

PURPOSE

The primary purpose of this study was to provide normative reference values for specific CMJ force-time characteristics of interest for women's NCAA Division-I volleyball. A secondary purpose was to develop and examine a novel method for evaluating stretch shortening cycle (SSC) efficiency during the CMJ.

METHODS

- Eighty-six resistance trained NCAA Division-I female volleyball athletes (height: 183.18 ± 9.81cm; weight: 77.58 ± 0.39kg) from eight teams participated in this study. CMJ data was collected at 1,000 Hz using uniaxial dual force plate systems (Hawkin Dynamics, Westbrook, ME, USA; Vald Performance, Brisbane, QLD, Australia).
- Percentile rank values for CMJ force-time metrics of interest were calculated for the sample and later categorized by position group (i.e., defensive specialist, libero, middle blocker, etc.) and performance category (see Table 1.)

RESULTS

- Normative CMJ force-time metrics of interest for athletes categorized as "elite" were; jump height=36.27- 45.75 cm; relative average propulsive power=1.47-39.87 W/kg; relative average braking power=-18.86 - -16.57 W/kg; time to takeoff=0.53-0.67 seconds and impulse ratio=2.53-3.65.
- Dynamic force (avg. propulsive force/avg. braking force) and power (avg. propulsive power/avg. braking power) ratios did not correlate significantly with jump height (r=-0.143-0.142; p=0.249 - 0.253) but did correlate strongly with impulse ratio (propulsive net impulse/braking net impulse) (r=0-0.910-0.846; p=<0.001).

CONCLUSIONS

Based on the observations of this investigation, normative values for elite, good, average, below average, and poor performers during the CMJ assessment were identified. Furthermore, a novel ratio for evaluating the efficiency of the SSC was developed that could enhance approaches for athlete monitoring and development.

PRACTICAL APPLICATIONS

- To the authors' knowledge, this is among the first published normative analysis specifically for NCAA Division-I female volleyball athletes.
- Furthermore, the collaboration between strength and conditioning professionals and sport scientists to support athlete health and performance contributed to the success of this project.
- Altogether, these findings can be utilized to enhance athletic development, progression, and performance through resistance training approaches and monitoring of neuromuscular fatigue with normative values as a reference.



The countermovement vertical jump (CMJ) assessment is widely accepted as a criterion measure of lower-body neuromuscular performance within athletic populations. However, limited information exists which has examined CMJ force-time characteristics within elite female collegiate volleyball athletes from multiple teams to provide normative reference values.



Table 1. Normative CMJ height (cm) data for NCAA Division-I female volleyball athletes.

Performance	Percentile	All	DS	LIB	MB	OH	OPP	S
ELITE	100%	45.8	42.1	29.7	45.8	42.1	44.8	42.1
	95%	41.8	41.6		43.5	40.0	44.1	41.6
	90%	39.3	41.3	29.3	39.7	37.1	43.3	38.1
	85%	37.2	39.4		38.0	36.1	38.8	34.8
	80%	36.3	37.2	28.8	37.4	35.6	37.9	33.8
GOOD	75%	35.4	36.5	28.6	35.7	35.3	37.0	33.0
	70%	34.8	35.5	28.6	35.2	35.0	36.6	32.4
	65%	33.9	35.1	28.4	33.7	34.7	36.2	32.1
	60%	33.2	34.2	27.8	33.2	34.0	34.9	31.7
	55%	32.7	33.2	26.9	32.6	33.5	33.2	31.5
AVERAGE	50%	32.2	32.7	23.0	32.1	32.9	32.4	31.1
BELOW	45%	32.0	31.5	19.1	31.4	32.7	31.9	30.5
	40%	31.4	30.2	18.6	31.1	32.5	31.4	29.5
	35%	30.8	28.7	18.5	30.5	32.3	31.1	28.6
	30%	29.9	28.6	18.3	29.7	32.1	30.7	27.5
POOR	25%	28.7	28.5	18.0	29.2	32.0	30.3	26.8
	20%	28.4	28.3	17.7	28.3	31.5	28.9	26.4
	15%	27.5	27.6	17.4	27.2	29.9	26.0	26.0
	10%	26.2	27.2	17.1	26.1	28.8	25.6	25.6
	5%	24.8	22.7	17.1	25.8	28.1	25.4	25.4

ACKNOWLEDGEMENTS

This research investigation was funded in part by the Clara Wu and Joseph Tsai Foundation.

REFERENCES

- Feltner ME, Bishop EJ, Perez CM. Segmental and kinetic contributions in vertical jumps performed with and without an arm swing. Research quarterly for exercise and sport 75: 216-230, 2004.
- Lees A, Vanrenterghem J, De Clercq D. Understanding how an arm swing enhances performance in the vertical jump. Journal of biomechanics 37: 1929-1940, 2004.
- Cabarkapa D, Philipp N, Cabarkapa D, Eserhaut D, Fry A. Comparison of Force-Time Metrics Between Countermovement Vertical Jump With and Without an Arm Swing in Professional Male Basketball Players. International Journal of Strength and Conditioning 3: (1), 2023.