



STRETCH-SHORTENING CYCLE PROPERTIES ARE MAINTAINED WHEN COMPARING JUMPS WITH AND WITHOUT ARM SWING

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Introduction

Countermovement (CMJ) and static (ST) jumps are often used to assess lower body stretch-shortening cycle (SSC) function (6), with efficient use of the SSC related to performance in sporting activities (1). Practitioners can assess SSC performance by comparing jumps with or without arm swing (AS). Jumps without AS may allow for isolated assessment of lower body SSC function without AS influence (4). However, jumping performance can be strongly influenced by AS, with AS jumps realizing greater peak force and jump height than jumps without AS (3). However, how the eccentric utilization ratio (EUR) and other SSC metrics are influenced by AS is less explored.

Purpose

The purpose of this study was to compare SSC characteristics between jumps with and without AS in recreationally trained jumpers.

Methods and Materials

- Participants: recreationally active males (n = 5) and females (n = 3) ($X \pm SD$, age = 19.8 ± 0.5 yrs., height = 166.2 ± 16.7 cm, mass = 74.1 ± 13.7 kg).
- Participants completed 12 jumps: 3 CMJ with AS (CMJ-AS), 3 static (ST) with AS (ST-AS), 3 CMJ without AS (CMJ-NAS), and 3 ST without AS (ST-NAS). Depth was self-selected, with ST holding depth for 3 seconds before the concentric phase. To eliminate AS, NAS jumps held a wooden dowel on the shoulders. Jumps with the greatest flight times (FT) were retained for analysis. Participants rested for ≥ 2 minutes between jumps. Jumps were performed on a uniaxial force plate sampling at 1000 Hz.
- Flight times and JH were analyzed, with JH calculated from FT. Also, SSC characteristics between AS and NAS jumps were analyzed. The eccentric utilization ratio (EUR, $[(CMJ - SJ) / SJ] * 100$), pre-stretch augmentation percentage (PSAP, $[(CMJ - SJ) / SJ * 100]$), and reactive strength calculation (RSC, $[(CMJ - SJ) / SJ]$) were calculated from JH.
- A 2x2 repeated measures ANOVA compared differences in FT and JH between all jumps. Paired samples t-tests compared the EUR, PSAP, and RSC between AS and NAS jumps. Hedges' g effect sizes were calculated. Pearson product-moment correlations assessed SSC relationships between AS and NAS jumps. ($p < 0.05$).

Results

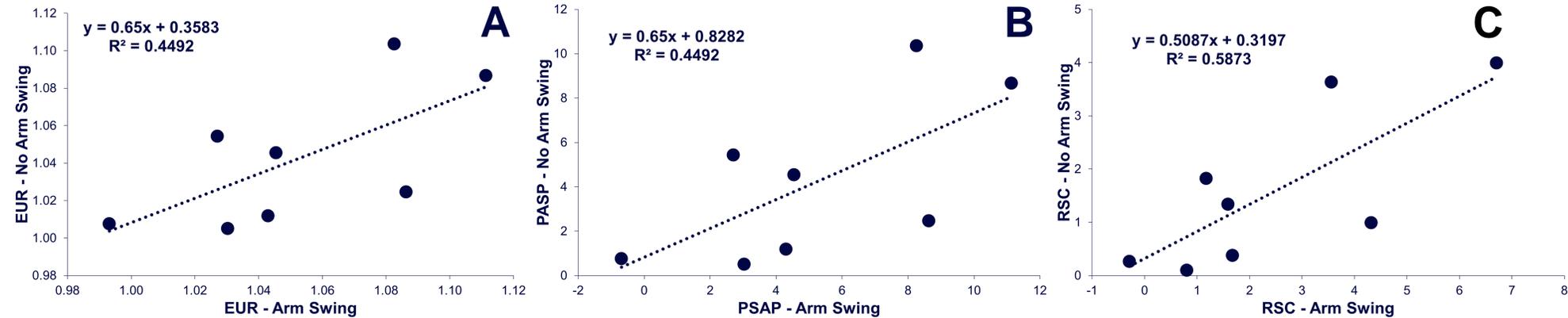


Figure 1. Scatter plots with lines of best fit, regression equations, and R^2 values comparing the SSC relationships between AS and NAS jumps for EUR (A), PSAP (B), and RSC (C).

Flight Time and Jump Height

- Main effects for AS and jump type (CMJ vs ST) were observed ($p < 0.05$).
- For FT and JH, CMJs and AS jumps had greater FT and JH than STs and NAS jumps ($p = < 0.01-0.02$, $\eta^2_p = 0.59-0.95$) (Table 1).

Stretch-Shortening Characteristics

- When comparing the SSC characteristics, no differences in EUR, PSAP, or RSC were observed between AS and NAS jumps (Table 2).
- Additionally, strong relationships in SSC characteristics between AS and NAS jumps were observed ($r = 0.67-0.77$, $p = 0.03-0.07$) (Figure 1).

Table 1. Flight time and jump height data for countermovement and static jumps with and without arm swing.

Variable	CMJ-AS	ST-AS	CMJ-NAS	ST-NAS
Flight Time (sec)	0.60 ± 0.08	0.58 ± 0.07	0.53 ± 0.07	0.52 ± 0.06
Jump Height (cm)	44.82 ± 11.89	42.38 ± 9.99	35.31 ± 8.87	33.75 ± 7.84

Data presented as $\bar{X} \pm SD$. CMJ, countermovement jump; ST, static jump; AS, arm swing; NAS, no arm swing.

Table 2. Comparison of stretch-shortening cycle characteristics between jumps with and without arm swing.

Variable	Arm Swing	No Arm Swing	T-test		Correlation	
			p	ES	r	p
EUR	1.05 ± 0.04	1.04 ± 0.04	0.39	0.31	0.67	0.07
PSAP (%)	5.24 ± 3.84	4.23 ± 3.72	0.39	0.31	0.67	0.07
RSC (cm)	2.44 ± 2.27	1.56 ± 1.51	0.14	0.56	0.77	0.03

Data presented as $\bar{X} \pm SD$. Hedges' g effect sizes (ES) and Pearson product-moment correlations (r) are shown. EUR, eccentric utilization ratio; PSAP, pre-stretch augmentation percentage; RSC, reactive strength calculation.

Conclusion

Though FT and JH differences were noted between AS and NAS, SSC characteristics were maintained. Also, strong relationships were observed between SSC variables for AS and NAS jumps, indicating maintained SSC performance between jump type. Although output measures like JH and FT are impacted by arm swing (3), the JH ratio between CMJ and ST is similar when AS is removed. Previous work recommends assessing a timing component for SSC efficiency (5), such as modified reactive strength index (RSImod). This takes JH and time to takeoff (TTT) into account, which may provide insight into jump strategy and performance improvement. However, previous work has found similar TTT between AS and NAS jumps, despite different JH and RSImod, suggesting JH may be the primary driver in RSImod differences between AS and NAS (2). Though assessing timing may help monitor adaptations over time, the similar SSC metrics and strong relationships between AS and NAS jumps suggest that SSC characteristics and the ratio between CMJ and SJ performance are maintained when removing AS.

Practical Application

Using AS may be a sport-specific decision coaches make when implementing jumps into a program. As SSC properties appear to be maintained between jumps with and without AS, coaches may be able to implement either style of jumps while observing similar SSC activity in athletes.

References

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