The Impact of Injury and Subsequent Time Loss on the Development and Performance of Pupils at an Independent Boarding School in the UK

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Introduction

School sport provides a vast array of opportunity for adolescents to develop physically. However, injury can be a consequence of exposure to sports during adolescence, with little research presenting findings on incidence and burden of injury seen during adolescence. As such, through a thorough audit process, the Physiotherapy Department of an independent school aimed to report the sports with the highest incidence and burden across the school's team invasion sports. Aiming to inform practitioners on appropriate methods of injury risk reduction.

Methods

Injuries were triaged daily and audited (weekly) over the course of an academic year (September 2017 – July 2018), from a population (N = 1248) of pupils at an independent boarding school (ages 13-18 years). Data was collected on the week of occurrence, which sport the injury occurred in, if the injury was sustained during training or match play and finally the time loss (days) resulting from each injury. Descriptive statistical analysis was conducted to assess total injury incidence per 1000 hours of training and match exposure, time loss (days) for each injury (training and match), allowing the subsequent burden of injury per sport to be calculated. Analysis was conducted on how each injury occurred (designated as contact or non-contact injury) and burden of injury was calculated for each injury type within each sport analysed.

Results

A total of 622 injuries were recorded in triage. The highest injury burden was in Girls Hockey and the lowest was in Netball. Boys Hockey had the greatest training injury burden. Girls Hockey presented the high match injury burden, see Figure 1. Figure 2 illustrates the cause of injury across the sports. The highest number of contact and non-contact injuries were in Rugby, and the lowest number of contact and non-contact injuries in boys hockey. Figure 3 depicts the burden of injury per body part / per sport (1000 hrs exposure). As can be seen, total knee injuries were the most burdensome in Rugby, Football, Girls Hockey and Netball. Boys hockey had the highest burden of injury related to the ankle.

Figure 1. Injury burden (no. Injuries/ 1000 hours) training and match play 2017-18 academic year (team invasion sports)

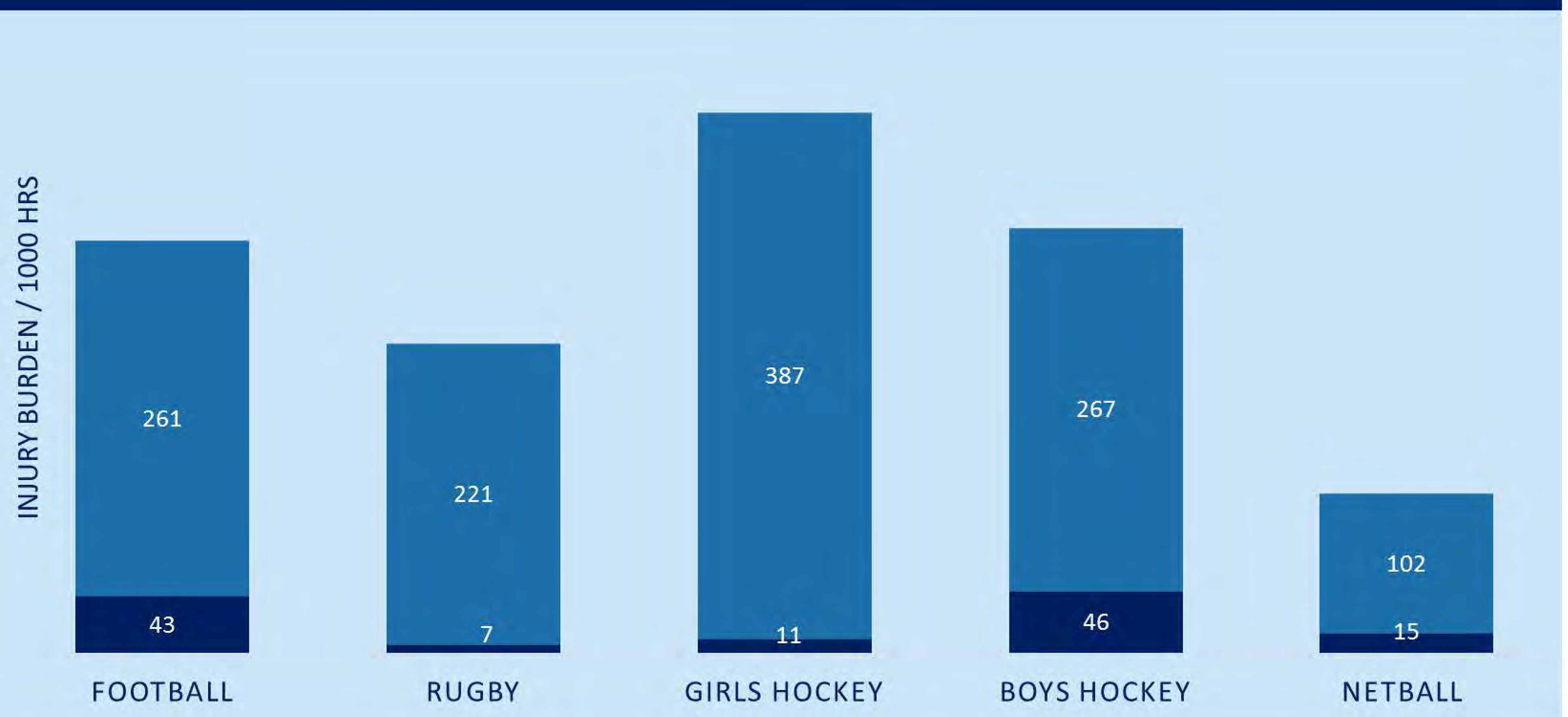
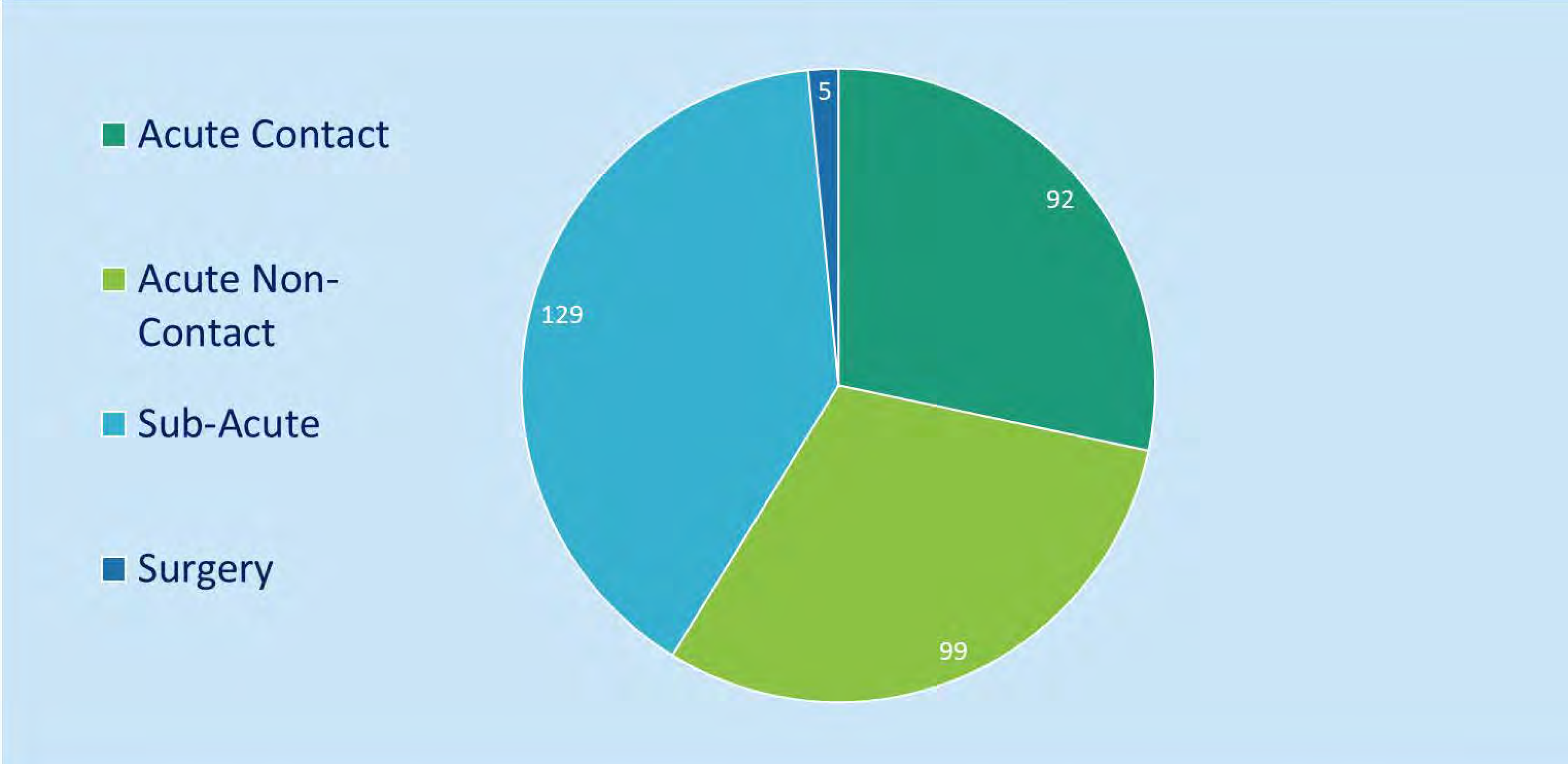


Figure 2. Injury occurrence % in Rugby, Football, Hockey (boys and Girls) and Netball academic year 2017-18



Summary and Conclusion

This data provides an insight into injury incidence and burden in a UK independent school. This information could assist similar institutions in evaluating their own sports injury profile, contributing towards a greater understanding of injury risk in this demographic. This data may help direct sport and S&C coaches on implementing injury risk reduction protocols to minimise the incidence and burden of injuries in the identified sports programmes. For example, evidence supports the implementation of warm up protocols consisting of locomotion, proprioception and strength development in field based sports. The inclusion of neuromuscular training has been shown to decreased risk of common lower limb injuries in female athletes and the planned and progressive elevation of an acute to chronic workload has been shown to reduce injury occurrence across a range of invasion sports.

Acknowledgements

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Table 1. Total injury burden (1000 hrs exposure) per body area for Rugby, Football, Netball, Boys Hockey and Girls Hockey 2017-18 academic year

	Football	Rugby	Boys Hockey	Girls Hockey	Netball
Foot Total	19	2	6	0	89
Ankle Total	76	13	277	33	120
Lower leg Total	2	35	36	17	63
Groin Total	29	6	0	3	0
Hamstring Total	65	21	83	26	201
Quads Total	50	33	20	39	37
Knee Total	392	185	36	166	895
Shoulder Total	4	308	0	2	19
Upper limb Total	16	30	0	5	5
Spine Total	14	60	3	11	28
Concussion	24	23	27	33	50

Changes in salivary testosterone concentrations and subsequent voluntary squat performance following motivational self-talk and self-selected music

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INTRODUCTION

In sport, recent studies have investigated how motivational team talks (Cook & Crewther, 2012), videos (Cook & Crewther, 2012), and social environments (Cook & Crewther, 2014) can positively prime performance in training and competition. These studies note an increase in testosterone (T) concentrations which serves to modulate behaviour, supported by research showing that self-selected training loads increase in line with increases in T, in both males (Cook et al., 2013) and females (Cook & Beaven, 2013). The theory is that T motivates individuals to take more risks (Cook & Beaven, 2013) and become more sensitive to the rewards associated with success; it is also thought to act more generally on motivation (Apicella, et al., 2014). In this study, we aim to assess the priming capability of listening to self-selected music (SSM) or engaging in motivational self-talk (MST) to improve subsequent 3RM squat performance. We also investigate if these interventions invoke changes in the release of T and Cortisol (C) to at least partly explain the mechanisms at work.

METHODS

Methods are in alignment with those of Cook and Crewther (2012). In a randomised cross-over design, 15 participants sat in a room for 4 min, either passively (control group), listening to SSM, or engaging in MST, before undertaking a standardised warm-up. Prior to this and at the conclusion of the warm-up (15 min period), participants provided saliva samples for the analysis of T and C. Participants then had their 3RM back squat strength measured. Statistical significance was analysed using a one-way repeated measure ANOVA with Bonferonni Post hoc analysis. Practical differences were examined using effect size analysis.

RESULTS

Only practical differences were noted. Compared to the control condition, there was a small increase in 3RM squat performance in the MST and SSM conditions (ES = 0.23 and 0.27 respectively), which were accompanied by small increases in T (ES = 0.39 and 0.56 respectively). There were no differences noted in cortisol concentrations and when comparing MST with SSM; all results are illustrated in Figures 1 and 2.

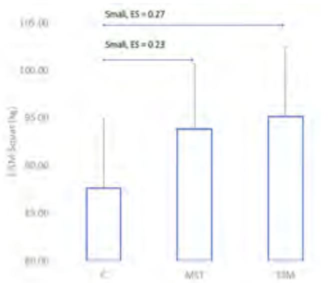

Figure 1. 3RM squat performance following control (C), motivational self-talk (MST) and self-selected music (SSM) interventions. ES = effect size

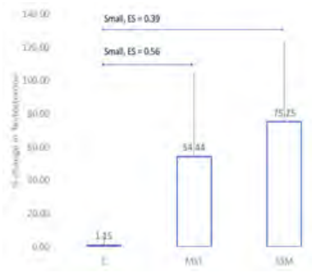

Figure 2. Change (%) in testosterone concentrations pre and post C, MST and SSM interventions

PRACTICAL APPLICATION

Similar to the findings of Cook and Crewther (2012), 3RM squat performance can be primed by strategies that increases concentrations of T, thereby serving to prime an individual's motivation to perform. While the effect of music has been examined extensively, it tends to be in the context of fitness classes or aerobic based training, where it mediates its benefits via rhythm (Kornysheva et al., 2010) and a dissociation from effort (Karageorghis & Priest, 2012). Here we posit that providing the music soundtrack resonates with the athlete and is of a high tempo (≥ 120 bpm), it can also get an individual "amped," and therefore be useful to strength and power-based training too. Self-talk, considered a form of "psyching-up," has been more widely examined and has been found to be beneficial to strength and power training, normally on account of the release of catecholamines (Tod et al., 2011). Here we can add to the literature supporting its use, but also demonstrating the novel finding that MST strategies are also facilitated by increases in T (this is also a novel finding with regards to music). In summary, simple, freely available strategies, such as SSM and MST can prime an athlete's performance during training sessions such that they are willing to work harder and take more risks.

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Does social media effect squat performance and hormonal response

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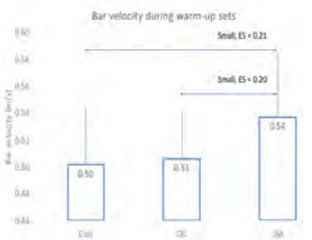
INTRODUCTION

In this study, we aim to assess the priming capability of the observer effect (OE) directly and via social media (SM). The OE was first established by Triplett (1898) examining how the behavior of an individual was affected by the presence of others, with current research supporting initial observations that skilled individuals tend to exhibit increased performance, while unskilled individuals tend to perform worse (Zajonc, 1965). In more recent years, SM platforms enable the presence of a virtual OE. While individuals acknowledge that observers will be higher in number, it is posited that this is potentially offset by the fact that they will not witness judgment firsthand, and that fundamentally, the video can be edited or even deleted. In this situation, unlike that of direct OE, we hypothesis that even less skilled individuals can be primed by SM to increase performance, owing to the fact that they can concentrate on our innate drive to seek status (Janak et al., 2015), which is in part be explained by the "Biosocial Model of Status" (Mazur & Booth, 1998). This model suggests that testosterone (T) motivates competitive behaviors that serve this primitive drive. We therefore also investigate if these interventions invoke changes in the release of T and cortisol (C), to at least partly explain the mechanisms at work.

METHODS

Following a standardised warm-up, which included measuring barbell velocity at a set load to determine readiness to train, 14 participants completed a back squat to failure test. The test used a load corresponding to 14RM. It was felt that this load would challenge the participants' capacity for sustained effort and ability to suppress or override our physiological urge to cease exercise, as described by St Clair Gibson et al., (2018) and Van Custem et al., (2017). Following the warm-up and in a randomised cross-over design, participants then completed the test under regular control settings, being observed by strangers and peers, or being filmed under the pretense that videos would be uploaded to SM platforms. To blind the participants from the fact that we were investigating the effect of OE and SM, participants were told that the study was investigating the day to day variability in repetitions to failure. Participants were informed of our desire to post their performance or the presence of observers prior to the warm-up, with saliva samples (to measure T and C) taken either side (15 min period). Practical differences were examined using effect size (ES) analysis.



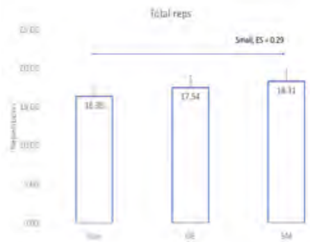
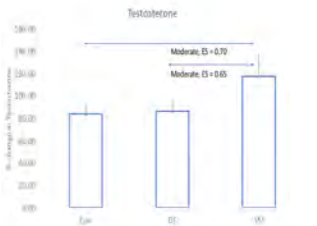
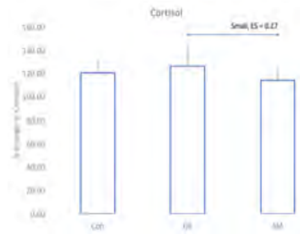


Figure 1 (bottom left). Bar velocity during warm-up sets I Figure 2. Total reps completed (bottom right) I Figure 3. Change (%) in T concentrations pre and post (top left) I Figure 4. Change (%) in C concentrations pre and post (top right)





RESULTS

Compared to control, SM caused a small increase in bar velocity during the warm-up sets (ES = 0.21) and a small increase in total reps completed (ES = 0.29). These were mirrored by moderate increases in T (ES = 0.63). Compared to OE, SM caused a small increase in bar velocity during the warm-up sets (ES = 0.20), a smaller increase in C (ES = 0.27), and moderately higher increases in T (ES = 0.65) No differences were noted when comparing OE to the control condition.

PRACTICAL APPLICATION

The thought that their physical performance would be shared on SM platforms, acted to prime effort, demonstrating a small improvement in performance. This was demonstrated by increases in bar velocity recording during the warm-up sets and the total reps completed. On account of these performance improvements being mirrored by moderate increases in T and the T:C ratio, we speculate that T modulated behavior and motivation to capitalize on what they perceived to be a status seeking opportunity.

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Inter-limb Asymmetries: The Need for an Individual Approach to Data Analysis

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PURPOSE

Inter-limb asymmetries have been a popular line of investigation in recent years, with numerous studies highlighting the task-specific nature of each test; this represented by the changing magnitude of asymmetry from test to test. However, information relating to which side the resulting asymmetry favours (i.e., left or right scoring better) is scarce. Thus, the purpose of the present study was to quantify levels of agreement between tests, to determine how frequently asymmetries favoured the same side.

INTRODUCTION

Previous research has shown that the magnitude of inter-limb asymmetries varies from test to test. When considering unilateral test protocols, vertical jumping has been shown to demonstrate larger side-to-side differences when compared to lateral and horizontal jumping (1). In addition, drop jumping and hopping tasks have also shown large discrepancies in asymmetry values (2). Thus, the prevalence and magnitude of asymmetry seems to be specific to the test selected.

In addition, recent studies have highlighted that both the left and right or dominant and non-dominant limbs can score higher during testing (3,4). Despite these findings, to the authors' knowledge, there is very little literature on whether inter-limb asymmetries consistently favour the same side (i.e., right or left limb) in spite of the tests being different. Therefore, the aim of the present study was to establish whether asymmetries favoured the same limb during unilateral strength and jumping-based tests.

METHODS

Twenty-eight recreational sport athletes completed three trials of a unilateral isometric squat, countermovement jump (SLCMJ) and broad jump (SLBJ) on each leg. Asymmetry was calculated for peak force (all tests) and braking and propulsive impulse (jump tests) in line with previous suggestions (1).

A Kappa coefficient was used to quantify how consistently asymmetries favoured the same side for a given metric across tests. For interpretation of Kappa values, 0.01-0.20 = slight, 0.21-0.40 = fair, 0.41-0.60 = moderate, 0.61-0.80 = substantial, and 0.81-0.99 = almost perfect (5).

RESULTS

Figure 1: Individual peak force asymmetry data

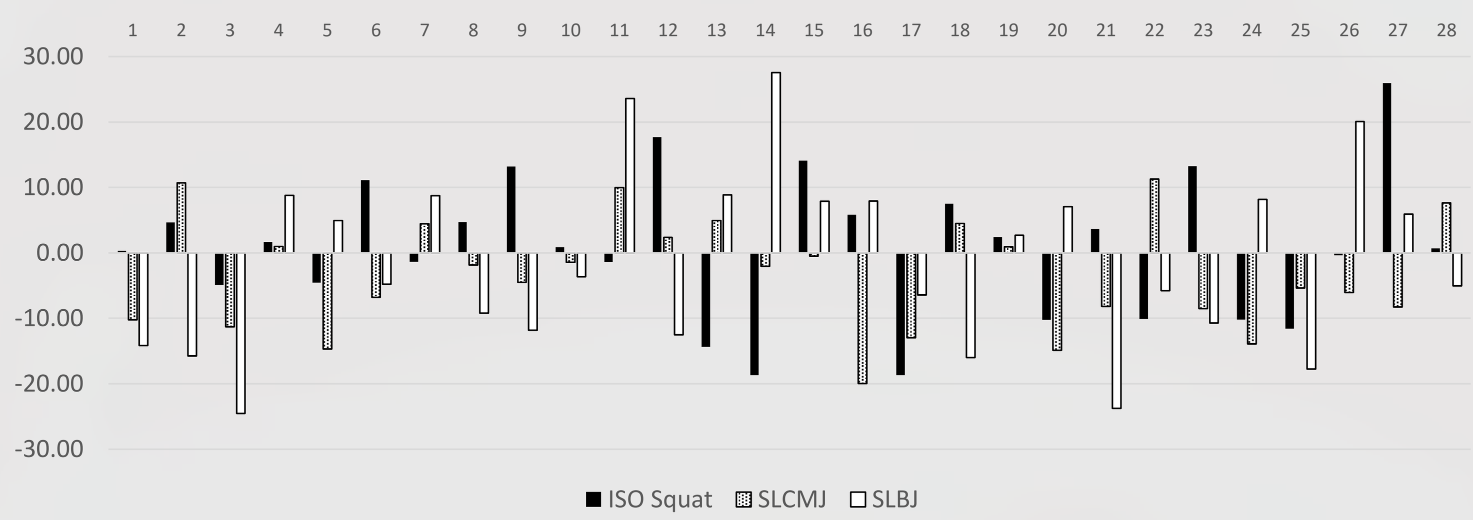
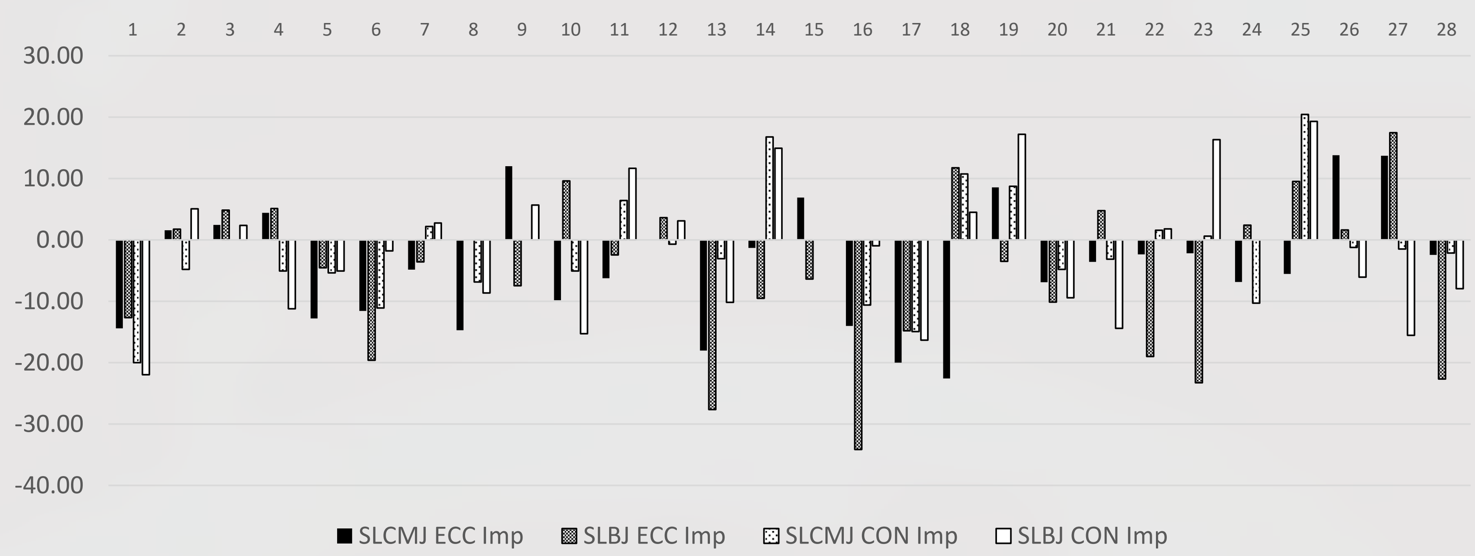


Figure 2: Individual eccentric and concentric impulse asymmetry data



RESULTS Continued…

Test Method	Kappa Coefficient	Levels of Agreement
Peak Force		
Iso Squat – SLCMJ	0.04	Slight
Iso Squat – SLBJ	-0.34	Fair
SLCMJ – SLBJ	0.05	Slight
Impulse		
SLCMJ-B – SLBJ-B	0.32	Fair
SLCMJ-P – SLBJ-P	0.79	Substantial
SLCMJ-B – SLCMJ-P	0.07	Slight
SLBJ-B – SLBJ-P	<0.01	Slight
SLCMJ-B – SLBJ-P	0.21	Fair
SLBJ-B – SLCMJ-P	-0.25	Fair

Iso = isometric; SLCMJ = single leg countermovement jump; SLBJ = single leg broad jump; B = braking (phase of impulse); P = propulsive (phase of impulse)

CONCLUSION

The findings of the present study show that inter-limb asymmetries rarely favour the same side when looking at the same metric across more than a single test. Given the individual nature and variation in these results, practitioners are advised to consider inter-limb asymmetries on a more individual basis. Furthermore, doing so will enable coaches to determine which athletes may require supplementary exercises in their programmes to minimise existing side-to-side imbalances.

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Vertical and Horizontal Asymmetries are Related to Slower Sprinting and Reduced Jump Performance in Elite Youth Female Soccer Players

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PURPOSE

The prevalence of inter-limb asymmetries has been a common line of investigation in recent years. Despite this popularity, few studies have established whether a relationship exists between inter-limb asymmetries and measures of physical performance. Such studies have typically been conducted in adult sporting populations and shown equivocal findings. Thus, establishing the relationship between asymmetry and performance was warranted in a youth sporting population, and was the main purpose of this study.

INTRODUCTION

Many different methods are often employed for athlete testing, with strength and power considered important physical qualities for virtually all athletes. Time-efficient methods are considered a priority for practitioners; therefore, jump testing serves as a useful measure of physical performance, due to its quick and efficient means of reporting athlete performance (1), or readiness to train (2).

When concerned with asymmetries, Maloney et al. (3) showed that faster athletes had significantly smaller jump height asymmetries (from a unilateral drop jump); whereas, Dos'Santos et al. (4) reported no correlations between distance asymmetries (from single and triple hop tests) with change of direction speed performance.

Given the conflicting findings in comparable literature and that these studies used adult populations, further research was warranted in a youth athlete population.

METHODS

Nineteen elite youth female soccer players (age: 10 ± 1.1 years; height: 141 ± 7.9 cm; body mass: 35 ± 7.1 kg) from a Tier 1 professional soccer club performed a single leg countermovement jump (SLCMJ), single leg hop (SLH), triple hop (TRH), crossover hop (CRH) and 20m sprint test (inclusive of 5 and 10m split times).

Inter-limb asymmetries were quantified via a standard percentage difference method (1). A one way ANOVA was performed to examine any potential differences in asymmetry, and Pearson's *r* correlations were used to determine the strength of the relationships between asymmetry values and sprint times and jump performance (significance set at $p < 0.05$).

RESULTS

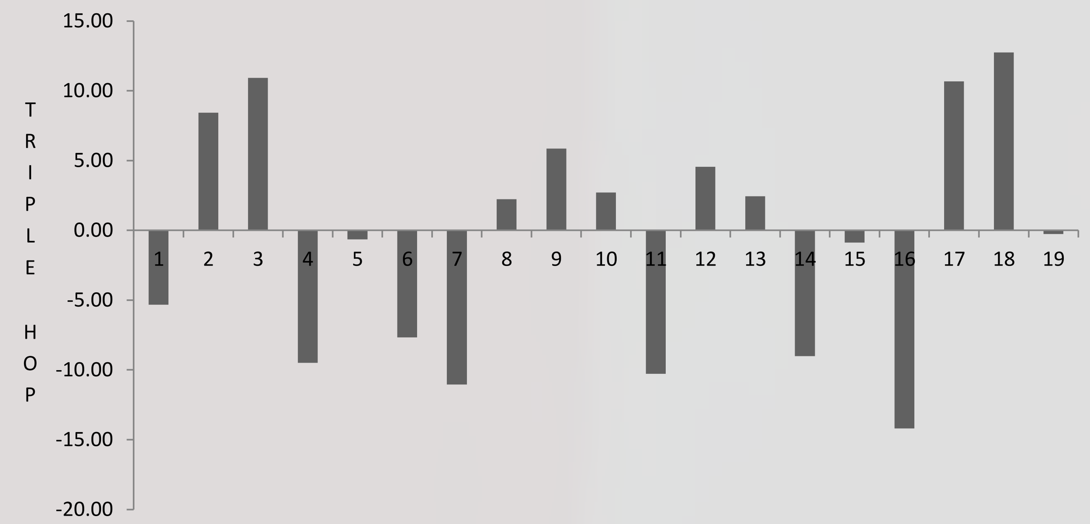
Table 1: Correlations between sprint performance and asymmetry scores.

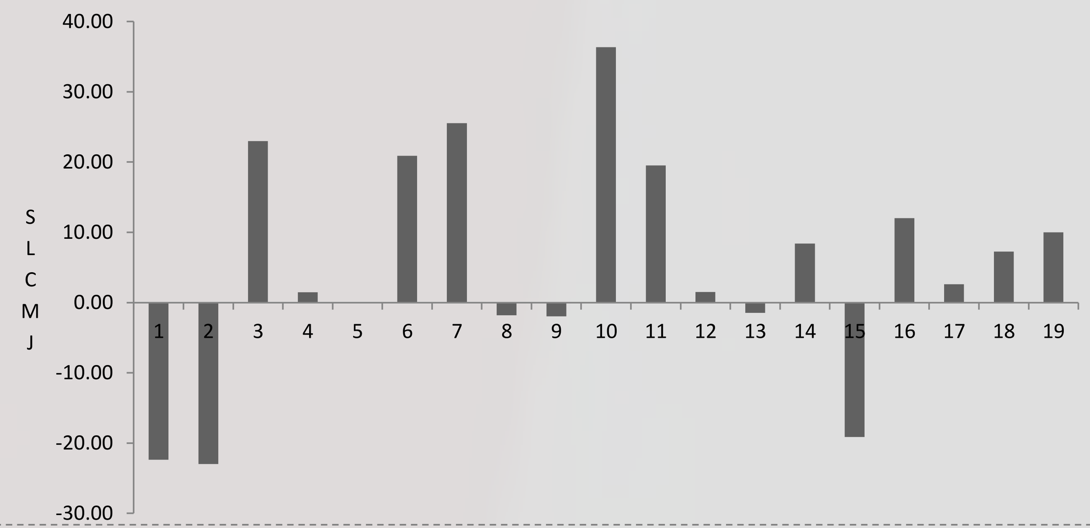
Speed Test	SLH Asym	TRH Asym	CRH Asym	SLCMJ Asym
5m	-0.33	0.35	0.25	0.49*
10m	0.12	0.25	0.14	0.52*
20m	0.09	0.26	0.37	0.59**
** $p < 0.01$; * $p < 0.05$				

Table 2: Correlations between jump performance and asymmetry scores.

ASYM	SLH R	SLH L	TRH R	TRH L	CRH R	CRH L	CMJ R	CMJ L
SLH %	-0.13	-0.23	-0.18	-0.12	-0.08	-0.12	-0.07	0.01
TRH %	-0.53*	-0.56*	-0.48*	-0.47*	-0.58*	-0.57	-0.15	-0.33
CRH %	-0.40	-0.46	-0.29	-0.43	-0.41	-0.45	-0.44	-0.38
CMJ %	-0.31	-0.14	-0.39	-0.33	-0.34	-0.45	-0.47*	-0.53*
* $p < 0.05$								

ASYMMETRY SCORES





CONCLUSION

Owing to the significantly larger asymmetries (*p* < 0.05) in the SLCMJ compared to all other tests, and significant correlations with reduced sprint performance (Table 1), the SLCMJ appears to be a useful test for the detection of side-to-side differences.

In addition, SLCMJ asymmetries were associated with reduced vertical jump performance and triple hop asymmetries associated with reduced horizontal jump performance, showing asymmetries to also be direction-specific.

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Influence of drop jump reactive strength index and temporal phase variables on sprint acceleration and maximal velocity in youth academy male football players

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Introduction

Elite football has seen an increased emphasis of maximal speed running in recent years (Faude, Koch and Meyer 2012 and Andrzejewski et al 2013). Reactive strength capacity is an important component of players achieving high sprint speeds, as the production of high forces in minimal time is required (Douglas et al 2014). Reactive strength enables the utilization of fast stretch shortening cycle (F-SSC) during ground contact, facilitating a more rapid contraction to take place (Haff and Triplett 2015), potentially improving sprint speed.

The aim of this study was to determine the impact of drop jump reactive strength index (DJ-RSI) and DJ temporal phase variables (flight time (FT) and contact time (CT) on sprint performance, in academy male youth football players.

Method

After gaining ethical approval 12 male youth academy football players (mean + SD; age: 15yrs ± 0.71; height 174.8cm ± 6.96; mass 61.3kg ± 8.31) completed 20 and 40m sprints. Drop jumps were performed from heights of 20, 40 and 60cm with FT and CT measured using the Opto-jump system (Microgate Bolzano, Italy). Participants were instructed to jump for maximal height with minimal ground contact time while remaining with hands on their hips to restrict arm movement. RSI was calculated as Jump height (m) divided by CT (s). Players were divided using a median split based on 20 and 40m times into 'faster' and 'slower' groups, with effect sizes (Cohens d) used to calculate the differences in RSI, FT and CT between groups. The magnitude of the effect sizes calculated were deduced as trivial <0.2, small 0.2-.06, moderate 0.6-1.2, large 1.2-2, very large 2-4 (Hopkins 2004). The significance level of $p < 0.05$ was utilized throughout every statistical analysis.

Discussion

Reactive strength capacity is a key factor associated with maximum speed running performance. Greater RSI drop jump scores were found to be significant in players who recorded faster maximal velocity rather than acceleration times. Players with faster maximal velocity times were able to utilize the F-SCC from DJ heights of 40cm and 60cm, due to greater eccentric leg control. This study found that shorter CT's were only found to influence maximal 40m sprint times. This suggests that youth players with faster 40m times were capable of producing higher forces in less time, with the largest effect size being at a DJ of 40cm. In contrast, players who could produce longer FT's at all DJ heights had faster 20m acceleration times with the largest effect size again at DJ 40cm. This suggests that players who could accelerate faster over 20m were able to efficiently reposition their limbs during aerial time to facilitate more meaningful ground contact.

Practical Applications

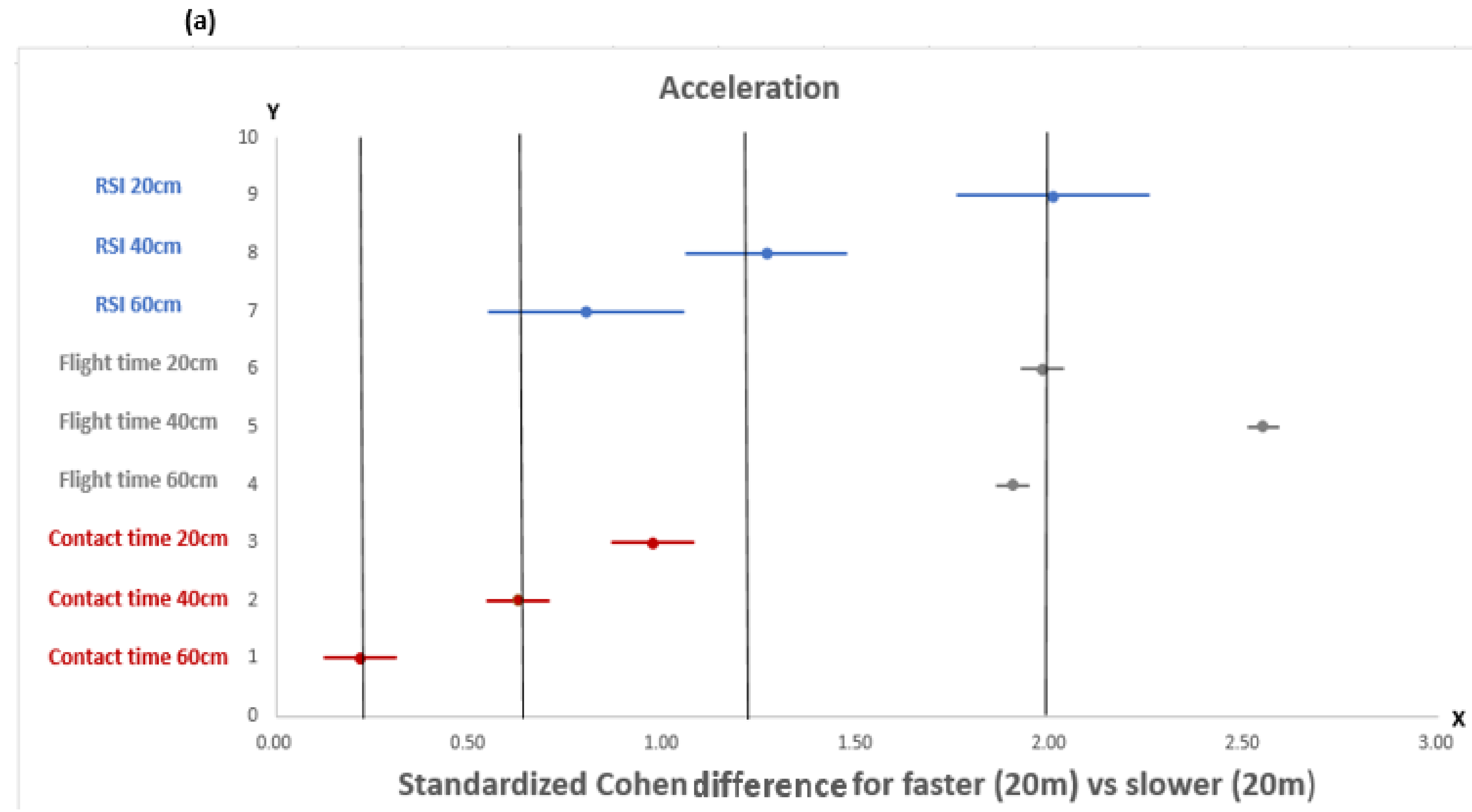
- Specific focus should be on integrating plyometric training via DJ's with the focus on producing maximal forces in minimal time, alongside sprint training to effectively improve Reactive strength capabilities.
- Drop jumps should be incorporated from a moderate height (40cm) to maximize maximal speed potential in elite youth soccer players through efficiently utilizing the F-SCC.

Results

Table 1. Whole group statistics, Mean and SD of all performance variables

Variables	(N=12)
20m (s)	3.18 ± 0.12
40m (s)	5.75 ± 0.26
RSI 20cm	0.66 ± 0.18
RSI 40cm	0.69 ± 0.21
RSI 60cm	0.70 ± 0.24
FT 20cm (s)	0.46 ± 0.04
FT 40cm (s)	0.47 ± 0.02
FT 60cm (s)	0.47 ± 0.03
CT 20cm (s)	0.42 ± 0.08
CT 40cm (s)	0.42 ± 0.10
CT 60cm (s)	0.44 ± 0.13

(a)



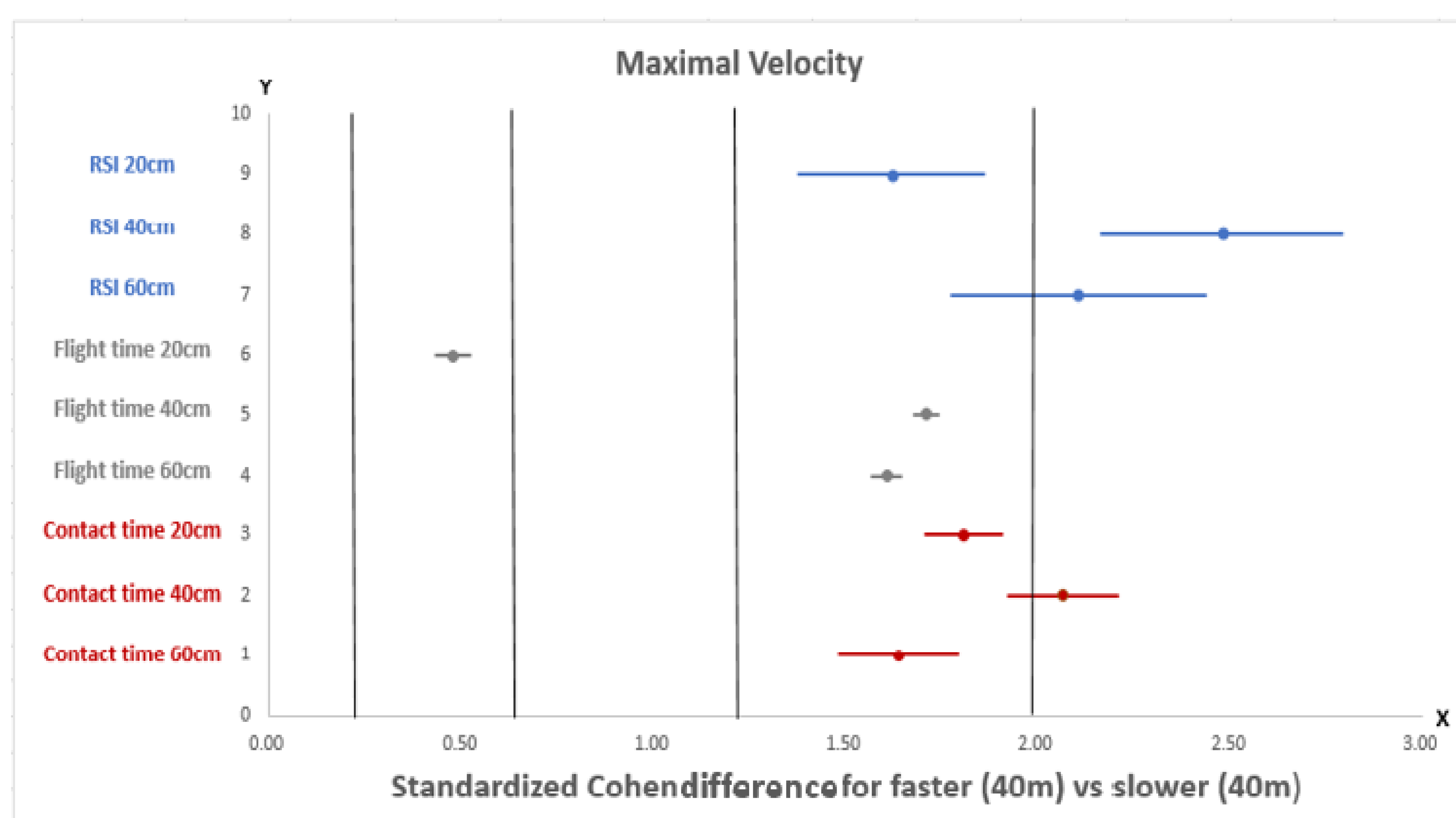


***Figure 1.** The magnitude (Cohen d) of differences for faster participants (n=6) vs slower participants (n=6) over acceleration (a) and maximal velocity (b)*

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The effect of competitive Gaelic football match-play on player hormonal status.

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IT Carlow[1] , Dublin Gaelic Athletic Association[2] , Dublin City University[3]

INTRODUCTION

Recent research by Halson (2014) has suggested the importance of monitoring both internal and external training load of athletes to optimise both recovery and subsequent performances. Global Positioning System (GPS) has become common place in quantifying external workload in team sport athletes, however, GPS alone is insufficient. Salivary hormones, namely testosterone (T) and cortisol (C), have been utilised as a means to explore individual training load tolerance in team sports such as rugby and soccer and have been reported to fluctuate in response to competitive match-play (West *et al.*, 2014) with temporary immunosuppression also reported (Cunniffe *et al.*, 2010). Exploring the relationship between biomarkers of training load tolerance and commonly collected internal and external training load data, such as GPS, is essential for developing understanding of training optimisation. This study aims to identify the salivary hormone response to competitive Gaelic football match-play in elite male GAA athletes.

METHODS

Elite male Gaelic footballers (*n*=4; mean±SD; age 25.3±1.9 yr, height 184.8±6.0 cm, body mass 87.0±3.4 kg) provided saliva samples over two in-season games; game one (*n*=2) and game two (*n*=3), to determine T and C concentrations (ng.mL^{-1}). Five samples were collected around a competitive game (see Fig 1); 40 and 6hr pre-match (15:00h) with post-game samples collected immediately post-, 48 and 72hr post-match, respectively. GPS data was collected during all training sessions and games to quantify both the external volume and intensity imposed on players. Total distance (TD) and high-speed running (HSR) distance were measured to determine volume, while total distance per minute (m.min^{-1}) was recorded as a measure of intensity.

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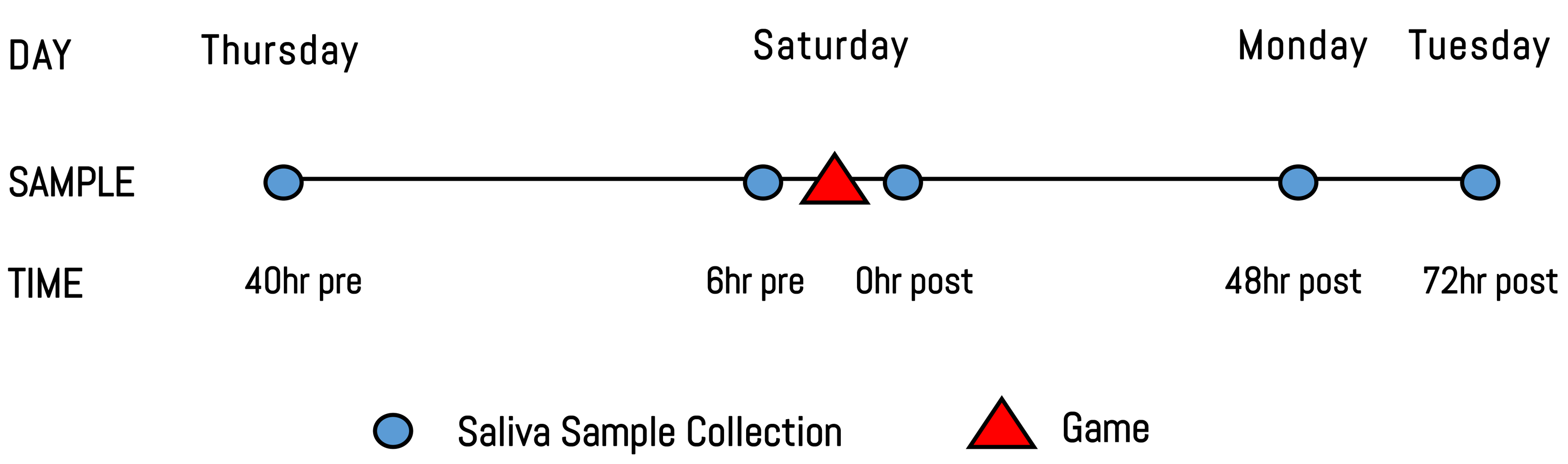
Figure 1. Scheduling of sampling points around a game



RESULTS

- Mean±SD salivary C concentration increased significantly from pre- to post-game (145.3±29.4 vs. 290.7±82.9ng.mL^{-1}; *P<0.05*), with no significant variation in mean salivary T concentration across time.
- Post-game C concentration reduced significantly after 48hr (290.7±82.9 vs. 128.9±39.0ng.mL^{-1}; *P<0.05*).
- Mean±SD game time was 49.6±37.2min during which TD covered was 5935.3±4288.2m with 528.9±440.7m HSR. Mean±SD total distance per minute was 128.2±15.3m.min^{-1}.

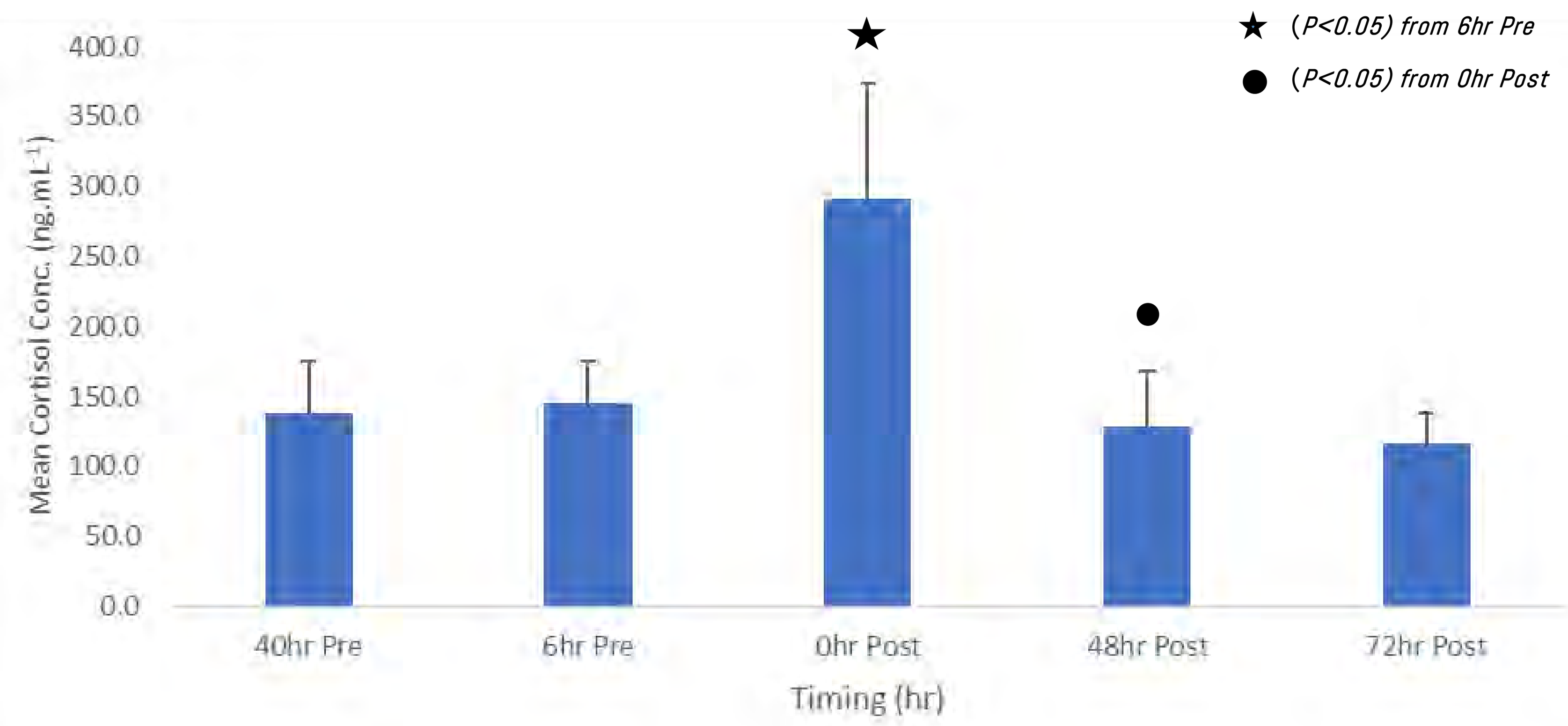


Figure 2. Mean salivary cortisol conc. across time , error bars denote SD

Hormone	Player	Game	40hr Pre	6hr Pre	0hr Post	48hr Post	72hr Post	Pre vs. Post Difference
Cortisol	1	1	120.0	194.6	246.2	171.3	138.6	51.6
	2		164.6	128.2	378.5	137.2	114.0	250.2
	3		185.7	121.1	216.2	153.5	138.9	95.0
	1	2	91.3	133.3	229.6	110.8	101.4	96.2
	4		129.7	149.1	383.1	71.6	92.1	234.0
	Mean (±SD)		138.3 (±37.3)	145.3 (±29.4)	290.7 (±82.9)*	128.9 (±39.0)*	117.0 (±21.3)	145.4 (±90.3)
Testosterone	1	1	3.39	3.94	1.76	4.17	4.73	-2.18
	2		8.21	3.64	21.3	9.21	6.21	17.66
	3		4.64	6.74	3.68	5.11	3.47	-3.06
	1	2	0.54	8.73	2.22	3.51	2.55	-6.51
	4		2.82	6.27	5.29	4.5	2.6	-0.98
	Mean (±SD)		3.9 (±2.8)	5.9 (±2.1)	6.9 (±8.2)	5.3 (±2.3)	3.9 (±1.6)	1.0 (±9.5)

*Table 1. Salivary cortisol and testosterone conc. (ng.mL^{-1}) for players across games * P <0.05*

PRACTICAL APPLICATIONS

1. The significant increase in C concentration from pre- to post-game may be indicative of the physiological stresses imposed by the Gaelic football match-play loads and intensities found in this study.
2. The significant reduction in C concentration 48hr post-match in line with pre-match concentrations may indicate sufficient recovery has occurred and that players may tolerate intense training from 48hr post-match.
3. These data display similar responses to previous research (Cunniffe *et al.*, 2010 and West *et al.*, 2014) highlighting the effect of competitive match-play on player hormonal and recovery status.

ACKNOWLEDGEMENTS

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Measuring Neuromuscular Fatigue During Competition in Intercounty Hurlers.

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Abstract

Introduction: Optimisation of training load is essential to achieve peak performance and requires significant attention in light of the varied competitive calendar in Gaelic games, and the prevalence of 'burnout'. Daily monitoring of neuromuscular fatigue using countermovement jump (CMJ) and drop jump (DJ) protocols has become commonplace, as the change in an athletes' ability to produce force, power and speed during sport-specific tasks and performance tests may be indicative of their training status or ability to tolerate further training load (Gathercole *et al.,* 2015; Thorpe *et al.,* 2015) .

Aim: The aim of this study was to assess acute and chronic fatigue in elite intercounty hurlers during the competitive season.

Methods: Twenty-four male Division 2 intercounty hurlers (n=24; mean±SD; height 1.85±0.05m, age 25.3±3.3yr, body mass 85.26±7.03kg) performed three CMJ's and two DJ's from 30cm (DJ30) and 40cm (DJ40), respectively, 30min prior field training sessions twice weekly (48 and 120h pre and post-match) over 8 weeks. Maximum jump height (JH; cm) and peak power (PP; W) from CMJ were recorded, along with contact and flight time (ms) from DJ, for determination of reactive strength index (RSI).

Results: CMJ and DJ data indicated that players remained fatigued 48h post-match across observed 8 weeks. However, performances returned to, or surpassed, pre-match scores at 120h, indicating a timely return to performance readiness. Both JH and PP produced significant changes across time (*P*<0.05), while RSI varied to a lesser extent across time (*P*<0.05). Across training weeks, CMJ (JH 0.85cm & PP 12.98W) and RSI at DJ40 (0.07) performance exceeded the SWC at each time point. DJ30 (0.06) failed to do exceed the SWC.

Conclusion: Current data suggest that neuromuscular fatigue, measured via CMJ and DJ variables, persists in Division 2 intercounty hurlers for up to 48h. However, neuromuscular fatigue appears to dissipate at 120h post-match, which may be indicative of a timely return to performance readiness in advance of the next competitive exertion. Furthermore, data indicated that CMJ is a superior method of monitoring changes in neuromuscular performance in comparison to DJ at selected heights, with 40cm DJ indicating greater sensitivity than 30cm for assessing fluctuations in neuromuscular fatigue. Results have shown that acute fatigue is evident but chronic fatigue is not. The present data indicates that implementing neuromuscular fatigue monitoring through CMJ and 40cm DJ protocols pre-session can assist in determining neuromuscular status and fatigue state in athletes, further assisting the strength and conditioning coach in optimising training load throughout the Gaelic games calendar on an individual and team basis.

Introduction

Hurling is a sport similar to Gaelic football, both are fast paced sports involving multiple sprints over varied distances interspersed with low-intensity rest periods of varying duration depending on the intensity of the game (Malone, Salone, Collins & Doran, 2016; Malone, Salone & Collins, 2017). There is a requirement on both anaerobic and aerobic systems during the game as both slow-steady minimal effort and fast paced maximal effort situations are reported (Cullen *et. al.,* 2013).

Neuromuscular fatigue has been defined as the change in the ability of skeletal muscle to produce force and power during sport specific tasks and performance tests such as sprinting and jumping (Gandevia, 2001). The fatigue aspect of this phenomenon can be characterised as the exercise-induced impairment in performance (Knicker, 2011), and, in sport specific terms, may manifest as reduced ability to sprint, run and jump

Optimisation of training load is essential to achieve peak performance and requires significant attention in light of the varied competitive calendar in Gaelic games, and the prevalence of 'burnout'. Daily monitoring of neuromuscular fatigue using countermovement jump (CMJ) and drop jump (DJ) protocols has become commonplace, as the change in an athletes' ability to produce force, power and speed during sport-specific tasks and performance tests may be indicative of their training status or ability to tolerate further training load (Gathercole *et al.,* 2015; Thorpe *et al.,* 2015) .

Aim

The aim of this study was to assess acute and chronic fatigue in elite intercounty hurlers during the competitive season.

Methods

Twenty-four male Division 2 intercounty hurlers (*n*=24; mean±SD; height 1.85±0.05m, age 25.3±3.3yr, body mass 85.26±7.03kg) were selected to participate in this longitudinal repeated measures study. This study was conducted with two phases, each lasting 4 weeks. Phase 1 required participants to complete CMJ's and phase two required participants to complete DJ's. During phase 1 participants performed three CMJ's and during phase 2 participants completed two DJ's from 30cm (DJ30) and 40cm (DJ40), respectively, 30min prior to field training sessions twice weekly (48 and 120h pre- and post-match) over the 8 weeks. Maximum jump height (JH; cm) and peak power (PP; W) from CMJ were recorded, along with contact and flight time (ms) from DJ, for determination of reactive strength index (RSI).

Statistical Analysis

Data was analysed via repeated measures ANOVA to determine significant change across time, with *post-hoc* Bonferroni test used for pairwise comparisons (1 X 7, CMJ and 1 X 9, DJRSI). Alpha was set at P<0.05). This study conducted neuromuscular measures of fatigue across multiple time points via countermovement jump (CMJ) and drop jump reactive strength index (DJRSI) which was calculated via flight time/contact time during a competitive hurling season. *Smallest Worthwhile Change (SWC)* was calculated for each CMJ and DJRSI. Data were analysed using IBM SPSS Statistics (IBM, Armonk, NY, USA).

Results

Upon inspection CMJ and DJ data indicated that players remained fatigued 48h post-match across observed 8 weeks. However, performances returned to, or surpassed, pre-match scores at 120h, indicating a timely return to performance readiness. Repeated measures ANOVA demonstrated significant changes for JH and PP across time (*P*<0.05), while RSI varied to a lesser extent across time (*P*<0.05).

Minor significant change occurred for DJ40 whereas no significant change occurred for DJ30 (*P*<0.05). Across training weeks, CMJ (JH 0.85cm & PP 12.98W) and RSI at DJ40 (0.07) performance exceeded the SWC at each time point. DJ30 (0.06) failed to do exceed the SWC. Changes in mean scores across time for CMJ are depicted in Figures 1a and 1b, with changes in DJ depicted in Figures 2a and 2b.

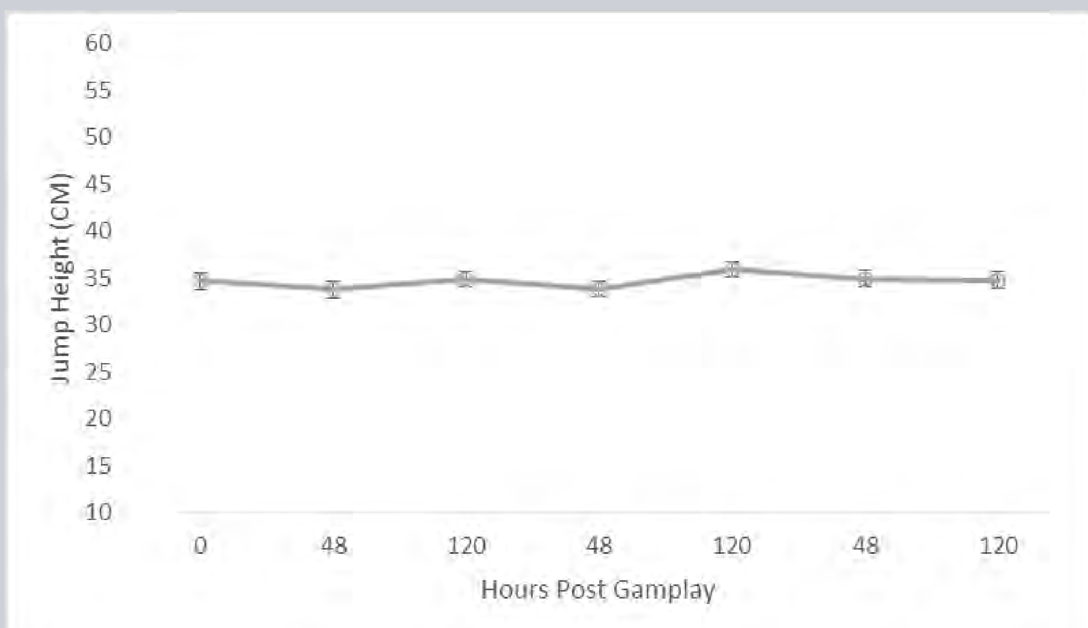

Figure 1a: Mean CMJ jump height (cm) across time, error bars denote *SWC*

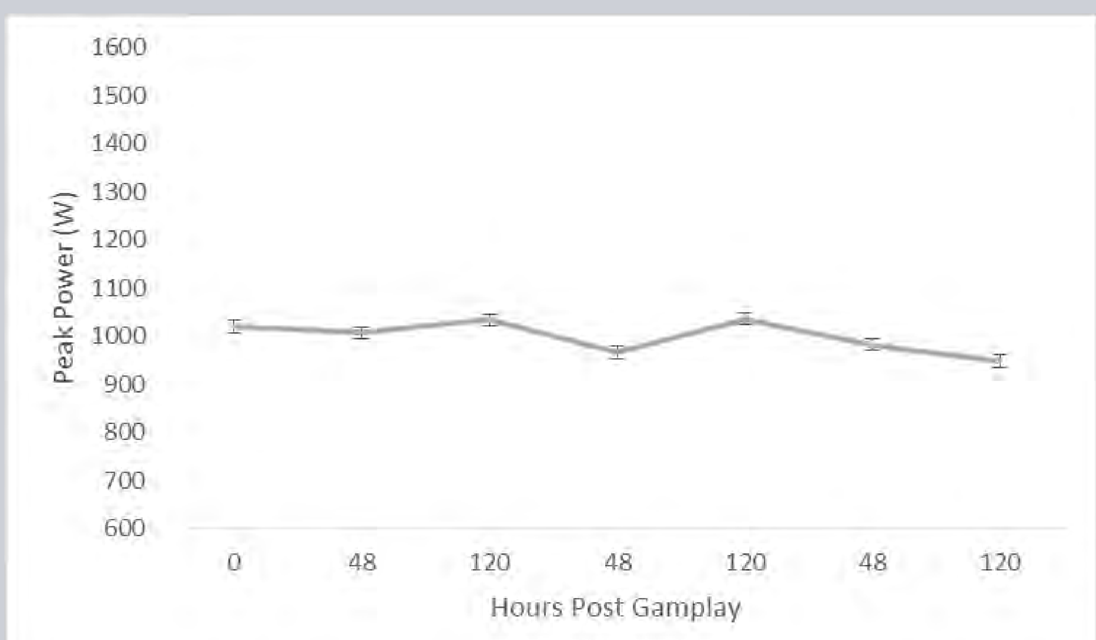

Figure 1b: Mean CMJ peak power (W) across time, error bars denote *SWC.*

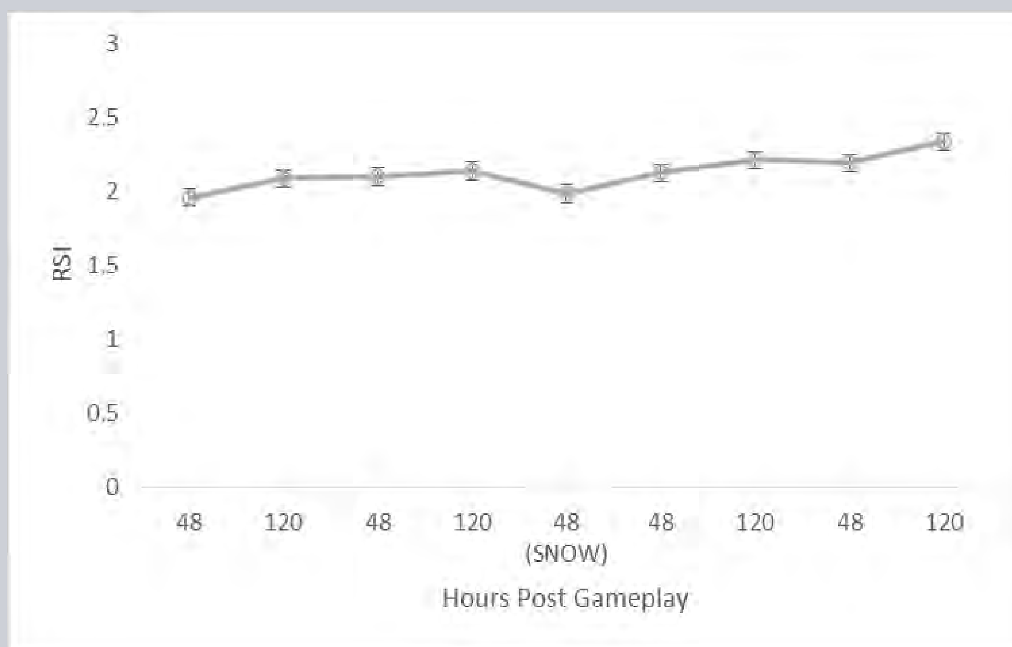

Figure 2a: Mean RSI measured via DJ30cm, error bars denote *SWC.*

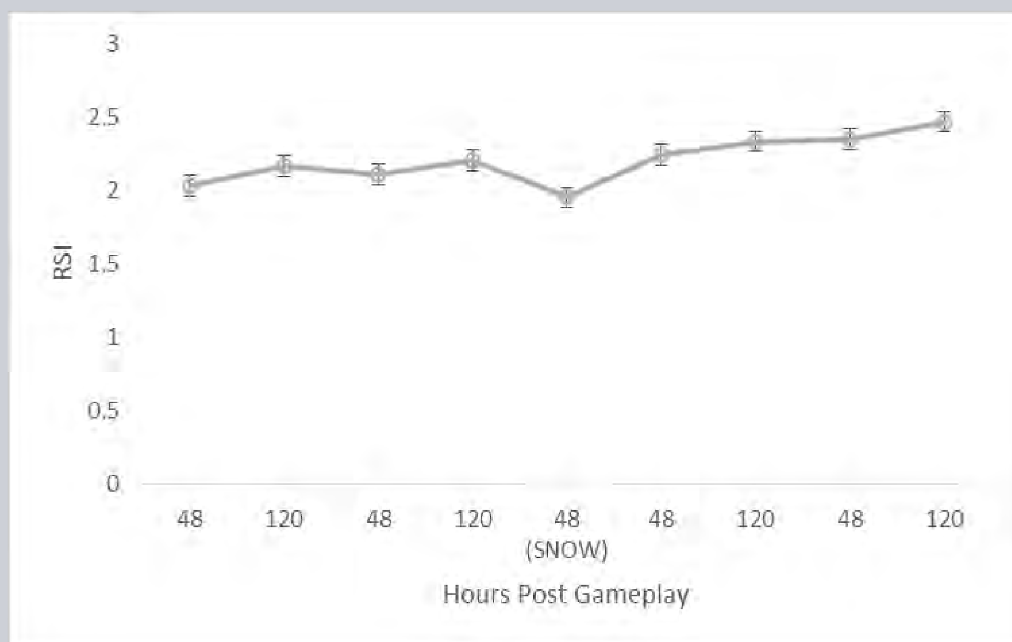

Figure 2b: Mean RSI measured via DJ40cm, error bars denote *SWC.*

Conclusions

The results of this study show that athletes experience fatigue which manifest as decrements in performance at 48h post gameplay. However, performance returns to/ surpasses baseline at 120h. As the strength and conditioning practitioners role is to ensure players are in peak physical condition on game day, data suggests neuromuscular recovery has occurred at 120h post-game, which has implication for training distribution between games, and prior to successive fixtures.

Training sessions at 48h usually consist of aerobic and regeneration based running with prolonged warm-ups to allow for fatigue to dissipate and recovery to occur. As supercompensation is based around eliciting optimal fatigue and recovery to cause an overall increase in performance the practitioners of this team may have achieved optimal load and dosage which does not allow chronic fatigue to occur.

Further research should be conducted on gameday, particularly, as previous research has demonstrated that fatigue persist for up to 72h post-match. Therefore, monitoring athletes at 72h (Gathercole *et al.*, 2015) and gameday could provide crucial insight for planning macro and mesocycles in-season to optimise performance.

Key Points

- Acute neuromuscular fatigue is observed 48h post-match, which dissipates by 120h post-match.
- Chronic fatigue was not evident across in-competition weeks.
- CMJ variables PP and JH may be more sensitive to changes in neuromuscular performance capacity than DJ variables, with DJ40 providing greater sensitivity than DJ30.
- Peak power showed the greatest sensitive in measuring neuromuscular fatigue.

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Overspeed Jump Training for the Acute Enhancement of Reactive Strength

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Abstract

Aim: To determine if assisted jump training (AJT) elicits an acute PAP response quantified by the 10/5 reactive strength index (RSI) in male collegiate field sport athletes.

Methods: Eleven male collegiate field sport athletes (age: 23.4 ±1.8 years, body mass: 79.7 ± 7.5 kg, height: 179.6 ± 6.6 cm) participated in a cross over study using a 3 x 6 repetition protocol of assisted countermovement jumps (CMJ) with 20% bodyweight reduction or bodyweight CMJ control, measured via force plate (Hur Labs, Finland). Assisted jumps were performed using elasticated rubber bands. Prior to intervention and again at 1, 4 & 8 min intervals post a 10/5 RSI test was performed using an optojump (Microgate, Italy). Repeated measures ANOVAs were performed for statistical analysis.

Results: Results indicated that RSI significantly increased for the AJT intervention at 4-minutes and 8-minutes proceeding the intervention compared to baseline (6.1%, ES = 1.87, very large, $p < 0.05$ and 3.8%, ES = 1.12, very large, $p < 0.05$). In contrast no significant differences and only trivial effect sizes were noted for the CMJ group p > 0.05. In addition significant large difference at the 4 min time point was present for the jump height variable in the AJT intervention (5.69%, ES = 0.88, large, $p < 0.05$).

Conclusion: The present study demonstrated that a series of 20% BWR assisted jumps elicited a PAP response which resulted in significant ($p < 0.05$) improvements in RSI performance following an acute rest of 4 and 8-minutes after the series completion.

1. Introduction

Assisted jump training (Figure 1) is a novel exercise stimulus which specifically targets the velocity aspect of the force velocity curve. Research has demonstrated the application of supramaximal efforts in both running and jumping to elicit positive adaptations[1,2]. Plyometric activity has also been identified as a method to acutely enhance jumping and sprint performance[3,4]. However there is limited research examining the potential post-activation potentiation (PAP) response AJT may have on dynamic reactive performance. Therefore the aim of this study was to determine if AJT elicits an acute and practical PAP response quantified by the 10/5 reactive strength index (RSI) in male collegiate field sport athletes.

2. Methods

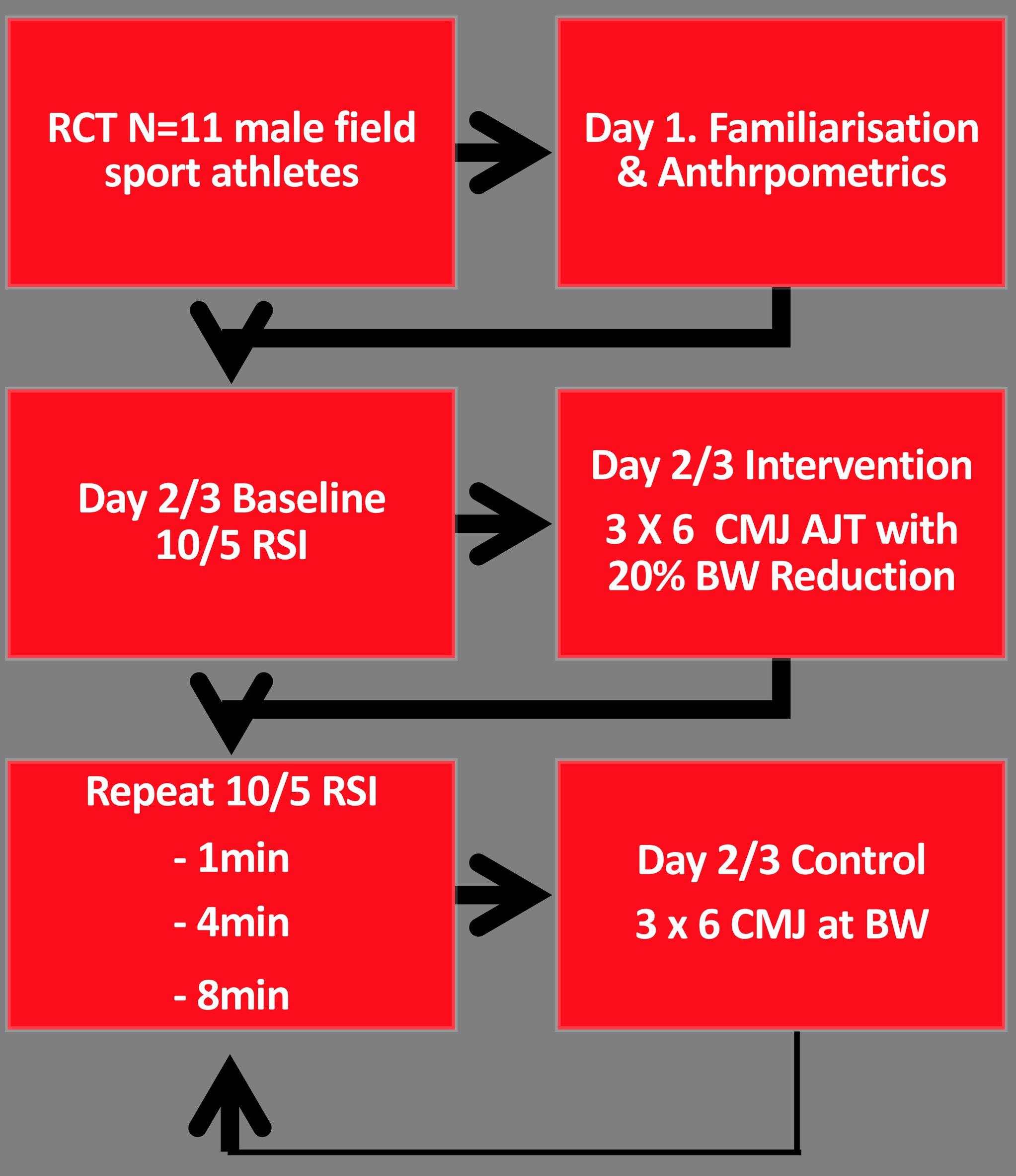

Figure 1: Assisted jump configuration, using 20% BW reduction.

3. Results

Results indicated that RSI significantly increased for the AJT intervention at 4-minutes and 8-minutes proceeding the intervention compared to baseline (6.1%, ES = 1.87, very large, $p < 0.05$ and 3.8%, ES = 1.12, very large, $p < 0.05$). In contrast no significant differences and only trivial effect sizes were noted for the CMJ group p > 0.05 (Figure 2). In addition significant large difference at the 4 min time point was present for the jump height variable in the AJT intervention (5.69%, ES = 0.88, large, $p < 0.05$) (Table 1).

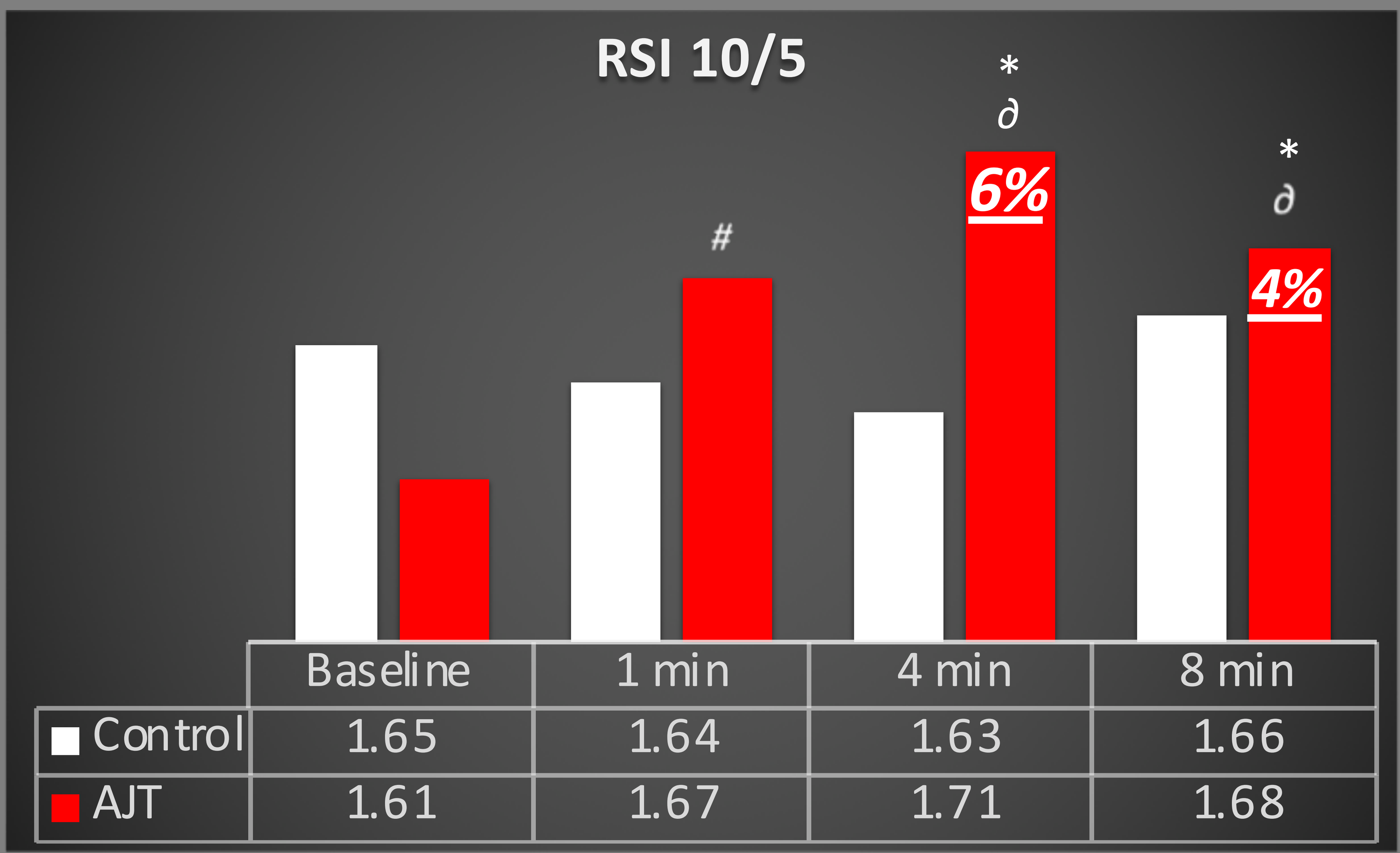

Figure 2: Reactive strength index response using 10/5 protocol.
**Statistically significant effect compared to Pre-Intervention ($p < 0.05$).*
∂ Very large effect size
Large effect size

TABLE 1: MEAN (± SD) FOR REACTIVE STRENGTH INDEX VARIABLE PERFORMANCE.

JUMP HEIGHT	Pre	1-minute	ES	4-minutes	ES	8-minutes	ES
CONTROL	31.6 ± 4.8	32.7 ± 5.1	0.49	31.8 ± 4.5	0.08	32.8 ± 4.7	0.49
AJT	31.9 ± 4.5	33.4 ± 3.6	0.61	**33.7 ± 3.6***	**0.88**	33.0 ± 3.7	0.48
GROUND CONTACT TIME	**Pre**	**1-minute**	**ES**	**4-minutes**	**ES**	**8-minutes**	**ES**
CONTROL	.192 ± .01	.200 ± .19	0.50	.196 ± .01	0.35	.197 ± .01	0.53
AJT	.197 ± .01	.201 ± .01	0.29	.197 ± .01	0.09	.198 ± .01	0.05

** Statistically significant effect compared to Pre-Intervention ($p < 0.05$).*

4. Conclusion

The present study demonstrated that a series of 20% BWR assisted jumps elicited a PAP response which resulted in significant ($p < 0.05$) improvements in RSI performance following an acute rest of 4 and 8-minutes after the series completion. AJT may be used in the future to elicit a PAP response, and may be an appealing method to utilise due to the lowered acute fatigue, potential injury risks and practicality when compared to a heavy resistance stimulus.

Acknowledgements: IT Carlow conference support fund.

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The physical capacities of youth swimmers

NUMBER ONE

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INTRODUCTION:

The relationship between physical capacities and sporting performance has been a continuing source of interest for strength and conditioning coaches (Amaro et al., 2017). Swimming requires a high amount of lower body force and power when diving, turning and kicking (Bishop et al., 2009), with dry-land training featuring in their periodised cycles to help improve these capacities.

With ever increasing pressure put on young athletes to succeed in sport, there is a demand to quantify the physiology that links to performance so we might better identify talent from a young age (Allen & Hopkins, 2015). This information will also help to define key physical aspects that could lead to an improved swimming time when designing programmes and developing athletes.

METHODS:

21 swimmers (male, n = 12; female n = 9) were involved in their clubs profiling tests. Verbal and written Informed consent was gained from participants and parents as well as the club. Anthropometric data can be found in table 1.

The participants were tested in one visit, which consisted of measurements of anthropometrics, including peak height velocity and predictions of peak height. After a 10 minutes specific warm up, they were given an additional 5 minutes for self-selected warm up if desired. They then performed 3 isometric mid-thigh pulls (IMTP) on a force platform (FP4, HUR labs, Finland) followed by 3 repetitions of each of the following jumps; squat (SJ), countermovement (CMJ) and drop (DJ). Peak values were recorded.

Data was analysed using SPSS. Pearson's correlations were used to compare physical capacities to 50 m freestyle performance, and t-tests to compare males to females

Table 1: Anthropometric data in male and female youth swimmers. Reported in Mean ± Standard Deviation. * denotes a difference from male ($p<0.05$)

	Male (n=12)	Female (n=9)
Age	14.9 ± 2.3	15.1 ± 1.9
Stature	176.1 ± 8.4	167.8 ± 6.5*
Mass	63.0 ± 4.6	63.8 ± 2.4
% Predicted adult height	99.2 ± 2.8	99.3 ± 1.1

RESULTS:

Table 2: Performance data for jumps and swim times in male and female youth swimmers. Reported in Mean ± Standard Deviation. * denotes a difference from male ($p<0.05$)

	Male (n=12)	Female (n=9)
SJ (cm)	29.6 ± 4.6	23.4 ± 3.7*
CMJ (cm)	32.0 ± 5.0	25.3 ± 4.2*
EUR (AU)	1.09 ± 0.09	1.08 ± 0.09
DJ (cm)	30.3 ± 5.0	24.0 ± 4.3
50 m Sprint times (s)	28.8 ± 1.61	29.6 ± 2.36
CMJ Peak Power (W)	2928 ± 622	2402 ± 294*
Drop Jump RSI	2.1 ± 0.4	1.8 ± 0.3*

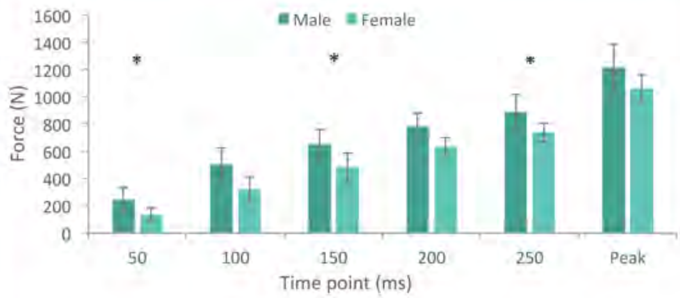

Figure 1: Force at different timepoints during the IMTP for males and females. * denotes a difference from male ($p<0.05$)

Correlations between 50 m freestyle performance and CMJ (r=-0.333, p=0.035) and reactive strength index (r=-0.524, p=0.015) showed an acceptable relationship.
Jump kinetics and IMTP at different time points did not correlate to 50 m sprint performance, despite some variables showing differences between groups

CONCLUSION:

The correlations suggest that some physical aspects of swimming are connected to better performances. Coaches might want to look at improving lower body power on land, building on previous research finding improved resistance training performance could equate to as much as a 2.8% improvement in 50 m freestyle performance (Girold et al, 2007). However, the current study did not test if adaptations in these physical capacities would have an equally positive effect on swim times. Future research could monitor the changes in these qualities to compare to kinematic data during sprint swims.

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What Does It Take to Transition? Competition Based Physical Activity Profiles of Independent School Boy Rugby Sevens through Under 14, Under 16 and Under 18 Age Groups

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MILLFIELD INSTITUTE OF SPORT AND WELLBEING

CATAPULT

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INTRODUCTION

In independent school sport, pupils transition through chronological age groups within their selected sports programmes. However, little is known about the physical activity demands associated with these age group transitions [1, 2, 3]. Therefore, the purpose of this study was to establish normative data on the activity profiles of schoolboy rugby sevens through age groups under 14, 16 and 18. It is hoped that this data will support the education of both rugby and athletic development coaches on the identified physical activity demands required to make successful transitions through the selected chronological year groups and in doing so allow pupils to optimise their physical performance in rugby sevens.

METHODS

Rugby sevens matches were analysed retrospectively between 2016-18 via Playertek GPS by Catapult. Two forwards and three backs were randomly selected to wear the GPS monitors in each match. Across all three age groups, 18 competitive rugby sevens matches were analysed. Data was analysed via magnitude-based inferences, with the activity profiles for each year group analysed against each other. The activity profiling and subsequent analysis was centred on average total distance (km), average sprint distance (m), average distance per minute (m/min) and maximum velocity (m/s).

RESULTS

Average total distance was *likely lower* in U14 in comparison to both U16 and U18 (1.04 ± 0.20 vs 1.26 ± 0.19 & 1.39 ± 0.31 km respectively). Average total distance between U16 vs U18 was *unclear*. U14 average sprint distance (137.68 ± 47.46 m) was *very likely* and *likely lower* compared to U16 (201.03 ± 33.94 m) and U18 (215.26 ± 63.50 m) respectively. Average sprint distance between U16 vs U18 was *unclear*. U14 maximum velocity (8.21 ± 0.30 m/s) was *unclear* compared to U16 (8.42 ± 0.25 m/s), though *very likely lower* compared to U18 (8.89 ± 0.32m/s). U16 maximum velocity was also *very likely lower* than U18. Distance per minute was *likely lower* in U14 than U16 (92.69 ± 7.57 vs 99.77 ± 4.89 m/min) and *most likely lower* than U18, as was U16 vs U18 (112.25 ± 3.17 m/min).

Table 1. Differences between age groups in schoolboy rugby sevens

	U14 vs U16	U14 vs U18	U16 vs U18
Total Distance (km)	U14 Likely ↓	U14 Likely ↓	Unclear
	-1.09 ± 1.07	-1.03 ± 1.01	-0.31 ± 1.0
Sprint Distance (m)	U14 Very Likely ↓	U14 Likely ↓	Unclear
	-2.26 ± 1.68	-1.28 ± 1.42	-0.11 ± 0.94
Maximum Velocity (m/s)	Unclear	U14 Very Likely ↓	U14 Very Likely ↓
	-0.70 ± 1.23	-1.85 ± 1.25	-1.27 ± 1.01
Distance per Minute (m/min)	U14 Likely ↓	U14 Most Likely ↓	U16 Most Likely ↓
	-1.33 ± 1.51	-5.71 ± 1.47	-3.49 ± 1.34

SUMMARY AND CONCLUSION

These results suggest rugby and physical preparation coaches in independent schools should be aware of the specific and variable physical activity demands associated to rugby sevens performance across chronological age groups. In particular, there may be the requirement for schoolboy rugby sevens players to be exposed to high intensity rugby training and conditioning drills as they transition through chronological groups [1]. Specifically, exposure to high speed running and energy system development may be necessary when transitioning into U18 and U16 rugby sevens respectively [1, 2]. Future research should evaluate interventions aimed at increasing sprint velocity and markers of fatigue in this population.

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A Longitudinal Analysis of Movement Competency, Fundamental Movement Skill and Muscle Capacity in Sports Pupils in a UK Independent School

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MILLFIELD INSTITUTE OF SPORT AND WELLBEING

INTRODUCTION

Movement Competency (MC) and Fundamental Movement Skill (FMS) have been identified as the building blocks of more advanced and complex movement [1], with research showing a positive association between MC and health related fitness in youth athletes [2]. In addition, assessing and enhancing muscle capacity has been shown to be a reliable method to help identify an individual's ability to resist fatigue, reduce injury risk and improve movement efficiency in both the upper limb, lower limb and trunk [3, 4, 5]. Therefore, the purpose of this study was to highlight differences in performance through and between chronological year groups, and between male and female sports pupils to better support the development of movement skill, movement competency and muscle capacity in sport pupils at Millfield School.

METHODS

- Data was collected termly across three academic years.
- Movement Competency was assessed via video analysis of the overhead squat (OHS).
- Fundamental Movement Skill was assessed in action via a-walk and hold, single leg Romanian deadlift walk, lunge walk, lateral shuffle, high knee running, hop and stick and countermovement jump.
- OHS and FMS performance were graded against a technical criteria.
- Muscle capacity was assessed via press ups, inverted rows, double leg lowers, single leg calf raise and single leg hamstring bridge.
- Muscle capacity tests were performed to volitional exhaustion or technical failure with tempo normalised via a metronome.
- In total, 358 female and 524 male OHS datasets, 33 female and 68 male FMS datasets and 402 female and 507 male muscle capacity data sets were recorded across all year groups.
- All differences were assessed using magnitude-based inferences.

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RESULTS

Boys ranged from *possibly* to *almost certainly greater* than girls in all muscle capacity assessments, with *unclear* differences observed in the OHS and FMS.

Table 1. Consecutive year group differences in OHS performance. Data are presented as magnitude-based inference followed by standardised mean difference.

	Y10 vs. Y11	Y11 vs. Y12	Y12 vs. Y13
OH Squat	Unclear -0.16 ± 0.63	Unclear 0.34 ± 0.69	Y13 Likely ↑ 0.43 ± 0.59

Table 2. Consecutive year group differences in FMS performance. Data are presented as magnitude-based inference followed by standardised mean difference.

	Y9 vs. Y10	Y10 vs. Y11
Fundamental Movement Skill	Y10 Likely ↑ 0.73 ± 0.56	Unclear 0.04 ± 0.44

Table 3. Consecutive Year Group Differences in Muscle Capacity in Male Pupils. Data are presented as magnitude-based inferences followed by standardised mean difference.

	Y10 vs. Y11	Y11 vs. Y12	Y12 vs. Y13
Press Ups	Unclear 0.20 ± 0.67	Y12 Likely ↑ 0.43 ± 0.57	Y13 Likely ↑ 0.77 ± 0.59
Inverted Row	Unclear 0.16 ± 0.45	Unclear 0.30 ± 0.57	Unclear 0.01 ± 1.02
Double Leg Lowers	Unclear -0.12 ± 0.54	Unclear -0.18 ± 0.69	Y13 Likely ↑ 0.65 ± 0.69
Calf Raise Left	Unclear -0.20 ± 0.49	Unclear 0.26 ± 0.62	Unclear -0.95 ± 1.96
Calf Raise Right	Unclear 0.04 ± 0.47	Unclear 0.35 ± 0.55	Unclear -0.53 ± 1.14
Hamstring Bridge Left	Y11 Possibly ↑ 0.37 ± 0.47	Unclear 0.08 ± 0.37	Y13 Possibly ↑ 0.38 ± 0.49
Hamstring Bridge Right	Unclear -0.24 ± 1.05	Unclear 0.14 ± 0.35	Unclear 0.30 ± 0.55

SUMMARY AND CONCLUSION

Given the unclear nature of these results, it may be advised to track individual physical development to assist in further understanding when a real and/or practically important change has occurred. Furthermore, an advanced chronological age does not guarantee enhanced lower limb muscle capacity, however it may contribute to upper limb, OHS and FMS performance. As such, early engagement in a formalised physical preparation programme may be advised, particularly for movement skill development.

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The impact of a resistance training intervention on the weight status of overweight children: A case study.

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BACKGROUND

- The prevalence of obesity amongst youth continues to increase worldwide (De Onis *et al*., 2010) and there has been a rise in research into the development of suitable prevention and treatment programmes, including the effectiveness of physical activity (PA) interventions (Benson *et al*., 2008).
- While the physical activity guidelines (WHO, 2011) include '*activity to strengthen muscle and bone*', this has not been a focus of the PA intervention research to date.
- There are many potential benefits of resistance training, including a positive effect on weight status (Lloyd *et al*., 2014).
- Despite recommended PA guidelines and position standpoints, the effect of resistance training interventions on weight status in youth remains unknown.

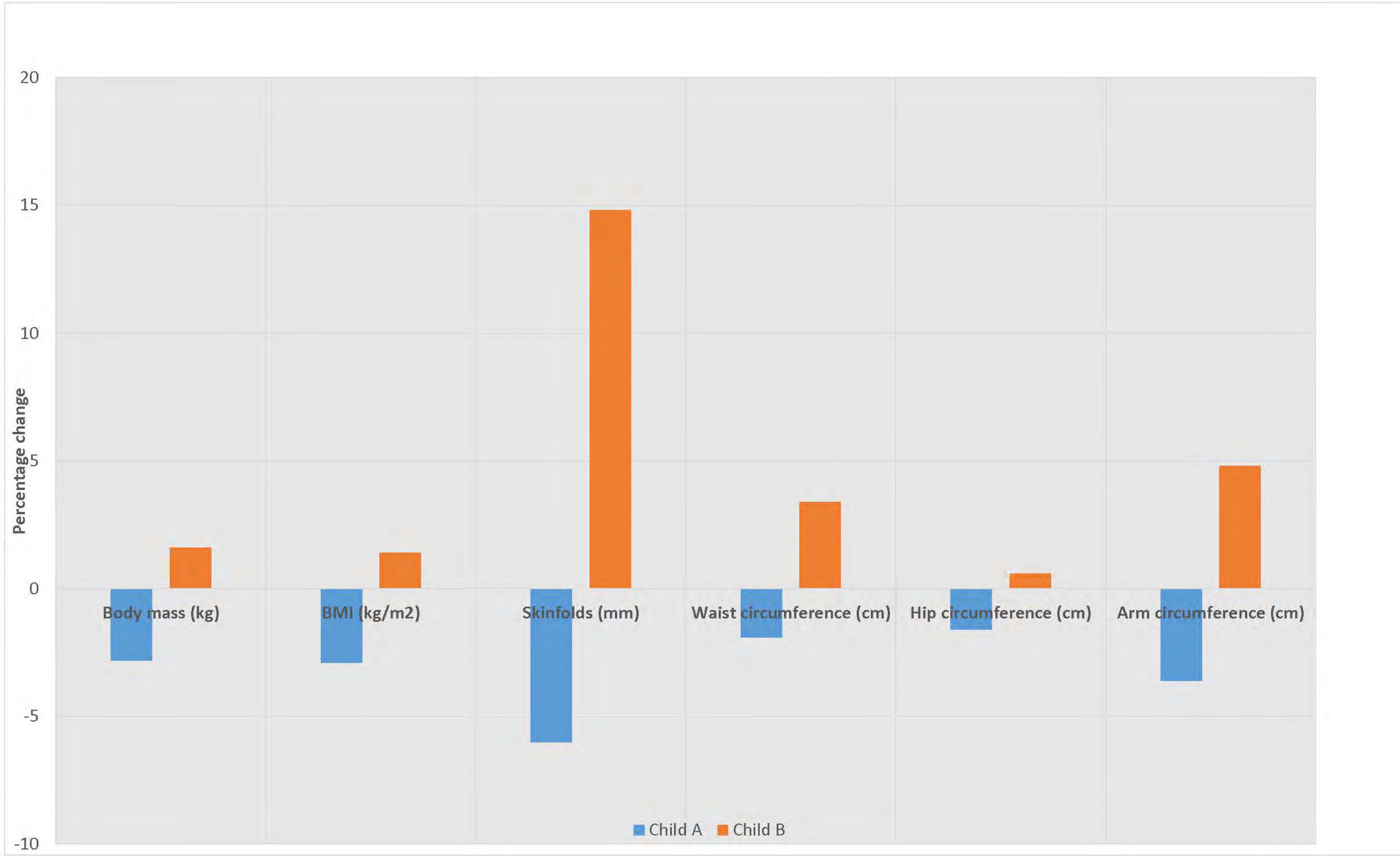

Figure 1 Percentage change of anthropometric measures.

AIM

This case study aimed to evaluate the impact of a resistance training intervention on the weight status of two overweight children.

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CASE STUDY APPROACH

- Following ethical approval, a resistance training intervention was implemented.
- For the purpose of this case study, the data from two male children (aged 10 years) who were classified as 'very overweight' and in the 99th (child A) and 98th (child B) percentile for their age (NHS, n.d) were included in the evaluation.
- Baseline anthropometric measures were taken. This included: stretch stature (cm), body mass (kg), body mass index (kg.m^{-2}), 4 site skinfolds (mm), and arm, waist and hip circumferences (cm).
- Following these measures, child A took part in a 4 week, twice weekly, 45 minute, supervised strength intervention and child B continued his regular activity.
- Following the intervention period, further anthropometric measures were taken.
- Additionally, both children wore accelerometers (Actigraph GT3X+) for 7 days pre and post the intervention period.

RESULTS

- The attendance of child A was 100% for the 4 week intervention.
- As shown in Figure 1, in child A, all anthropometric measures decreased and for child B, all measures increased. This shows a positive impact of the intervention on child A independently and in comparison to child B.
- Although the intervention was only 4 weeks long (8 sessions), there was a substantial improvement in the weight status of child A but deteriorations in the measurement of child B.
- Child A did not meet the physical activity recommendations of 60 minutes of daily moderate to vigorous physical activity (MVPA) (Chief Medical Office, 2011), although this did increase from 38 minutes pre intervention to 47 minutes post intervention.
- Despite deteriorations in measurements, child B took part in 83 minutes of daily MVPA pre intervention and 132 minutes following the intervention period.
- It is also important to note that the parent of child A described how positive the child (and parent) had been about taking part in the intervention (see quote below).

"He is buzzing from this more than anything else he's done, this could do wonders for his confidence."

PRACTICAL APPLICATIONS

- The results of this case study indicates that there is a potential positive benefit of resistance training on the weight status of overweight children.
- Furthermore, the increase in the measures of child B who was not taking part suggests a worrying trend of increasing obesity in the absence of an intervention strategy.
- Additionally, despite child B meeting the guidelines for MVPA, this appears to be not enough to improve or maintain measure of weight status and therefore additional action should be implemented.
- The inclusion of resistance training as a part of physical activity could be an important strategy in combatting the rise in obesity levels, particularly as child A had 100% attendance and was very positive about the experience.
- This case study also demonstrates the crucial role of the strength and conditioning coach out with performance sport and in an area critical for health.

ACKNOWLEDGMENTS

- Thank you to the children who took part in the study and to my PhD supervisors.

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The Acute Effect of a Drop Jump Protocol on the Kinematics of Acceleration on a population of Irish Sprint Athletes

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ABSTRACT:

Aim

The purpose of this study was to analyse the effect of implementing one set of five drop jumps prior to sprint activity on sprint kinematics and speed.

Methods

Eight track athletes (age,21.3 ± 3.3 years; weight 80.6 ± 8.2 kg; height 179.3 ± 7.0 cm). All performed two separate warm up conditions, a dynamic warm up and a dynamic warm up with the implementation of one set of five Drop Jumps straight after. Testing took place over two days with a week in between. One day analyzed the effect of DYNWU alone and the second day analyzed the effect of the DYNDJ protocol on acceleratory kinematics.

Results

Statistical analysis displayed a significant improvement in 5m, 10m & 15m time for DYNDJ in comparison to DYNWU(6.9%, F = 9.430, p = 0.01, 3.9%, F = 11.795, p = 0.01, 2.7%, F = 8.201, p = 0.02). Additionally ground contact time received a significant (2.4%, F = 3.997, p = 0.049) improvement. However other kinematic variables analysed did not receive any significant change between conditions Step length (F = 0.904, p = 0.76), flight time (F = 0.290, p = .12) and stride length (F = 1.563, p = .56).

Conclusion

Implementing one set of five drop jumps sufficiently potentiates lower limb extensors to improve acceleration speed and kinematics

INTRODUCTION:

Track athletes by the nature of their sport are required to accelerate to maximum velocity in the shortest period of time possible. To achieve this the athlete must generate large amount of force is quick efforts to initiate propulsion and overcome external resisting forces (Mackala & Fostiak, 2015; Samozino et al., 2015).

While initiating an acceleration an athlete is required to initiate an explosive concentric action of the hip and knee extensors, allowing the maximum generation of force in the shortest period of time possible (Maćkała, Fostiak, & Kowalski, 2015). Considering this action to produce force, best practice would suggest using a representative method of enhancement in conjunction with a dynamic warm up to maximise potential force output (Lima,et al., 2011).

Previous research into the area of applying plyometric stimulus to maximise force production capabilities have applied various different methods to enhance force production are inclusive of drop jumps, weighted bounds, loaded squat jumps and single legged bounds (Lima, et al.,2011; Byrne et al,. 2014; Dello iacono et al,. 2016).

No previous research has analysed the effect of drop jumps on sprint acceleration and the subsequent kinematic variables associated with sprinting, as a result no causation for enhancement has been highlighted regarding acceleratory action post implementing drop jump stimuli

AIM:

This Study aimed to compare the effect of PAP in the form of drop jumps on acceleration speed and the associated kinematic variables.

METHODS:

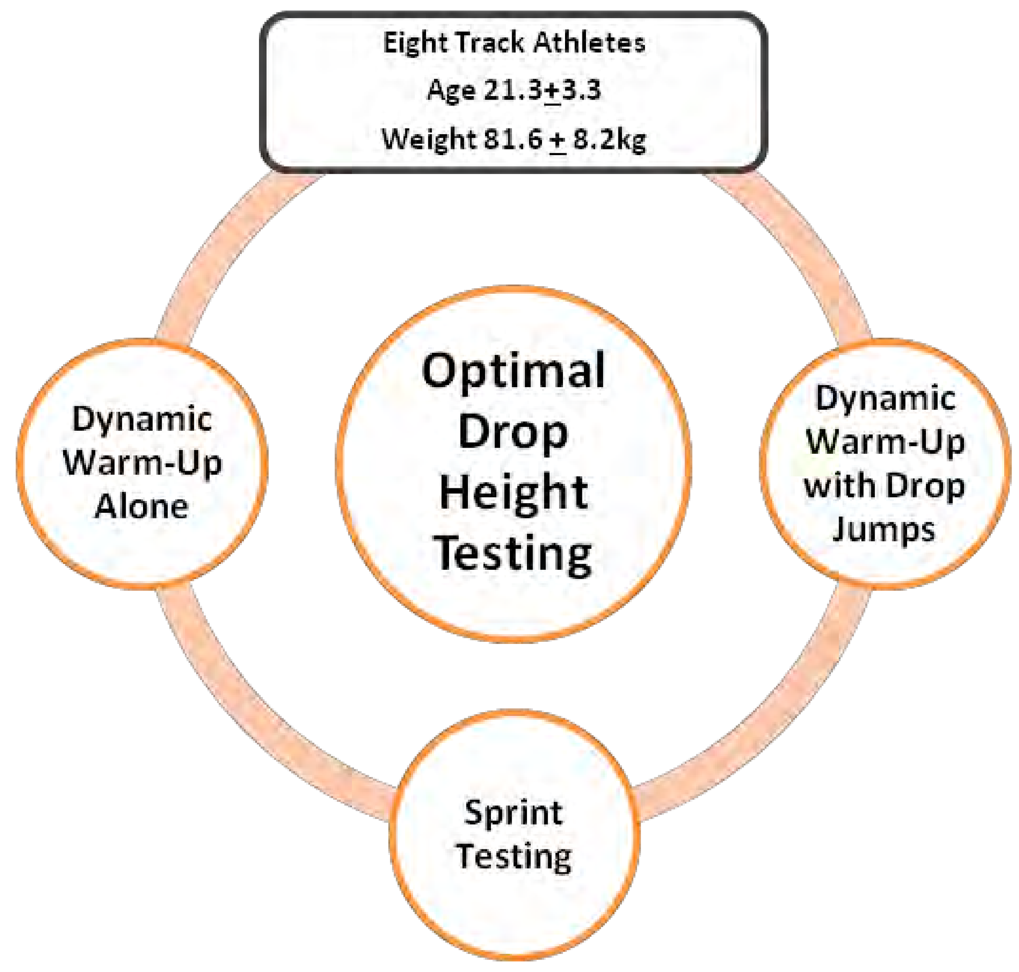


Table 1. Dynamic Warm-Up Protocol

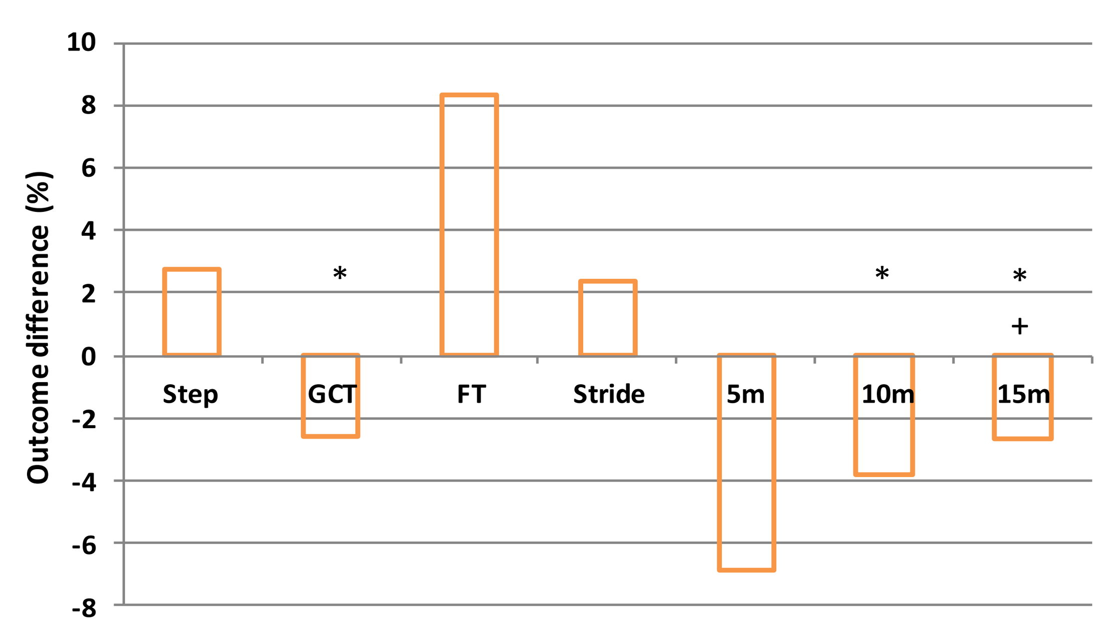
Jogging	3 minutes
High Knee hold	1 minute
Heel slide	1 minute
Straight leg march	1 minute
Lateral shuffle	1 minute
High Knee Jog	1 minute
High Knee skip	1 minute

RESULTS:

A two way within within repeated measures analysis of variance (ANOVA; within subject factor condition [DYNWU and DYNDJ] X trial [1, 2 &3]) was conducted.

There was no significant effect on variables including step length ($F(1,74) = 0.90$, $p = 0.76$, partial-eta² = 0.04), flight time ($F(1,66) = 0.29$, $p = 0.12$, partial-eta² = 0.13) and stride length ($F(1,65) = 1.56$, $p = 0.56$, partial-eta² = 0.01).

A significant effect was observed on GCT ($F(1, 74) = 3.99$, $p = 0.04$, partial-eta² = 0.53). In addition a significant effect was observed on acceleration performance over three distance splits (5m: $F(1,53) = 9.43$, $p = 0.01$, Partial eta = 0.48; 10m: $F(1,147) = 11.79$, $p = 0.01$, partial eta = 0.63; 15m: $F(7,172) = 8.20$, $p = 0.02$, partial eta = 0.53). Pair wise comparison revealed the largest effect at trial 2 for each distance (5m: 6.9%; 95% CI .029 - .118; p = 0.001;10m: 3.8%, 95% CI:0.028 - 0.107, p = 0.005;15m: 2.7% 95% CI .027 - .100 ; p = 0.004) .



Step	2.73
GCT	-2.6
FT	8.37
Stride	2.4
5m	-6.9
10m	-3.85
15m	-2.68

+ significant effect between trials (p ≤ 0.05)
* significant effect between warm up protocols

CONCLUSION:

Acceleratory performance is enhanced by implementing one set of five drop jumps prior to sprinting. This improvement may be attributed to a reduction in ground contact time in the initial stages of the sprint this may be seen as the result of the occurrence of PAP. This finding suggests by implementing drop jumps as part of a dynamic warm up, sprint activity may be enhanced.

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CMJ Predictors of Linear Speed in Elite Rugby Sevens Players

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HARTPURY UNIVERSITY CENTRE

INTRODUCTION

Rugby sevens is a fast paced, high intensity sport that requires players to repeatedly sprint(1), change direction and contest the ball at tackle areas and rucks(2), interspersed with periods of low and moderate intensity running(3).

It has previously been reported that linear speed (LS) and acceleration ability are important components in field sports, whereby the ability to cover ground quickly and from varying starting speeds is critical to success(4). Research has shown sprint velocity, evasive change-of-direction manoeuvres and the ability to out-pace an opposition player to yield a competitive advantage and contribute to successful team performance in both rugby union(5,6) and rugby league(7). During rugby sevens match play 39% of game time is played at speeds between 12 - > 20.1 km·h^{-1}; with an average sprint distance of 20 m, covered at average maximal speeds of 25.9 km·h^{-1} (8). These findings suggest that LS ability is, therefore, an important contributor to successful match performance in rugby sevens.

Subsequently, methods that influence LS, such as jump training (9,10,11) are important for athletes to perform. However, to programme effectively it is crucial for the S&C coach to understand which kinetic variables of jumping exert an influence of sprint performance. Furthermore, limited information exists within the sport of Rugby sevens. Therefore, the purpose of this study was to determine which countermovement (CMJ) variables predict LS performance in elite rugby sevens players.

METHODS

Participants

Thirteen elite male national rugby sevens players participated in this research study (age 22.8 ± 3.7 years, height 1.84 ± 0.08 m, body mass 91.4 ± 8.3 kg). Anthropometric data collection and physical testing occurred over two sessions (48 hours).

Assessments

Countermovement Jump (CMJ)

Participants' stood erect on a force platform with a plastic bar (< 1 kg) positioned across shoulders to remove the effect of arm swing and isolate force generated by the lower extremity(12). On command participants descended into a squat position of which depth was self-selected, before jumping to achieve maximal height. Three trials of CMJ were performed, on a dual force platform (NMP Technologies Ltd., ForceDecks Model FD4000a, London, UK) sampling at 1000 Hz; situated within the floor of a custom isometric rack (Sportesse, Essen, Germany); interspersed with 60 s rest.

Linear Speed (LS)

Participants performed three maximal 30 m sprints (Figure 1) interspersed with 3-4 m passive recovery. Wireless, double-beam photocell timing gates (Witty, Microgate, Bolzano, Italy) were placed at subjects' approximate hip height at 0-, 5-, 10-, 15-, 20- and 30 m distances to provide total time and splits. Only times ≤ 20 m were analysed; the additional 10 m ensured the 20 m distance was maximal effort devoid of deceleration. Participants' initiated the sprint from standing 1 m before the first gate.

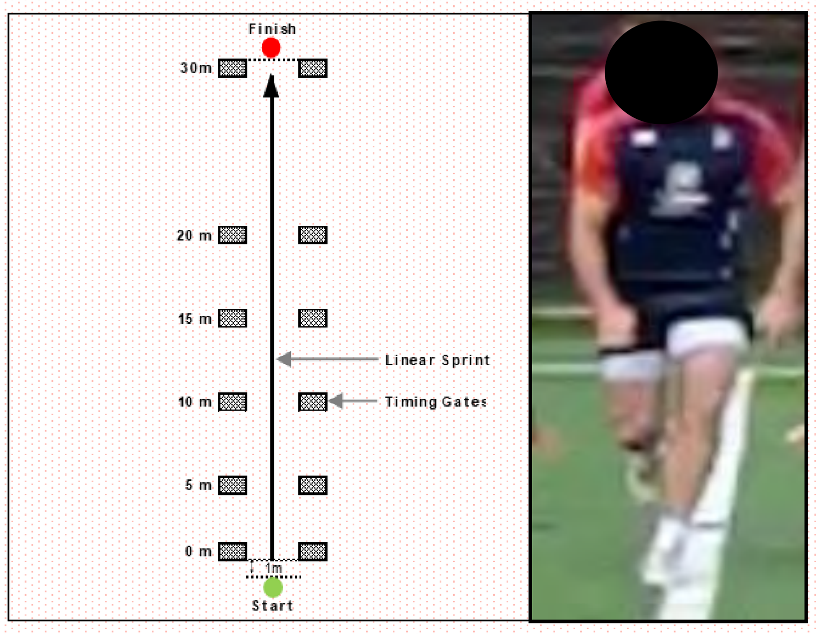

Figure 1. Format of the LS test.

Statistical Analysis

Some data were scaled in an allometric manner as research has suggested a more suitable comparative analysis when body mass is considered(13). Analysis was performed using SPSS, 24.0 (SPSS Inc., Chicago, IL, USA). All Data was tested for normality using Shapiro-Wilks test and the visual examination of histograms; whereby normality was indicated. Pearson bivariate correlation analysis was performed to assess significant relationships between independent variables (IV) and dependant variables (DV). All predictors showing significant moderate relationships (r = ≥ 0.3) were retained for further analysis with other variables removed. Stepwise multiple linear regression analysis was then used to identify the proportion of variance explained by the remaining IV predictors on DV correlates, as indicated by the coefficients of determination (R^2). The alpha value was set at $P \leq 0.05$ denoting significance.

RESULTS

Table 1. Correlations of those variables carried forward into the regression analysis (*R* values displayed).

Assessment	Variable	Linear Speed (s) 5 m	10 m	15 m	20 m
Countermovement Jump (CMJ)	**Absolute**				
	Concentric Peak Velocity (m·s^{-1})	-0.624*	-0.646*	-0.524	-0.497
	Relative				
	Relative Average Eccentric:Concentric Force Ratio	-0.317	-0.375	-0.494	-0.579*
	Relative Concentric:Eccentric Duration (Ratio)	-0.315	-0.472	-0.469	-0.611*
	Relative Concentric Duration (ms)	-0.793**	-0.724**	-0.645*	-0.815**
	Relative Contraction Time (ms)	-0.674*	-0.561*	-0.618*	-0.668*
	Relative Jump Height (Flight Time) (cm)	-0.498	-0.587*	-0.579*	-0.574*
	Relative Movement Start to Peak Power (ms)	-0.676*	-0.550	-0.603*	-0.656*
	Relative Takeoff RFD - First 200 ms (N·kg·s^{-1})	-0.740**	-0.680*	-0.497	-0.663*

** Correlation significant at *P* <0.01 (2-tailed). * Correlation significant at *P* <0.05 (2-tailed). RFD: Rate of force development

Table 2. The coefficients of determination (R^2), unstandardized (*B*) and standardized (β) Beta values for each of the four stepwise linear regression models.

Assessment	Step	Variable	R^2	*B*	*SE*	β
5 m sprint time	1	Relative Concentric Duration (ms)	0.679	-0.045	0.011	-0.671**
	2	Concentric Peak Velocity (m·s^{-1})	0.811	-0.065	0.026	-0.395*
10 m sprint time	1	Relative Concentric Duration (ms)	0.522	-0.041	0.014	-0.530*
	2	Concentric Peak Velocity (m·s^{-1})	0.733	-0.093	0.035	-0.498*
15 m sprint time	1	Relative Concentric Duration (ms)	0.416	-0.062	0.022	-0.645*
20 m sprint time	1	Relative Concentric Duration (ms)	0.726	-0.099	0.019	-0.852**

** Standardized beta values significant at *P* < 0.01. * Standardized beta values significant at *P* < 0.05.

Relative concentric duration explained 67.9% of the variance (R^2 = 0.679) in 5 m time. When concentric peak velocity was added to the model, this increased to 81.1% (R^2 = 0.811). Significant standardised Beta values (β = -0.671 and β = -0.395) predicted for a 1 *SD* (0.51 ms) increase in relative concentric duration a resultant 5 m time decrease of 0.02 s would occur. A predicted 1 *SD* increase in concentric peak velocity (0.2 m·s^{-1}) would result in a -0.01 s improvement in 5 m time. The variables relative concentric duration and concentric peak velocity from the CMJ contributed 73.3% of the variance (R^2 = 0.733) in 10 m time. Significant standardised Beta values (β = -0.530 and β = -0.498) predicted a 1 *SD* increase in relative concentric duration or concentric peak velocity would result in a 5 m time decrease of 0.02 s respectively. Relative concentric duration from the CMJ contributed a total of 41.6% of the variance (R^2 = 0.416) for 15 m sprint time. Standardised Beta value (β = -0.645) indicated a 1 *SD* increase in relative concentric duration results in 5 m time decrease of 0.03 s. Again, relative concentric duration from the CMJ contributed to a total of 72.6% of the variance (R^2 = 0.726) in 20 m time. Standardised Beta value (β = -0.852), indicating a 1 *SD* increase in relative concentric duration would result in a 0.05 s reduction in 20 m time.

PRACTICAL APPLICATIONS

It is essential when working in high performance and elite sport settings that S&C coaches have an extensive understanding of the performance needs of their athletes and the demands of the sport in which they are working. This information will dictate the prescription of the CMJ, to induce adaptions appropriate to the requirements of the sport. In relation to the findings of the present study, the athletes able to create a larger impulse through the concentric phase of the CMJ are able to generate greater force outputs which effectively displace the centre of mass (COM) and overcome inertia during the initial acceleration phase of sprinting. Therefore, when using the CMJ as a training tool to improve LS, the applied practitioner should look to focus on:

- ✓ Enhancing relative concentric duration/impulse (E.g. Heavy weighted vertical jumps > 75% 1RM squat, focus on 'pushing harder').
- ✓ Improving concentric peak velocity (E.g. Band assisted vertical jumps).
- ✓ Reducing muscle slack (pre-tension/no SSC. E.g. Box squat and pin squat jumps).

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Blood Flow Restriction Training Following Osgood Schlatter Disease In A Youth Footballer - A Case Study

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Manchester City Football Academy[1], Nottingham Trent University[2]

Introduction

Osgood-Schlatter disease (OSD) is an overuse growth related injury that causes reduced lower extremity control (7), accompanied by noticeable muscle atrophy, antalgic gait and strength decrements. OSD is the most common cause of missed training among the youth athlete, peaking at the U13 age group (6). It has been described as an inflammatory response caused by repetitive knee extensor contraction, which leads to micro avulsion injuries due to traction forces (1,3,7).

Blood flow restriction training (BFRT) is widely referenced as a tool for accelerated hypertrophy and strength in an adult population at a lower intensity of training load (5). Reported physiological mechanisms include increased mTOR pathway protein synthesis, cell swelling and metabolic accumulation due to the prevention of venous return (4). However, its use within a youth population is underreported. Therefore, the aim of the present case study was to evaluate the effect of a BFRT intervention within a return to play protocol following OSD in a youth footballer.

Methods

Using an interdisciplinary approach, it was determined that a brief period of deloading was required while OSD symptoms settled. Baseline bilateral thigh girth and unilateral bodyweight repetition maximum tests (sit-to-stand, feet elevated bridge and calf raise) were recorded (no data was available from pre-OSD symptoms), followed by a 3-week deloading period during which the player was instructed to rest. An accelerated period of hypertrophy was desired, however, before BFRT could be considered a reduced volume of body-weight squat derivatives were implemented due to the adopted movement strategy induced by pain. Subsequently, a one-week program of body-weight squat variations were used to address altered movement patterns. Thigh circumference measurements were taken 20cm proximal to the tibial tuberosity.

Parental consent was obtained prior to BFRT. An occlusion cuff (width - 11 cm) was placed at the proximal thigh of the atrophied limb (right), using 150mmHg pressure, which remained constant throughout the protocol. Bodyweight squats and split squats were then performed using a 30, 15, 15, 15 repetition protocol, interspersed by 1-minute rest intervals, 4 times per week for 4 weeks (5).

Figure 1. Bilateral thigh hypertrophy during the BFRT intervention period

Safety Protocol

- Parental consent
- Pre-BFRT screening questionnaire
- Clinical examination by GP

BFRT Risks

13,000 surveyed (8);

- Bruising (13.1%)
- Pain/Discomfort – usually mild and self limiting
- Numbness (1.3%) – Again, normally self-limiting and very mild
- Cerebral anaemia (0.3%)
- Cold Feeling (0.1%)
- Venous Thrombosis (0.06%)
- Pulmonary embolus (0.01%)
- Rhabdomyolysis (0.01%)
- Deterioration in heart disease (0.01%)

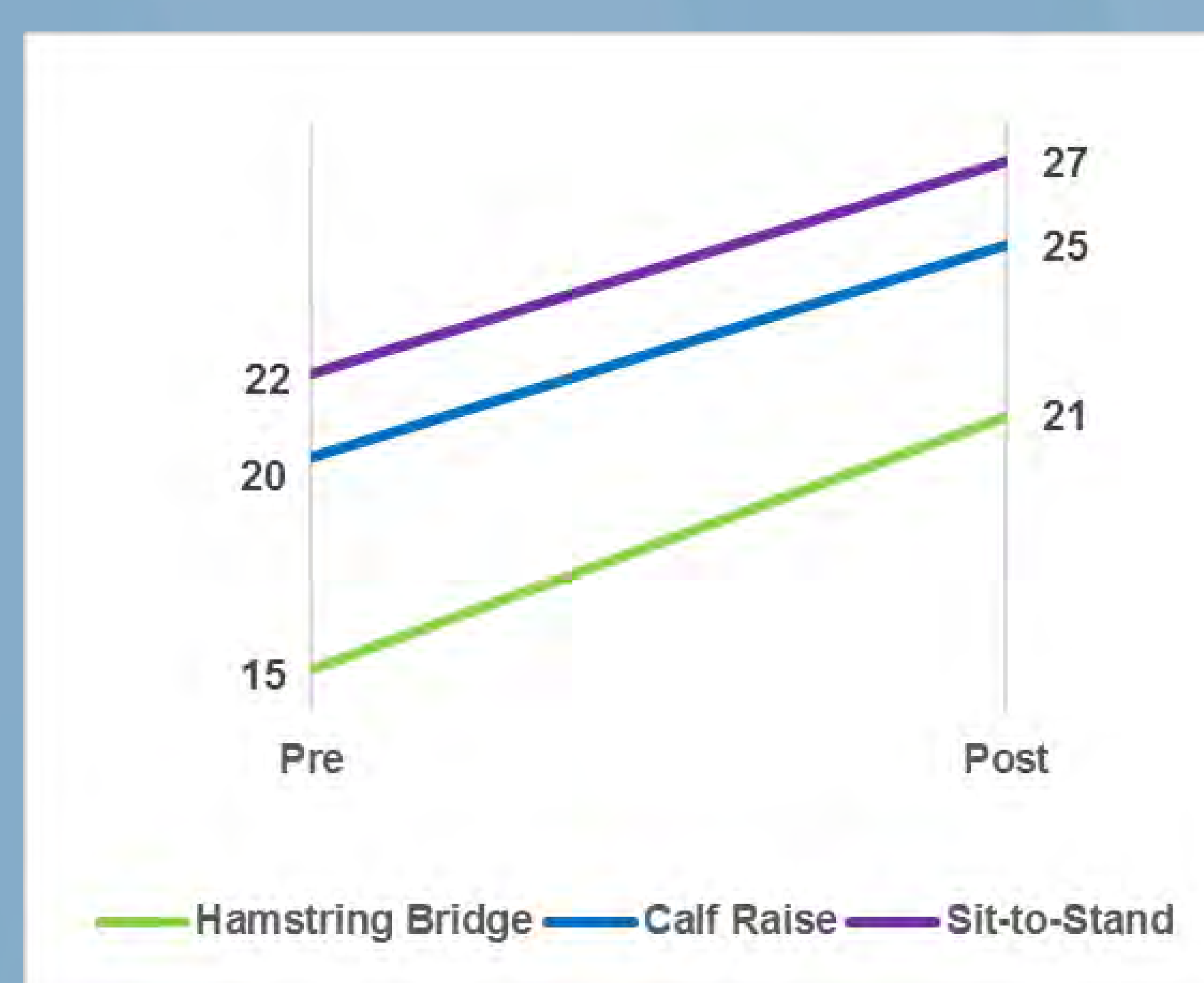

Figure 2. Pre and post intervention repetition maximum scores of the right lower limb

Results

There was a baseline 12 % bilateral thigh girth difference (recorded prior to the deloading period when the player was removed from football training) pre BFRT intervention (left - 45 vs right - 40 cm), which decreased to a 2 % difference post BFRT intervention (left - 46 vs right - 45 cm) [see Figure 1.]. Unilateral thigh girth of the atrophied limb improved by 12.5 % (hypertrophy - 5 cm) post BFRT intervention.

Bilateral repetition maximum differences for the sit-to-stand (left - 26 reps vs right - 22 reps; 17 % difference), foot elevated bridge (left - 19 reps vs right - 15 reps; 24 % difference) and calf raise (left - 22 reps vs right - 20 reps; 10 % difference) were observed. Unilateral repetition maximum of the atrophied limb improved for each test (sit-to-stand - 20 % increase; foot elevated bridge - 33 % increase; calf raise - 22 % increase) increased post BFRT intervention [see Figure 2.].

Discussion

The present findings infer that BFRT accelerated hypertrophy and repetition maximum scores of an atrophied limb in a youth footballer following a 4-week protocol, which is supported by previous findings in adults (5). Although strength gains in the youth population are related to neural and intrinsic muscle adaptations rather than hypertrophic factors (2), the present findings along with observed improved movement and a reduction of symptoms related to OSD cannot be ignored. The present case study results demonstrated the potential efficacy of BFRT as a training modality in the youth athlete.

Practical Application

BFRT has proven to be an effective method to accelerate hypertrophy in this case study of a youth athlete. Published guidelines should be followed along with an appropriate safety protocol and regular monitoring of the athlete.

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RELIABILITY OF KINETIC DROP JUMP VARIABLES IN ELITE YOUTH SOCCER PLAYERS AT DIFFERENT STAGES OF MATURATION

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Introduction

Kinematic variables of drop jump performance have been well researched in female youth soccer players. There is a paucity of data relating to drop jump performance in male youth soccer players and a lack of data pertaining to kinetic variables in either male or female populations. Leppänen *et al.* (2016) and Hewett *et al.* (2006) have observed relationships between peak force and knee injury risk in young female athletes but to date this is the only variable that has been investigated. Due to the potential relationship with injury aetiology, it seems appropriate to investigate kinetic variables further.

Method

43 male youth soccer players (*n* = 21 pre-peak height velocity; *n* = 22 post-peak height velocity) participated in a test-retest investigation. Participants performed 30 cm drop jumps onto 2 force plates on 2 occasions separated by 7 days. Force data was processed to determine a variety of novel variables that might potentially indicate risk of injury and that have previously not been investigated. Reliability was determined using a combination of change in mean, intra-class correlation coefficient, typical error of estimates and coefficient of variation.

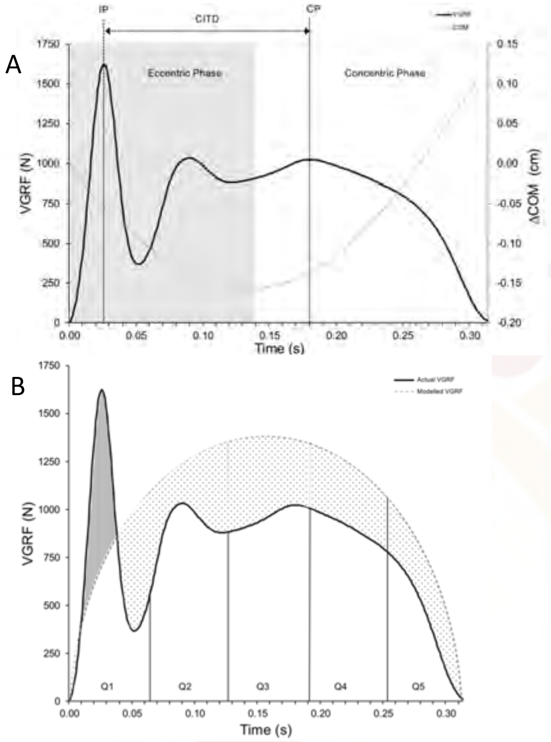
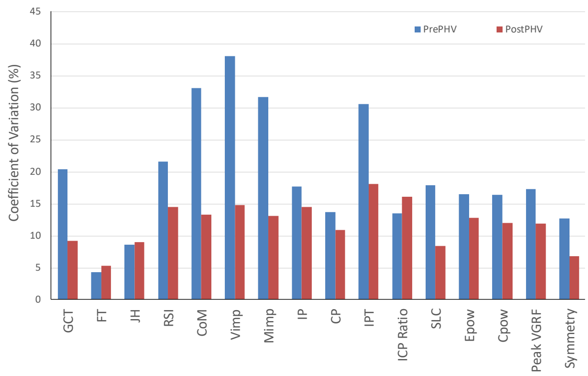


Figure 1. *A) Visual representation of force peaks and their timings; B) Visual representation of impulse related variables. IP = Impact Peak; CP = Concentric Peak; CITD = Concentric Impact Peak Timing Difference; COM = Centre of Mass; VGRF = Vertical Ground Reaction Force.*

Results

No significant differences were seen between testing days for either pre- or post-peak height velocity groups (PHV). The post PHV group displayed superior coefficient of variations (CV) and intra-class correlation coefficients (ICC) for most variables in comparison to the pre-PHV group. Only flight time, take-off velocity and jump height displayed CV < 10% in the pre-PHV group. Ground contact time, flight time, jump height, take-off velocity, spring-like correlation and symmetry presented CV < 10% in the post-PHV group.



Conclusion

Ground reaction force variables are less reliable in pre-PHV male soccer players than post-PHV in terms of peak ground reaction force and ground contact time. Consequently, other variables calculated from these variables are also less reliable. This could mean that the use of drop jump kinetic variables to predict injury is better in post-PHV athletes, but further research is needed to confirm. Despite often high levels of variability, existing research suggests DJ variables may be very sensitive to change, in that context reliability may be acceptable.

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'THE EFFECTS OF CONTRASTING INTRA-SET REST PERIODS ON BAR VELOCITY'

Joey O'Brien, Declan Browne

ABSTRACT

Aim: The aim of this study was to assess the effects of contrasting intra-set rest periods on barbell velocity during Trap Bar Deadlift (TBD) at 85% 1RM while also comparing Cluster Sets (CS) and Traditional Set (TS) configurations.

Methods: Twelve strength trained males (30.25 ± 5.7 years, 90.55 ± 7.85 kg, 182.63 ± 7.45 cm, 181.3 ± 15.2 1RM) participated in this study. Participants performed 4 sets of 6 repetitions with contrasting intra-set rest periods at 85% 1RM with 5 minutes inter-set rest. The order of the 4 sets with contrasting intra-set rest was randomly assigned before each session commenced.

Results: Mean Velocity (MV) and Peak velocity (PV) was significantly greater ($p < 0.05$) in TS when compared to CS configurations. There was no significant difference ($p < 0.05$) when comparing different CS configurations.

Conclusion: Results show TS configurations are more applicable to velocity maintenance in the TBD exercise when compared to CS.

INTRODUCTION

When designing resistance training programs two methods of set structure manipulation are often used Traditional Sets (TS) and Cluster Sets (CS). TS concentric velocities decrease as the number of repetitions increase (Tufano et al., 2016) which in turn decreases the average velocity of the set, this reduction in velocity is caused by the on-set of fatigue. It has been described by Bogdanis et al. (1996) that reduced availability of phosphocreatine (PCr) and rate of adenosine triphosphate (ATP) resynthesis is the primary cause of fatigue in the working muscles. ATP and PCr stores are significantly reduced after intense effort with the immediate store of ATP within muscle limited to around 20-30 mmol/kg of muscle which would be depleted after several seconds high intensity exercise (Mora-Custodio et al., 2018). One approach to avoid this on-set of muscular fatigue due to inadequate recovery is to employ CS (Haff et al., 2003). CS structures provide intra-set rest periods which lead to enhanced recovery due to a greater maintenance of PCr stores in conjunction with an increased metabolite clearance. This enhanced recovery in turn leads to maintenance of velocity and a higher set average velocity. The primary purpose of this study was to investigate the effects of contrasting intra-set rest periods on MV and PV in CS and compare TS and CS configurations.

METHODS

Participants: Twelve strength trained males (30.25 ± 5.7 years, 90.55 ± 7.85 kg, 182.63 ± 7.45 cm, 181.3 ± 15.2 1RM) participated in this study.

Procedure: One testing session consisted of 4 sets of 6 repetitions with contrasting intra-set rest periods at 85% 1RM and 5 minutes inter-set rest. The order of the 4 sets with contrasting intra-set rest was randomly assigned before each session commenced. The sets consisted of TS (no intra-set rest), CS 15 (15s intra-set rest on rep 2 & 4), CS 30 (30s intra-set rest on rep 2 & 4) and CS 45 (45s intra-set rest on rep 2 & 4). All kinematic and kinetic data was collected by Pushband (Vancouver, Canada) and Mean Velocity (MV) and Peak Velocity (PV) were recorded on Apple (California, USA) devices.

RESULTS

Results showed that there was a significant difference between MV in TS and CS 15 (z = -3.88, p = .00), CS 30 (z = -3.14, p = 0.02) and CS 45 (z = -2.58, p = 0.01) while results showed no significant difference between MV CS 15 and CS 30 (z = -.963, p = .33), CS 45 (z = -1.18, p = .24) or CS 30 and CS 45 (z = -4.90, p = .62). Results showed that there was a significant difference between PV in TS and CS 15 (z = -2.61, p = .009), CS 30 (z = -2.48, p = 0.01) and CS 45 (z = -2.06, p = 0.039) while results showed no significant difference between PV CS 15 and CS 30 (z = -.65, p = .51), CS 45 (z = -.939, p = .348) or CS 30 and CS 45 (z = -.529, p = .597). There was no significant difference ($p < 0.05$) found during rep to rep analysis over the 4 protocols.

Table 1: Average mean and peak velocity within each protocol (mean ± SD)

	TS	CS 15	CS 30	CS 45
Mean Velocity	0.56 ± 0.10	0.49 ± 0.07	0.50 ± 0.07	0.51 ± 0.06
Peak Velocity	0.88 ± 0.14	0.81 ± 0.09	0.83 ± 0.11	0.83 ± 0.11

*TS = Traditional Set, CS15 = Cluster Set with 15 seconds intra-set rest, CS30 = Cluster Set with 30 seconds intra-set rest, CS45 = Cluster Set with 45 seconds intra-set rest

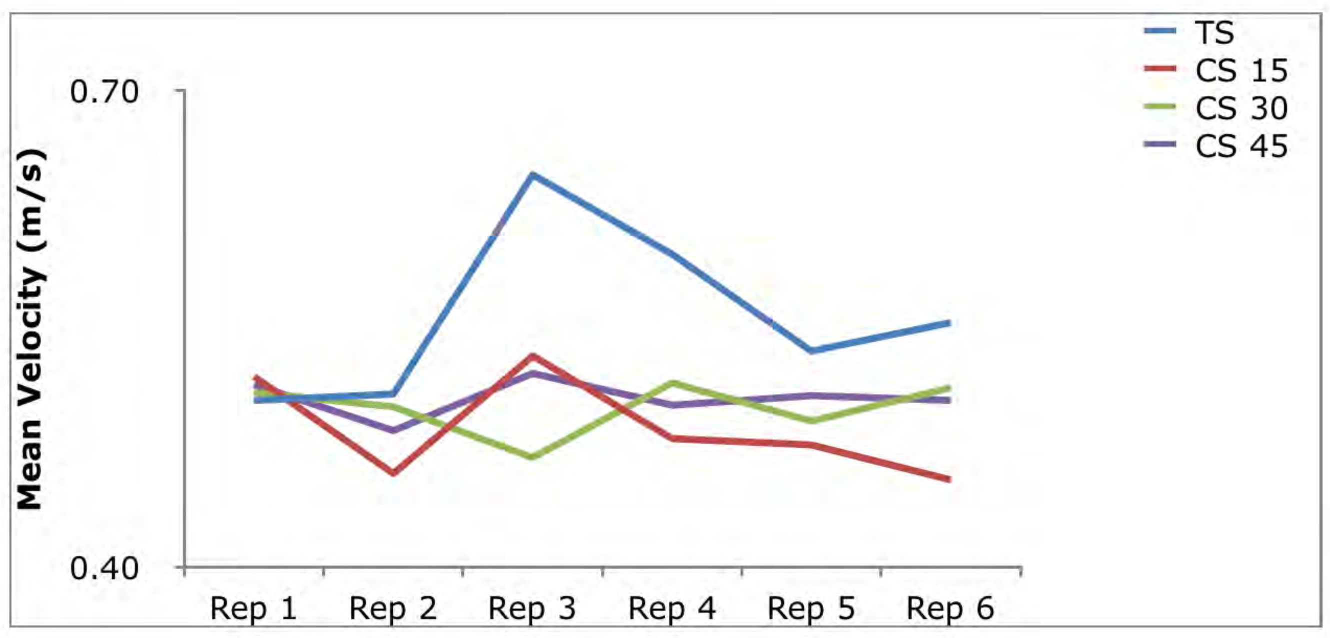

Figure 1:
Mean velocity from contrasting set configurations over six repetitions.

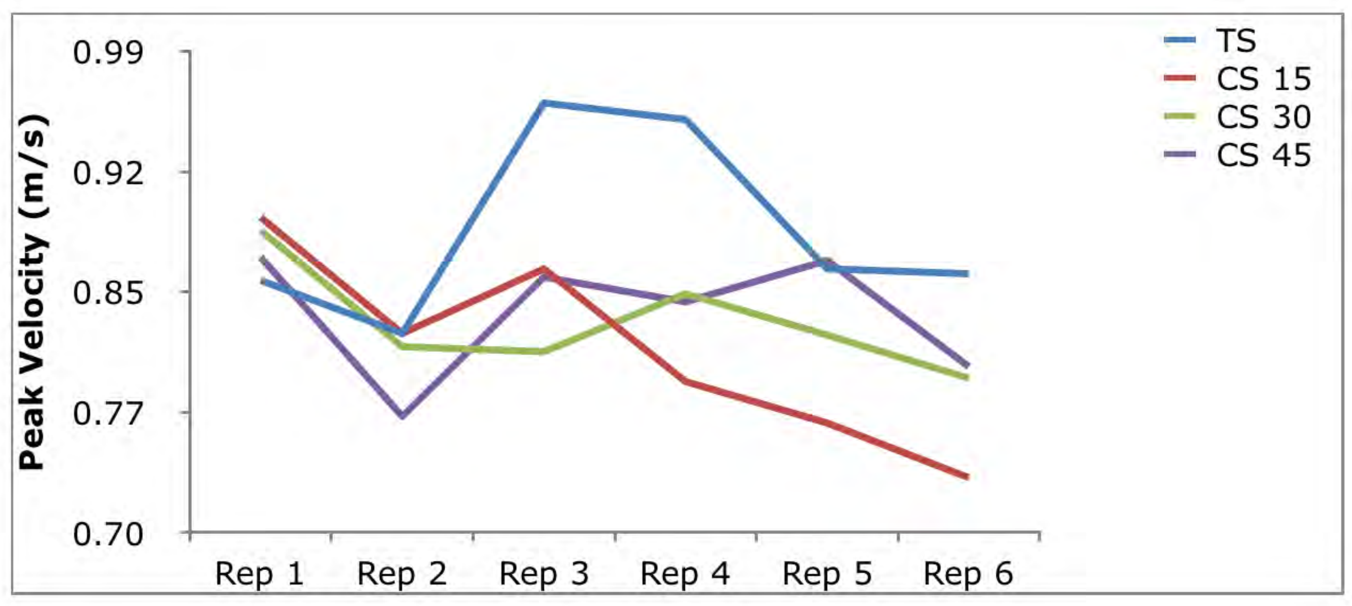

Figure 2:
Peak velocity from contrasting set configurations over six repetitions.

CONCLUSIONS

In conclusion this study found that TS configurations are more applicable to velocity maintenance in the deadlift exercise when compared to CS and that there was no statistical significant difference (p = < 0.05) between 15, 30 and 45 intra-set rest periods in CS configurations but data suggests that 15s was the least applicable for velocity maintenance over 6 repetitions. A single repetition of a Deadlift requires a concentric phase which is followed by an eccentric phase so the stretch shortening cycle (SSC) may be utilized when repetitions are performed continuously (Moir et al., 2013). CS configurations may halt recruitment of the SSC. The deadlift exercise may not be appropriate for velocity maintenance in CS structure due to the elimination of the SSC which creates more time under tension and fatigue but for these reasons may be best applied to strength development.

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Lower limb asymmetries of club level Muay Thai Athletes

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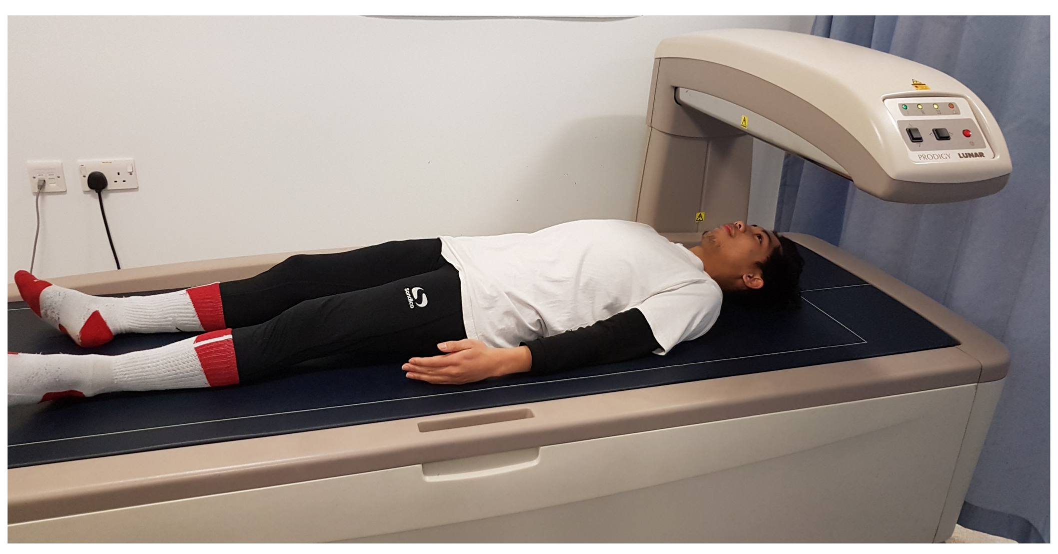
INTRODUCTION

Muay Thai athletes undertake extensive preparations that involve complex technical and tactical demands in order to demonstrate top performance (47). These high technical demands in turn raise their physical demands and according to Douda et al., (14) structural changes are experienced in the movement system, which leads to one side preference more than another. Athletes with developed lower limb asymmetry, are more likely to put more effort by bringing non-dominant side into action and this exposes body to increased risk of injury following with reduction in performance (5,7). Depending on the volume of training, the occurrence of lateral preference and its impact on both the functional and structural adaptation of the Muay Thai athletes could be a major contributor to the injuries in this combat sport (48).

The notion of asymmetries has been a topic of numerous research studies, which determined that such a factor might be harmful to performance or even cause injuries (5,18). Previous studies defined asymmetry as difference between dominant and non-dominant side muscles size, mass and strength (26). Dominance of the upper and lower limbs on a single side of the body is a common occurrence in sports (2,11,56). Awareness of lower limb asymmetry may provide better understanding of injury risk, rehabilitation, and performance (13,36). Previous literature has focused on relationship between asymmetry and injury (6,28,35) as well as impact on athlete's performance (3,5,21) however, the results of these relations is divided.

Many research papers have found a strong correlation between injury and lower limb asymmetry as a cause. Hart et al., (21) investigated Australian Rules football to identify if strength imbalances are detrimental to performance. Researchers assessed the impact of lower limb lean mass (measured via DXA scanning) and strength symmetry on kicking accuracy. Findings revealed that accurate kickers did not contain significant inequality in lean mass and unilateral strength between lower limbs. However, inaccurate kickers showed significant asymmetry in lean mass (~3%), and strength (~8%) indicating an inefficiency of non-dominant leg. Furthermore, Kim et al., (27) study on competitive fencers identified major muscle imbalances due to stance specificity and repetitive movements performed at high speeds. It was suggested that by reducing lower limb imbalances, the number of injuries such as ligament sprains, hamstring and quadriceps strains could be prevented.

The aim of this investigation was to measure lower limb asymmetries (through lean, fat mass, bone density and dynamic strength) of club level Muay Thai athletes and compare results to age-matched individuals. The secondary aim was to determine anthropometric and total-body composition characteristics of Muay Thai athletes through 3-compartmental analysis using DXA scanning.



METHODS

Twenty age-matched male participants' healthy and free of lower limb injuries in the past 12 month's period were recruited. Ten of participants were club level, competitive Muay Thai athletes with 2.22±1.2 years' experience in the sport (21.4 ± 1.78; range= 18-24 years vs. 21.1 ± 0.99; range= 20-23 years respectively). Ten participants were athletic, age-matched individuals with no experience in any combat sport.

Dual-energy x-ray absorptiometry (DXA):
Participants underwent a single total-body dual-energy x-ray absorptiometry scan (Lunar Prodigy densitometer 4, with Encore software version 11.0, UK) in a euhydrated state. Participants were instructed to lie on the scanning table in supine position, with arms held at side and feet backed up with the lunar ankle strap (38). Lean and fat mass data were calculated based on the ratio of soft tissue attenuation of two X-ray energy Bone mineral content was identified from absorption of each beam by bone (Figure 1).

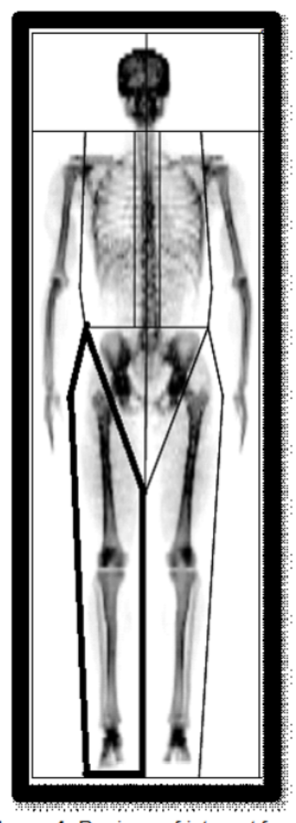


Figure 1. Regions of interest for Dual-energy X-ray absorptiometry (Vivid line)

Countermovement Jump (CMJ)
Leg dominance was determined prior to testing. All jumps were carried out on two embedded Kistler force plates. Participants hands were on the hips reduces impact of arm swing on jump. self-selected depth was used for each jump. Ground reaction forces (Peak force) were recorded at 1000 Hz.

Single leg counter-movement jump (SLCMJ)
SLCMJ jumps were randomised and performed after every CMJ (both legs, dominant, non-dominant and both legs, non-dominant, dominant) with 3 minutes rest in between trials to prevent fatigue. Identical instructions were used from CMJ, except that inactive limb was held behind with knee flexed during SLCMJ without swinging in the pre-jump. Familiarization session was conducted same day at least 6 hours prior testing.

Symmetry Angle Asymmetry was defined for each variable (Fat mass, Lean mass, Bone mineral content, Peak force (CMJ), Peak force (SLCMJ)) using a Symmetry Angle formula proposed by Zifchock et al., (58) and recently supported by Bishop et al., (4).

Equation 1.
(45° – arctan (Left limb ÷ Right limb)) ÷ 90° x 100
Adjusted formula for Microsoft Excel™ analysis:
Step 1: =DEGREES (ATAN (L ÷ R)) = A
Step 2: ((45 –A) ÷90) x 100 = Asymmetry score (expressed in %).
*Zero % indicates perfect symmetry between lower extremities.
* Arctan- a mathematical function that is the inverse of the tangent function.

Statistical Analysis
Normality of the data were assessed using Shapiro-Wilk test, when p> 0.05. For regional DXA data both relative and absolute values were identified. The Symmetry Angle formula was used to determine differences in body composition between the legs (dominant leg vs. non-dominant leg). Independent samples t-tests were used to compare body composition, between limb difference, strength and size of lower extremities. One-way analyses of variance with SA at 4-levels (0-5%, 5-10%, 10-15%, and >15%) were used to compare force difference (CMJ, SLCMJ) between groups. Effect sizes in the form of Cohen's d was reported to represent the magnitude of observed differences and interpreted according to Rhea (44).

Equation 2. Effect size (d) calculation
d = (Mgroup1 – Mgroup2)/SDpooled
Where SDpooled = √([SD2group1 + SD2group2]/2)

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RESULTS

Table 1. Anthropometric and total-body composition characteristics of Muay Thai athletes and age-matched controls

	Controls (n=10)	Muay Thai (n=10)	*p* value
Body mass (kg)	74.9±7.6	79±10	0.311
Height (cm)	173.5±4.9	179.3±6.6	0.039[a]
BMI (kg/m2)	24.9±2.2	24.5±1.7	0.661
Fat mass (kg)	16.5±4.4	13.4±3.8	0.113
Lean mass (kg)	54.6±4	62.1±8.2	0.22
%BF	22.9±4.1	17.7±4.3	0.012[a]
BMC (g)	3241±277	3480±434	0.161

[a] denotes statistical significance at $P \leq 0.05$.BMI body mass index; %BF body fat percentage; BMC bone mineral content. (mean ± standard deviation).

Table 2. Absolute and relative regional composition of lower limbs in Muay Thai athletes and age-matched controls (mean ± standard deviation).

	Controls (n=10)	Muay Thai (n=10)	*p* value	Effect size
Fat mass (kg)	5.7±1.6	4.7±1.4	0.146	-0.04
Lean mass (kg)	19.3±1.8	21.4±3	0.77	1.16
BMC (g)	1258.9±113.4	1320±153.2	0.324	0.69
Fat mass (%)	21.5±3.5	17.1±4	0.017[a]	-0.75
Lean mass (%)	73.7±3.2	78.1±3.9	0.014[a]	0.8
BMC (%)	4.81±0.1	4.85±0.1	0.837	-0.26

[a] denotes statistical significance at $P \leq 0.05$; BMC bone mineral content.

Table 3. Percentage (%) asymmetry in lower body composition of Muay Thai athletes and age-matched controls (mean ± standard deviation).

	Controls (n=10)	Muay Thai (n=10)	*p* value	Effect size
Fat mass	0.81±0.65	0.96±0.82	0.638	0.17
Lean mass	0.8±0.66	0.98±0.82	0.583	0.22
BMC	0.46±0.37	1.02±0.69	0.038[a]	0.92

[a] denotes statistical significance at $P \leq 0.05$. BMC bone mineral content.

Table 4. Descriptive characteristics for each variable of interest.

		Controls (n=10)	Muay Thai (n=10)	p value	Effect size
Lean mass (kg)					
	DL	9.74±0.85	10.75±1.45	0.74	1.19
	NDL	9.59±0.96	10.63±1.57	0.91	1.1
Fat mass (kg)					
	DL	2.88±0.81	2.36±0.69	0.138	-0.05
	NDL	2.84±0.83	2.37±0.7	0.189	-0.03
Peak Force (N) CMJ					
	DL	480.2±89.1	619.3±141.67	0.17	0.94
	NDL	446.1±98.1	542.3±79.9	0.25	1.08
Peak Force (N) SLCMJ					
	DL	619.4±95.6	856.8±137.4	0	1.97
	NDL	592±101.42	783.4±148.63	0.003	1.41

CMJ counter-movement jump; SLCMJ single leg counter-movement jump; DL dominant leg; NDL non-dominant leg.

Table 5. Number of individuals falling within defined intervals of asymmetry for each dependent variable with minimal and maximal scores for each category.

	Percent asymmetry (%)				Effect size
	0-5	5-10	10-15	>15	
Peak force CMJ					0.29
Muay Thai	5(1.12-4.45)	3(7.98-8.83)	2(10.67-11.79)	0	
Controls	8(0.72-4.1)	2(4.1-5.63)	0	0	
Peak force SLCMJ					0.85
Muay Thai	6(0.3-3.89)	3(5.54-7.58)	1(10.01)	0	
Controls	9(0.75-4.21)	1(8.54)	0	0	

CMJ counter-movement jump; SLCMJ single leg counter-movement jump.

DISCUSSION

- ❑ Significantly lower BF%, lower relative fat mass % of legs and higher relative lean mass % of lower extremities was identified in Muay Thai athletes.
- ❑ Greater lean mass % and significantly higher peak force of lower extremities in comparison with controls, demonstrates higher strength levels of Muay Thai athletes
- ❑ Significantly greater bone mineral content difference of lower limbs in Muay Thai athletes was observed.
- ❑ Lean mass asymmetry of 0.98 ±0.81% was obtained for Muay Thai athletes, revealing uneven force distribution of lower extremities.
- ❑ The findings of current investigation revealed that Muay Thai athletes obtained higher levels of force asymmetry during double and single leg CMJ tasks with average asymmetry of 6.31±3.68% and 4.06±3.18% respectively.
- ❑ None of the controls were considered as 'high risk of injury' using an arbitrary cut off level of 10% asymmetry, with maximal asymmetry score for double-leg CMJ jump task of 5.63%, and 8.54% for SLCMJ jump task, with average asymmetry of 2.52±1.96% and 3.15±2.15% for CMJ. Three Muay Thai athletes were considered as 'high risk of injury' with 10.67% and 11.79% level asymmetry during double-leg CMJ jump task and one obtaining 10.01% level asymmetry during SLCMJ jump task.

PRACTICAL APPLICATION

Muay Thai athletes are significantly taller, possess higher relative lean mass and lower relative fat mass in lower limbs than age matched controls. Bone mineral content and jumping asymmetry between lower extremities of Muay Thai athletes was significantly higher than controls and should be addressed through training stimulus.

The data points may provide strength and conditioning professionals with deeper understanding of Muay Thai as a sport and could help with developing between-limb symmetry training programmes.

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THE EFFECTS OF MATURITY STATUS ON MUSCLE ARCHITECTURE IN BOYS

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INTRODUCTION

- The arrangement of fibres within the muscle has implications for muscle function, with longer fascicles producing force at higher velocities, and larger muscle thickness and pennation angles increasing force generating capabilities (1).
- Research has demonstrated that adults have greater muscle thickness, pennation angle, and fascicle lengths of the knee extensor and plantar flexor muscles compared with children (2,3). However, no studies have identified how muscle architecture changes throughout maturation.
- The aim of this cross-sectional study was to identify potential differences in these muscle architecture variables between pre-, circa- and post-peak height velocity (PHV) boys.

METHODS

- Biological maturity of 126 school-aged boys was determined using anthropometric measures to predict age from PHV (4). Subjects were assigned to either a pre-PHV (maturity offset of < -1 yr PHV), circa-PHV (maturity offset between -0.5 – +0.5 yr PHV), or post-PHV group (maturity offset of >1 yr PHV).
- Muscle architecture of both the gastrocnemius medialis (GM) and vastus lateralis (VL) were determined using ultrasonography and analysed using open source image processing software (ImageJ) to quantify muscle thickness, pennation angle, and fascicle length.
- A one-way ANOVA with a Bonferroni post-hoc analysis was used to identify differences between maturity groups, for all variables ($p < 0.05$). Effect sizes (*Cohen's D*) were calculated to interpret the magnitude of between-group differences: <0.20 (trivial), 0.20-0.59 (small), 0.60-1.19 (moderate), ≥ 1.20 (large).

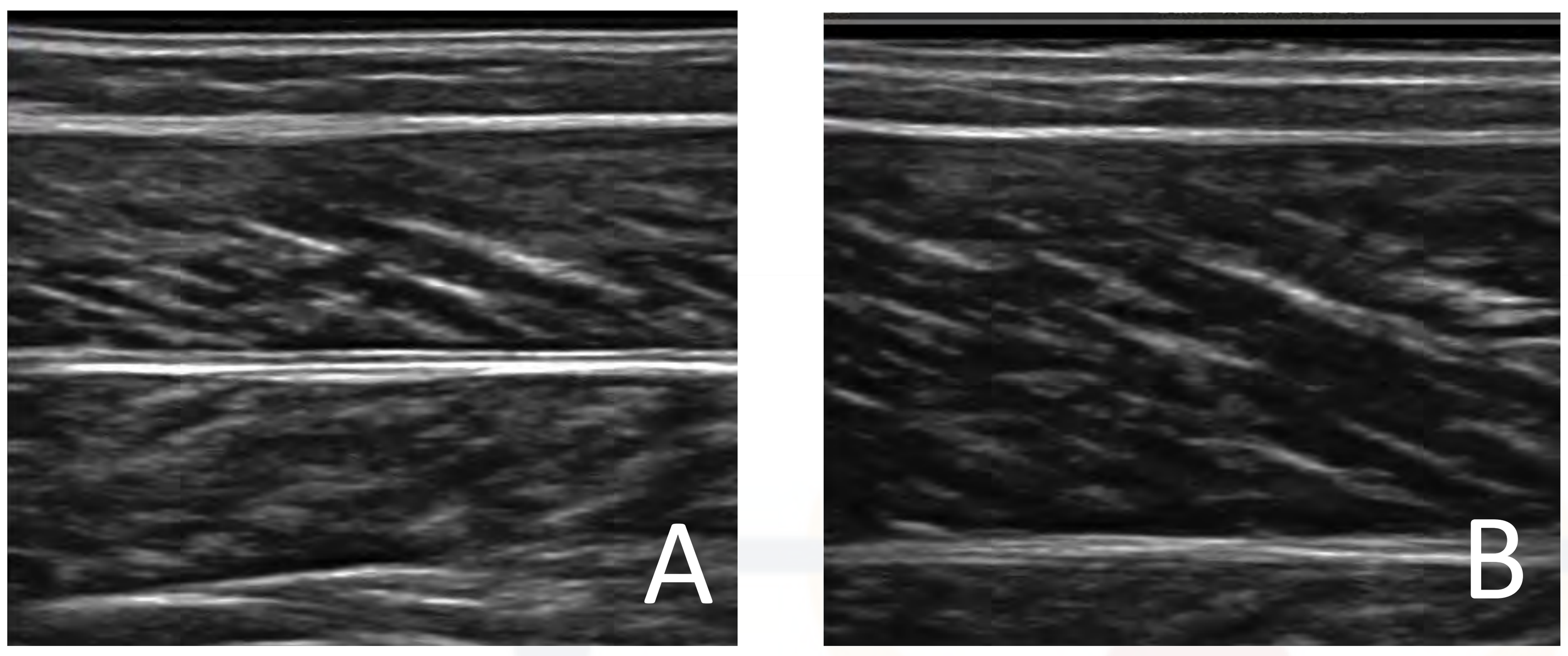

Figure 1. Gastrocnemius muscle thickness differences between pre-PHV (A) and post-PHV (B)

RESULTS

- Results show that all muscle architecture variables, excluding GM FL, were significantly larger in the post-PHV compared to the pre-PHV groups (ES = 0.3 – 0.71).
- GM MT was significantly greater in the circa-PHV compared with the pre-PHV (ES = 0.45), and VL MT was significantly different between pre-PHV and circa-PHV, and circa-PHV to post-PHV (ES = 0.51 and 0.36 respectively).
- Additionally, GM PA significantly increased between circa- and post-PHV groups (ES = 0.3).

Table 1. Descriptive statistics for all anthropometric variables for the pre-PHV, circa-PHV and post-PHV groups (Mean + SD)

	Pre-PHV (n = 57)	Circa-PHV (n = 32)	Post-PHV (n = 37)
Age	12.45 + 0.54	14.06 + 0.68	15.81 + 0.97
Standing Height	152.47 + 6.37*#	167.40 + 5.48*	176.59 + 6.62
Seated Height	76.61 + 3.94*#	85.24 + 2.65*	91.94 + 2.66
Body Mass	42.10 + 5.81*#	56.45 + 8.80*	68.52 + 9.93
Maturity Offset	-1.75 + 0.46	0.09 + 0.25	1.93 + 0.54

* significantly different to Post- PHV group (p ≤ 0.05)
# significantly different to Circa- PHV group (p ≤ 0.05)

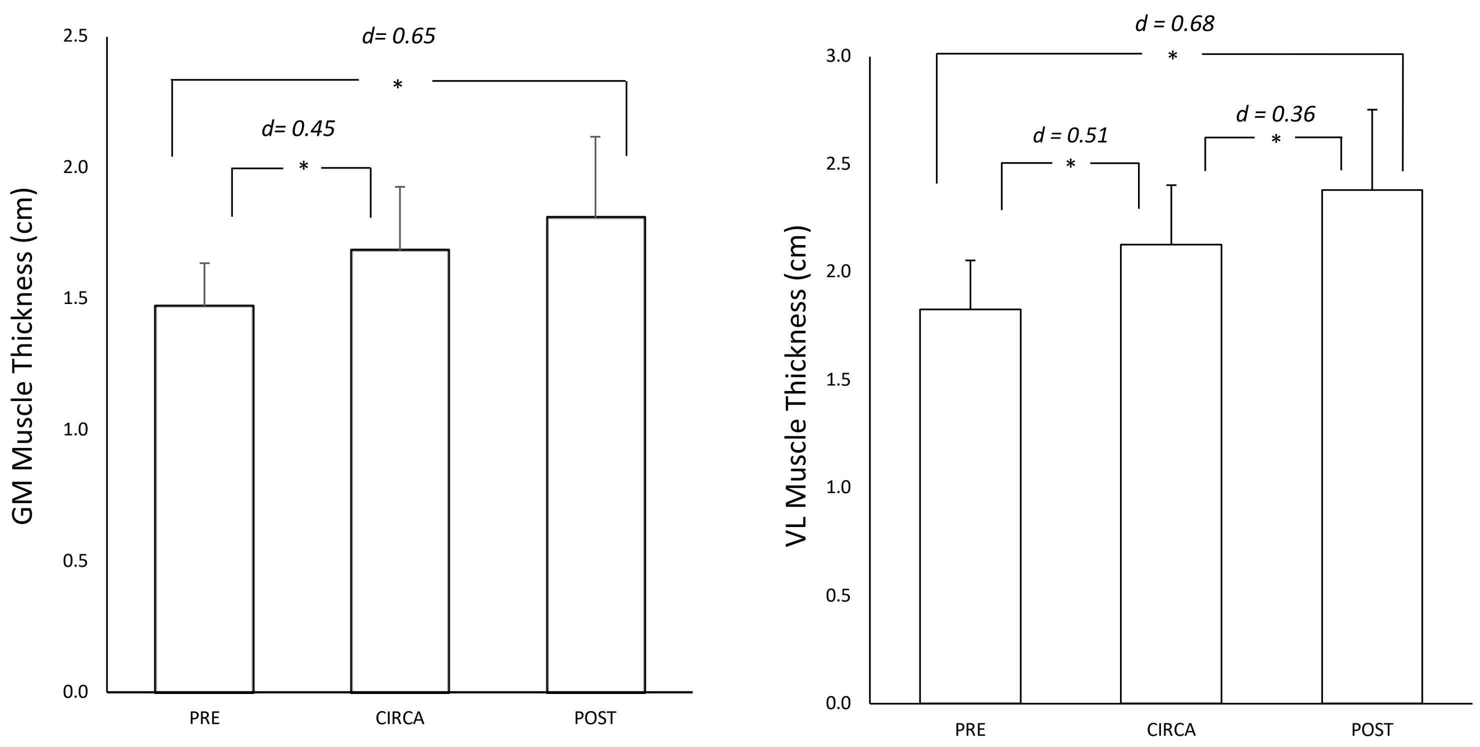

Figure 2. GM and VL muscle thickness differences between the three groups. * indicates significant difference between groups (p ≤ 0.05); *d* = Effect size.

PRACTICAL APPLICATIONS AND CONCLUSIONS

- The current study showed small to moderate significant increases in muscle thickness and pennation angle (GM and VL) and fascicle length (VL) in boys between pre- and post-PHV.
- The largest effect sizes were found between the pre- to post-PHV groups for GM and VL muscle thickness, suggesting that the greatest adaptations happen in muscle size during maturation.
- Furthermore, all variables (excluding GM PA) demonstrated larger effect sizes between pre- to circa-PHV compared to circa- to post-PHV, suggesting that a more pronounced degree of adaptation occurs in the earlier stages of puberty.
- Intuitively, these maturity-related increases in architectural variables may impact on the development of muscular strength and power in boys.
- In line with the concept of synergistic adaptation (5), practitioners should consider the findings of this study and attempt to align appropriate training stimuli (e.g. strength training) with these naturally occurring adaptations (i.e. increases in MT and PA) to potentially augment the force producing qualities of muscle.

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Canolfan Ddatblygu Corfforol Ieuenctid

The Effect of Augmented Eccentric Loading on 1,000-m Rowing Ergometer Time Trial Performance in Junior Elite Rowers

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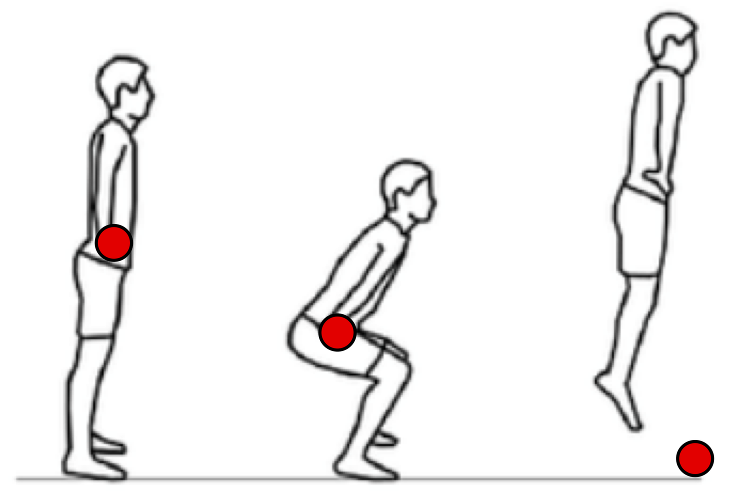
INTRODUCTION

Rowing is a whole-body strength-endurance sport, which demands both superior level of muscular strength and endurance (Maestu et al., 2005). Although rowing success is greatly correlated with a high aerobic endurance (Hagerman, 1984), anaerobic power is very important during the powerful rowing initial sprint (approximately 30 - 45s) and final sprint, the last 250 meters (Körner & Schwanitz (1985). In addition, study by Steinacker (1993) reported that the initial burst at the race demands the largest amount of the power output per stroke (800-1,200 W) to develop the boat's acceleration to its desired speed. Moreover, a strong correlation was found between boat speed and rowers' ability to produce force (Pérez-Treus et al., 2015). The main goal of competitive rowers is to complete the race in the shortest time possible (Baudouin & Hawkins, 2004). To achieve this, the rower should optimize their performance technique by increasing the efficiency of force production and minimizing power losses (Penichet-Tomás et al., 2012).

Augmented Eccentric Loading

Considering that fast and slow SSC rely on differing biomechanical mechanisms, therefore, could have a different effect on performance (Flanagan & Comyns 2008). Ebben et al. (2008) reported that the countermovement jump has higher muscle fiber recruitment compare to the other plyometric exercises. Furthermore, researchers have suggested that applying additional external load throughout the eccentric phase of the jumping movement could magnify the SSC (Ojasto & Häkkinen, 2009) by increasing of force production and greater power outputs in concentric phase, known as augmented eccentric loading (AEL) (Moran & Wallace, 2007). Moore et al., (2007) interpreted the AEL application as a heavy eccentric force immediately prior to a lighter concentric force. In fact, a recent meta-analysis by Aboodarda et al. (2015) has revealed that augmented jumps (see Figure 1) have provided greater eccentric loading compared to simple jumps. However, the practice of incorporating AEL protocols is still relatively new and only a minor number of studies that have specifically investigated it on jumping movements (Aboodarda et al., 2013; Sheppard et al., 2007). In terms to rowing, rowers generate more than half of their power from their legs (Kleshnev & Kleshnev, 1998). Hypothetically, the intervention of an AEL protocol may be able to enhance power output in an athletes' lower body, therefore maximise their rowing performance.

Figure 1. Example augmented eccentric jump using a countermovement.

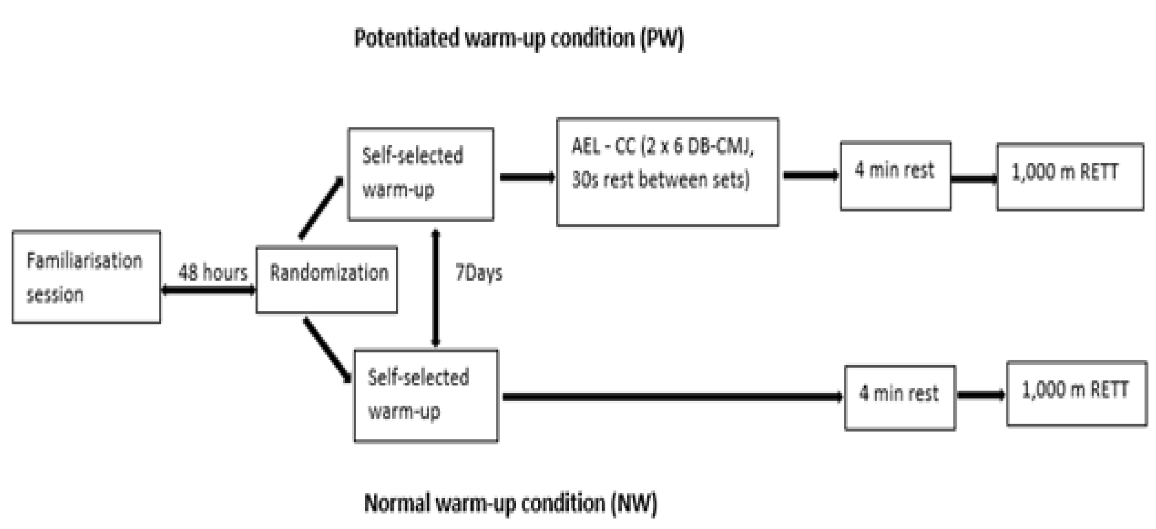


Athlete holds dumbbells in their hands and completes a countermovement jump to a self-selected depth. At the bottom position, the athlete releases the dumbbells and drives upwards in a succinct movement.

Aim

The aim of this study is to enhance initial acceleration and power production through the use of a pre-conditioning exercise known as augmented eccentric loading. The resultant output would be a faster 1000-meter row performance.

Figure 2. A schematic diagram of the experimental study design. AEL-CC – Augmented eccentric loading conditioning contractions, DB-CMJ – Dumbbell countermovement jump, RETT– Rowing ergometer time trial.



METHODS

Ten junior elite rowers, three females and seven males, volunteered to participate in the study (see Table 1). The participants were required to have at least one year of regular resistance training experience. All participants were free of any medical conditions or any injuries at the time of the study. Signed informed consent forms were obtained prior to commencement.

Table 1. Physical characteristcs of junior rowers (Mean ± Standard Deviation)

Age (years)	Height (m)	Body mass (kg)	20% of BM utilised for AE CMJ's (kg)
16.9 ± 0.74	1.75 ± 0.06	70.68 ± 7.8	14.136 ± 1.56

Testing Procedures

Participants attended on 3 occasions over a 2-weeks. Participants were assessed on two different sessions separated by 7 days: (1) Normal warm-up condition (NW) and (2) potentiated warm-up condition (PW), both conditions followed by a 1,000-m (RETT) (Figure 2). A familiarization session (FAM) was used for the AEL protocol. Augmented jumps were performed with the additional of eccentric load. This was accomplished by using dumbbells as an external load with a 20% of individual body mass (BM) (Table 1). The dumbbells weight calculation was based on previous study, which revealed that 20% –30% of additional external load has improved rate of force development (Aboodarda et al., 2014). Participants were randomly allocated to each group.

Normal warm-up (NW)

The NW protocol involved a regular warm-up followed by a four-minute passive rest and then performed on a 1,000-m rowing ergometer test (RETT). Rowers performed their self-selected warm-up, what they normally do in a pre-race situation. The warm-up routine consisted of static or dynamic stretching, including continues low and moderate intensity ergometer rowing.

Potentiated warm-up (PW)

PW protocol involved the same warm-up combined with an intervention of an augmented countermovement jumps (AE-CMJ) as a conditioning contractions (CC). The CC consisted of 2 sets of 6 dumbbell countermovement jumps (DB-CMJ), with 30-seconds rest between each set, by following a 4-minute passive recovery and a 1,000-m RETT.

Measurements

The 1,000-m RETT was conducted on a rowing ergometer (RE) (Concept 2, Model D, Wilford, Notts, UK). All rowers were familiarised with the ergo equipment their training. During each RETT trial, the participants performed with maximal effort and could use any pacing strategy they desired. An average power output (PW) and stroke rate (ST) and split time to complete each 100-meter split was measured during the 1,000-m RETT. Additionally, immediately after each test completion, participants were asked to evaluate their performance effort, the rating of perceived exertion (RPE) in 6-20 scale, with meaning 6-no effort, 20-maximal effort (Borg, 1998)

Statistical Analysis

Statistical analysis was conducted using Statistical Package for Social Sciences (SPSS, version 21), with the level of significance set at $p < .05$. All measured variables were presented as Mean ± Standard Deviation. Measures of normality were assessed using the Skewness and Kurtosis tests, normality assumed with Z score (± 1.96). The relative and absolute reliability of both warm-ups was examined via intra-class correlation coefficients (ICC, 2-way mixed, with absolute agreement) calculation. ICC values were considered as >0.75= excellent; 0.40 - 0.75 = moderate and < 0.40 = poor reliability. The warm ups effect were assessed using a Paired- Sample (T-Test) to determine any significant changes among PO, SR and completion time. RPE, 2 related samples (Wilcoxon) has been applied. To determine the practical significance, effect size (ES) magnitudes were analysed between PW and NW warm-up conditions. Effect sizes were calculated as per equation 1 and interpreted according to Rhea (2004) with participants being classed as "recreationally trained", whereby < 0.35 = trivial; 0.35 – 0.8 = small; > 0.8 – 1.5 = moderate; > 1.5 = large. Recreationally trained category was defined as individuals training consistently from 1–5 years. Effect sizes were calculated using Microsoft Excel.

Equation 1. Effect size (d) calculation

$$d = (M_{group1} - M_{group2})/SD_{pooled}$$

Where $SD_{pooled} = \sqrt{([SD^2_{group1} + SD^2_{group2}]/2)}$

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RESULTS

Data were normally distributed and reliability assumed. Results are presented in Table 2.

Figure 3 displays both warm-ups power output produced in every 100-m split during 1,000-m RETT. Over the first 5-splits, the greater power output was clearly shown for PW and the final 2-splits for NW. Figure 4 demonstrates the corresponding stroke rate, with an increased stroke rate as a result of the increased power production.

Table 2. Results of the 500-m and 1,000-m RETT for PW and NW conditions

Distance 0-500 m	N	PW Mean ± SD	NW Mean ± SD	Mean % difference (PW-NW)	*p* Value	Effect size (d)
MP (W)	10	297.60 ± 64.32	282 ± 53.11	5.5	.04 *	.37 (Small)
MSR (strokes·min-1)	10	28.49 ± 5.94	27.20 ± 5.12	4.7	.05 *	.33 (Trivial)
0-1,000 m						
MP (W)	10	267.73 ± 53.09	266.99 ± 48.22	.3	.85	.02 (Trivial)
MSR (strokes·min-1)	10	26.14 ± 5.04	26.17 ± 4.68	0	.93	-0.01 (Trivial)
MT (S)	10	220.83 ± 15.13	221.02 ± 16.01	-0.1	.74	.03 (Trivial)
RPE	10	18.2 ± 0.63	17.8 ± 1.03	2.2	.21	.66 (Small)

PW - potentiated warm-up condition; NW - normal warm-up condition; MP- mean power; MSR - stroke rate; MT – mean time; RPE - Rating of perceived exertion; * Significantly correlated between parameters (p < 0.05)

Figure 3. Breakdown of mean power output for each 100-m split during the 1,000-m RETT.

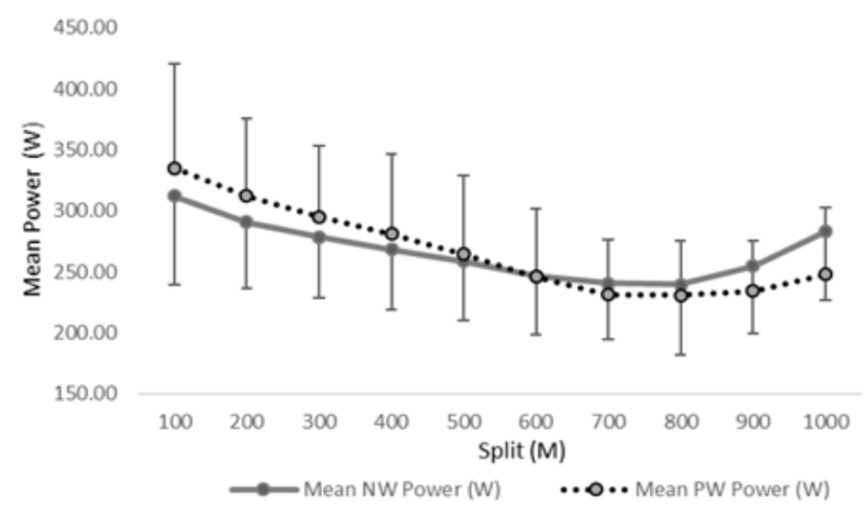
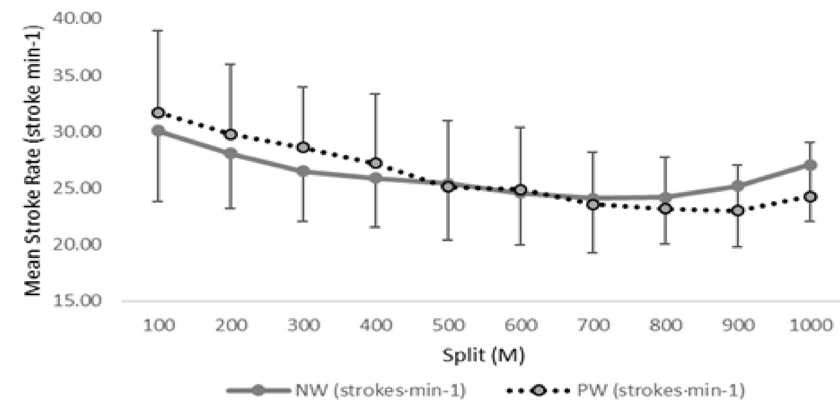


Figure 4. Mean stroke rate for each 100-m split during the 1,000-m RETT.



DISCUSSION

The results indicated that PW including two sets of six AECMJ (with 20 % of BM resistance) had no significant differences on 1,000-m RETT measurements above baseline, with the completion time was reduced by 0.19 seconds (0.1%) following NW condition (p = 0.739; d = -0.11). Interestingly, a larger change was observed in the initial 500-m rowing ergometer distance. The larger mean power output and higher stroke rate were increased following the PW, where power output was increased by 5.5% (p = 0.04; d = - 0.76) and stroke rate by 4.7% (p = 0.05; d = 0.72). However, mean power output and the stroke rates were decreased during the last 500-m and has reduced overall performance results (p > 0.05) in PW condition.

PRACTICAL APPLICATION

AEL can be used as part of a pre-event race strategy to elicit greater power output.

AEL should be familiarised through frequent use within training, alongside a weight training programme.

Further study with an adult population is required, as effects from the current youth population may be blunted due to training age and physical maturity.

AKNOWLEDGEMENTS

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Individualised training based on force-velocity profiling during jumping

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Introduction

Purpose: Determine the response to an individualised training program based on a force-velocity profile derived from jumping.

Background: Physical performance in cricket is determined by high levels of force, velocity and power during batting, fielding and bowling (Pyne et al., 2006). Recently it has been demonstrated that there is an optimal force-velocity profile that maximises ballistic performance (Samozino et al., 2012). Traditional training methods to improve ballistic performance could include heavy-load training, power training or combined training (heavy + power). However, individuals with different force-velocity profiles could benefit from greater focus on specific loading strategies.

Methods

Participant: Professional male cricketer (Age: 19; body mass: 70kg; stature: 1.81m).

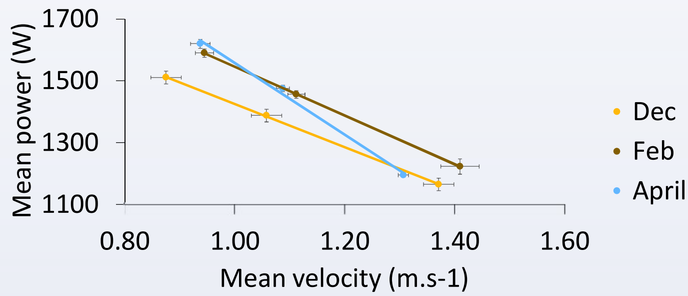
Force-velocity profile: Maximal vertical squat jumps without load (0kg) and with an additional 30kg and 50kg. The jump tests were performed using a loaded barbell and the Kinematic Measurement System (KMS) jump mat (Innervations, Muncie, IN, USA). Force-velocity profiles were determined using a pre-designed spreadsheet containing equations proposed by Samozino et al. (2014).

Training protocol: The athlete was assigned to a velocity deficient training program which included 3 velocity exercises, 2 power exercises and 1 force exercise based on the recommendations of Jimenez et al., (2017).

Table 1. Program design based on force-velocity profile.

Session 1	Sets x Reps
Power 1 Box jump	3 x 6
Power 2 CMJ + 50% BW	3 x 6
Force 1 Hip thrust	3 x 6
Session 2	**Sets x Reps**
Velocity 1 Assisted CMJ	3 x 6
Velocity 2 Double hop	3 x 6 (Each leg)
Velocity 3 Lateral med ball throw	3 x 6 (Each side)

Results



Large ↑ mean power at 0kg (ES = 1.40), 30kg (ES = 2.67) and 50kg (ES = 4.00) between December and February.

Large ↓ mean power at 0kg (ES = -1.42) between February and April.

Conclusion

Individualised training programs based on force-velocity profiling improves mean power at loads 0kg – 50kg.

Training with an emphasis on velocity can enhance jumping performance with heavier loads.

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Ankle dorsiflexion range of motion asymmetry does not influence landing forces during a bilateral drop-landing

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INTRODUCTION

Ankle dorsiflexion range of motion (ROM) has a reported relationship (r = -0.31) with peak vertical ground reaction forces (vGRF) during landing activities, with higher peak vGRF produced among those with the greatest ROM deficit.[2] The commonly reported inter-limb asymmetries in ankle dorsiflexion ROM among healthy populations[5] and athletes[3] are therefore, likely to influence the kinetic landing profile. However, the relationship between inter-limb asymmetry in ankle dorsiflexion ROM and the loading strategy utilised during landings has not yet been investigated.

AIM

The purpose of this investigation was to assess the relationship between asymmetries in ankle dorsiflexion ROM and kinetic variables associated with bilateral drop-landing performance.

METHODS

Forty-eight healthy and physically active volunteers (27 men, 21 women; age = 22 ± 4 years; height = 173.0 ± 10.9 cm; mass 71.7 ± 15.3 kg) reported to the laboratory for a single testing session. Participants performed the weight-bearing lunge test (WBLT) three times for both legs, with ankle dorsiflexion ROM recorded in degrees using the trigonometric function.[4] Participants then performed five bilateral drop-landings from a 45 cm box located 15 cm away from the target landing area, with 60 s recovery between trials. Two single axis force platforms (Pasco, Roseville, CA, USA), recording at 1000 Hz, were used to measure vGRF for the left and right legs simultaneously. vGRF data were low-pass filtered using a fourth-order Butterworth filter with a cut-off frequency of 50 Hz, with normalised peak vGRF, time to peak vGRF and loading rate (LR) calculated bilaterally and normalised peak vGRF calculated unilaterally for each limb (Figure 1). Asymmetry scores for the WBLT and peak vGRF during bilateral drop-landings were calculated using the percentage difference and bilateral asymmetry index 1 method, respectively.[1] To determine the direction of asymmetry, a positive value was arbitrarily assigned to right leg dominance, while a negative value indicated left leg dominance. Relationships between asymmetries in the WBLT and peak vGRF, time to peak vGRF, LR and asymmetries in peak vGRF were assessed using Pearson's correlation coefficient, with the a-priori level of significance set at $P < 0.05$. Ethical approval was provided by the Research Ethics Panel at the University of Cumbria.

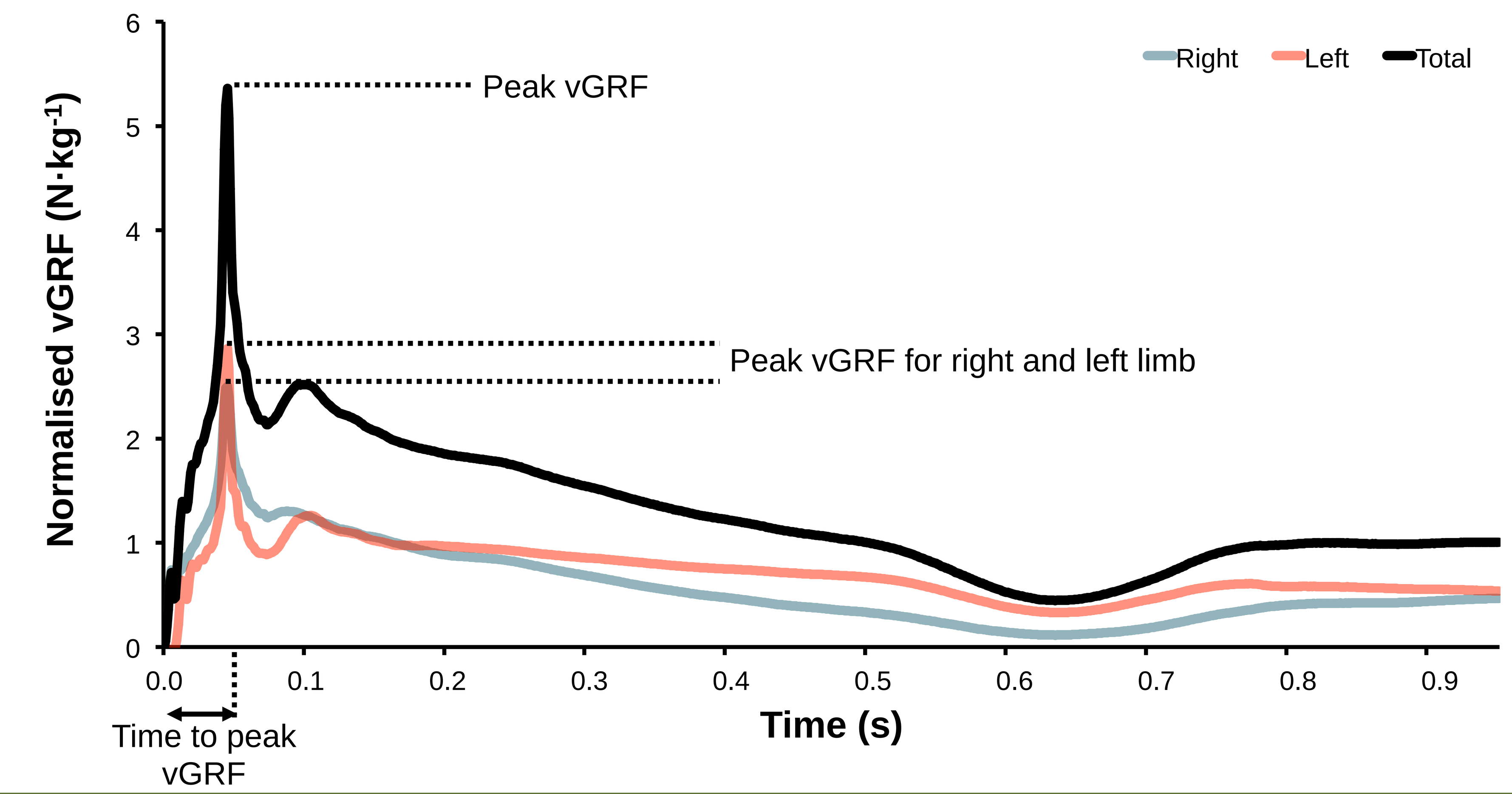

Figure 1. Example force-time data for bilateral drop-landings.

RESULTS

The mean inter-limb asymmetry scores for the WBLT was -2.1 ± 6.7% across all participants. Average peak vGRF, time to peak vGRF and LR was 3.98 ± 1.16 N•kg^{-1} , 0.055 ± 0.011 s and 79.0 ± 34.8 N/s, respectively. Furthermore, mean inter-limb asymmetries in peak vGRF was 6.8 ± 8.8%.

Table 1 presents all correlations. The relationship between asymmetries in the WBLT and peak vGRF, time to peak vGRF and LR during the bilateral drop-landing was non significant. Similarly, there was no significant relationship between asymmetries in the WBLT and inter-limb asymmetries in peak vGRF.

Table 1. Correlations between inter-limb asymmetries in ankle dorsiflexion ROM during the WBLT and kinetic variables associated with bilateral drop-landing performance.

Kinetic variable	*r*	*P* value
Peak vGRF	-0.08	0.61
Time to peak vGRF	-0.22	0.13
Loading rate	0.01	0.95
Asymmetry in peak vGRF	0.12	0.43

CONCLUSIONS

The findings from this investigation suggest that asymmetries in ankle dorsiflexion ROM do not influence the kinetic loading strategies associated with bilateral drop-landings. Furthermore, this investigation indicates that factors other than ankle dorsiflexion ROM asymmetry are likely to determine asymmetries in vGRF detected during bilateral landing tasks. Further research is required to identify the movement strategies that are adopted by athletes with asymmetrical limitations in ankle dorsiflexion ROM to allow for compensation during landing activities.

KEY POINTS:

- **Inter-limb asymmetries in ankle dorsiflexion ROM unlikely influence kinetic variables associated with bilateral drop-landing performance.**
- **Asymmetries in peak vGRF during bilateral drop-landing are not driven by inter-limb differences in ankle dorsiflexion ROM.**

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Relative Age Effects in U16 Rugby Union

The Presence and Effects on Selection into an Under 17's National Squad

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INTRODUCTION

It has been reported that individuals of the same chronological age, born in the first quarter of the selection year tend to be more physically mature compared to individuals born in the last quarter (1). It is therefore clear to see how a selection bias towards first quartile athletes could occur, especially in sports that rely heavily on physicality, such as Rugby Union. This phenomenon is known as a Relative Age Effect (RAE) and has been shown to exist in several sports (2).
There have been no previous studies that have combined an investigation into the presence of RAE, it's potential physical and maturational influences and the effects on selection within age grade Scottish Rugby Union.

METHODOLOGY

DATA COLLECTION

- Birth dates were retrieved from SRU U16's squad records.
- Physical and performance data was collected at the 2017 SRU National Testing Day and included: Body Mass (BM), Standing and Seated Height, Relative Power as measured by Countermovement Jump (CMJ), Sprint times and Momentum over 10,20,30 and 40m and YoYo Intermittent Endurance Test.
- Maturity Offset was calculated using the predicted age of peak height velocity and seated height measurements.

STATISTICAL ANALYSIS

- Players were split into 4 quartiles depending on birth date. (Q1=1st Jan-31st Mar, Q2=1st of Apr-30th Jun, Q3=1st Jul-30th Sep, 1st Oct-31st Dec).
- A chi-square analysis was undertaken to compare this data to the Scottish National birth date distribution form the year of the players' birth (2002).
- Odds Ratio (OR) tests were performed to reveal the odds of a Q4 player being selected compared to all other quartiles.

TRACKING U17'S

- To observe if an RAE is present after a selection process the above statistical analysis was rerun on the 25 players selected for the resulting U17's Squad.

N: 52

AGE: 15.6±0.3yrs

BODY MASS: 79.3±13.0kg

STANDING HEIGHT: 181.0±6.7cm

SEATED HEIGHT: 95.7±3.5cm

MATURITY OFFSET: 1.9±0.4yrs

FIGURE 1. *Subject Count and Anthropometric data*

RESULTS

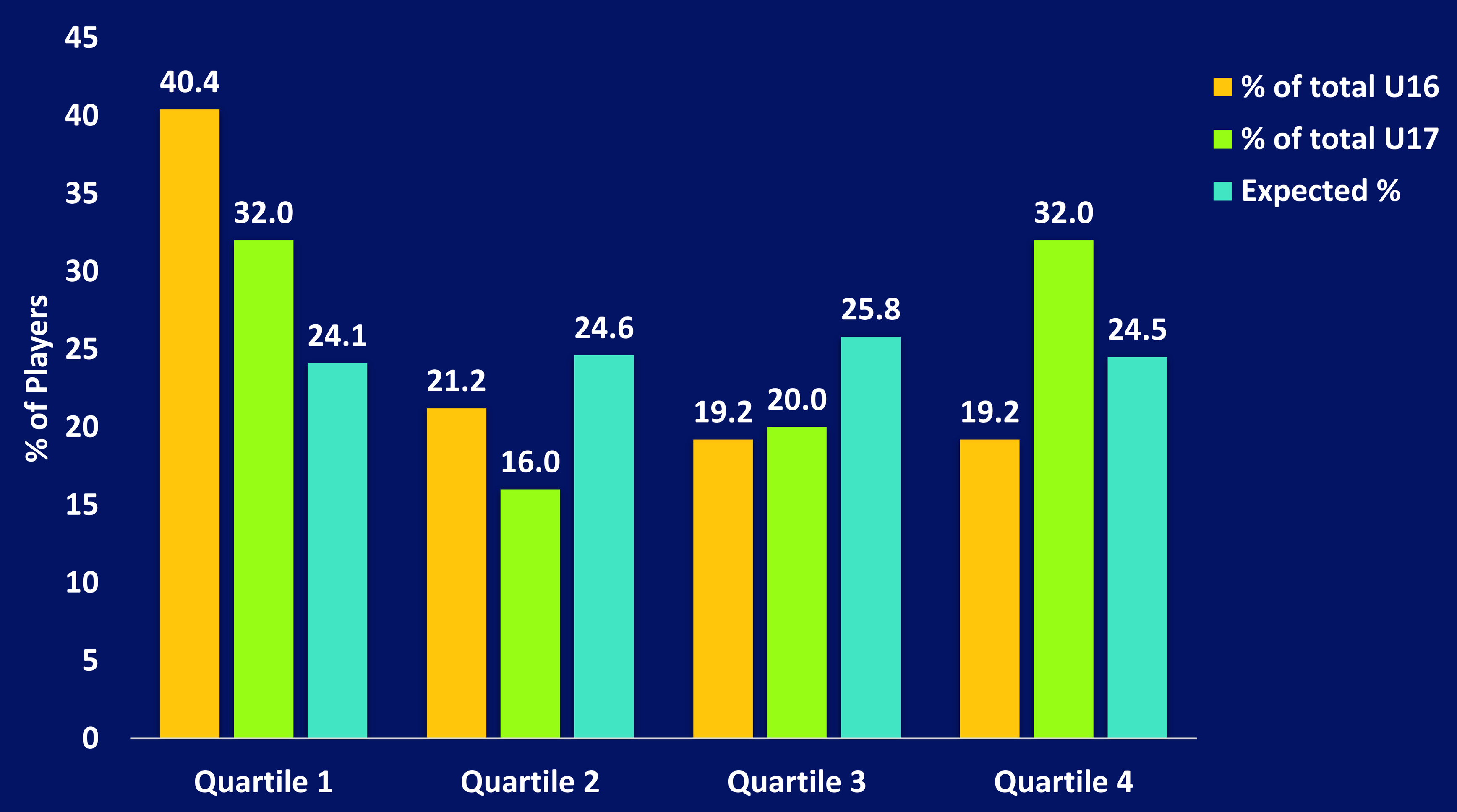

FIGURE 2. *% of players per quartile in the U16's squad, U17's squad and the expected % of players per quartile.*

TABLE 1. *Chi-Square analysis and Odds Ratio Tests for U16's and U17's Squads.*

Age Group	N	X^2 (df=3)	p-value	OR (CI) Q1 v. Q4	OR (CI) Q2 v. Q4	OR (CI) Q3 v. Q4
U16's	52	7.4	0.059	2.14 (0.72 -6.16)	1.10 (0.35 – 3.48)	1.00 (0.31- 3.21)
U17's	25	2.3	0.510	1.00 (0.22 – 4.47)	0.50 (0.1 -2.6)	0.63 (0.13 – 3.07)

X^2 - chi square, OR – odds ratio, CI – confidence intervals

U16
Statistically significant differences were found for age across all quartiles ($p<0.001$), BM between Q1 and Q3 ($p=0.017$), Seated Height for Q3 and all other quartiles ($p=0.012$), Maturity Offset between Q3 and Q1,Q2 ($p=0.001$) and 0-10m, 10-20m and 30-40m Momentum between Q1 and Q3 ($p<0.05$).

U17
Other than age ($p<0.001$) there were no statistically significant differences found for any of the measured variables ($p>0.05$).

SUMMARY

Our findings show that the U16's Squad does not significantly differ from the expected birth distribution, albeit marginally ($p=0.059$). OR's revealed that the odds of a Q1 player being selected for the U16's squad were over double that of a Q4 player, although this finding was not statistically significant ($p>0.05$).
In the U16's squad, all statistically significant findings, other than age, were associated with the advantages of Q3 players rather than Q1, leading us to believe that a possible RAE may not be influenced by physical and performance measures.
In the U17's selection, other than age, there were no statistically significant differences across the distribution, physical and performance measures. OR's revealed that a Q4 player had identical odds of being selected for the squad as Q1 player.
This suggests that the players chosen were a fairly homogenous group regardless of birth quartile. It is clear that the selection process has avoided a potential RAE.

CONCLUSION

This study revealed an obvious trend towards Q1 overrepresentation in an U16's age Grade Rugby Union squad, albeit marginally non-significant . However our findings show no relationship between birth quartile and physical measures or performance measures. Further research into other possible causes of RAE is required.
The finding that Q4 players had equal chance of selection into an U17's squad suggests that the selection process was effective in reducing bias towards Q1 players.

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The impact of Uphill vs. Horizontal repeated speed training on performance measures in male hockey players

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Abstract

Purpose
To compare the efficacy of an uphill repeated sprint training intervention vs. horizontal repeated sprint training intervention over an 8-week period in male university hockey players and their impact on performance measures.

Methods
Participants were randomly allocated to either an uphill sprint group (6% gradient) (n=9) or a horizontal sprint group (n=9) with sessions supplementing normal training. The protocol was progressed from 6 – 12 rounds of 30m max effort sprints interspersed with 30 seconds of active recovery over an 8 week period and was complete twice per week.

Results
Both groups significantly improved in all performance measures with the exception of 10m sprint speed. Larger effect sizes were seen in the uphill group in the hockey specific speed shuttle, 30m sprint speed and squat jump. Both groups significantly improved in the repeated speed assessment (7x30m), with the fatigue index in the uphill group being significantly lower than the horizontal group.

Conclusions
Supplementing short bursts of high intensity conditioning into a training week can have a positive impact on performance measures in male university hockey players. Using an uphill training modality may be more effective in some performance parameters.

Introduction

Repeated-sprint and prolonged high-intensity running ability are widely accepted as critical components of high-intensity intermittent team sports (Gabbett et al., 2013). Within team sport training time available for conditioning is often limited (Walker & Hawkins, 2017), and therefore finding time efficient and effective training modalities to improve performance are vital. Uphill sprint training has been considered as an effective modality to improve maximum speed and sprint performance vs. horizontal sprinting or a control, although this has been measured in a laboratory environment (Paradisis & Cooke, 2006) or for a short period of time (4 WKs) (Jakeman et al., 2016). This study aimed to assess the impact of 8 Weeks repeated sprint training on male university level field hockey players, comparing a horizontal and uphill intervention.

Methods

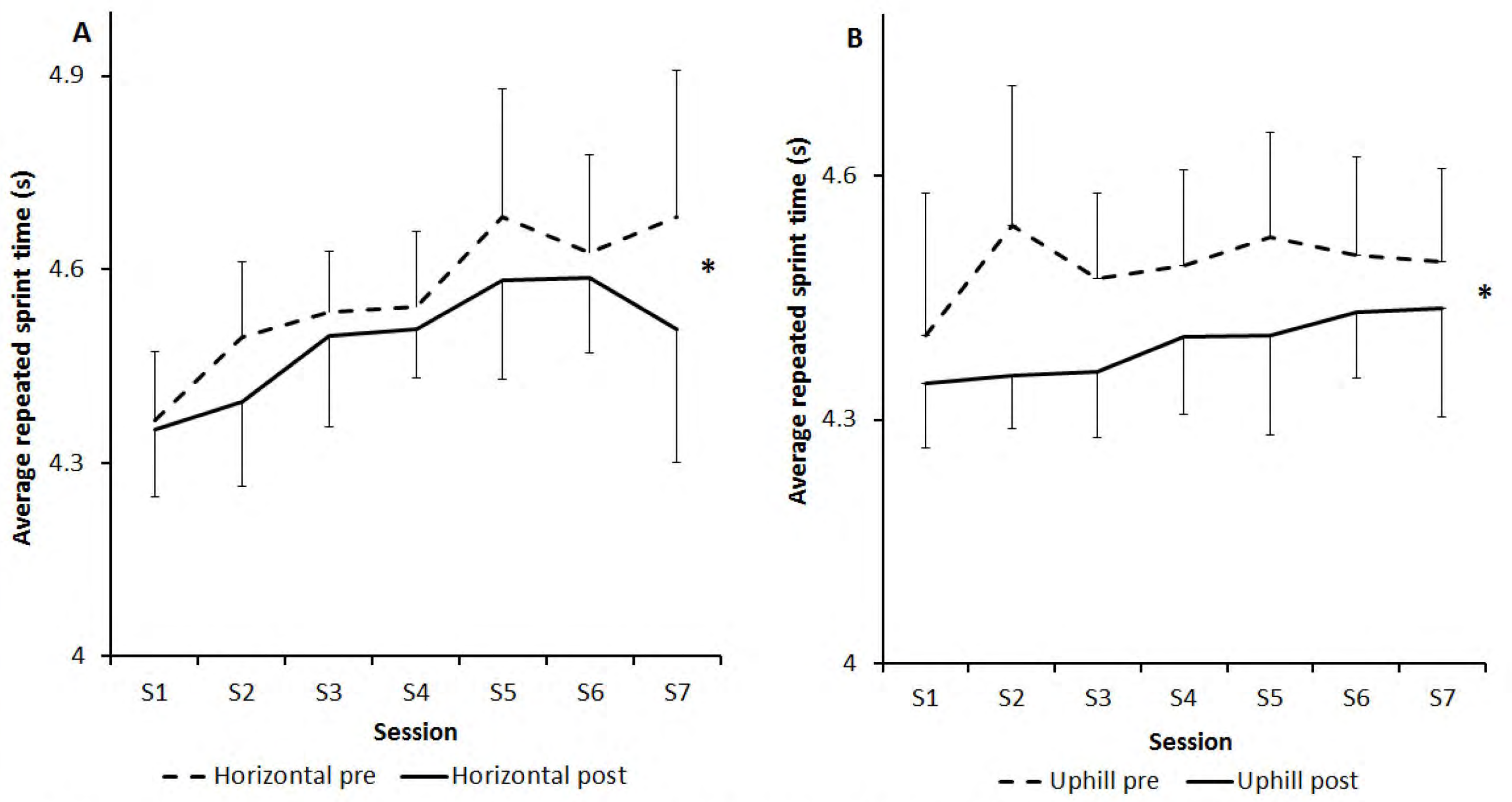
Eighteen male British university premier league standard hockey players took part in this randomised experimental design, used to investigate the effectiveness of the horizontal (n = 9, height 1.79 ± 0.07m, weight 75 ± 7.5 Kg) or uphill (n = 9, height 1.79 ± 0.04m, weight 76.2 ± 6.4 Kg) sprint training intervention. Participants were assessed for baseline measures of 10m and 30m speed, squat jump, Repeated speed ability (7x30m sprints with a 30s recovery), and hockey specific speed shuttle tests with and without a ball, in weeks 1 and 10. During weeks 2-9, participants continued their normal training week, 3 pitch based sessions and 2 gym based strength sessions. In addition to their normal training, two conditioning sessions of repeated 30m sprints, either horizontal or uphill (6% gradient), were completed prior to their pitch sessions. These sessions built from 6 sprints with a 30 second walking recovery to 12 over the 8 week intervention with a standardised warm-up completed for both groups prior.

Measures obtained pre and post-test were analysed using a repeated measures ANOVA, with the Mauchley sphericity test being used to check for homogeneity of variance. Where this was violated, the Greenhouse-Geisser value was used. Significance was set at $p < 0.05$ a priori, and Cohen's d effect sizes were calculated, with effect sizes of ≤0.2, 0.2-0.5, 0.6-1.1 and ≥1.2 being considered as trivial, small, medium and large respectively.

Results

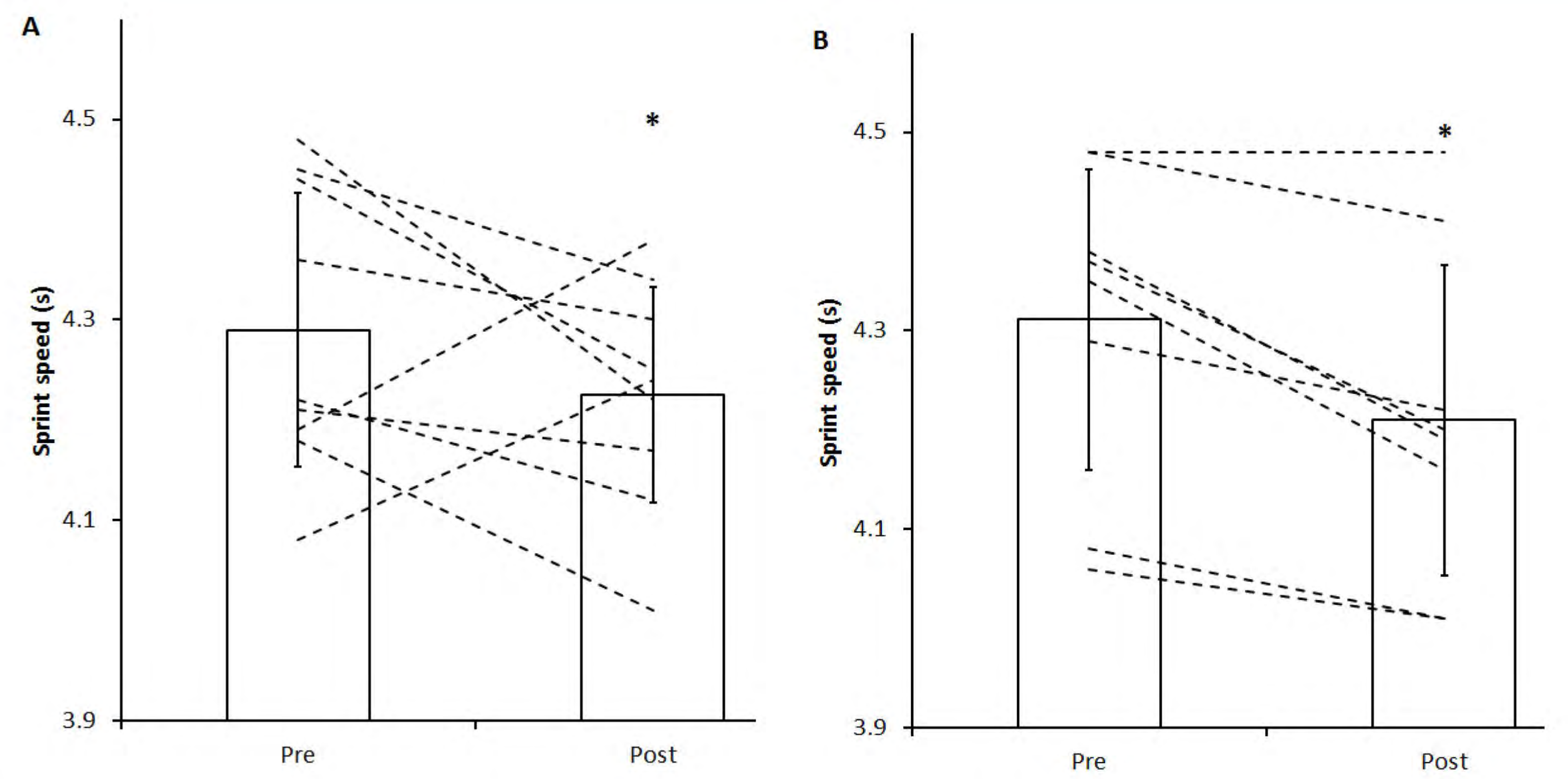
Significant improvements over time were observed in both groups for all parameters with the exception of 10m sprint speed, which was unchanged. Shuttle speed without ball improved by 0.5s and 0.6s in the horizontal and uphill groups respectively (*d* = 0.8 and 1.0). 30m Sprint speed improved by 0.06s and 0.1s in the horizontal and uphill groups respectively (*d* = 0.5 and 0.7). Squat jump performance improved significantly in both groups by a similar amount (3.84cm (*d* = 0.8) v 3.55cm (*d* = 0.7) in the horizontal and uphill groups respectively). There were no significant differences between groups on any of these parameters.
Significant improvements in repeated sprint ability were shown, with the fastest, slowest and total sprint times all being positively influenced ($p < 0.05$). A calculation of fatigue index was completed, which showed that while fatigue index decreased in both groups ($p < 0.05$), there was a significantly bigger decrease in the uphill group (4.6% pre v 4.4% post and 3.2% pre v 1.8% post for the horizontal and uphill groups respectively, $p < 0.05$)

Figure 1



Average repeated sprint speed for the (A) horizontal and (B) uphill conditions

Figure 2



30m sprint performance for the (A) horizontal and (B) uphill conditions

Conclusions

The addition of two sessions per week of running sprint interval training, to a normal training load, elicited significant improvements in physical performance across a range of parameters in male hockey players over an eight-week period. Both a horizontal and uphill training had a significant positive impact on performance, however if practitioners have access to a suitable uphill running surface, this may have more impact on repeated speed ability, particularly fatigue index which can be vital in maintaining repeated speed actions in intermittent team sports such as hockey.

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The Validity of using a PUSH wearable device and Repetitions in Reserve Rating of perceived exertion scale (RIR-RPE) for determining 5RM performance in the

Mark Helme, Dr Stacey Emmonds, Dr Chris Low.

Leeds Beckett University

Introduction

The rear foot elevated split squat has been investigated as a method of unilateral leg strength (McCurdy et al., 2004) and subsequent asymmetry. In previous literature, leg strength asymmetry has been investigated in a laboratory using force platform technology (Dos'Santos et al., 2016) or Isokinetic Dynamometry (Jones and Bampouras, 2010). However, such methods are often expensive and time consuming, which is prohibitive to most Strength and conditioning coaches. Helme at al., (unpublished research) therefore have established the RFESS as a cost and time effective valid and reliable measure of leg strength asymmetry. The purpose of this research was to examine the use of both the RIR-RPE scale and the PUSH Band, as a method of determining the achievement a valid 5RM performance in the RFESS, within field conditions.

Methods

26 volunteers from Leeds Beckett University were recruited, all subjects were engaged in a structured S&C program including both bilateral and unilateral exercise (Age 23.75 ± 4.63, height (m) 1.79±0.1, mass (kg) 88.1 ±10.7)

Participants were excluded from the sample if they have experienced a lower limb injury within the previous 6 months or have had an injury requiring surgery to either limb previously

Participants performed an incremental 5RM RFESS on both legs under test and re-test conditions, separated by 72 hours. The exercise was performed using two Kistler force plates, under the front and elevated rear feet. Kinematic variables were recorded using 3D motion capture using 10, reflective markers were placed on the either the end of the barbell.

Participants wore a PUSH band wearable device on the dominant forearm, and transferred to the PUSH™ App, via an iPad, which transforms the raw data. Following all trials, participants were asked to score the intensity of the exercises using the repetitions in reserve rating of perceived exertion (RIR-RPE).

Results

RESISTANCE EXERCISE-SPECIFIC RATING OF PERCEIVED EXERTION (RPE)

Rating	Description of Perceived Exertion
10	Maximum effort
9.5	No further repetitions but could increase load
9	1 repetition remaining
8.5	1-2 repetitions remaining
8	2 repetitions remaining
7.5	2-3 repetitions remaining
7	3 repetitions remaining
5-6	4-6 repetitions remaining
3-4	Light effort
1-2	Little to no effort

Figure 1: The repetitions in reserve—ratings of perceived exertion scale

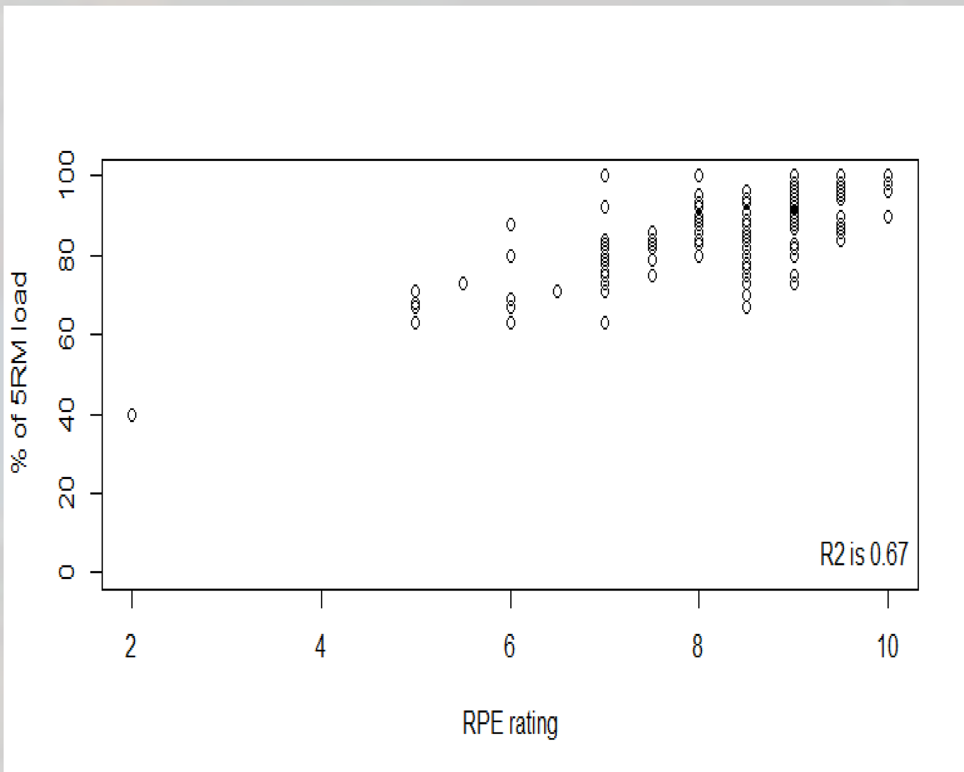

Figure 2: Scatter plot of the agreement between the RIR-RPE values and the respective percentage of maximal effort in a RFESS 5RM

Repetitions in Reserve RPE

Pearson product moment correlation found a most likely very large positive correlation between the percentage of 5RM and RIR-RPE indicated (r = 0.82, CI = 0.77-0.86).The mean RPE rating indicated for all maximal trials was 9.6 ± 0.8 (CV =8%),

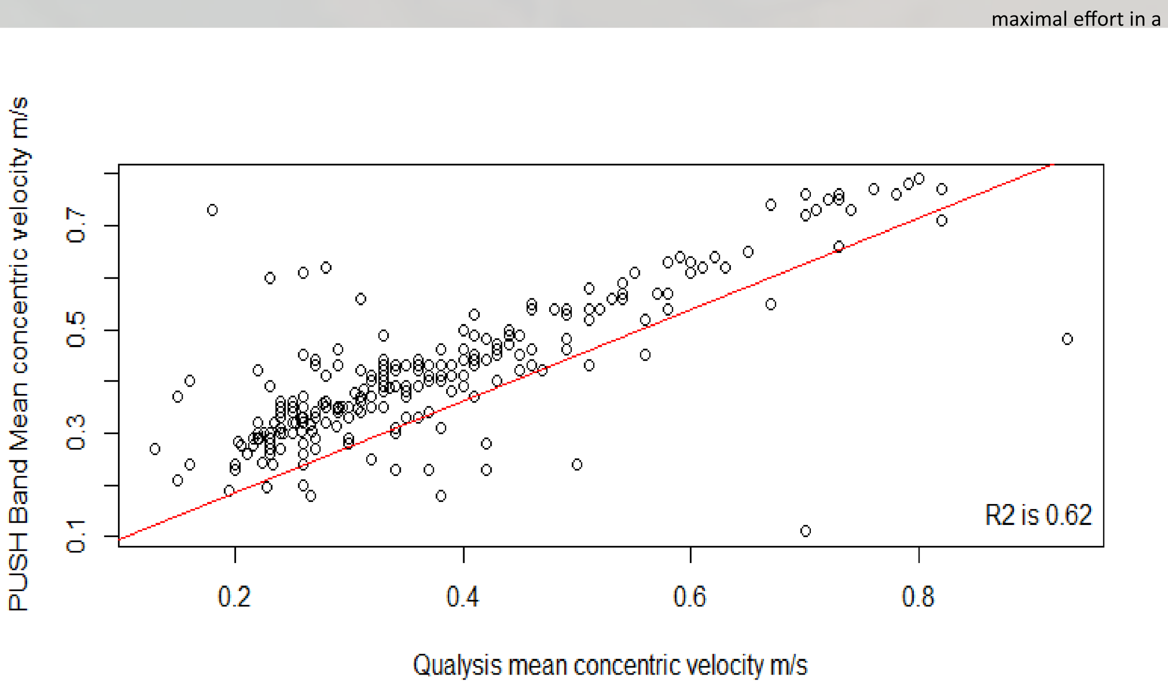

Figure 3: Scatter plot of the agreement between the mean concentric velocity recorded by the PUSH wearable device and 3D motion analysis in an incremental RFESS 5RM protocol

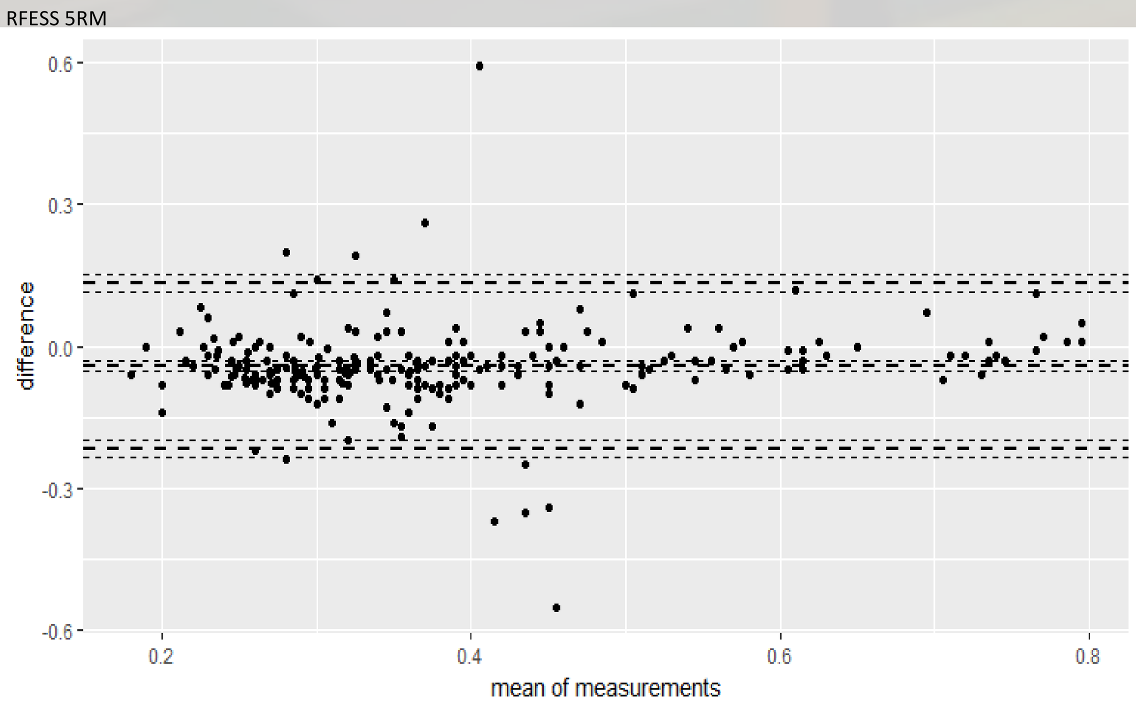

Figure 4: Bland-Altman plot comparing the mean concentric velocity recorded by the PUSH wearable device and 3D motion analysis in an incremental RFESS 5RM protocol

PUSH Band

A comparison of mean concentric velocity between 3D motion capture and the PUSH band were found to have a most likely very large positive correlations(r = 0.8 CI). The level of agreement between the PUSH ban and 3D motion capture , was excellent (ICC = 1.00),

Practical Applications

The RFESS has been reported to be an effective unilateral exercise which can be used to determine unilateral leg strength (McCurdy et al., 2004), and unilateral strength asymmetry (Helme et al, unpublished data). The results of this study indicate that a combined approach of using the RIR-RPE scale (Zourdos et al., 2016) and PUSH wearable device to measure concentric velocity is a valid and reliable method of determining maximal performance in the RFESS 5RM test. Therefore, strength and conditioning coaches may consider using a combined approach of an RPE score of ≥9.5 and a mean concentric velocity of ≈ 0.27m/s to increase the validity of field based test of RFESS 5RM.

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The effect of isoinertial and augmented eccentric loading strategies upon subsequent power clean velocity

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Abstract

Introduction

Augmented eccentric loading (AEL) has been theorised to potentiate concentric force production through the use of higher eccentric loads in coupled eccentric-concentric actions (Wagle et al., 2017). The use of higher eccentric loads has resulted in adaptations inclusive of increases in IIx cross sectional area (CSA) and shifts in myosin heavy chain isoforms, ultimately increasing force and power production (Friedmann et al., 2004; Ojasto et al.,2009). Emerging research has identified that AEL can potentiate power production during a range of explosive activities (Aboodarda et al., 2013; Sheppard et al., 2008). To the authors' knowledge, no research has analysed the application of AEL to potentiate Olympic weightlifting derivatives. Therefore the aim of this study is to compare the effectiveness of AEL and traditional isoinertial weightlifting activities upon subsequent power clean parameters.

Approach

Eight male university rugby players with a mean ± SD age, height, weight and resistance training age of 20.2 ± 1.64 y, 185 ± 6.21cm, 97.50 ±16.39kg and 4 ± 0.93yrs respectively, took part in the study. Initially baseline 1RMs for the back squat, conventional deadlift and power clean were measured on 3 separate occasions, 2-d apart. Following a RAMP warm up protocol, subjects completed 5 reps of the following 4 experimental trials in a randomised manner, separated by a minimum of 3-d: AEL conventional deadlift and AEL back squat (110/80%1RM), isoinertial back squat and conventional deadlift (80%1RM). Five minutes post trial; subjects then performed 2 repetitions of a power clean at 75%1RM during which peak velocity (m/s) and associated peak power (W) were recorded (GymAware, Kinetic Performance, Australia).

Results

Despite the augmented deadlift producing the highest mean ± SD peak velocity (2.23 ± 0.09 m/s) and power (2195 ± 475.9W), the results of the one way repeated measures ANOVA revealed no statistical difference between trials (F (4, 28) = 0.438, p>0.05). Additional analysis identified that higher individual absolute strength resulted in no further improvement in peak power and velocity during the trials.

Applications

Despite statistical significance, the results suggest that performing 5, 20% AEL reps of a conventional deadlift may potentiate the velocity and power output of a power clean. Further research is needed to establish the most optimal eccentric loading strategy.

Introduction

- Augmented eccentric loading (AEL) has been theorised to potentiate concentric force production through the use of higher eccentric loads in coupled eccentric-concentric actions (Wagle et al., 2017).
- The use of higher eccentric loads has resulted in adaptations inclusive of increases in IIx cross sectional area (CSA) and shifts in myosin heavy chain isoforms, ultimately increasing force and power production (Friedmann et al., 2004; Ojasto & Häkkinen, 2009).
- Research has identified that AEL can potentiate power production during a range of explosive activities (Aboodarda et al., 2015; Sheppard et al., 2008). It has been proposed that the mechanisms for such improvements are achieved through several mechanisms including: increases in afferent neural stimulation, increases in the active portion of the series elastic component, favourable alterations in the contractile apparatus and increased cross bridge formation prior to the concentric phase (Moore & Schilling, 2005).
- Ong et al., (2016) assessed the effects of an eccentric hip sled conditioning stimulus (105 & 125% 1RM) upon subsequent CMJ performance. Compared to the control condition (4143 ± 754 W), significant improvements in peak power were observed both 3 and 6 minutes post in both 105RM (4305 ± 876 and 4237 ± 842 W) and 125RM (4314 ± 848 and 4264 ± 768 W).
- To the authors' knowledge, no research has analysed the application of AEL to potentiate Olympic weightlifting performance. Therefore the aim of this study is to compare the effectiveness of AEL and traditional isoinertial weightlifting activities upon subsequent power clean parameters.

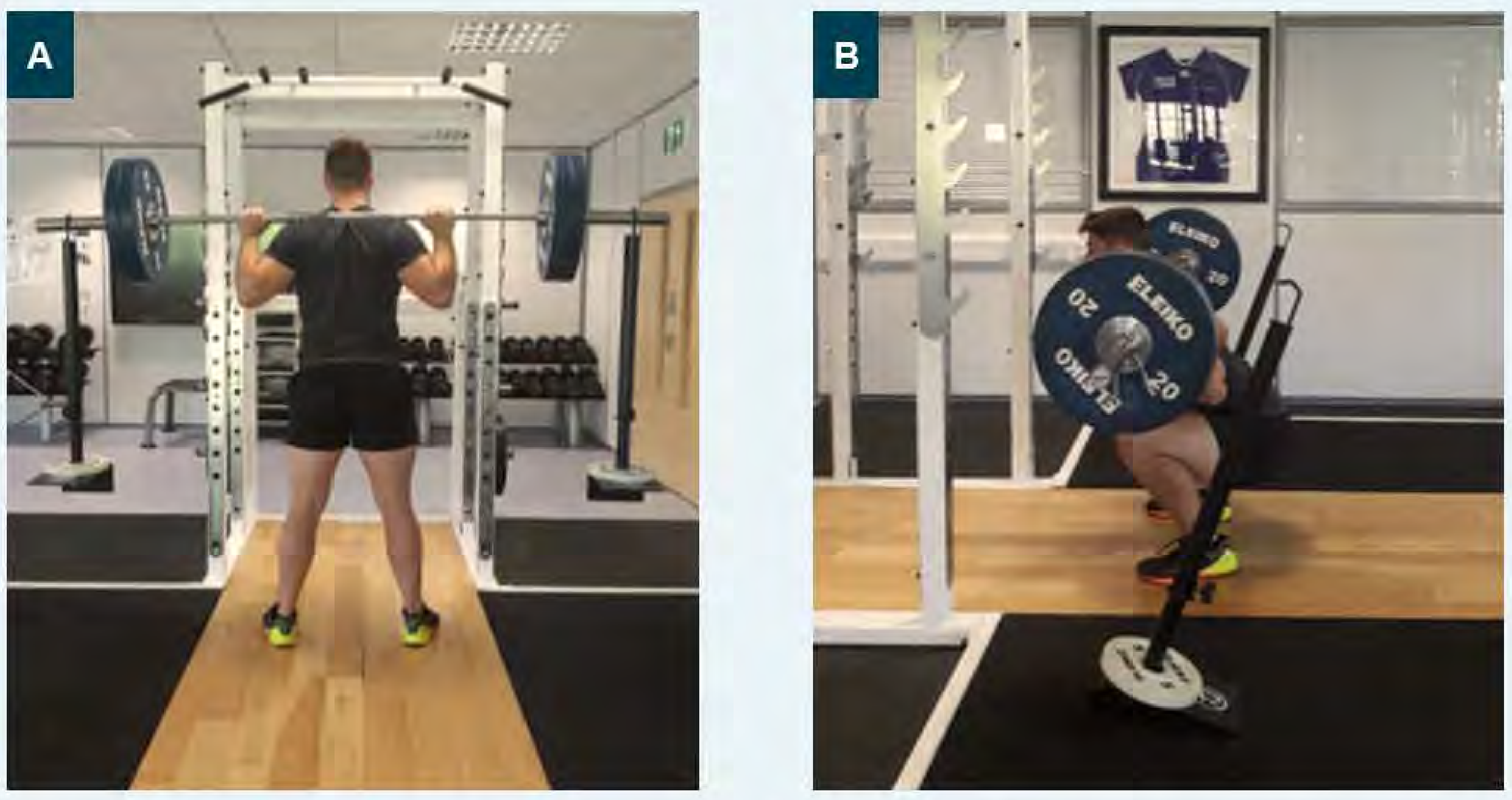

Figure 1: Visual representation of the AEL back squat start position (a) and bottom position (b) where the eccentric hooks are released.

Approach

- A pilot study was initially employed to determine the test-retest reliability of peak velocity (m/s) and peak power (W) whilst performing the power clean. A CV% of <5% was obtained for both parameters.
- Eight male university rugby players with a mean age, height, weight and resistance training age of 20.2 ± 1.64yrs, 185 ± 6.21cm, 97.50 ±16.39kg and 4 ± 0.93yrs respectively, took part in the main study.
- Initial baseline 1RM assessments were undertaken for the back squat, conventional deadlift and power clean (CT) on 3 separate occasions, each 2 days apart. Participants then rested for 5 days before conducting the main trial.
- Following a standardised RAMP warm up, subjects completed 5 repetitions of the following 4 experimental conditions in a randomised order, separated by a minimum of 3 days: AEL conventional deadlift (ALD) and AEL back squat (ALS) (110/80%1RM), isoinertial back squat (ISS) and conventional deadlift (ISD) (80%1RM).
- Five minutes post trial; subjects then performed 2 repetitions of a power clean at 75%1RM, during which peak velocity (m/s) and associated peak power (W) were recorded (GymAware, Kinetic Performance, Australia).
- For each condition, the highest peak velocity rep was selected for analysis and a one-way repeated measures ANOVA performed to assess statistical significance. Subjects were then split in accordance to absolute strength, and a two-way repeated measures ANOVA performed to identify any interaction upon peak velocity. Significance was accepted at p<0.05. All data is presented as mean ± SD.

Results

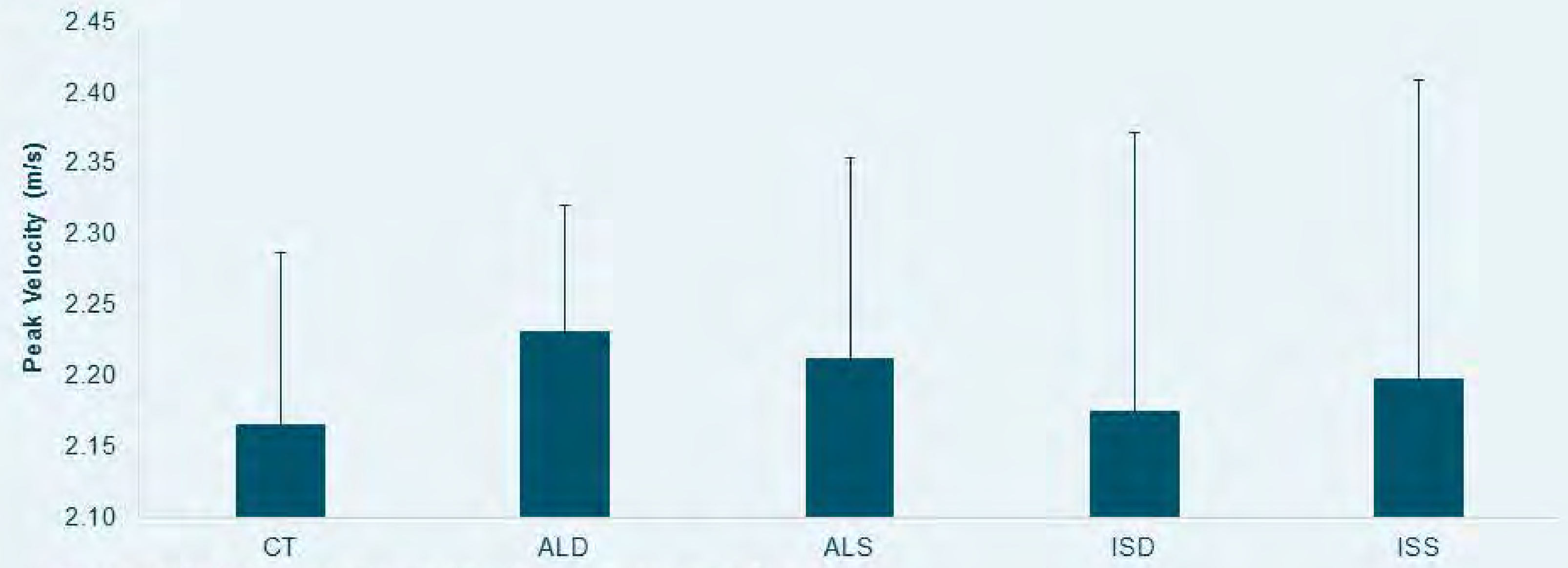

Figure 2: Mean peak velocity (m/s) during the five trials.

Figure 2 highlights that the greatest increase in peak velocity was during the ALD condition, however the results of the one way repeated measures ANOVA were insignificant (F (4, 28) = 0.438, p>0.05).

Table 1: Mean peak velocity (m/s) in accordance to absolute strength classification

	Squat		Deadlift	
	>140kg	**<140kg**	**>160kg**	**<160kg**
AEL	2.20 ± 0.18	2.23 ± 0.11	2.25 ± 0.08	2.20 ± 0.24
Control	2.16 ± 0.10	2.18 ± 0.23	2.14 ± .012	2.22 ± 0.24
IS	2.28 ± 0.12	2.14 ± 0.27	2.21 ± 0.23	2.11 ± 0.15

There was no statistical interaction between absolute strength and power clean peak velocity in either the squat or deadlift condition (F (2,12) = 1.38, p>0.05 and F (2,12) = 1.850, p>0.05 respectively), refer to table 1.

Applications

- Though no statistical significant difference was found, the results infer that augmented eccentric loading strategies can improve peak velocity of a power clean. In addition, the marginal improvement in the ALD condition may likely reflect the biomechanical correspondence of joint angles to the pull phases of the clean.
- Furthermore, subsequent analysis tentatively suggests that stronger athletes may be better able to further exploit augmented eccentric loads when utilising the deadlift.
- Coaches involved with explosive sports should explore the use of augmented eccentric loads as part of their warm up protocol. Further research should consider the relative load selected to enhance performance and the time frame deemed most optimal to potentiate the selected exercise.
- The use of AEL to potentiate explosive exercises should be trialled on repeated occasions and an individualised approach adopted.

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Do changes in knee angle effect muscle activation during a novel field based isometric posterior lower-limb muscle test

UNIVERSITY OF GLOUCESTERSHIRE

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Introduction

Hamstring muscle strain injury (HMSI) possess one of the greatest challenges for those working within athletic populations, particularly for sports involving high speed running [1,2,3], with their prevalence increasing on average of 2.3% per year since 2001[3]. Field based testing protocols that are non-invasive and simple to administer can enhance the practical utility of the athlete monitoring process. It is suggested that altering knee flexion angle during a supine isometric strength test changes preferential hamstring muscle recruitment[4]; however muscular contributions relative to the force output must first be fully understood prior to its widespread application. In addition, contributions from other posterior chain musculature need to be considered.

Aim: The aim of was to more clearly elucidate the electromyography (EMG)-knee joint angle relationship during isometric testing.

Method and Design

10 recreationally trained individuals (28 ± 2.4yr, 1.8 ± 0.3m, and 80.5 ± 6.4kg) volunteered for the study. A cross-sectional design was used. Standardised procedures were replicated at each test session including warm up, test set-up and participant instructions (Fig 1). A supine isometric test was performed on the dominant leg with the knee positioned at two pre-selected flexion angles (30° & 90°) (Fig 2)[4]. Surface electromyography (sEMG) of medial gastrocnemius (MG), medial hamstring (MH), bicep femoris (BF) and gluteus maximus (GM) was recorded to determine absolute mean EMG activity and percentage muscle contributions.

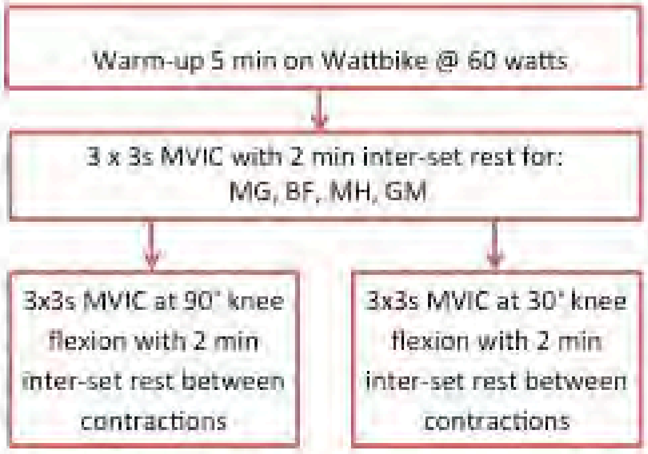

Figure 1: Schematic of research design

Figure 2: 90 Maximum voluntary isometric exercise

Results

Significant differences in the mean absolute sEMG value for the BF between the two angles was evidenced (p = 0.002). Findings further indicated a trend of greater posterior muscle activation with knee position at 30°,

Table 1. Percentage muscle contributions for both knee flexion angle.

Muscle Contribution (%)	Knee flexion angle (°) 30°	90°	% Difference	Effect Size (d)
MG	15 ± 11	14 ±10	5	0.07
BF	31 ± 9	22 ± 7	30	1.19
MH	34 ± 14	30 ± 12	15	0.4
GM	27 ± 10	24 ± 11	7	0.18

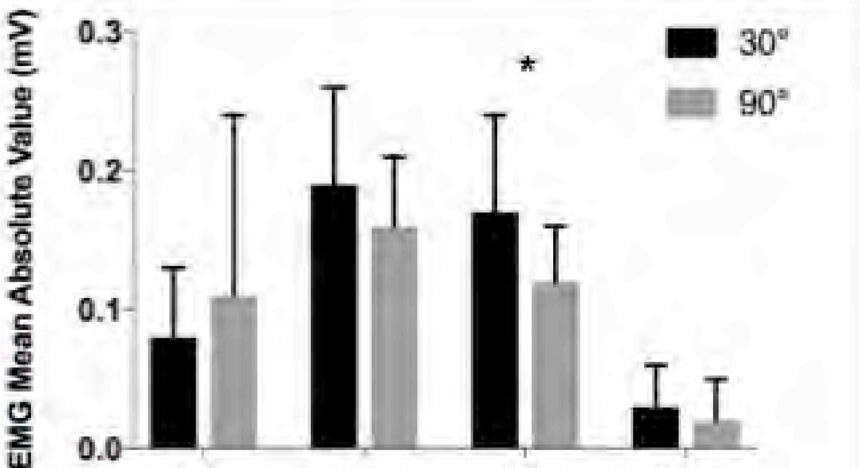

Figure 3. Electromyography (EMG) mean absolute values the medial gastrocnemius (MG), medial hamstring (MH), bicep femoris (BF) and gluteus maximus (GM) during 30° and 90° contractions. Results are mean ± SD, *significant difference between angles ($p < 0.05$).

Conclusion

The present study demonstrated that 30° knee flexion elicited significant increase in EMG muscle contributions and activation of the BF when compared with 90°. Further, there were significant differences in mean absolute value EMG activity for the BF between 30° and 90°. To our knowledge, this is the first study to look at the posterior chain muscle activation, more specifically hamstring contribution at 30° and 90° knee flexion during a single leg isometric glute bridge and the effect changes in knee angle has on posterior chain muscular recruitment.

Practical Application

The results of this study indicate that biceps femoris and overall posterior chain muscle activation increased with the knee positioned at 30° of flexion; thus, practitioners using this test to assess posterior chain muscle strength may wish to prioritize this knee position. However, large variation in muscle activation was present as indicated by the large standard deviations for the musculature tested. This was consistent across both test positions and although minimized via standardization of protocol, participant interpretation of the task may impact such results.

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Poster abstract presentation for the 14th United Kingdom Strength & Conditioning Association National Conference, Milton Keynes, August 2018

Conservative management of bilateral non-united lumbar pars defects in a junior elite golfer.

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ENGLANDGOLF UKSCA

Introduction

The case of a 17-year old elite male golfer with confirmed bilateral non-united L1 and L5 pars defects presented here highlights the efficacy of reconditioning as an alternative to surgical management of low-grade spondylolisthesis.

Why are junior golfers at risk of lumbar pars stress ?

Force: The full golf drive places up to 7500N of force at the lumbar spine.

High practice volumes: Golfers perform thousands of swings per week which often ↑ in response to a step up in level.

Biomechanical factors: Techniques can influence the stress experienced at the lumbar spine.

Poorly monitored: Golfers seldom record their golf volumes thus ↑ the risk of a training load error.

Action: High velocity extension-rotation x load associated with spondylolysis.

Maturation: growth leaves elongating pars inter-articularis susceptible

Results

Medical review 12 months post confirmed diagnosis showed no signs of further inter-vertebral slippage, and the subject remained asymptomatic 18 months post despite return to pre-injury golf volumes.

Reduced Load

7a

Figure 7a (Left). Pre-Injury Diagnosis. Excessive spinal lateral flexion/extension post-impact.

Figure 7b (Right) Post-Intervention. Reduced spinal lateral flexion/extension post-impact.

7b

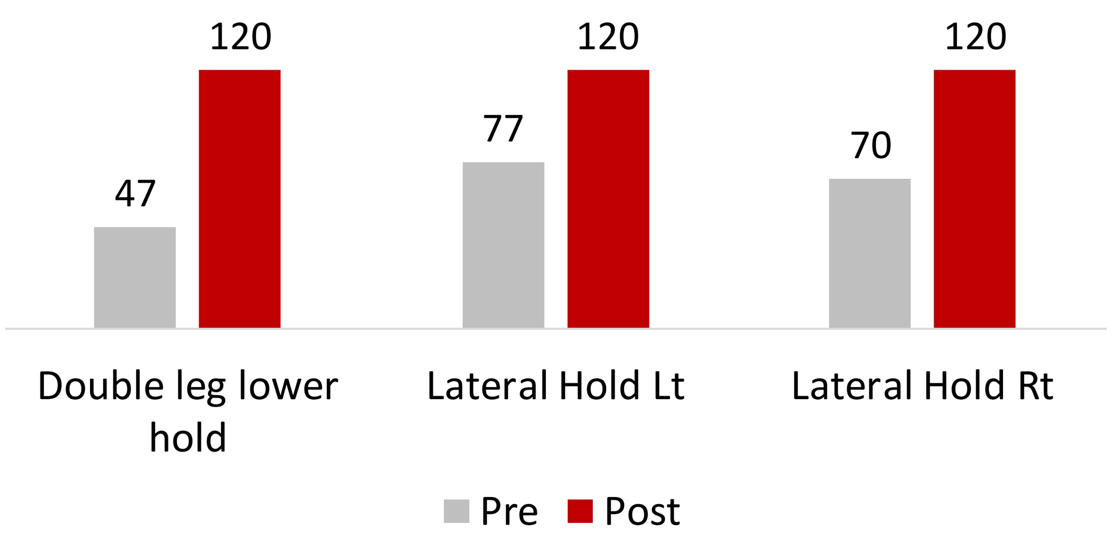
Increased Tolerance

Figure 8 (below). Self-selected (RPE 8) 5RM training loads Pre vs Post Intervention

Trap Bar Deadlift
Barbell RDL
Barbell Hip Thrust

40kg → 110kg

Figure 9. Trunk Capacity (s) Phase 1 vs Phase 3



Case Study Approach

Assessment revealed poor lumbo-pelvic control which manifested in excessive lateral flexion during downswing, and excessive lumbar extension during follow-through. Objectives of the 4-stage model of reconditioning are outlined below:

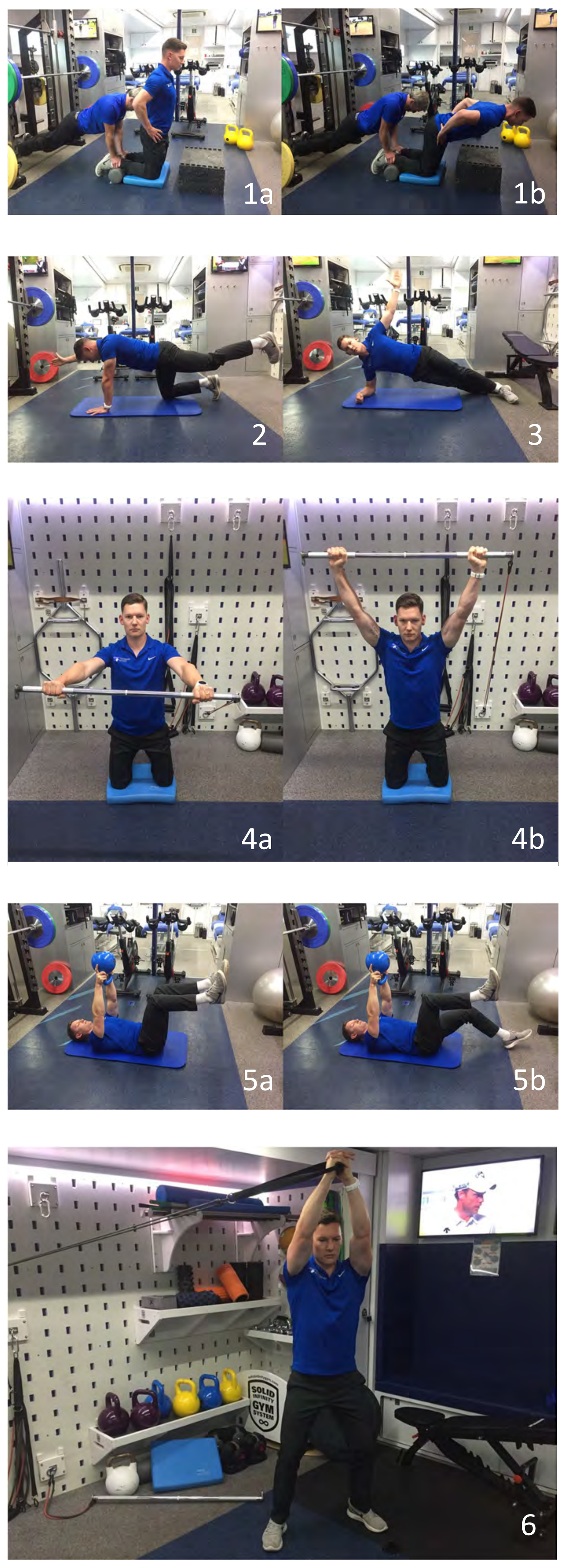
1. Acute Phase:
Establish hip-lumbar and lumbar-thoracic dissociation. Ensure requisite hip mobility to avoid excessive lumbar extension or lateral spinal flexion as compensatory patterns.Improve lumbo-pelvic control to enable deceleration of the clubhead resisting excessive lumbar extension.

2. Sub-Acute / Load Intro Phase:
Increase stability challenges: anti-extension, anti-rotation and anti-lateral flexion tasks. ↑ load tolerance via intro of general strength training and meet set trunk capacity criteria (figure 9). Re-introduce putting interspersed with 'movement breaks'.

3. Reconditioning Phase:
Progression of strength training via autoregulation (self-directed - 2 reps in reserve) – Trap Bar DL, BB RDL, BB Hip Thrust, DB Split Squats.↑ trunk stiffness using pertubated trunk holds, med ball and tornado ball work.

4. Return to Play Phase
↑ intensity via length of backswing / longer club selection before a controlled and graduated return of daily/weekly volume (balls hit).

Figure 1a,1b,2,3,4a,4b,5a,5b,6. Example acute/sub-acute phase exercises.



Practical Applications

Rehabilitation guidelines for the management of this condition are scarce, standard medical advice is limited to a period of rest (typically 12-weeks) from the provoking activity. For more advanced cases and spondylolisthesis, surgical stabilisation is often considered. This highly invasive intervention carries the usual risks associated with surgery, and also typically results in a rotational hypomobility which may prevent further participation in the sport. S&C professionals can play a major role in the conservative management of this condition even in advanced cases, as highlighted here. The 4-stage model of reconditioning provides a general guideline for practitioners and therapists.

THE INFLUENCE OF AGE AND MATURATION ON SPRINT FORCE-POWER-VELOCITY CHARACTERISTICS IN BOYS

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INTRODUCTION

- It is well recognised that the natural development of speed throughout childhood and adolescence is a non-linear process (1,2). While age and maturation have been shown to influence sprint performance, it is still unknown how these will affect the mechanical properties of sprinting.
- The theoretical model recently validated by Samozino et al. (3) enables the mechanical properties and Force- and Power-velocity (F-P-v) relationships in sprint acceleration to be identified via simple field based measurements summarised by the following variables: relative maximal theoretical horizontal force (F_0), maximal theoretical horizontal velocity (V_0), relative maximum horizontal power output (P_{max}), velocity at peak power production (V_{opt}), force at peak power production (F_{opt}) and the decrease in the ratio of horizontal- to- resultant ground reaction force to the increase in velocity (D_{rf}), represented graphically in Figure 1. The aim of this study was to investigate the influence of age and maturation upon F-P-v characteristics in a large cohort of boys.

METHODS

- Figure 2 details the data collection stages. Three-hundred and sixty-two school boys (age=13.0 ± 1.3yrs; age range=11.1-16.1yrs) volunteered to participate in data collection 1. Forty-nine of these participants (age=14.14 ± 0.75 years, age range=12.85-15.67yrs) volunteered to participate in the additional reliability data collection. Forty-three boys (age=10.90 ± 1.19yrs, age range=9.04-13.84yrs) volunteered to participate in the additional data collection (Data collection 2) required to determine the offset value, indicative of the time taken between the beginning of the force production and the trigger of the timing gate, that should to be applied to the dataset from data collection 1 for the current study.
- All participants completed anthropometric measurements (standing height, seated height and body mass) in addition to a 40m maximal sprint, measured by photoelectric timing gates. The sprint split times were corrected using an offset value obtained from the offset group. From these, F-v and P-v relationships were derived (3).
- Test-to-test reliability was assessed for all F-P-v variables through change-in-the-mean, coefficients of variation (CV) and intraclass correlation coefficients (ICC). Participants were grouped according to predicated years from peak height velocity (PHV) (pre-PHV and circum-PHV) and chronological age (U12, U13, U14, U15 and U16) and one-way analysis of variances (ANOVA) was used to examine for differences in F-P-v characteristics between age and maturity groups.

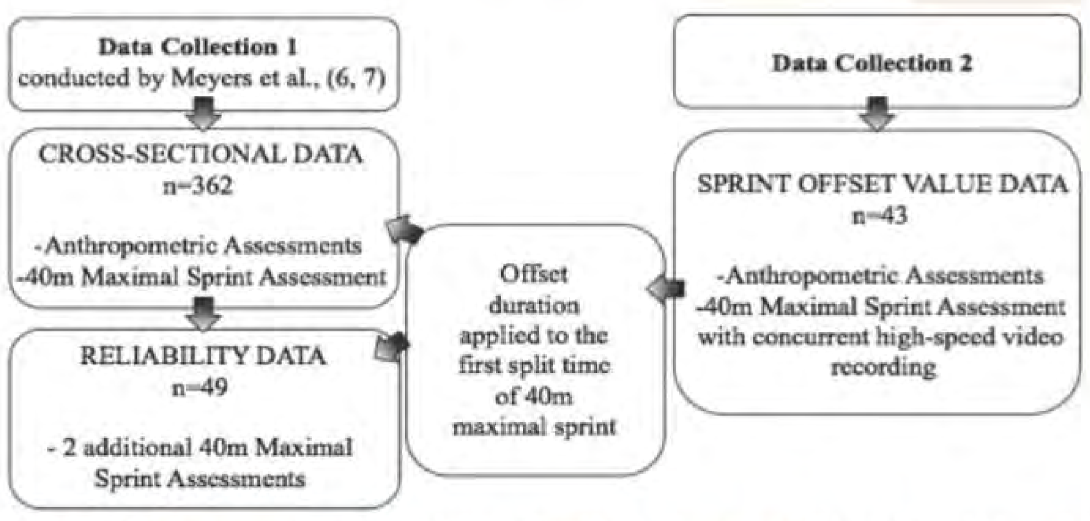

Figure 2. A schematic of the data collection stages and flow of participants.

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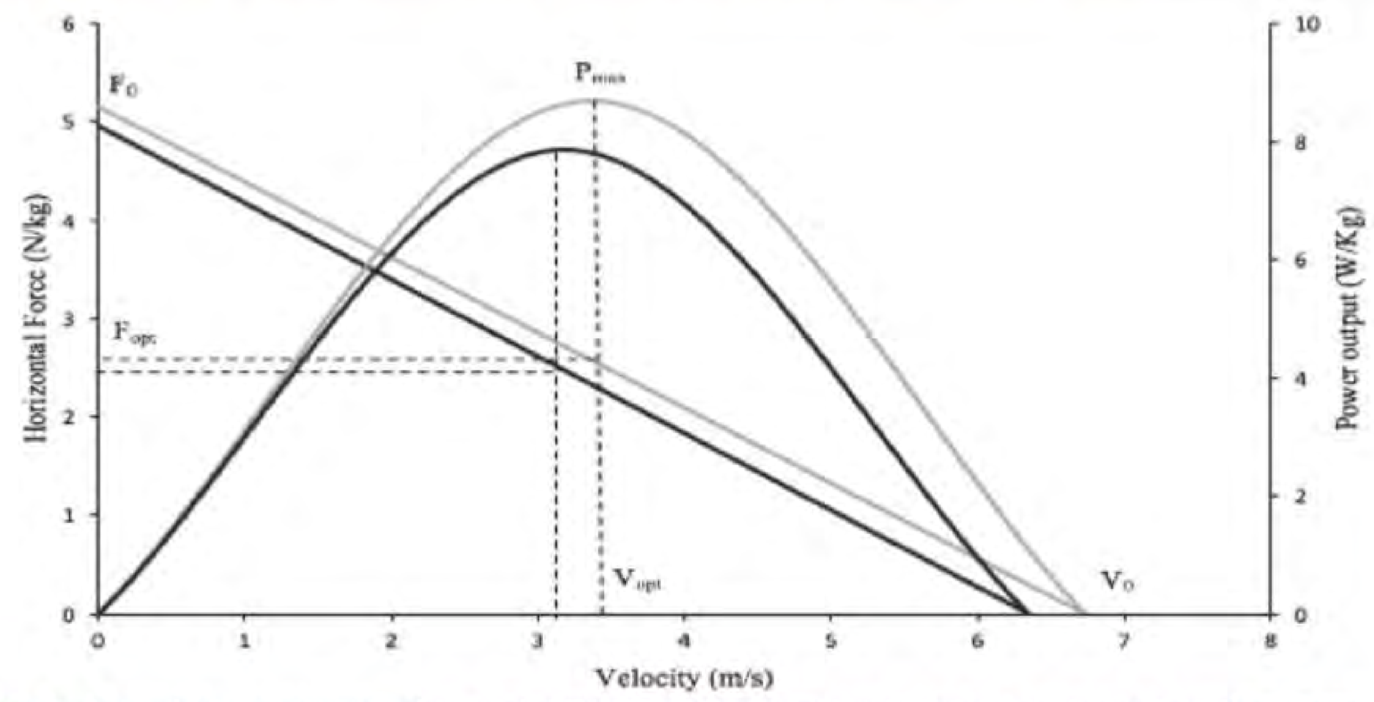

Figure 1. A graphical representation of the F-P-v profiles and associated optimal force and velocity values relative to power output for pre-PHV(black) and circum-PHV(grey) boys over a 40m over-ground sprint.

RESULTS

- The majority of variables were shown to exhibit acceptable levels of reliability with CV <10% (4) and ICC >0.5 (5). CV and ICC for D_{rf} were however indicative of poor reliability (CV =12.7 - 12.8% , r =0.33 - 0.36, respectively).
- As shown in Table 1, P_{max} was found to be significantly ($p < 0.05$) greater with increasing age. Furthermore, F_0 was significantly ($p < 0.05$) greater with increasing age from U13.

Table 1. Chronological age and maturity group analysis of F-P-v variables (Mean ± SD).

Group	F_0 (N/kg)	V_0 (m/s)	P_{max} (W/kg)	D_{rf} (%)	V_{opt} (m/s)	F_{opt} (N)
U12 n=88	4.95 ± 0.51	6.15 ± 0.65	7.62 ± 1.22	-0.81 ± 0.11	3.08 ± 0.32	105.08 ± 27.10
U13 n=22	4.90 ± 0.47	6.29 ± 0.70	7.71 ± 1.18	-0.79 ± 0.12	3.14 ± 0.35	114.46 ± 33.43
U14 n=59	4.96 ± 0.43	6.69 ± 0.85 ^{e}	8.32 ± 1.45 ^{a}	-0.75 ± 0.10 ^{a}	3.34 ± 0.43 ^{a}	131.13 ± 35.56 ^{e}
U15 n=59	5.31 ± 0.57 ^{e}	6.68± 1.03 ^{a}	8.88 ± 1.67 ^{ab}	-0.82 ± 0.18	3.34 ± 0.52 ^{a}	162.13 ± 44.65 ^{e}
U16 n=34	5.17 ± 0.48 ^{b}	7.64 ± 0.92 ^{e}	9.92 ± 1.65 ^{e}	-0.68 ± 0.09 ^{abd}	3.82 ± 0.46 ^{e}	173.01 ± 37.03 ^{abc}
Pre-Pubertal n=115	4.95 ± 0.45	6.34 ± 0.58	7.85 ± 1.07	-0.79 ± 0.10	3.17 ± 0.29	92.67 ± 17.77
Circum-Pubertal n= 112	5.14 ± 0.54^{f}	6.74 ± 1.00^{f}	8.68 ± 1.67^{f}	-0.78 ± 0.16	3.37 ± 0.50^{f}	152.13 ± 35.96^{f}

^{a} = Sig. greater than U12 only ($p \leq 0.05$); ^{b} = Sig. greater than U13 only ($p \leq 0.05$); ^{c} = Sig. greater than U14 only ($p \leq 0.05$); ^{d} = Sig. greater than U15 only ($p \leq 0.05$), ^{e}= Sig. greater than all younger age groups ($p \leq 0.05$), ^{f} = Sig. greater than pre-pubertal ($p \leq 0.05$).

PRACTICAL APPLICATIONS AND CONCLUSIONS

- It appears that around the onset of puberty, boys may show an increased reliance on the ability to generate high levels of force, in addition to a reduction in the ability to apply such force at faster velocities.
- On this basis, it may be recommended that training during the pre-pubertal stage of maturation should aim to develop force producing capabilities, while training at the circum-pubertal stage should focus on improving the ability to produce force at higher velocities. However, future studies employing such training interventions are recommended to better determine the most advantageous training approach.

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Variable resistance training: The trade-off for performance versus activation

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Introduction

Variable resistance training (VRT) has been shown to produce superior strength-power adaptations compared to traditional resistance training[3]. Surface electromyography (sEMG) may be able to provide an insight into how VRT affects neural mechanisms such as motor unit recruitment and rate coding. Previous research shows that performing a deadlift at 85% 1RM with accommodating chain resistance of approximately 20%, decreased sEMG activity of the gluteus maximus in comparison to a traditional free weight condition[1]. Although performing the deadlift with accommodating band resistance has been shown to increase power and velocity[2], no previous studies have investigated how this affects muscle activation patterns.

Aim: The purpose of this study was to compare muscle activation, bar power and bar velocity during the deadlift performed with and without bands

Method and Design

- Fifteen resistance trained men (age: 28.7 ± 9.3 y; stature: 180.4 ± 8.5 cm; mass: 92.5 ± 15.1 kg) performed six deadlift repetitions during four loading conditions:
  - **100 kg bar (NB)**
  - **80 kg bar with 20 kg band tension (B20)**
  - **75 kg bar with 25 kg band tension (B25)**
  - **70 kg bar with 30 kg band tension (B30)**
- Load was equated to ~100 kg at the top of the lift during the band conditions
- Muscle activity from the medial gastrocnemius (MG), semitendinosus (ST), vastus medialis (VMO), vastus lateralis (VL), and gluteus maximus (GM) were recorded using sEMG during the concentric phase of the lift and expressed as a percentage of each muscle's maximal activity, recorded during a maximal isometric contraction (MVIC%)
- Bar power and velocity measurements were recorded during the concentric phase using a linear position transducer

Figure 1. Deadlift performed with VRT

Results

Repeated measures ANOVA's showed that sEMG activity significantly decreased as band resistance increased in the MG and ST ($p < 0.05$) and progressively decreased in the GM.
No changes were observed for the VMO or VL.
Peak and mean bar velocity and power significantly increased as band resistance increased.

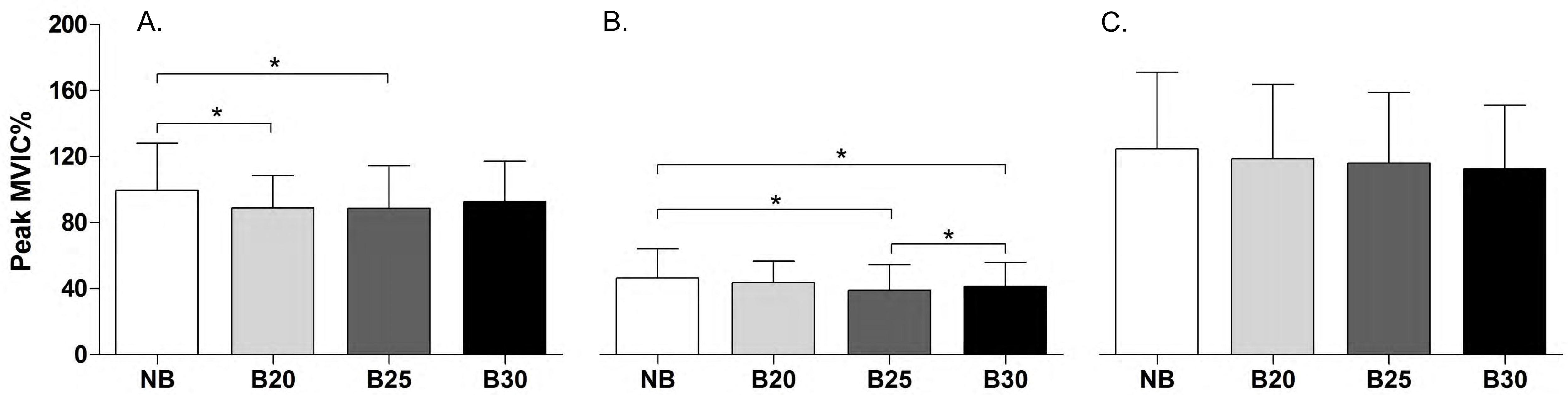

Figure 2. Mean (±SD) values for peak MVIC% across the banded conditions. A. represents medial gastrocnemius (MG); B. represents semitendinosus (ST) and C. represents gluteus maximus (GM). *Denotes significant difference between conditions ($p < 0.05$).

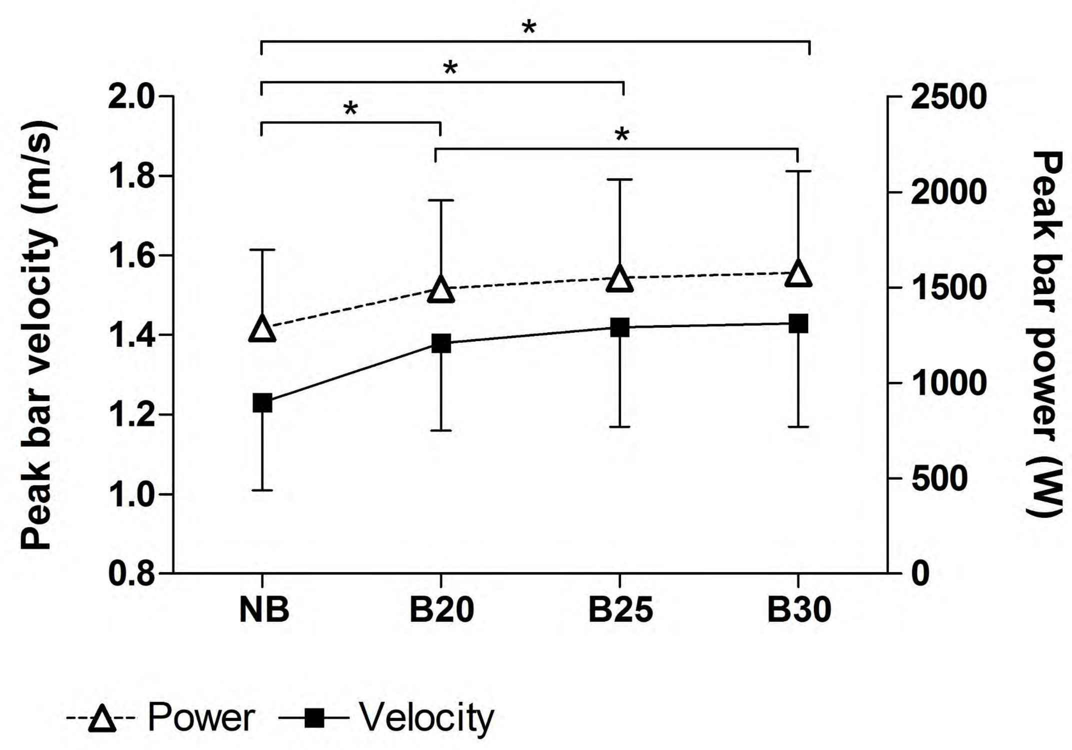

Figure 3. Mean (±SD) values for peak concentric power and peak barbell velocity across conditions. *Denotes significant difference ($p < 0.05$).

Conclusion

Performing the deadlift with bands increases concentric muscle power and barbell velocity, whilst concurrently decreasing muscle activation of the posterior chain musculature. There also appears to be a point of diminishing return for increases in bar power and velocity during the deadlift when using banded variable resistance.

Practical Applications

Practitioners prescribing the deadlift with banded variable resistance may wish to include additional posterior chain exercises that have been shown to elicit high levels of muscle activation. Athletes may also gain most benefit from this specific exercise when implemented into a peaking or pre-competition phase, due to the increases in bar power and velocity.

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Post-activation potentiation of 20-m sprint performance using plyometric exercise amongst youth participants

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Abstract

Purpose
This research project incorporated a post-activation potentiation (PAP) protocol within a warm-up amongst youth participants aiming to enhance subsequent 20m sprint performance. This consisted of weighted vest conditioning contractions (CC). The rationale for this method was to give younger athletes a better chance of overcoming fatigue and exploiting a PAP effect in comparison to traditional heavy CCs (>75% 1-RM) whilst also providing a CC that possessed arguably the greatest biomechanical similarity to sprinting

Methods
During this within-subject design study, each participant (n=9, mean + SD age of 15 ± 0.71 years, height 175.36 ± 6.45 cm, body mass 62.1 ± 5.92 Kg, and body composition 16.9 ± 2.71 %) was required to attend the laboratory on five occasions over the course of five weeks. The main study included four trials separated by seven days in a randomised order with only one trial completed on each day. The trials were weighted vest sprints at 10 (WV10), 20 (WV20) and 30% (WV30) of their bodyweight and a control condition which was simply without any additional vest or weight. Following a dynamic warm-up, participants were required to sprint 20m with a pre-selected vest and remove it upon completion. Bodyweight 20m sprints were completed at four, eight and twelve minutes rest to measure different rest periods and weighted conditions. A two-way repeated measures ANOVA was performed to assess statistical significance between split intervals and pre-load stimulus. Significance was accepted as $P<0.05$. Additional effect sizes (ES) were calculated for each split interval and pre-load stimulus (Rhea, 2004 & Cohen, 1992).

Results
At four min, 20m sprint performance was greatest following WV10 (3.30 ± 0.15 sec) compared with WV20 and WV30 (3.38 ± 0.15 and 3.39 ± 0.19 sec, respectively (P = 0.958)). At eight min, 20m sprint performance was greatest post WV30 (3.30 ± 0.14 sec) in comparison with WV20 (3.33 ± 0.18 sec) and WV10 (3.33 ± 0.17 sec (P = 0.958)). At twelve min, 20m sprint performance was greatest post WV10 (3.30 ± 0.17 sec) compared with WV20 and WV30 (3.35 ± 0.13 and 3.37 ± 0.17, respectively (P = 0.958)). Relative to CON, 10 and 5m sprint times were improved similarly at twelve min post WV20 (1.92 ± 0.09 and 1.13 ± 0.09 sec, respectively (P = 0.604, P = 0.794).

Conclusion
Although no significance was found, a 2.79% increase in 20m sprint performance was observed 12 min after the 10% trial and 10 and 5m sprint times were greatest after the 20% condition (+2.67 and +3.15% respectively). The effect size calculations revealed no specific trend towards strength levels, however, it suggested that stronger participants were able to realise a greater PAP effect earlier than their weaker counterparts. Furthermore, the current study suggests that performance was greatest on average 8-12 minutes post CC. In conclusion, the results suggest that a weighted vest CC, particularly at 10 and 20% of bodyweight may provide a more attractive alternative to that of a dynamic warm-up alone.

Purpose

- Post-activation potentiation (PAP) refers to an increase in muscle performance following a conditioning contraction (CC (Seitz & Haff, 2016)). The two primary mechanisms responsible for PAP are associated with phosphorylation of regulatory light-chains and an increased recruitment of higher order motor units (H-reflex (Tillin & Bishop, 2009)).
- If PAP is utilised successfully within a warm-up it has the potential to enhance subsequent explosive activity (e.g. sprinting) amongst youth participants (Dipla et al., 2009), potentially outweighing the benefits associated with a dynamic warm-up alone (Smith et al., 2014).
- Traditionally, PAP has been undertaken using a heavy resistance CC (75-95% 1-RM). However, this method of inducing PAP has limited application to the pre-competition (e.g., warm-up) of many athletes (Turner et al., 2015) as well as potentially being too intense for youth participants (Dipla et al., 2009).
- Turner et al., (2015) identified that the use of a weighted vest (10%) during 3 sets of 10 alternate leg bounds could improve 20-m sprint performance by ~2.2% providing adequate rest is provided. Alternate leg-bounds are a technically difficult exercise to execute, therefore it may be more pertinent to explore the effect of sprinting with additional load in a youth population.
- Therefore, the aim of this study was to investigate the PAP effects following a lower intensity weighted vest (WV) CC at 10, 20 and 30% body mass upon subsequent 20-m sprint performance amongst youth participants.

Methods

- Nine male amateur football players (mean ± SD; age 15 ± 0.71 years, stature 175.4 ± 6.45 cm, body mass 62.1 ± 5.92 kg and body fat 16.9 ± 2.71%) completed a baseline testing session (back squat 1-RM & 20-m sprint), before undergoing four main experiment trials (control & weighted vest (WV) sprints at 10% (WV10), 20% (WV20) & 30% (WV30)) of bodyweight.

- The main experiment trials consisted of a dynamic warm-up followed by a randomised CC (control, WV10, WV20 & WV30 over 20-m) prior to bodyweight sprints at 4, 8 and 12 minute time intervals. Split intervals were recorded at 5m, 10m and 20m (Smart speed timing gates, Fusion Pro, Fusion Sport, Coopers Plains, Australia).
- A two-way repeated measures ANOVA was performed to assess statistical significance between split intervals and pre-load stimulus. Additional effect sizes (ES) were calculated for each split interval, rest period and pre-load stimulus (Cohen, 1992). All data is presented as mean ± SD.

Results

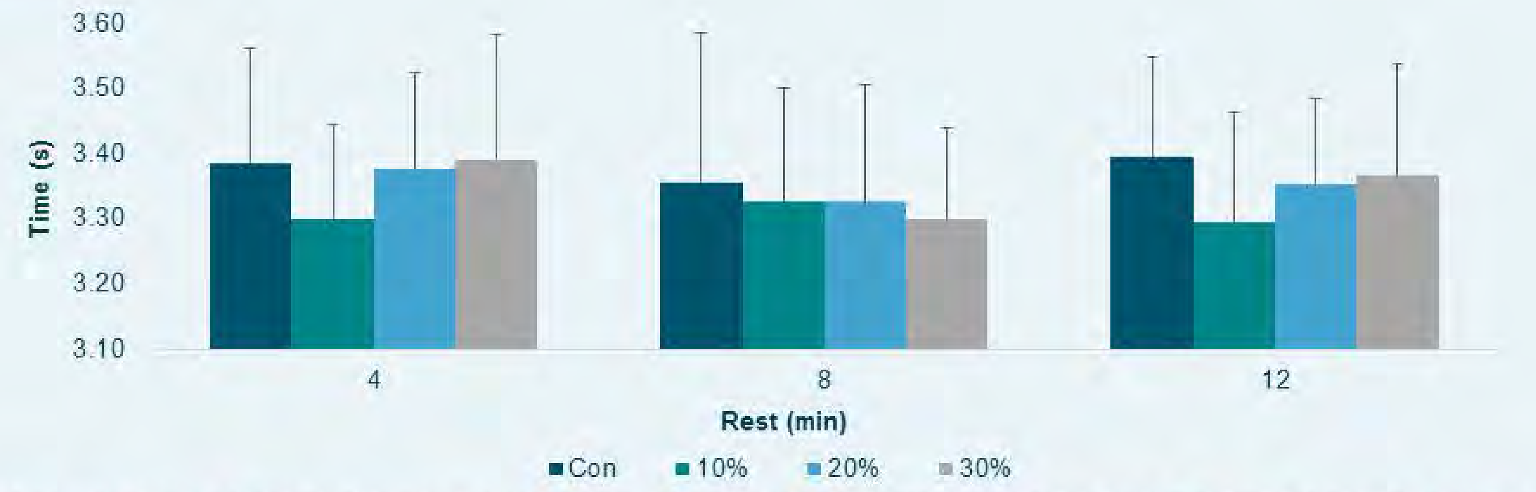

Figure 1. Mean ± SD sprint times (s) for 20-m after control, WV10, WV20 and WV30 conditions at 4, 8 and 12 minutes rest.

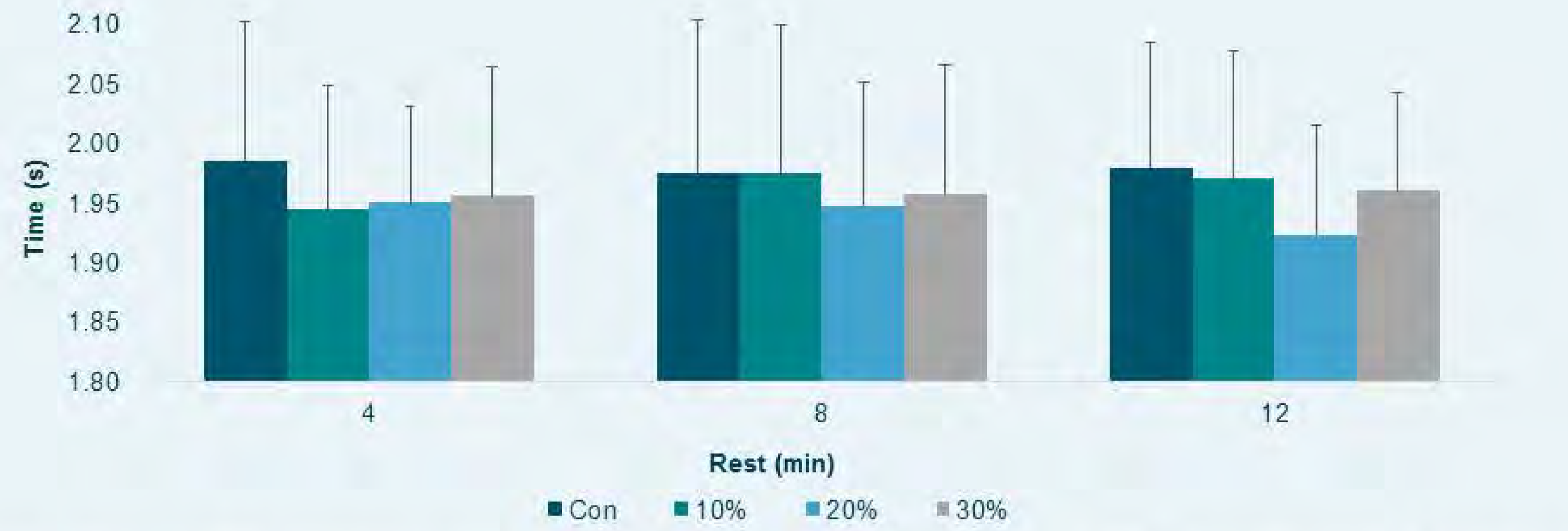

Figure 2. Mean ± SD sprint times (s) for 10-m after control, WV10, WV20 and WV30 conditions at 4, 8 and 12 minutes rest.

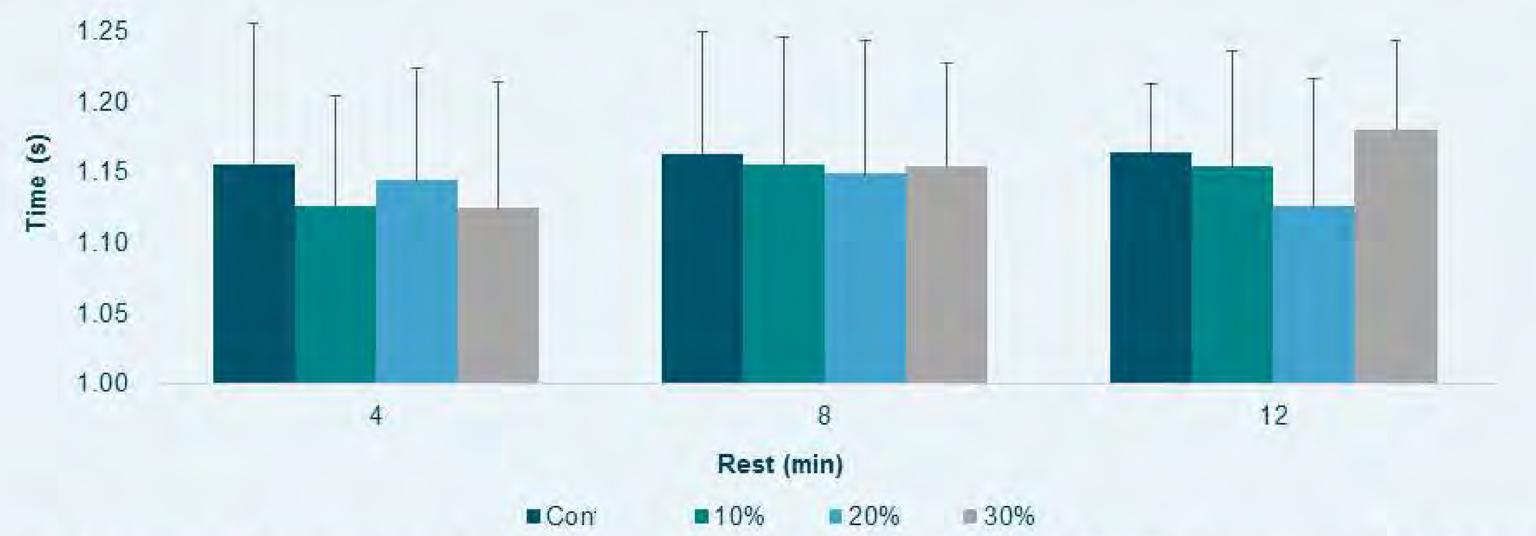

Figure 3. Mean ± SD sprint times (s) at 5-m after control, WV10, WV20 and WV30 conditions at 4, 8 and 12 minutes rest.

Table 1. Effect size (ES) for strong (n=5, 1RM >1 x BW) and less strong (n=4, 1RM <1 x BW) participants. ES was considered trivial (<0.35), small (0.35-0.80), moderate (0.80-1.50) and large (>1.50) based upon a specific classification method (Rhea, 2004).

Classification	10%								
	5-m			10-m			20-m		
	4	8	12	4	8	12	4	8	12
Strong	0.1	0.11	0.23	0.21	0	0	0.52	0.38	0.46
Less strong	0.54	0.09	0.04	0.53	0	0.21	0.55	-0.02	0.88
	20%								
	5m			10-m			20-m		
	4	8	12	4	8	12	4	8	12
Strong	0.1	0.09	1.68	0.38	0.11	0.96	0.2	0.31	0.38
Less strong	0.15	0.25	-0.13	0.36	0.36	0.36	-0.13	0.03	0.27
	30%								
	5-m			10-m			20-m		
	4	8	12	4	8	12	4	8	12
Strong	0.33	-0.33	-0.27	0.16	-0.29	0.23	0.21	0.39	0.23
Less strong	0.32	0.65	-0.42	0.35	0.48	0.2	-0.43	0.24	0.11

Conclusion

- Although not significant, a 2.79% improvement in 20-m sprint performance was observed 12 min post WV10. The greatest improvement in sprint performance at 10 and 5m were observed after WV20 at 12 min (+2.67 and +3.15%, respectively). These suggest that WVs could be exploited as part of a warm up protocol.
- In contrast to similar research (Till & Cooke, 2009 & Turner et al., 2015), performance was greatest on average 8-12 minutes post CC.
- The current data highlights a varied response to the use of WVs and suggests coaches should adopt an individualised approach to the use of WVs to elicit a PAP effect during 20m sprint performance. Furthermore, additional absolute strength analysis failed to show any noticeable trends in the data (table 1).
- Future research should look to replicate this work, with consideration given to multiple set analysis of additional WV loads.

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