RELATIONSHIPS BETWEEN GRIP STRENGTH TESTS IN MALE STRENGTH SPORT ATHLETES

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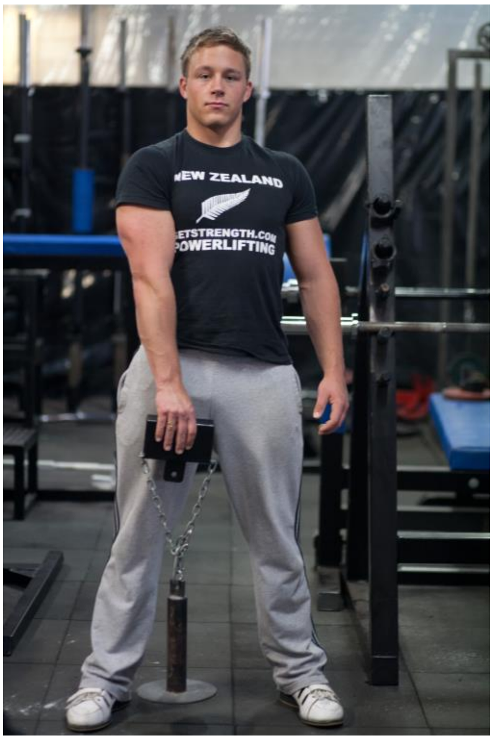
The purpose of this study was to examine the relationships between a number of common grip strength tests in strength sport athletes. Thirty-four male athletes competing in weightlifting, powerlifting or strongman were assessed for their maximum performance in the handgrip dynamometer, pinch grip and revolving thick bar grip strength tests. Correlations between the three strength test were: handgrip and pinch grip (r = 0.40), handgrip and revolving thick bar (r = 0.66) and pinch grip and revolving thick bar (r = -0.03). These varying relationships between the three strength tests suggest a relative specificity of strength test assessment, which may also be interpreted to suggest that strength and conditioning coaches need to select the appropriate grip exercises to improve sports specific grip performance in their athletes.

KEYWORDS: correlation, finger, strength testing.

INTRODUCTION: Hand function including grip strength is an important correlate to an individual's overall wellbeing and health status over the lifespan (Garcia-Hermoso et al., 2018; Kobayashi-Cuya et al., 2018). A recent review has indicated that athletes competing in sports such as judo, wrestling, rock climbing and the strength sports e.g. weightlifting, powerlifting, strongman and specific grip strength competitions have a significantly greater grip strength than the general population, further supporting the utility of grip strength as a surrogate measure of total body strength (Cronin, Lawton, Harris, Kilding, & McMaster, 2017). In these sporting events, the hands may need to produce high levels of force in a variety of tasks including a crushing grip, pinch grip (also referred to as the pincer grip) or holding onto a thick bar or rope, such as involved in climbing and sailing. However, intensive training sessions involving high grip load exercises such as a deadlift may actually exceed the momentary capacity of the grip muscles, with wrist straps increasing lifting speed and force production (Coswig, Machado Freitas, Gentil, Fukuda, & Del Vecchio, 2015).
According to Chapman (2008), the pinch (pincer) grip requires the thumb to produce flexor moments that result in the generation of equal and opposite forces from the thumb to the fingers; whereas in a friction grip that characterises holding a thick bar or rope, there are many points of force application by multiple digits. Ultimately, the resultant normal force produced by the digits multiplied by the coefficient of friction between the digits and the object must exceed the weight force of the object if it is to be lifted vertically or if the body is to be held unsupported in space such as hanging from a tree (Chapman, 2008). As different grip tasks will require somewhat unique muscular synergies with these muscles potentially acting at different points of the force length and force-velocity relationships (Kinoshita, Kawai, & Ikuta, 1995), the manner in which these forces are most effectively will tend to differ somewhat across different grip strength tests. It is also possible that the dimensions of the hand and fingers will influence grip performance, particularly in wide diameter pinch groups or thick bar/rope events. Specifically, the larger the hand and finger span in these events (up to a point), the greater the proportion of the grip force that will act normal to the weight force of the implement (Fallahi & Jadidian, 2011; Visnapuu & Jurimae, 2007). Such anthropometric dimensions may be advantageous during the pinch grip and or thick bar/rope grip events.

Ultimately, such factors may indicate that there is relatively little generality of grip strength. If such a result was observed, it may indicate that grip strength needs to be: 1) assessed in a manner replicating the activity of daily living/sporting event; and 2) trained in a manner similar to that required in the sport if positive transfer is to occur. Therefore, the aims of this present study were to assess the correlations between three grip strength (handgrip dynamometer, pinch grip and thick bar) tests in a group of experienced resistance trained strength athletes competing in the strength sports of weightlifting, powerlifting and strongman. It was hypothesised that a range of correlations will exist between the tests, with the strength of these correlations perhaps dependent on the type of grip (pinch or friction) as well as task goal (squeezing as in the handgrip dynamometer compared to gripping and lifting a 1RM load vertically in the pinch grip and revolving thick bar tests).

METHODS: This study sought to examine the relationship between three maximal grip strength tests, namely handgrip, pinch grip and revolving thick bar (approximation of the Rolling Thunder grip strength test (Ironmind^{TM}, Nevada City, USA) in 34 male strength sport athletes using their preferred hand. All participants (age: 28.2 ± 8.7 years; height 179 ± 7 cm; mass 92.1 ± 17.2 kg) completed all assessments in this study. To be eligible, they needed to be actively participating in a strength sport (powerlifting, weightlifting or strongman) and have a 1RM deadlift exceeding 1.5 times bodyweight. Any participant with a recent history of forearm/hand injury were excluded from participation. After providing written informed consent, each participant was required to perform the three strength tests in a random order.
Prior to performing the maximal assessment for each grip test, participants were allowed several submaximal trials as a warmup and to guide their selection of loads for the pinch grip and revolving thick bar tests (see Figure 1).



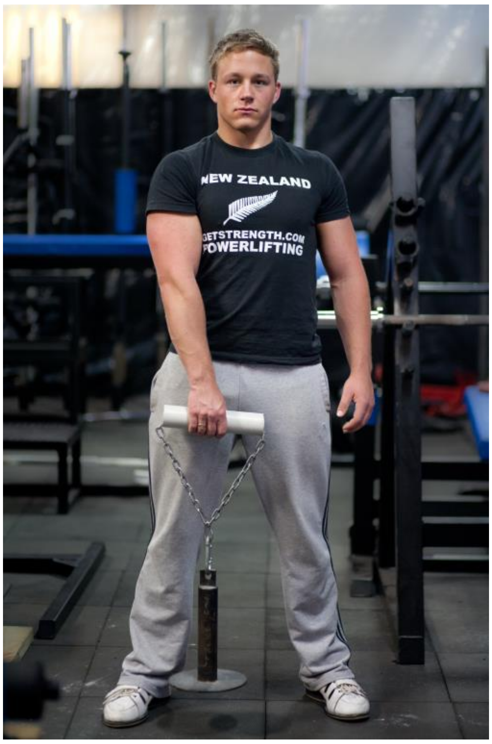


Figure 1: Completed position for the pinch grip and revolving thick bar (Rolling Thunder) test, respectively.

During their warm-ups and maximal strength assessments, all athletes were allowed to use lifting chalk. Maximal hand grip strength was assessed using a handgrip dynamometer (Jamar Model J00105, Lafayette Instruments, Lafayette, USA), with the best of three trials recorded for data analysis. Pinch grip and revolving thick bar strength were assessed by determining the one repetition maximum (1RM) load (to a precision of 1.25 kg) that could be lifted using a one-handed partial deadlift technique with two different objects that were connected to a vertical weight pole by a metal chain. Maximal pinch grip strength was assessed by holding a 3 inch (7.62 cm) wide pinch block, while maximum revolving thick bar strength was assessed using a 2 3/8 inch (6.03 cm) diameter revolving handle. For the handgrip and revolving thick bar lifts, the maximum load lifted successfully across three increasingly heavier 1RM attempts, separated by one minutes rest, were recorded for data analysis. For the handgrip and revolving thick bar lift attempts to be counted, the participant had to stand fully upright and the lower the implement with control to the floor. Each participant was free to self-select their starting loads for the handgrip and revolving thick bar lifts and to nominate their second and third attempts as is standard in the sports of weightlifting, powerlifting and strongman

Each participants' best result for each of the three grip assessments was recorded in an Excel spreadsheet. Descriptive statistics were calculated for each grip test, with relationships between the three tests examined using a Pearson Product Moment Correlation (r) and the coefficient of determination (R^2). Correlations were described as being trivial (±0-0.09), small (±0.10-0.29), moderate (±0.30-0.49), large (±0.50-0.69), very large (±0.70-0.89), nearly perfect (±0.90-0.99) or perfect (±1.00) (Hopkins, 2000). To gain some insight into the generalisability of these correlations, a spreadsheet was also used to calculate a 90% confidence limit (CL) (Hopkins, 2000).

RESULTS: Table 1 summarises their performance across the three grip tests, with the relationship between the three grip strength tests presented in Table 2.

Table 1: Maximal grip performance.

Grip test	Maximum performance (kg)
Handgrip	60.8 ± 8.6
Pinch grip	20.6 ± 3.8
Revolving thick bar	67.6 ± 13.6

Table 2: Correlation (with 90% CL) between grip tests.

	Handgrip	Pinch grip	Revolving thick bar
Handgrip	1.00	-	-
Pinch grip	0.40 (0.13 - 0.62)	1.00	-
Revolving thick bar	0.66 (0.46 - 0.80)	-0.03 (-0.31 to 0.26)	1.00

DISCUSSION: It was interesting to observe the varying correlations between all three grip tests. For example, a large positive correlation in performance was observed between the handgrip and revolving thick bar tests (r = 0.66; R^2 = 0.40), a moderate positive correlation between handgrip and pinch grip performance (r = 0.40; R^2 = 0.16) and a trivial correlation between the pinch grip and revolving thick bar tests (r = -0.03; R^2 = 0.01). The relatively low coefficient of determination between the pinch grip and the other two grip strength tests appear somewhat consistent with the different biomechanical and motor control demands of the pinch versus friction grip (Chapman, 2008). Such results may suggest a relative degree of specificity in the assessment of pinch versus friction grip strength.

In contrast, the two friction grip tests (handgrip and revolving thick bar) demonstrated a relationship in which 40% of the variation in one test was associated with variation in the other test. Both of these friction grip tests required the five digits to be flexed around their respective grip apparatus, thereby resulting in multiple points (and likely direction) of force application for the digits on the implement. Therefore, the results of our study provide some additional support to the view that changes in the demands of the grip task may alter the optimal coordination of digit forces during precision gripping with light loads (Kinoshita et al., 1995). Specifically, our results extend that of the precision grip literature by suggesting that when assessing maximal grip strength in the three strength tests used in the study, the task goal (squeezing a stationary object versus performing a 1RM) and relative wrist position may be less important than the number of points (and direction) of force application on the object. The relative lack of importance of wrist position may reflect the similarity in the wrist positions across the three tests, and the relative lack of wrist movement. It is however unknown if the correlations between grip events involving more wrist movement such as seen in arm wrestling as well as strength sport grip competition events including the wrist roller (wrist flexion/extension), front hammer lever (wrist abduction/adduction) and hammer rotations (supination/pronation) may differ our results.

CONCLUSION: To the authors' knowledge, this is the first study to assess the relationship between various grip strength tests in a sample of athletes requiring high grip strength. The results demonstrated a range of relationships between the three strength tests, with the magnitude of these correlations being -0.03, 0.40 and 0.66. Such correlations suggest a relative specificity of grip strength, which may reflect a variety of factors including the exercise task goal, hand and finger anthropometry and the relative position of the wrist and digits that may influence the force length relationship of the involve musculature. Ultimately, these findings have two important implications. For sports requiring a high degree of grip strength in a range of positions and tasks, our results may suggest 1) strength needs to be assessed in a variety of grip tests; and 2) a variety of grip exercises may be required to fully develop all of the grip requirements required for a sport. Future research should look to recruit larger and perhaps more homogenous samples of grip sport athletes, assess their hand and finger anthropometric measurements, incorporate a larger range of grip strength tests and examine the effects of various training programs on sports specific performance.

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