The Relationship between Physiological and Musculoskeletal Characteristics and Tactical Performance in Naval Special Warfare Operators

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ABSTRACT

Naval Special Warfare SEAL Operators must possess musculoskeletal and physiological characteristics necessary to meet mission related tasks, preserve health and physical fitness, and maintain physical readiness. Previous reports of physical training and fitness characteristics of SEALs are not contemporary and have not investigated these characteristics as they relate to tactically-relevant activities. **PURPOSE:** To examine the relationship between musculoskeletal and physiological laboratory measures and tactical task performance of SEAL Operators. **METHODS:** Thirty eight SEAL Operators (Age: 30.4±5.8 yrs, Height: 1.8±0.1 m, Mass: 88.2±13.2 kg) completed testing for body fat (BF%), fat mass (FM), and fat free mass (FFM); aerobic capacity (VO2Peak) and lactate threshold (LT); isokinetic shoulder strength, knee strength, and lumbar strength; and tactical events, including a medicine ball toss, broad jump, 5-10-5 agility drill, 25 lb pull ups, body weight bench press, 1 RM dead lift, and 300 yd dash. A correlational analysis (α=0.05) was performed to determine the relationship between lab variables, individual tactical task performance, and a cumulative tactical task ranking (CTTR). **RESULTS:** The following significant correlations were revealed: CTTR with BF%, FM, FFM, VO2 @ LT, shoulder strength, knee strength, and lumbar strength(r=-0.61 to 0.55, p<0.05); medicine ball toss with FFM (r=0.73, p<0.001); broad jump with BF%, FFM, shoulder strength, knee strength, and lumbar strength (r=-0.56 to 0.71, p<0.05); 5-10-5 drill with BF%, FM, VO2 @ LT, shoulder strength, knee strength, and lumbar strength (r=-0.57 to 0.46, p<0.05); pull ups and bench press with BF, FM, VO2Peak, shoulder strength, and knee strength (r=-0.67 to 0.58, p<0.05); dead lifts with FFM and knee strength (r=0.33 to 0.43, p<0.05); 300 yd dash with BF, FM, VO2Peak, knee strength, and lumbar strength (r=-0.66 to 0.70, p<0.05). **CONCLUSION:** Laboratory-based physiological and musculoskeletal characteristics are significantly correlated to tactically-relevant tasks. Optimizing these characteristics through physical training may enhance a SEAL Operator's overall tactical readiness. These results may provide practical implications for assessing the tactical readiness of Navy SEALs.

INTRODUCTION

- Naval Special Warfare (NSW) Sea, Air, and Land (SEAL) Operators must possess musculoskeletal and physiological characteristics necessary to:
  - Successfully perform mission related tasks
  - Preserve health and physical fitness
  - Maintain physical readiness
- Previous reports of physical training and fitness characteristics of NSW SEAL Operators are not contemporary have not investigated these characteristics as they relate to tactically-relevant activities
- Research is warranted to examine the relationship between musculoskeletal and physiological laboratory measures and physical-tactical performance of NSW SEAL Operators

EXPERIMENTAL DESIGN AND METHODS

STUDY DESIGN

- Cross-sectional, correlational research design

SUBJECTS

- 38 NSW SEAL Operators (30.4±5.8 yrs, 1.8±0.1 m, 88.2±13.2 kg)

PRODECURES

- **LABORAORY DATA COLLECTION (Day 1)**
  - Body Composition (BOD POD Body Composition System, Cosmed, Chicago, IL) **(Figure 1)**
  - Isokinetic Strength (Biodex Multi-Joint System 3 Pro Dynamometer, Shirley, NY) **(Figure 2)**
    - Shoulder internal/external rotation
    - Knee extension/flexion
    - Lumbar extension/flexion
  - Maximal Oxygen Uptake (VO2Peak) and Lactate Threshold (LT) **(Figure 3)**
    - Graded treadmill exercise test
      - Inspired/expired gases collected with TrueOne2400 (ParvoMedics, Sandy, UT)
      - Constant speed, incline increased by 2% every 3-minutes until volitional fatigue
      - Blood lactate collected during final 30s of each stage (LacatePro, Arkray Inc, Japan)
- **TACTICAL TASK COLLECTION (Day 2)**
  - Medicine ball toss
  - Broad jump
  - 5-10-5 agility drill
  - 25 lb pull-ups
  - Body weight bench press
  - 1 RM dead lift
  - 300 yd dash

  - Cumulative tactical task ranking (CTTR) was determined by ranking results of each task (1 being the highest rank) and calculating the sum of combined rank score

STATISTICAL ANALYSIS

- Correlational analysis was performed to determine relationship between lab variables, individual tactical task performance, and CTTR
  - Pearson Correlation Coefficients were calculated for data following assumptions of normality
  - Spearman's Rho Correlation Coefficients were calculated for data violating assumptions of normality

Figure 1. BOD POD Body Composition Assessment

Figure 2. Isokinetic knee extension/flexion strength testing

Figure 3. Maximal Graded Treadmill Exercise Test

RESULTS

- The following significant correlations were revealed:
  - CTTR with body fat (BF%), fat mass (FM), fat free mass (FFM), shoulder, knee, and lumbar strength (Table 1)
  - Medicine Ball toss with FFM (Table 2)
  - Broad jump with BF%, FFM, shoulder, knee, and lumbar strength (Tables 2-3)
  - 5-10-5 with BF%, FM, VO2 @ LT, shoulder, knee, and lumbar strength (Tables 2-3)
  - Pull-ups and bench press with BF%, FM, VO2Peak, VO2 @ LT, shoulder, and knee strength (Tables 2-3)
  - Dead lifts with FFM and knee strength (Tables 2-3)
  - 300 yd dash with BF%, FM, VO2Peak, VO2 @ LT, shoulder, knee, and lumbar strength (Tables 2-3)

TABLE 1. Significant CTTR and Laboratory Variable Correlation Coefficients (p<0.05)

Variable	BF%	Fat mass (lbs)	FFM (lbs)	Shoulder Rotation Strength (Nm %BW)	Shoulder Ext Rotation Strength (Nm %BW)	Knee Extension Strength (Nm %BW)	Knee Flexion Strength (Nm %BW)	Lumbar Flexion Strength (Nm %BW)
CTTR	0.545	0.467	-0.408	-0.524	-0.380	-0.610	-0.463	-0.326

CTTR = Cumulative Tactical Task Rank, where 1 is the highest (best) rank
Spearman's Rho Correlation Coefficients reported for all variables

TABLE 2. Significant Tactical Task and Physiological Variable Correlation Coefficients (p<0.05)

Variable	MedBall (in)	Broad Jump (in)	5-10-5 time (sec)	25 lb Pull Up (max reps)	Bench Press (max reps)	Body Weight 1 RM Dead Lift (lbs)	300 yd dash (sec)
BF (%)	--	-0.560	0.461*	-0.671	-0.616	--	0.693*
Fat mass (lbs)	--	--	0.429*	-0.632*	-0.573*	--	0.697*
FFM (lbs)	0.729	0.351	--	--	--	0.429	--
VO2Peak (ml/kg/min)	-0.340	--	--	0.577	0.539	--	-0.662*
VO2 @ LT (ml/kg/min)	--	--	--	-0.380*	0.354	0.392	-0.708*

* = Calculated with Spearman's Rho. All other correlations calculated as Pearson's Correlation Coefficient

TABLE 3. Significant Tactical Task and Strength Variable Correlation Coefficients (p<0.05)

Variable	Med Ball (in)	Broad Jump (in)	5-10-5 time (sec)	25 lb Pull Up (max reps)	Bench Press (max reps)	Body Weight 1 RM Dead Lift (lbs)	300 yd dash (sec)
Shoulder External Rotation (Nm %BW)	--	0.365	--	0.524	0.415	--	--
Shoulder Internal Rotation (Nm %BW)	--	0.457	-0.443*	0.535	0.579	--	-0.327*
Knee Extension (Nm %BW)	--	0.713	-0.568*	0.47000	0.421	0.329	--
Knee Flexion (Nm %BW)	--	0.501	-0.452*	0.547	0.539	--	-0.363*
Lumbar Extension (Nm %BW)	--	--	-0.380*	--	--	--	--
Lumbar Flexion (Nm %BW)	--	0.353	-0.380*	--	--	--	-0.343

* = Calculated with Spearman's Rho. All other correlations calculated as Pearson's Correlation Coefficient

SUMMARY AND CONCLUSIONS

- Laboratory-based physiological and musculoskeletal characteristics are significantly correlated to physical, tactically-relevant tasks
  - Optimizing these characteristics through physical training may enhance a NSW SEAL Operator's overall physical-tactical readiness
  - These results may provide practical implications for assessing the physical-tactical readiness of NSW SEAL Operators

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