strength is early phase (0.4-0.5 ms) and late phase (0.5-0.7 ms) for muscle-tendon section current force changes on different range of motion and dynamic angular access (Kahraman, 2024). Over angular joint motion in of muscle isometric force is dynamic strength indicator, enable to peak or average force time dependent test protocols show active muscle activation in generally range of motion (Karagiannopoulos, Griech & Leggin, 2022).

Isometric force terms of regional maximum force able to movement change for example upper and lower body torque, specifically, isometric time dependent trials were allocated on dynamometer test (Karagiannopoulos et al., 2022). To evaluate isometric force used a new handheld dynamometers used in regional muscle force both upper and lower compartment with various reliability test options but have limited regional muscle complex coordination (Maffiuletti et al., 2016). The study have been reported *Activforce* upper compartment muscle-tendon section application was reliability and variability.

The isometric force indicators were used on a new handheld device *Activforce* 2 dynamometer, thus joint torque of all muscles activations are identified peak and average force from two strain impulse newton/kg gauge limitation (Karagiannopoulos et al., 2022; Maffiuletti et al., 2016). Additional, maximal isometric force rate of force development was obtained peak force/body variability time dependent second/millisecond (Kahraman, 2024). These approaches from validity measurement implicated in all health and unhealthy population evaluated isometric force muscle generation by dominant extremities (Karagiannopoulos et al., 2022; Maffiuletti et al., 2016). Force analysis was produced from an strip handheld dynamometer, however it lack information has in literature study related to regional muscle joint tork studied on limited studies, therefore optimal force ranges of postural muscle location force have values of peak and average force, however, not used in general population.

In this direction, we hypothesis was to investigate isometric force production on one population sample group, able maximum range detection within reliability and various techniques. The first aim was testing potential various isometric force used *Activforce* dynamometer on maximum isometric force. Other hypothesis was to investigate dynamic indicators of regional upper body muscle action. Therefore, this aim of study is evaluating reliability to isometric force using a new handheld dynamometer.

MATERIALS AND METHODS

Subjects

The population sample size was detected in one group women. Sample size analysis resolved on statistic program G.power software (v3.1.9.7). A priority population has been computed, difference from constant one sample case to determine on actual power 0.95; H1– >0.75 effect size; alpha error probability .05. Total sample size n = 26, on required one t-test used, was detected on critical t value 2.05 and noncentrally parameter δ 3.82. Statistical power analysed (1 – β error probability) on $p < .05$.

As statistical analysis, subjects formed n = 26 and 16 to 18 ages in this study. The experimental design to subjects were investigated in handheld dynamometer using isometric force protocols. Ensured to all subjects were tested on complete upper compartment test options. All testing protocols were applied into 24 hours during standard time of day.

Experimental test condition

Study subjects were included in isometric 2 hypothetical force impulse gauge on various experiences. Isometric peak and average force protocol was applied on fitness laboratory condition. Their tested to one session with measurement of peak and average force potential strength condition. A total of 15-20 minutes of individual testing was performed with the resting test time was 1 min. Each isometric force measurements are 5 second peak force and the average force 1 second, providing an adequate time dependent fatigue. Time-dependent force (N/kg) performed upper compartment muscle-tendon joint force condition by one doctor and fitness trainer working experience.

To peak force and average force measured in *Activforce* systems. "*Activforce 2 handheld dynamometer device*" was used to 14 region upper compartment complex (*Activforce* 2, Australia). The system links a handheld dynamometer 78 mm wide, 95 mm long, and 33 mm high with software designed to evaluate an individual's muscle constant force. Muscle isometric force derived from maximal muscle contraction and various joint range of motion. In environmental test conditions, handheld dynamometer tested to multiple joints and limbs, a valid measurement method was examined isometric muscle activation. In all measurements, isometric force obtained proximal to the nearest joint. All tests were performed in up position.

Reference joint range of motion points were tested:

A) arm epicondyle proximal for shoulder flexion,
B) arm epicondyle proximal for shoulder extension,
C) arm epicondyle proximal for shoulder abduction,
D) arm epicondyle proximal for shoulder adduction,
E) on forearm proximal of the styloid process for shoulder lateral/internal rotation,
F) on forearm proximal of the styloid process for shoulder medial/external rotation,
G) elbow flexion on distal styloid process of forearm,
H) elbow extension on distal styloid process of forearm,
I) elbow supination on proximal lateral styloid process of forearm,
J) elbow pronation on the proximal lateral styloid process of forearm,
K) wrist flexion on proximal of the metacarpophalangeal joint,
L) wrist extension on proximal of metacarpophalangeal joint,
M) wrist adduction on proximal of metacarpophalangeal joint,
N) wrist abduction on proximal of metacarpophalangeal joint.

Statistical analysis

Mean and standard deviation descriptive analysis tested on force activations. Population test was derived from confidence interval (95% CI) to detect significant and high effect of all measurement because of interaction analysis. The mean difference and standard deviation have been resolved one sample t-test and normality descriptive calculated (-1.30 to 1.30) skewness and kurtosis values. The absolute relatively study risk solved coefficient of variance CV = (σ / μ). Result of CV risk ratios were explained <1 low, 1 to 2 intermediate and 2 to 3 high and >3 very high. In the studies performed, one observation population effect size was calculated all measurement as two equal resolutions ($d = M - \mu 0 / \sigma$). In the analysis of reference effect size was small effect size 0.00 < 0.20 very weak, 0.20 < 0.50 weak, 0.50 < 0.80 moderate, 0.80 < 1.20 strong, 1.20 < 2.00 very strong 2 or >2 calculated as extremely strong effect size.

RESULTS

The experimental handheld dynamometer isometric force test outcomes resulted on upper compartment muscle-tendon joint. In this condition, determined test protocols (Figure 1).

Figure 1. Isometric force measure protocols.

Isometric peak force various reliability analyses were concluded on peak and average force. As the force various reliability method reported mean, standard deviation to N/kg, as descriptive mean results were determined various effect size values and concluded low risk ratio of coefficient of variance. Analysis of peak and average can be reported one experimental force variabilities resulted on only 14 region (Tables 1-2).

DISCUSSION

Muscle-tendon tork and isometric force activations promote on isometric action to high range of motion and regional force development. Furthermore, target different isometric force changes by actions producing static range of motion provide as our study tested regional muscle force activities (Jan Nijhof & Gabriel, 2006).

Table 1. Peak force outcomes.

Upper regions	Peak force (Kg)	ES	Peak force (N)	CV
Shoulder flexion	10.56 ± 2.30	4.59	103.55	0.21
Shoulder extension	10.02 ± 2.27	4.41	98.26	0.22
Shoulder abduction	10.74 ± 3.16	3.39	105.32	0.30
Shoulder adduction	9.36 ± 2.32	4.03	91.79	0.24
Shoulder lateral/internal rotation	10.70 ± 3.73	2.86	104.93	0.34
Shoulder medial/external rotation	8.96 ± 2.16	4.14	87.86	0.24
Elbow flexion	13.58 ± 3.51	3.86	133.17	0.25
Elbow extension	11.60 ± 3.46	3.35	113.75	0.29
Elbow supination	8.77 ± 2.28	3.84	86.00	0.25
Elbow pronation	11.32 ± 3.78	2.99	111.01	0.33
Wrist flexion	8.89 ± 2.26	3.93	87.18	0.25
Wrist extension	7.88 ± 1.83	4.30	77.27	0.23
Wrist adduction	7.03 ± 1.93	3.64	68.94	0.27
Wrist abduction	9.24 ± 3.46	2.67	90.61	0.37

Table 2. Average force outcomes.

Upper regions	Average force (Kg)	ES	Average force (N)	CV
Shoulder flexion	8.50 ± 1.97	4.31	83.35	0.23
Shoulder extension	8.49 ± 1.93	4.39	83.25	0.22
Shoulder abduction	9.37 ± 2.33	4.02	91.88	0.24
Shoulder adduction	7.48 ± 1.89	3.95	73.35	0.25
Shoulder lateral/internal rotation	8.38 ± 2.67	3.13	82.17	0.31
Shoulder medial/external rotation	7.74 ± 1.95	3.96	75.90	0.25
Elbow flexion	10.74 ± 2.76	3.89	105.32	0.25
Elbow extension	9.29 ± 2.96	3.13	91.10	0.31
Elbow supination	7.24 ± 1.64	4.41	71.00	0.22
Elbow pronation	9.04 ± 2.66	3.39	88.65	0.29
Wrist flexion	7.59 ± 2.11	3.59	74.43	0.26
Wrist extension	6.91 ± 2.70	2.55	67.76	0.27
Wrist adduction	5.83 ± 1.61	3.62	57.17	0.27
Wrist abduction	8.04 ± 2.88	2.79	78.84	0.35

Isometric muscle contraction enable to peak and average force on time dependent force characteristics specified early and late peak force curves (Karagiannopoulos et al., 2022). Early peak force is indeed potential strength indicators to maximal force improvement (Maffiuletti et al., 2022). In this case, our study showed that high and low peak and average force able to promote strength and exercise condition. Primarily outcomes firstly were reported to effectiveness and reliability of maximal test protocols contrast to other upper body was actualized to composed muscular isometric regional muscle force and coordinated force potential to observe reliable force action during isometric contraction (Maffiuletti et al., 2016). The upper body peak and average force are a combination isometric action (Karagiannopoulos et al., 2022). Isometric action was noted on range of motion in different angular joint range (Hill, 1938). To this study reported muscular isometric activation was used a upper body range of motion models used to new handheld dynamometer measure methods. Upper body characteristics determine effort of upper arm tendon section force, although difference regional activities according to baseline test option. In this condition, it was thought that muscle force can be

determined through isometric action by *Activforce* dynamometer to exercise and training experience before, or after strength and exercise condition.

Peak and average force splits, these are results constant force test evaluated isometric force generation by 14 region force difference. However, previous *Activforce* muscle isometric force outcomes noted that shoulder region was a limitation (Maffiuletti et al., 2016). Similarly, in the other tests were used in other studies to investigate constant training effectiveness (Jan Nijhof & Gabriel, 2006). Therefore, potential studies reported various range of motion test protocols, however, specific tests were provided high force changes on sport or health population (Kahraman, 2024). This of using technique maximum isometric force tests were investigated to men and women unsimilar, ages promoted to measure regional muscle-tendon area (Nm/kg) force activation using handheld isokinetic dynamometer reliability and validity method (Jan Nijhof & Gabriel, 2006). In conclusion to study was reliability on shoulder abduction, shoulder external rotation, elbow flexion and extension. For one individual test, program an isometric force evaluation, was reported that maximum force reach performance tested on maximum force or explosive force, however, similarly time dependent force activation indeed occur short and long time neural fire potential of skeletal muscle enable maximum isometric force i.e., 5-7 s, according to isometric force testing on resistance training population (Kahraman, 2024). Is that this condition, isometric force tests similarly are determining isometric potential action and isometric time dependent force activation experiences (Jan Nijhof & Gabriel, 2006). Similarly, one study was reported *Activforce* handheld dynamometer tests provided peak (5 s) and average (1 s) force activation, able objective outcome to regional upper and lower compartment muscle activations (Karagiannopoulos et al., 2022). One study reported that muscle upper compartment force various tests are reliability and variability to shoulder region, therefore, *Activforce* measurement protocols can be use upper body postural muscle activation and force changes (Maffiuletti et al., 2016).

CONCLUSIONS

The limited studies have *Activforce* handheld dynamometer measurement, to enable isometric force action in joint torque. Most studies may be report *Activforce* handheld dynamometer protocols related maximum force according upper and lower compartment range of motion. The study recommended to isometric peak and average force noted reliability and various force point to all regional upper body muscle-tendon section force. Therefore, this direction most studies must report to a new handheld dynamometer muscle force test option.

AUTHOR CONTRIBUTIONS

The authors provide assay section as methodology, literature, discussion and contribution upper compartment regional force testing.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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