

Neuromuscular and Bounce Drop-Jump Responses to Different Inter-Repetition Rest Intervals during A Composite Training Session in Hurling Players

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Abstract: The purposes of this study were to a) compare a 4-min to an 8-min rest interval between composite training (jump-sprint combination) repetitions in a single session to allow for the recovery of neuromuscular and bounce drop-jump (BDJ) performance and b) investigate if super compensation would occur after 168hrs of rest. Twelve players were randomly assigned to either a 4-min or an 8-min rest interval group. Participants first completed a BDJ test to identify individual BDJ drop heights followed by a 20m sprint test. Seventy-two hours later, a composite training session of two repetitions (three BDJs followed by a 20m sprint after a 15s rest) with either a 4-min or an 8-min rest interval was performed. A three repetition maximum (3RM) back squat strength test, a BDJ, countermovement jump (CMJ) and a sprint performance test were completed 10-mins pre- and immediately post-session, and 168 hrs post-session. CMJ force (8-min group) and BDJ (height and reactive strength index (RSI)) measures decreased significantly post-session (4-min and 8-min groups; $P \leq 0.05$). Pre-session to 168 hrs post-session, relative 3RM back squat strength and 20m sprint performance increased significantly for the 4-min group only ($P \leq 0.05$). In conclusion, a 4-min composite training inter-repetition rest interval leads to a significant decline in BDJ measures (RSI and jump height) which may act as fatigue markers for monitoring. However, 4-mins provides sufficient recovery during the session which, in conjunction with 168 hrs of recovery, causes super compensation in neuromuscular performance in hurling players.

Key Words: Neuromuscular, stretch-shortening cycle, recovery, strength, sprinting.



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Introduction

Post activation potentiation (PAP) is a phenomenon where acute muscle performance is enhanced because of the muscle's contractile history, and it is stimulated by a voluntary muscle contraction performed at near maximal or at maximal intensity [1, 2, 3]. Two primary mechanisms have been proposed to explain PAP: i) the phosphorylation of myosin regulatory light chains, and, ii) the increased recruitment of higher order motor units [1]. However, there is evidence of an additional mechanism which relates to muscle architecture; specifically, a decrease in angle of pennation that may stimulate PAP [4]. PAP may ensue because of the interaction between both the central and peripheral mechanisms [5] (For reviews on PAP, readers are directed to previous work [1, 3]).

Evidence shows that bounce drop-jumps (BDJ) are effective at expressing PAP acutely to

enhance explosive activities such as jumping and sprinting [6, 7, 8, 9]. BDJs from a pre-determined height improved 50m sprint performance after both 10-mins and 15-mins recovery [9]. Moreover, BDJs from an individualised drop height enhance both jump [8] and sprint [6, 7] performance when employing 3 to 5 repetitions with rest intervals of 15 s to 2 mins between the BDJs and the jump or sprint. Despite these studies reporting significant improvements in sprint and jump performances using BDJs, no studies to date have examined the response to multiple repetitions of a BDJ PAP protocol during a training session on neuromuscular and BDJ performance.

We developed the novel term 'composite training' in previous work [7] to differentiate from complex training [10]. Composite training can be defined as the combination of a plyometric exercise with an explosive activity such as a sprint run,

performed as a 'combined repetition' / session. However, previous research has examined the single session responses to plyometric exercise where a decline in drop jump height, countermovement jump (CMJ) height and maximum rate of force development was observed [11, 12]. One study examined responses to a maximal speed training session where neuromuscular performance was shown to decline significantly for CMJ power and rate of force development immediately post-session [13]. To date, one study has examined a seven-day (168 hr) recovery period in response to muscle damaging exercise responses to plyometric activity [12].

Due to the novelty of composite training, the rest interval between jump-sprint repetitions needs to be identified for programming purposes and to determine immediate and super compensation [14] responses. The neuromuscular system requires an appropriate recovery time for the restoration of force and power production and previous work provides evidence that recovery times of 3- to 5-min between weight training sets is adequate [15]. From a PAP perspective, a meta-analysis suggests a greater PAP effect occurs when 0.3 to 4-mins rest between a plyometric exercise and the subsequent performance is employed [16]. Moreover, stronger participants require 5 to 7-mins rest between the conditioning activity (moderate to high intensity) and subsequent performance whereas weaker participants need a rest interval of ≥ 8 -mins. Indeed, Verkhoshansky [17] employs rest intervals of 8- to 10-mins between complex training repetitions of maximal squats and drop jumps to enable recovery of the neuromuscular system and drop jumps. Based upon these recommended rest intervals, a study designed to compare 4-mins to 8-mins of recovery would allow for the interrogation of an appropriate timeframe for neuromuscular and BDJ recovery between composite training repetitions.

The aims of this study were to a) compare a 4-min to an 8-min rest interval between composite training repetitions in a single session in 7-days to allow for the recovery of neuromuscular and BDJ performance and b) investigate if super compensation would transpire after 168hrs of rest. We hypothesized that the 4-min rest interval would

lead to a lesser decline in neuromuscular and BDJ performance and lead to greater improvements (super compensation) after 168hrs recovery than the 8-min rest interval.

Methods

Experimental approach

A randomised counterbalanced research design compared a 4-min and an 8-min rest interval between two composite training repetitions. Participants were divided into a 4-min or 8-min group to compare the efficacy of these rest intervals of passive recovery between two composite training repetitions. Composite training repetitions were designed based upon the appropriate BDJ volume, BDJ intra-repetition rest interval and the rest interval between the BDJs and the subsequent 20m sprints (intra-composite rest interval) previously determined [7].

Participants

Twelve male hurling players (mean \pm SD; age = 20.3 ± 2.3 years; mass = 80.6 ± 2.5 kg; height = 185.6 ± 2.5 cm) who competed in the Irish Collegiate Championship, and at club level, volunteered to participate in the study. Players had on average 13 years' game experience, four years of weight training experience and one year of plyometric training experience. Testing occurred during participants' pre-season where players were hurling training on average twice per week, weight training twice per week and playing a match once per week. No participant had an orthopaedic or musculoskeletal injury to their lower extremities in the six months before testing. Ethical approval was provided by the principal investigator's institutional ethics committee, and written informed consent was obtained from all participants before the study began.

Procedures

Participants were familiarised with the testing and training procedures during one familiarization session. Testing and training were

performed at the same time of day to account for diurnal variations (14:00–16:00 hours) and conducted indoors in the human performance laboratory. Participants performed a dynamic warm-up before familiarization, testing and training. This comprised of five minutes of self-paced low intensity jogging over 10m followed by a protocol of five dynamic stretches targeting the lower limb musculature [18]. One-week post-familiarisation, the first testing session determined BDJ drop height by performing BDJs onto a portable force plate, and the collection of 20 m sprint times which were used to randomly allocate players into one of two counterbalanced groups. After a 72 hr recovery period, depending upon which group they had been allocated to, participants performed a session of composite training of two repetitions using a 4-min or an 8-min inter-repetition rest interval. Pre- and post-test scores for CMJ, BDJ, 20 m sprint times (including 5m and 10 m split times) and 3 repetition maximum (3RM) back squat strength were collected 10-mins before and 10-mins after the training session. An additional post-test was conducted after 168 hrs of no training to observe the effects of this period of recovery on neuromuscular and BDJ responses.

Reactive strength index (RSI) testing and drop height determination

Participants performed a BDJ test to determine their maximum RSI, which was used to monitor reactive strength and to identify drop height for BDJ training. Two BDJs from five different drop heights (0.20 m, 0.30 m, 0.40 m, 0.50 m and 0.60 m) were performed using an incremental protocol; employed so that the stretch load (intensity) could be progressively increased. To minimize fatigue, 2-mins rest was allowed between drop heights [19]. The highest RSI of two BDJs for each drop height was used for analysis. Drop height was determined by employing the RSI method [20]; which identified the drop height to be used as the height that produces the maximum RSI. Ground contact time (GCT) for each BDJ jump was required to be < 0.250s [21].

CMJ testing

Participants were required to perform three maximal CMJs by squatting to a self-selected depth followed by jumping upward for maximum height, taking-off and landing on a portable force plate (Type 92886AA, Kistler Instruments Ltd, Hook, United Kingdom). Hands were akimbo for the entire jump movement, and participants performed three trials with the best trial, based upon jump height, used for subsequent analysis.

Sprint performance testing

Before maximal efforts, participants performed a sprint warm-up comprising of two sprints at 50%, and three at 80% of maximum over 20m on a synthetic indoor track which was located in the laboratory [22]. Players were allowed 30s recovery between the 50% sprints, 1-min recovery between the 80% sprints, and 1-min recovery between the final 80% sprint and the first maximal sprint effort. Maximal 20m sprinting began with participants using a two-point sprint start, 0.5m behind the first Witty photocell (Microgate, Bolzano, Italy) and were instructed when to start. Participants performed three maximal sprints with 3-mins recovery. Split times were collected at both 5m and 10m, and the fastest 20m sprint time were used for analysis.

3RM back squat strength testing

After the third maximal 20m sprint was completed, a 3-min rest interval was allowed before the participants performed a modified 3RM back squat strength test protocol [23]. A warm-up began with two sets of eight repetitions at 50% of predicted 1-RM followed by four repetitions at 70% predicted 1-RM. After completing the latter four repetitions, participants attempted to perform three repetitions at a 3RM load. Testing required participants to squat down, with a weighted bar across their shoulders, until their thighs were parallel with the ground; this position was set individually by means of a bench placed behind the lifter. A 2-min recovery and a 5-min recovery were allowed between the warm-up sets and the 3RM attempts respectively. The 3RM

trials continued until the participant was unable to complete the lift through the designated range of movement. Relative strength [(RS) was calculated as: $RS = 3RM \text{ (kg)} / \text{body mass (kg)}$.

Data analysis for CMJ, RSI testing and drop height determination

A portable multi-component force plate with an in-built charge amplifier (Type 92886AA, Kistler Instruments Ltd, Hook, United Kingdom) was used to measure force-time indices at a sampling frequency of 1000 Hz. Data were saved and analysed using bespoke BTS-SMART software (BTS Spa, Milan, Italy).

The measures of jump height, peak velocity, peak force, peak power and average eccentric rate of force development (ECC-RFD) were calculated from the CMJ test data. Variables were derived as absolute and relative (to body mass (kg)) values except for jump height and peak velocity. Peak force was considered as the highest ground reaction force in the vertical component during the concentric phase of the jump. Peak power was computed from the product of peak force and peak velocity of the centre of mass from the CMJ. To calculate peak velocity, centre of mass velocity was derived from the numerical integration of vertical acceleration; calculated by dividing the vertical ground reaction force by the participant's body mass. ECC-RFD was calculated during the eccentric phase of the CMJ from the force-time curve when force exceeded body weight (N), and ended when velocity was equal to zero (bottom of descent before moving in an upward direction towards take-off) [24]. Jump height (H) for the CMJ and BDJ was calculated from flight time using the following equation [25]:

$$H = gt^2 / 8 \quad \text{where: } g = \text{acceleration due to gravity (9.81ms}^{-2}\text{); } t = \text{flight time (s)}$$

BDJ GCT during the amortization phase (the timeframe in which a participant is in contact with the ground before the subsequent jump) was calculated as the time between initial foot contact and take-off [26]. The RSI was calculated as: $RSI = \text{jump height (m)}/\text{contact time (s)}$.

Statistical analyses

Data are summarised as means \pm SDs for all measures. A three (time: pre-session, post-session and 168 hrs post-session) by two [groups: 4-min and 8-min] within-between repeated measures ANOVA was performed to determine if significant differences existed between the main effect of 4-mins versus 8-mins of inter-repetition rest time during composite training. Effect sizes (partial eta) and power were also computed for each of the comparisons. *Post-hoc* pair-wise comparisons were made using paired *t*-tests with a Dunn-Sidak adjustment to the level of statistical significance. Individual pair-wise comparisons were performed on 20 m sprint times and relative 3RM back squat strength pre-session to 168 hrs post-session; and BDJ GCTs post-session to 168 hrs post-session. Effect sizes (ES) for these pairwise comparisons were estimated using Cohen's *d* and interpreted as: $<0.2 = \text{trivial}$, $0.2-0.5 = \text{small}$, $0.5-0.8 = \text{moderate}$, and $0.8 \geq = \text{large}$ [27]. Scores for the CMJ, BDJ, 3RM back squat strength test and 20m sprint performance measures were reliable based upon ICC values ranging from 0.88 to 0.99. Statistical significance was set at $P \leq 0.05$ and data were analysed using the Statistical Package for the Social Sciences v23 [SPSS Inc., Chicago, Illinois].

Results

Non-significant changes were observed for group main effects and group by time interactions on all measures for both the 4-min and the 8-min rest intervals.

Neuromuscular responses

CMJ height showed a time main effect ($F = 20.1$ ($P < 0.001$); partial eta = 0.66; power = 0.99), however, the rest of the CMJ measures did not show significance for the recovery time main effect.

Absolute and relative force significantly decreased pre- to post-session in the 8-min group. CMJ height (4-min and 8-min groups), relative peak power, and absolute and relative ECC-RFD increased significantly post-session to the 168 hrs post-session for the 4-min group (Table I).

Table 1. Counter movement jump (CMJ) scores (mean \pm SD) for the 4-min and 8-min groups at pre-, post- and 168 hrs post- the composite training sessions.

	Pre	Post	ES1	168 hrs post	ES2	ES3
Height (m)						
4-min	0.38 \pm 0.05	0.35 \pm 0.04	-0.61	39.7 \pm 3.7 **	1.02	0.30
8-min	0.35 \pm 0.04	33.7 \pm 5.1	-0.45	37.5 \pm 5.0 *	0.72	0.36
Velocity (m s⁻¹)						
4-min	2.87 \pm 0.34	2.68 \pm 0.26	-0.61	2.92 \pm 0.24*	0.88	0.17
8-min	2.73 \pm 0.35	2.65 \pm 0.21	-0.31	2.57 \pm 0.22	-0.35	-0.55
Force (N)						
4min	1796	1805	0.05	1822	0.10	0.17
8min	1845	1756#	-0.49	1903	0.56	0.23
Force (N kg⁻¹)						
4-min	2.27	2.27	-	2.32	0.27	0.32
8-min	2.46	2.35#	0.47	2.49	0.61	0.13
Power (W)						
4-min	5197	4863	-0.37	5324	0.59	0.16
8-min	5070	4675	-0.43	4856	0.28	-0.26
Power (W kg⁻¹)						
4-min	64.61	60.26	-0.41	66.74*	0.69	0.22
8-min	66.34	61.43	-0.43	62.89	0.16	-0.39
ECC-RFD (N s⁻¹)						
4-min	4611	4459	-0.08	5410*	0.55	0.42
8-min	5653	5006	-0.25	6111	0.22	0.18
ECC-RFD (N kg⁻¹)						
4-min	5.80	5.59	-0.09	6.88**	0.62	0.47
8-min	7.60	6.80	-0.21	7.96	0.33	0.11

ES1 = effect size for pre- to post-session; ES2 = effect size for post- to 168 hrs post- session; ES3 = effect size pre- to 168 hrs post-session.

#P \leq 0.05 decrease from pre- to post-session. *P \leq 0.05 increase from post- to 168 hrs post- session. **P $<$ 0.01 increases from post- to 168 hrs post- session.

Table 2. Sprint performance scores (mean \pm SD) for the 4-min and 8-min groups at pre-, post- and 168 hrs post- the composite training sessions.

	Pre	Post	ES1	168 hrs post	ES2	ES3
5m (s)						
4-min	1.08 \pm 0.03	1.07 \pm 0.04	-0.36	1.05 \pm 0.02	-0.26	-0.86
8-min	1.11 \pm 0.04	1.11 \pm 0.05	-	1.09 \pm 0.07	-0.31	-0.32
10m (s)						
4-min	1.82 \pm 0.05	1.82 \pm 0.04	-	1.81 \pm 0.02	-0.21	-0.16
8-min	1.84 \pm 0.06	1.83 \pm 0.05	-0.18	1.84 \pm 0.06	0.17	-
20m (s)						
4-min	3.13 \pm 0.08	3.13 \pm 0.06	-	3.06 \pm 0.06*	-0.97	-0.82
8-min	3.14 \pm 0.07	3.14 \pm 0.09	-	3.14 \pm 0.09	-	-

ES1 = effect size for pre- to post-session; ES2 = effect size for post- to 168 hrs post- session; ES3 = effect size for pre- to 168 hrs post-session.

*P \leq 0.05 increase from pre-session to 168 hrs post- session.

Table 3. 3RM back squat strength scores (mean \pm SD) for the 4-min and the 8-min groups at pre-, post- and 168 hrs post- the composite training session.

	Pre	Post	ES1	168 hrs post	ES2	ES3
3RM (kg)						
4-min	105.8 \pm 10.8	103.6 \pm 15.1	-0.17	111.1 \pm 14.5	0.52	0.43
8-min	107.3 \pm 17.2	108.3 \pm 17.3	0.06	111.6 \pm 14.4	0.21	0.28
(kg BM(kg)⁻¹)						
4-min	1.32 \pm 0.17	1.29 \pm 0.21	-0.18	1.40 \pm 0.20*	0.52	0.41
8-min	1.41 \pm 0.21	1.42 \pm 0.22	0.08	1.45 \pm 0.20	0.17	0.23

ES1 = effect size for pre- to post-session; ES2 = effect size for post- to 168 hrs post- session; ES3 = effect size for pre- to 168 hrs post-session.

*P \leq 0.05 increase from pre-session to 168 hrs post- session.

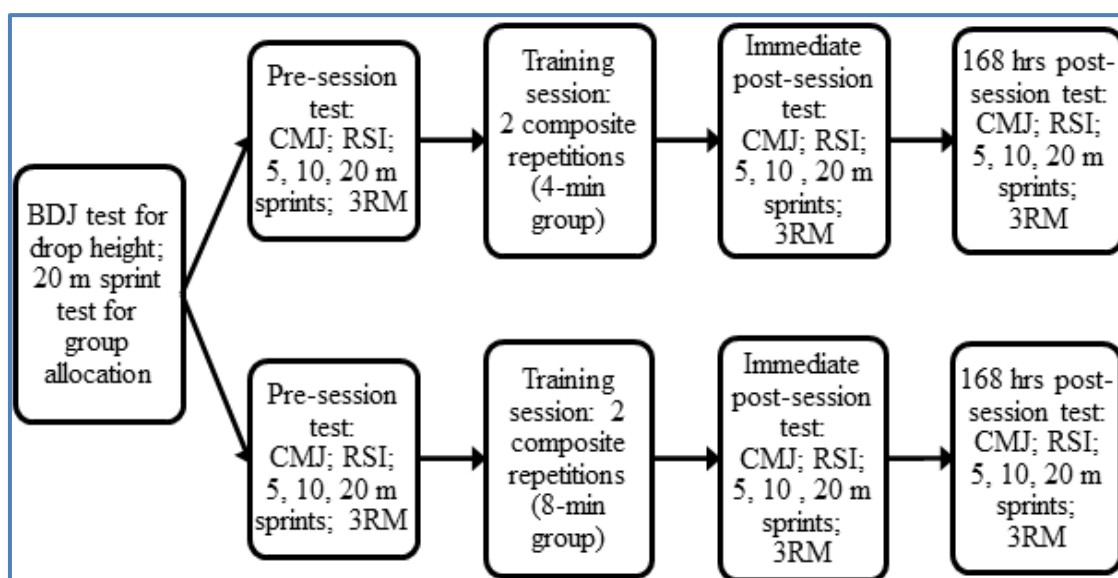


Figure 1. Schematic diagram of study. CMJ = countermovement jump, RSI = reactive strength index, 3RM = 3 repetition maximum back squat test.

Absolute and relative force significantly increased from pre-session to 168 hrs post-session in the 4-min group. Absolute force decreased pre- to post-session in the 8-min group. CMJ height (4-min and 8-min groups), relative peak power, and absolute and relative ECC-RFD increased significantly post-session to the 168 hrs post-session for the 4-min group (Table 1).

For 20m sprint performance ($Z = -1.89$; $P = 0.05$; -2.1%), a pair-wise comparison showed a significant increase from pre- to 168 hrs post-session for the 4-min group (Table 2). Absolute 3RM ($F = 5.1$ ($P = 0.01$); partial eta = 0.33; power = 0.75) and relative 3RM ($F = 4.12$ ($P = 0.03$); partial eta = 0.29; power = 0.66) back squat strength showed a significant time effect (Table 3). Relative 3RM back squat strength ($t = -2.75$; $P = 0.04$; 5.6%) significantly

BDJ responses

Significant time effects were found for RSI ($F = 21.10$ ($P < 0.001$); partial eta = 0.67; power = 1.0) and height ($F = 14.38$ ($P < 0.001$); partial eta = 0.59; power = 0.99). Both groups experienced significant decreases in RSI and jump height pre- to post-session, and significant increases in both these measures post-session to 168 hrs post-session. GCT in the 4-min group showed significant improvement from post-session to 168 hrs post-session (Figure 1).

Discussion

The current study is the first to compare rest intervals between two composite training repetitions to document neuromuscular and BDJ responses post-session and after a 168 hrs recovery. The findings indicate that BDJ (RSI and height) measures and CMJ peak force are sensitive to acute fatigue post-session and may act as fatigue monitoring markers dependent on the rest interval employed. Moreover, a 4-min rest interval led to significant improvements after 168 hrs recovery in 3RM back squat strength and 20 m sprint performance suggesting a training effect (super compensation) was induced. Consequently, a 4-min rest interval is efficient and enables adaptation leading to enhanced strength and sprint performance in hurling players.

Neuromuscular responses

The majority of CMJ measures in both groups decreased post-session whereas the majority of sprint performances and 3RM back squat strength measures remained unchanged. The decrease in CMJ height (4-min: 8.3%; 8-min: 6%) post-session (Table 1) was similar to the decreases in height of 10% after a sprint training session [13] and 7% after a drop-jump session [28] (50 jumps). Post composite session decreases in power (6.4% - 7.8%) for both groups in our study were similar to those previously reported (4.6% - 4.7%) [13]. ECC-RFD post-session, the decrease in absolute values for the 4-min group showed an average decrease of 3.6% which is comparable to the 4.9% reported by Johnston et al. [13].

Present sprint performances are difficult to compare to the literature because previous studies only assessed 5m and 10m sprint performance 24 hr post a vertical jump training session and not immediately after as in our study [12]. However, when comparing sprint performances over 5m and 10m after a post-session recovery of 168 hrs, the 5m adaptation is similar. In our study, the participants' 10m times appear to have adapted with an improvement only in the 4-min group.

Comparing maximum strength changes in the lower limb is difficult because, to the best of our

knowledge, our study is the first to assess 3RM back squat strength changes in relation to jump, sprint or combined jump-sprint training sessions. However, non-significant changes in concentric peak torque are evident after a session of 100 jumps and after 120 hrs of recovery [29]. This outcome [29] may be explained by a moderate relationship between an isokinetic velocity of 2.09 rad s⁻¹ and drop jump height [30], consequently, velocities greater than 3.14 rad s⁻¹ should be considered. This is commensurate with our findings, where a significant increase in relative 3RM back squat strength occurred after 168 hrs of post-session recovery.

It is possible that decreases in performance post-session are sensitive to training volume and this provides scope for further research in terms of programming and fatigue monitoring. Nevertheless, factors including the type of training undertaken, maximum strength levels, and the rest intervals, volume, intensity and duration of the intensity of training will need to be considered. These factors may impact how fatigue impacts adaptation to generate super compensation [31].

BDJ responses

In our study, BDJ height for both groups displayed a significant post-session decrease (4-min = 14.5% vs. 8-min = 12.2%) which is greater than that reported by Skurvydas et al. [32], where DJ height decreased by greater than 8.7% after 8-mins post-100 DJs in untrained males. Furthermore, after 20-mins recovery post-50 DJs, untrained males and sprinters decreased DJ height by 11.3% and 8.9% respectively [28]. To compare our findings directly with those from these two studies is challenging, due to differences in study design related to the forms of exercise used, and the volume and post-session rest times employed. Furthermore, DJs with a countermovement to an angle of 90 degrees were employed [32]. This DJ technique produces lower ground reaction forces, torque and power in comparison to the BDJ used in our study [33].

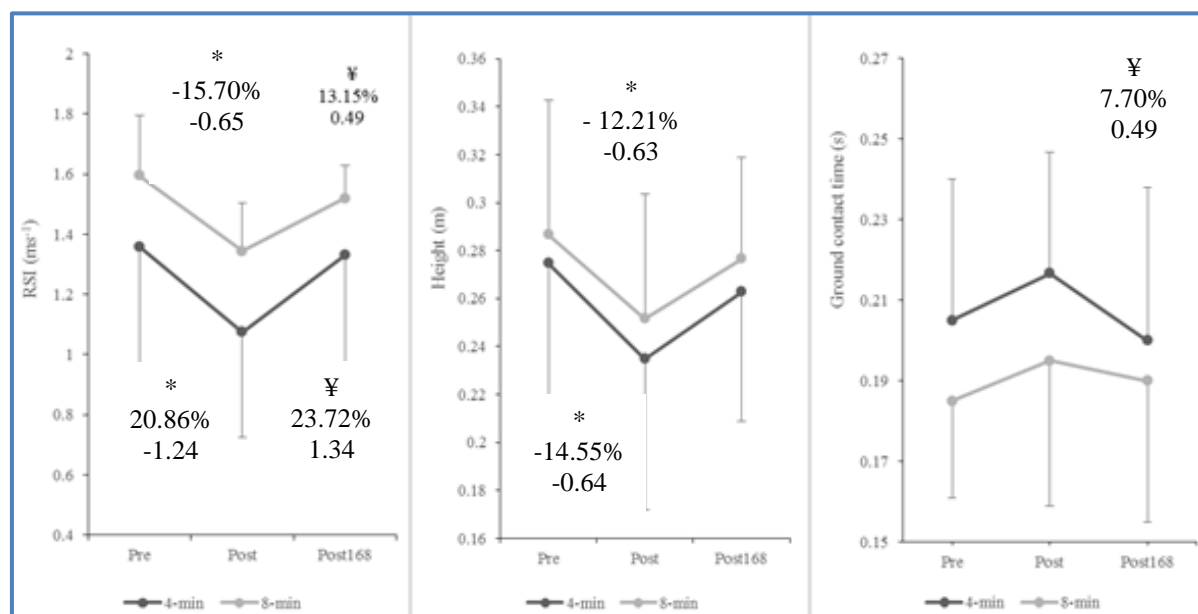


Figure 2. BDJ (mean \pm SD) scores (RSI, jump height and GCT) for the 4-min and the 8-min groups at pre-, post- and 168 hrs post- the composite training session.

ES1 = effect size for pre- to post-session; ES2 = effect size for post- to 168 hrs post- session; ES3 = effect size for pre- to 168 hrs post-session.

*P \leq 0.05 increase from post- to 168 hrs post-session.

*P \leq 0.05 decrease between pre-session and post-session. ¥P < 0.05 increase in performance between post-session and 168 hrs post- session.

This technique difference may also explain why our participants experienced a greater decrease in DJ height, as force decrease may have led to a compromised ability to switch rapidly from an eccentric to a concentric muscle contraction.

The decrease in neuromuscular and BDJ functioning may be explained by central [34, 35] and peripheral [36] mechanisms of fatigue. Force generating capacity can be reduced peripherally because of action potential failure, excitation-contraction coupling failure or impaired cross-bridge cycling and centrally by a decline in neural drive to the active muscle [37]. The consequence of local muscle failure and impairment may have been the modulation of reflex and stiffness interaction [38].

Both our groups displayed similar declines in the majority of CMJ measures from pre- to post-session. Furthermore, BDJ function displayed similar decreases pre- to post-session. The exception, the 8-min group, displayed a greater decrease in peak force

and ECC-RFD. The 8-min rest interval in conjunction with the relatively weak participants [39] possibly dampened the composite training PAP effect due to lacking fatigue resistance enabling fatigue to dominate.

When considering the recovery 168-hrs post-session based upon effect size, both groups experienced similar improvements in CMJ height. Nonetheless, only the 4-min group exhibited super compensation through augmented responses for 3RM back squat strength (ES = 0.41-0.43; 4.9-5.6%), CMJ measures (relative force (ES = 0.32; 2%) and ECC-RFD (ES = 0.42-0.47; 30%)) and sprint performance (5 m (ES = -0.86; -2.7%) and 20 m (ES = -0.82; -2.1%)). Our findings support a review where recovery of maximal voluntary contractile strength occurs after 144- to 192-hrs following SSC performance [40].

A limitation of our study was the limited sample size. Recruiting players from this amateur

sport proved challenging due to their college coursework and training regime. In hurling, there is generally not a transition phase in the annual training cycle for player recovery and volunteered when a break existed. We acknowledge that the inclusion of additional time points (i.e. 48 and 72 hrs) would have provided valuable data, but participant access was limited. Further research should examine the neuromuscular and fast SSC DJ responses to a composite training session of six repetitions of 20m to 30m sprint accelerations as suggested previously [41].

Practical applications

A composite training session comprising of multiple repetitions is recommended to employ a 4-min inter-repetition rest interval. When observing the immediate responses to two repetitions, the 4-min rest interval induced a lesser decline than 8-mins in CMJ measures including relative peak force, peak power and ECC-RFD. After 168 hrs of rest, super compensation was observed where relative 3RM back squat strength and sprint performance was improved with the 4-min rest interval. When considering additional parameters that improved pre- to 168 hrs post-session based upon effect size but not statistically significant, it is important to monitor responses in absolute 3RM strength; CMJ height, relative peak force and ECC-RFD; and 5 m sprint performance. The application of a 4-min rest interval proves time efficient because training time for the sports science practitioner working with hurling players at collegiate and club level is limited.

Conclusions

The authors have demonstrated that a 4-min rest interval between composite training repetitions is time efficient and attenuates certain CMJ measures to a lesser degree than 8-mins. Super compensation is evident when employing a 4-min rest interval through augmentations in maximum strength and 20 m sprint performance after 168 hrs recovery in hurling players.

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Competing Interests:

The authors declare that they have no competing interests.

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