Comparison of Handgrip Strength and Endurance in Collegiate Male Athletes
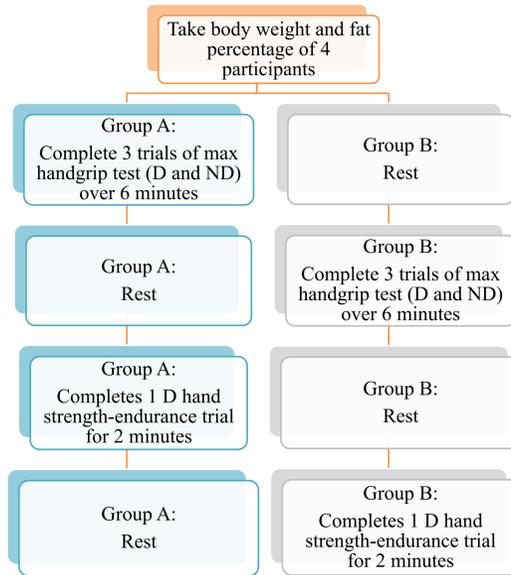
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This project makes no effort to suggest generalizability. Instead, it was designed to demonstrate competency using lab equipment, capacity to integrate knowledge with application, and understanding of the scientific method.
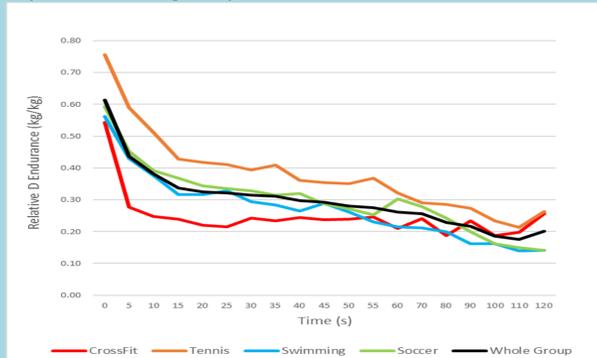
Introduction

- According to Wang et al. (2018), handgrip strength is an indicator of overall strength and a predictor of strength outcomes.

- Handgrip strength reflects muscular strength as well as motor unit recruitment and coordination, and neuromuscular control.

- Elite and successful athletes tend to show greater handgrip strength in comparison to sub-elite and less successful counterparts (Fry et al., 2004; Cronin et al., 2017). This may be due to the sport-specific nature of neuromuscular adaptations (Shields et al., 1999).

- For men between the ages of 18 and 24, absolute dominant (D) handgrip strength averages 47.0 kg +/- 8.1 kg (Wang et al., 2018)

- The purpose of this study was to compare relative handgrip strength and endurance between college-aged males that participate in four different sports: CrossFit, Tennis, Swimming, and Soccer.

- It was hypothesized that both relative handgrip strength and endurance would be higher in grip-intensive sports (CrossFit and tennis) than in non-grip-intensive sports (swimming and soccer) due to training specificity. Further, it was hypothesized that tennis players would show the greatest difference between dominant (D) and non-dominant (ND) hands.

Methodology

Participants
- 16 males between the ages of 18 and 25 from Gardner Webb University
- Inclusion criteria: Biological male currently signed on an NCAA DI swimming (n = 4), tennis (n = 4), or soccer team (n = 4), or a CrossFit athlete (n = 4).

Study Design
- Quasi-experimental
- Independent variable: The sport in which the athlete participated
- Dependent variables: relative D and ND maximal handgrip strength. Absolute D and ND maximal handgrip strength, ratio of absolute D and ND maximal handgrip strength, and handgrip strength-endurance on D hand.

Instrumentation
- Baseline Evaluation Instruments' hydraulic hand dynamometer: used for grip strength and endurance tests
- Omron Fat Loss Monitor HBF-306C via bioelectrical impedance: used to calculate body fat percentage

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Take body weight and fat percentage of 4 participants

Group A: Complete 3 trials of max handgrip test (D and ND) over 6 minutes

Group B: Rest

Group A: Rest

Group B: Complete 3 trials of max handgrip test (D and ND) over 6 minutes

Group A: Completes 1 D hand strength-endurance trial for 2 minutes

Group B: Rest

Group A: Rest

Group B: Completes 1 D hand strength-endurance trial for 2 minutes

Results

Table 1. Descriptive Statistics

	Age (years)	Weight (kg)	Body Fat (%)	D-Max (kg/kg)	ND-Max (kg/kg)	ND/D Ratio	D-120s Mean (kg/kg)	D-120s Mean (% of Max)
CrossFit (n = 4)								
Mean (SD)	22.5 (1.7)	92.6 (13.1)	15.5 (6.2)	0.54 (0.12)	0.52 (0.01)	0.96 (0.07)	0.15 (0.11)	45 (7)
Range	21 - 25	78.2 – 109.1	9.4 – 23.9	0.39 – 0.6	0.39 – 0.6	0.88 – 1.05	0.06 – 0.31	37 - 53
Tennis (n = 4)								
Mean (SD)	20.8 (1.0)	75.2 (3.0)	9.4 (1.3)	0.76 (0.09)	0.68 (0.09)	0.90 (0.02)	0.17 (0.03)	50 (5)
Range	20 - 22	70.9 – 77.3	8.1 – 10.9	0.67 – 0.86	0.60 – 0.78	0.88 – 0.92	0.13 – 0.20	44 - 57
Swimming (n = 4)								
Mean (SD)	22.0 (1.4)	76.4 (6.6)	13.9 (1.8)	0.56 (0.12)	0.57 (0.10)	1.03 (0.08)	0.12 (0.03)	49 (4)
Range	21 - 24	70.9 – 85.9	11.7 – 16.1	0.43 – 0.70	0.48 – 0.66	0.94 – 1.11	0.10 – 0.16	43 - 52
Soccer (n = 4)								
Mean (SD)	20.8 (2.9)	83.0 (5.2)	11.3 (4.0)	0.59 (0.13)	0.59 (0.12)	1.00 (0.05)	0.14 (0.02)	51 (4)
Range	19 - 25	76.4 – 89.1	7.5 – 17.0	0.48 – 0.77	0.49 – 0.76	0.94 – 1.06	0.12 – 0.17	48 - 56
Grip-Intensive Sports (n = 8)								
Mean (SD)	21.6 (1.6)	83.9 (12.8)	12.5 (5.3)	0.65 (0.15)	0.60 (0.12)	0.93 (0.06)	0.16 (0.07)	48 (6)
Range	20 – 25	70.9 – 109.1	8.1 – 23.9	0.37 – 0.86	0.39 – 0.78	0.88 – 1.05	0.06 – 0.31	37 - 57
Non-Grip-Intensive Sports (n = 8)								
Mean (SD)	21.4 (2.2)	79.7 (6.6)	12.6 (3.2)	0.58 (0.11)	0.58 (0.10)	1.02 (0.07)	0.13 (0.03)	50 (4)
Range	19 – 25	70.9 – 89.1	7.5 – 17.0	0.43 – 0.77	0.48 – 0.76	0.94 – 1.11	0.10 – 0.17	43 – 56
Whole Group (n = 16)								
Mean (SD)	21.5 (1.9)	81.8 (10.1)	12.5 (4.2)	0.61 (0.13)	0.59 (0.11)	0.97 (0.08)	0.15 (0.06)	49 (5)
Range	19 - 25	70.9 – 109.1	7.5 – 23.9	0.37 – 0.86	0.39 – 0.78	0.88 – 1.11	0.06 – 0.31	37 - 57

Note. Abbreviations: SD = standard deviation; kg = kilograms; D-Max = dominant hand maximum; ND-Max = non-dominant hand maximum; ND/D = ratio of non-dominant to dominant hand maximum. Mean handgrip endurance over 120 s (D-120s Mean) is reported relative to bodyweight (kg/kg) and as a percentage of original D-Max (% of max).

Figure 1. Grip Strength-Endurance Decay as a Percentage of Maximum

Note. See Figure 2.

Results continued

Figure 2. Relative Grip Strength-Endurance

Note: Relative Dominant (D) Endurance, measured relative to bodyweight in kilograms (kg/kg). Time, measured in seconds (s). First value at 0 seconds was taken from highest value of the three trials of maximum handgrip test.
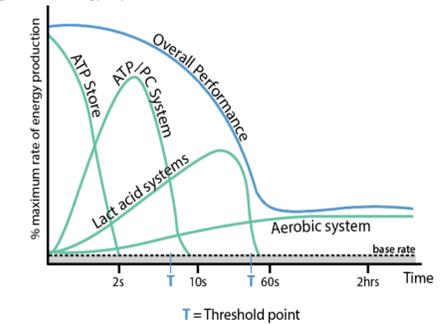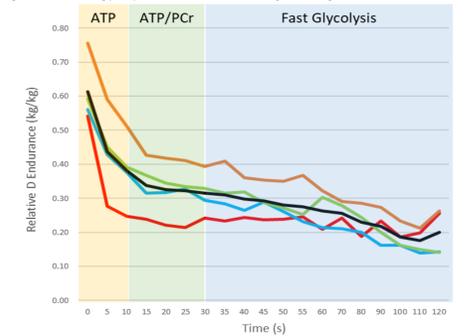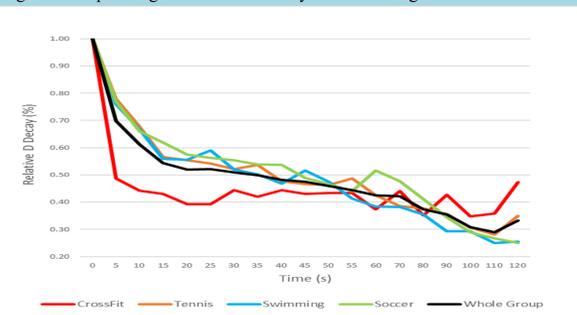
Discussion

- The hypothesis was confirmed in that grip-intensive sports showed higher mean relative strength and endurance than non-grip-intensive sports.

- This may reflect the specific nature of training adaptations; similarly, Kratrantou et al. (2020) found that a specialized grip training program improved maximal handgrip strength more than non-specific wrestling training among adolescent wrestlers after only 4 months of training.

- Maximal handgrip strength tests reflect power development, and not force capacity alone. Both the maximal and endurance handgrip tests reflect neural factors such as recruitment and coordination and psychological factors such as pain tolerance and motivation. Furthermore, tennis athletes showed the lowest ND/D ratio (0.9) when compared to CrossFit (0.96), swimming (1.03) and soccer (1.00). This may reflect the unilateral nature of tennis training.

- However, Shields et al. (1999) noted that cross-education can occur, where adaptations transfer to the contralateral limb, probably due to neurological adaptations learned and applied to the untrained limb. This may explain limited variation in ND/D ratio due to sport.

- According to McArdle et al. (2015), energy systems show training specificity. An 120s endurance test activates strength-power (ATP; 0 - 10 s); sustained power (ATP + phosphocreatine [PCr], 10 - 30 s); and anaerobic power-endurance (fast glycolysis, 30 - 180 s) systems (see Figures 3 and 4).

- Performance throughout the endurance test may reflect how training taxes these energy systems.

- CrossFit, for example, saw the fastest decline but had the highest percentage of original D-max at the end of 120s, reflecting hand-grip training that requires anaerobic power-endurance (see figure 1)

- Dias et al. (2012) found that participation in judo did not result in higher absolute handgrip strength, but did increase resistance to fatigue.

- Correcting for body-weight in kilograms may inadequately represent sport differences due to differences in body fat percentage. For example, CrossFit athletes showed lower relative D-max than athletes of all three D1 sports; however, they also showed higher bodyweight and body fat percentages, meaning that handgrip strength relative to fat-free mass may be underestimated.

Figure 3. Energy Systems

T = Threshold point

Figure 4. Energy Systems Used During Strength-Endurance Test

Conclusion

- The lab conducted was to test which sports resulted in a higher relative handgrip strength and endurance between two grip-intensive sports, and two non-grip-intensive sports.

- Sixteen male participants were gathered from two grip-intensive sports and two non-grip intensive sports. Participants took place in a relative handgrip test, as well as an endurance test. During the relative handgrip test, participants alterated testing their dominant(D) and then their non-dominant(ND) overall grip strength for a total of three trials. During the endurance test, participants tested grip strength for 120 seconds, and data was collected periodically for each five second mark and then each ten second mark.

- Maximum handgrip strength is a reflection of overall power performance and endurance handgrip is an indicator for overall neural factors.

- The testing protocol confirmed the hypothesis that grip-intensive sports would score higher in relative handgrip strength, as well as endurance compared to non-grip-intensive sports.

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