THE RELATIONSHIP OF BODY COMPOSTION TO COUNTERMOVEMENT VERTICAL JUMP CHARACTERISITCS ACROSS LOADED CONDITIONS

[1]MacDonald, C.J., [1]Lamont, H.S., [1]Smith, J.C., [1]Cholewa, J.C. [1,2]Suppe, A.M., [3]Gentles, J.A., and [1]Hurlbert, L.D.

[1]Coastal Carolina University, Department of Kinesiology, Conway, SC, USA

[2]Main Line Health Fitness and Wellness, Glenn Mills, PA, USA

[3]Armstrong State University, Department of Health Sciences, Savannah, GA, USA

INTRODUCTION: The tracking of physiological characteristics, specifically vertical jumping, is not only an important technique to appropriately assess acute adaptations, but it also serves as an efficient metric to evaluate long-term adaptations. In fact, the tracking of physiological characteristics, and vertical jumping, has grown concomitantly with the rise of the field of sport science (Ache Dias, et al, 2011; Appleby, et al, 2012; Klavora, 2000; Kraska, et al, 2009; and Vuk, et al, 2012). Vertical jump monitoring and tracking has likely expanded due not only to its ease of execution and familiarity, but also because one maximal effort vertical jump can supply a copious amount of information on the physiological abilities of an individual. Vertical jump characteristics (especially in loaded conditions) have also been shown to be able to delineate between the strong and weak, the fatigued and the prepared, and the trained and the untrained (Kraska, et al, 2009). The purpose of the current project was to identify any significant relationships between body composition (as measured by total skinfold thickness (Appleby, et al, 2012)) and CMJ characteristics (jump height & average jump power/body mass) across loaded conditions (0kg, 5kg, 10kg, 15kg, & 20kg).

METHODS: Sixty-five individuals (9 collegiate athletes; 56 recreationally trained; males, n = 24: age = 22.04(±1.94) years; height = 179.23(±6.40) cm; body mass = 88.67(±18.46) kg; skinfold thickness = 67.66(±36.78) mm; females, n = 41: age = 22.12(±3.35) years; height = 164.80(±5.90) cm; body mass = 68.86(±12.10) kg; skinfold thickness = 77.49(±23.66) mm), free of any musculoskeletal injury that would adversely affect vertical jumping, participated in this study. Prior to the testing session, all participants read and signed informed consent and health history documents, which were approved by the Coastal Carolina University's Institution Review Board.

Participants' anthropometrics were collected first, which included: standing height (cm; Detecto, Webb City, MO, USA); body mass (kg; Detecto, Webb City, MO, USA); and total three site skinfold thickness in millimeters (males: pectoralis, abdominal, quad; females: triceps, oblique, quadriceps; Lange skinfold caliper, Beta Technology, Santa Cruz CA, USA). This was immediately followed by a normalized warm-up protocol: 5 minutes of static stretching; 5 minutes pedaling a cycle ergometer at 0.5 kilopond resistance and 60 revolutions per minute; and one unloaded CMJ, with arm swing, at a perceived 50% effort. Following the warm-up, 12 total maximal effort jumps were completed by each participant in the following order: two unloaded CMJ with arm swing; two 0kg fixed arm CMJ; two 5kg fixed arm CMJ; two 10kg fixed arm CMJ; two 15kg fixed arm CMJ; and two 20kg fixed arm CMJ. All jump conditions were executed by the participant stepping onto the jump mat, followed by the prompt, "three, two, one, jump!" Sixty seconds of rest was allotted between jumps, the depth of the countermovement was self-selected, and participants' arms were fixed by holding a PVC pipe or weightlifting bar (Werksan IWF Certified Training Barbell, Werksan USA, Moorestown, NJ, USA) in the high bar squat position (Schoenfeld, 2010).

CMJ characteristics assessed for this work were peak jump height (cm) and average jump power per kg of body mass (Watts/kg). CMJ height was calculated using a jump mat (Just Jump! Mat; Probotics Inc.; Huntsville, AL, USA). CMJ average power per kg of body mass collected using a linear position transducer (GymAware Power Tool LPT; 50Hz, ACT, Australia). All CMJ data were averaged between the two maximal efforts under each condition to give a more accurate representation of the individual's typical performance (Henry, 1967).

All statistical analyses were performed using SPSS software (SPSS version 22.0; IBM, New York, NY, USA). Pearson's correlations (r) were used to evaluate the relationships between the total skinfold thickness and the following conditions: 0kg CMJ average power/kg of body mass; 5kg CMJ average power/kg of body mass; 10kg CMJ average power/kg of body mass; 15kg CMJ average power/kg of body mass; 20kg CMJ average power/kg of body mass; 0kg CMJ with arm swing height; 0kg CMJ height; 5kg CMJ height; 10kg CMJ height; 15kg CMJ height; and 20kg CMJ height. The correlations were evaluated with all participants considered, male only participants, and female only participants. Initial statistical significance was set at an alpha level of 0.05. Additionally, visual inspection of the practical trends in the relationships of that same data was used to further assess the outcomes.

RESULTS: Descriptive statistics for the populations are provided in Tables 1, 2, & 3. All body composition to jump characteristic relationships are provided in Tables 4 – 9. The results identify that all relationships between the measure of body composition (total skinfold thickness) and the jump characteristics were weak to moderate and of an inverse nature, ranging from r = -.173 to -.559. Additionally, all but two relationships (female only body composition to 0kg CMJ average power/kg body mass r = -.173, p = .280 and male only body composition to 5kg CMJ average power/kg body mass r = -.349, p = .095) were statistically significant. Additionally, there were similar ranges in the strengths of the inverse, statistically significant relationships within genders (male r = -.417 to -.549; female r = -.429 to -.559).

DISCUSSION: These results showed a weak-to-moderate inverse relationship between body composition (as measured by total skinfold thickness) and countermovement vertical jump height and associated scaled average power, across a loading paradigm. Additionally, no one condition (0kg vs. 5kg vs. 10kg vs. 15 kg vs. 20kg) elucidated stronger relationships in jump height or scaled average power, consistently. These results were expected as they indicate that the greater the amount non-contractile subcutaneous tissue, the lower and less powerful vertical jumps will be. Also, the lack of data representing any one loading condition being more consistently related to body composition is probably a result of the heterogeneous population sample.

The practical implication from this work would be that not only should training include work to improve the musculoskeletal system in areas of strength and power, but in addition, dedicate parts of training to reducing the amount of non-contractile tissue. Both training foci should result in improved performance. Of note, reporting body composition as only a measure of total skinfold thickness is a relatively novel approach (Appleby, et al, 2012) and admittedly needs more work to continue to validate it's use in many populations. However, we feel that it does provide the researchers and participants with a time and cost efficient method of evaluating body composition that can also be easily tracked over time. Further research in this area is warranted to not only expand the current data set but also to investigate a large sample size of highly trained individuals.

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Table 1: Participant Anthropometrics (mean ± standard deviation)

	Age (years & months)	Training History (months)	Standing Height (cm)	Body Mass (kg)	Skinfold Total (mm)
Males (n=24)	22.04 (±1.94) & 5.92 (±3.51)	11.67 (±27.10)	179.23 (±6.40)	88.67 (±18.46)	67.66 (±36.78)
Females (n=41)	22.12 (±3.35) & 4.85 (±3.48)	22.72 (±46.93)	164.80 (±5.90)	68.86 (±12.10)	77.49 (±23.66)

Table 2: Participant Average Jump Power/kg Body Mass (Watts/kg) Characteristics (mean ± standard deviation)

	0kg CMJ	5kg CMJ	10kg CMJ	15kg CMJ	20kg CMJ
All Participants (n=65)	30.33 (±6.53)	30.03 (±6.89)	28.53 (±7.00)	28.37 (±6.76)	26.99 (±6.81)
Male (n=24)	34.26 (±6.66)	35.23 (±6.43)	34.23 (±6.23)	33.90 (±6.37)	32.69 (±5.82)
Female (n=41)	28.02 (±5.29)	26.98 (±5.15)	25.19 (±5.02)	25.13 (±4.54)	23.65 (±4.88)

Table 3: Participant Jump Height (cm) Characteristics (mean ± standard deviation)

	0kg CMJ w/ AS	0kg CMJ	5kg CMJ	10kg CMJ	15kg CMJ	20kg CMJ
All Participants (n=65)	47.92 (±11.71)	40.30 (±8.71)	38.95 (±9.28)	35.43 (±9.12)	33.85 (±9.14)	31.43 (±8.98)
Male (n=24)	59.28 (±9.59)	48.23 (±7.68)	47.673 (±8.20)	44.06 (±8.14)	42.70 (±7.74)	40.24 (±7.51)
Female (n=41)	41.27 (±6.63)	35.66 (±5.26)	33.85 (±5.19)	30.38 (±4.92)	28.68 (±4.99)	26.27 (±4.77)

Table 4: All Participants - Relationship between Body Composition and Jump Height

Characteristics

		0kg CMJ w/ AS Ht (cm)	0kg CMJ Ht (cm)	5kg CMJ Ht (cm)	10kg CMJ Ht (cm)	15kg CMJ Ht (cm)	20kg CMJ Ht (cm)
Skinfold Total (mm)	Pearson Correlation	**-0.484**	**-0.46**	**-0.444**	**-0.463**	**-0.431**	**-0.41**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.001

Table 5: All Participants - Relationship between Body Composition and Jump Power Characteristics

		0kg CMJ Power (Watts/kg)	5kg CMJ Power (Watts/kg)	10kg CMJ Power (Watts/kg)	15kg CMJ Power (Watts/kg)	20kg CMJ Power (Watts/kg)
Skinfold Total (mm)	Pearson Correlation	**-0.338**	**-0.412**	**-0.473**	**-0.431**	**-0.423**
	Sig. (2-tailed)	.006	.001	.000	.000	.000

Table 6: Male Participants - Relationship between Body Composition and Jump Height Characteristics

		0kg CMJ w/ AS Ht (cm)	0kg CMJ Ht (cm)	5kg CMJ Ht (cm)	10kg CMJ Ht (cm)	15kg CMJ Ht (cm)	20kg CMJ Ht (cm)
Skinfold Total (mm)	Pearson Correlation	**-0.549**	**-0.492**	**-0.453**	**-0.533**	**-0.479**	**-0.435**
	Sig. (2-tailed)	.005	.015	.026	.007	.018	.034

Table 7: Male Participants - Relationship between Body Composition and Jump Power Characteristics

		0kg CMJ Power (Watts/kg)	5kg CMJ Power (Watts/kg)	10kg CMJ Power (Watts/kg)	15kg CMJ Power (Watts/kg)	20kg CMJ Power (Watts/kg)
Skinfold	Pearson	**-0.417**	*-.349*	**-0.518**	**-0.429**	**-0.418**

Total (mm)	Correlation					
	Sig. (2-tailed)	.043	.095	.010	.037	.042

Table 8: Female Participants - Relationship between Body Composition and Jump Height Characteristics

		0kg CMJ w/ AS Ht (cm)	0kg CMJ Ht (cm)	5kg CMJ Ht (cm)	10kg CMJ Ht (cm)	15kg CMJ Ht (cm)	20kg CMJ Ht (cm)
Skinfold Total (mm)	Pearson Correlation	**-0.559**	**-0.492**	**-0.516**	**-0.475**	**-0.46**	**-0.456**
	Sig. (2-tailed)	.000	.001	.001	.002	.002	.003

Table 9: Female Participants - Relationship between Body Composition and Jump Power Characteristics

		0kg CMJ Power (Watts/kg)	5kg CMJ Power (Watts/kg)	10kg CMJ Power (Watts/kg)	15kg CMJ Power (Watts/kg)	20kg CMJ Power (Watts/kg)
Skinfold Total (mm)	Pearson Correlation	*-.173*	**-0.452**	**-0.45**	**-0.429**	**-0.434**
	Sig. (2-tailed)	.280	.003	.003	.005	.005