



JUMPING TO CONCLUSIONS: MapMyRun's Recovery-Monitoring Service 'Jump Around' is Sensitive to Neuromuscular Fatigue & Over-reaching in Runners

OVERVIEW

'Jump Around' is a footwear-integrated digital self-testing tool designed to assess neuromuscular fatigue through the measurement of the flight time of a series of six repeated vertical jumps (VJs). Although fatigue-monitoring via counter-movement VJ performance has been validated in the literature (1, 3-5, 8-11, 14, 15), and reinforced by interviews with coaching practitioners in elite sport (e.g. UA Ski & Snowboard, Canadian Sport Inst., Liverpool John Moores Univ., IMG Acad., Notre Dame Univ.), much discovery remained in deploying this technical service within the MapMyRun (MMR) application to serve runners typical of Under Armour's Connected Fitness user base. So, a Pilot Implementation Run Study was conducted late autumn 2016 to prepare for the commercial release of 'Jump Around' (JA) in early 2017. The study's primary objectives included:

1. To guide the software integration of JA within MMR and prove out its functionality.
2. To investigate the relationship between shoe-borne jump scores (i.e. performed recovery) and self-reported measures of well-being (i.e. perceived recovery) as runners were exposed to variable training loads.
3. To compare jump scores to heart-rate-based measures which are more traditional tools for monitoring fatigue.

Eleven subjects (2F, 9M; avg. age 33.6 +/- 4.5 years) were enrolled in the study. Each subject was at minimum moderately trained and had incorporated running into their training regimen; weekly mileage ranged from 10 to 60 miles per subject. Most participants had previously completed a half-marathon. Subjects' race experience ran the distance gamut (marathons, 10k races, Half Ironmans, Spartan races).

Subjects self-enrolled in a six-week program designed with sufficient training loads to deliberately induce fatigue levels that could be deemed counter-productive to performance (i.e. non-functional over-reaching). Training was divided into three 2-wk phases: baseline training, overload training, and active recovery. Participants were surveyed each weekday as to their perceived level of stress, sleep quality, muscle soreness, and general fatigue. Subjects also performed the JA jump-test before and after a 3-minute warm-up. Lastly, heart-rate (HR) measures were captured, including resting HR, running HR (85% estimated VO2 max), and recovery HR (recorded one minute after a steady-state treadmill run).

TAKEAWAY

For a small sample of trained runners tracked over six weeks of variable training load, shoe-borne jump scores are reliable, sensitive measures of neuromuscular fatigue.

STUDY HYPOTHESIS

- Jump scores will vary with each subject's **training phase** (Baseline - BL, Overload - OL, or Active Recovery - AR) and as a function of each subject's adaptations to variable running loads.
- Jump scores will correlate directly with self-reported measures (fatigue, soreness) and with HR-based measures.

MAIN FINDINGS

- During OL, post-warmup jump performance decreased progressively throughout the first week, likely reflecting the increase in cumulative training load effected by successive days of high-intensity training. Reduced jump scores also coincided with reduced running performance and an overall increase in subjects' self-reported muscle soreness and fatigue. HR measures exhibited significant effects in the second week of OL, a response that seemed delayed relative to expectations.
- Jump performance began to return to baseline levels during the second week of OL training even as load remained high, suggesting positive adaptations; however, self-reported muscle soreness remained elevated during OL phase. This finding is consistent with published research showing that muscles soreness peaks after athletic performance (as measured by force production) begins to rebound (2, 6, 7, 13, 16).

STUDY IMPLICATIONS

- Research has shown that runners often experience large week-to-week changes (5-10%) in training load. Moreover, fluctuations in load (>10%) have also been shown to increase the risk of illness or injury. Practical tools that manifest the athlete's level of fatigue and the body's status in recovering from variable loads would greatly inform a runner's training plan (12).
- Using HR-based measures to monitor fatigue may prove less informative than tracking jump scores since HR measures may lag or be dampened by fitness gains. JA appears to offer a more sensitive (less latent) fatigue indicator in that jump scores alert runners before training loads become acutely burdensome or chronically counterproductive. This study suggests that runners would benefit from the JA service to monitor recovery and optimize their training. 'Jump Around' performance, as tracked in this study, appears sufficiently sensitive to detect both recovered and over-



reached (both functionally and non-functionally) states. This finding is worth exploring further, in a longer study with a larger sample of athletes and more rigorous HR monitoring. In light of the greater expense and attendant rigor in capturing HR measures (e.g. via wristwatch, chest strap, etc.) relative to pre-training jump-testing in a pair of running shoes, the latter offers athletes and coaches the promise of a very portable, practical solution for tracking neuromuscular fatigue.

- JA jump scores are most informative amid consistent conditions and consistent effort; consistency yields a relevant baseline of scores, thus permitting conclusions to be drawn from meaningful deviations from each user’s normal range of jump performance. Daily jump-testing is recommended; a minimum frequency of every third day is required to keep the service current and sustain the JA baseline as a relevant performance reference. Athletes should maintain consistent behaviors before and during the test for maximal comparative value.
- *Test with or without warm-up?* For time-constrained runners, there is at most a small boost in jump scores (1-3%) gained

from warming up. Consistent jumping conditions are more critical (for fatigue detection) than a warm-up, so runners could perform the test with just a few priming jumps.

However, conducting JA with a warm-up is recommended for competitive runners seeking greater fatigue sensitivity, provided that warm-up is reproducible.

STUDY LIMITATIONS

Connected Fitness staff recruited and enrolled a limited number of participants for this study given the amount of time available. The study sample skewed toward subjects whose weekly mileage was lower than target MMR users. A larger study with more runners having more race experience may have yielded different findings, especially given the dynamic and highly individual relationship between fitness and fatigue. Also, given the timing of this study, conducted amid the Thanksgiving holiday, subjects’ vacations and nutritional loading may not have been ideal for the prescribed training loads and recovery monitoring. The study monitored participants’ jump performance and run-logs through the holiday interval, but participants made clear that compliance was a real challenge during this time.

WEEKLY AND OVERALL STUDY TRENDS

		BASELINE		OVERLOAD		RECOVERY		OVERALL TRENDS
		Week 1	2	3	4	5	6	
TRAINING LOAD (objective and perceived)	Yesterday	↑	↑	↑	↑	↑	↑	Training load increased during weeks 3 and 4
	Cumulative	↑	↑	↑	↑	↑	↑	
RUNNING PERFORMANCE				↓				Running performance decreased during the 3rd week
PERCEIVED RECOVERY	Sleep Quality							Reported fatigue increased during the 3rd week while reported soreness increased during the 3rd and 4th week
	Fatigue			↑				
	Soreness	↑	↑	↑	↑	↑	↑	
JUMP PERFORMANCE	Jump Ar., Cold		↑					Cold jump increased during the 2nd week while warm jump decreased during the 3rd week
	Jump Ar., Warm			↓				
HEART RATE MEASURES	HR Steady State					↑		Heart rate increased during the 4th and 5th week
	HR Recovery				↑	↑		
	HR Resting				↑	↑		

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