

RELATIONSHIP BETWEEN REACTIVE STRENGTH INDEX VARIANTS IN RUGBY LEAGUE PLAYERS

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ABSTRACT

Two reactive strength index (RSI) variants exist, the RSI and RSI modified (RSI_{mod}) which are typically calculated during the drop jump (DJ) and countermovement jump (CMJ), respectively. Both RSI variants have been used to monitor athletes' ability to complete stretch-shortening cycle actions quickly, but they have never been compared. The purpose of this study was to determine if they yield reliable information about reactive strength characteristics. Male professional rugby league players ($n = 21$, age = 20.8 ± 2.3 years, height = 1.82 ± 0.06 m and body mass = 94.3 ± 8.4 kg) performed three DJs (30 cm) and CMJs on a force plate. RSI and RSI_{mod} were subsequently calculated by dividing jump height by ground contact time (GCT) and time to take-off (TTT), respectively. All variables were highly reliable (intraclass correlation coefficient ≥ 0.78) with acceptable levels of variability (coefficient of variation $\leq 8.2\%$), albeit larger variability was noted for DJ variables. Moreover, there was a large relationship between RSI and RSI_{mod} ($r=0.524$, $P=0.007$), whereas very large relationships were noted between jump heights ($r=0.762$, $P<0.001$) and between GCT and TTT ($r=0.705$, $P<0.001$). Additionally, RSI (0.90 ± 0.22) was largely and significantly ($d=2.57$, $P<0.001$) greater than RSI_{mod} (0.47 ± 0.08). The DJ-derived RSI yields much larger values than the CMJ-derived RSI_{mod} and although a large relationship was noted between them, it equated to just 22% shared variance. These results suggest that the two RSI variants do not explain each other well, indicating that they do not assess entirely the same reactive strength qualities and should not be used interchangeably.

KEYWORDS

Countermovement jump; drop jump; correlation; plyometric; monitoring

INTRODUCTION

Reactive strength describes the ability to complete a fast stretch-shortening cycle (SSC) action, that is to perform a rapid eccentric (braking) phase and then transition quickly into a rapid concentric (propulsion) phase (37). The ability to utilize the SSC quickly is typically assessed during vertical jumping tasks by calculating the reactive strength index (RSI). The RSI is usually calculated during vertical jumping tasks that have an identifiable ground contact time (GCT), such as the drop jump (DJ). The RSI provides valuable insight into neuromuscular and SSC function by accounting for the duration over which force has been produced to achieve a given jump height (JH) (14). It is calculated, therefore, by dividing JH by GCT (38). An amended version of the RSI calculation, termed RSI modified (RSI_{mod}), was more recently created to overcome the issue of RSI being exclusively applied to jumps involving an obvious GCT, by replacing GCT with time to take-off (TTT) (12). RSI_{mod} can therefore be determined for a range of countermovement-initiated jumping tasks, such as the countermovement jump (CMJ), whereby the feet are already in contact with the ground before the jump commences. This is done by dividing JH by TTT (calculated from the initiation of the countermovement to take-off) (12).

Traditionally, fast SSC tasks are considered to involve GCTs ≤ 250 ms, with slow SSC tasks involving GCTs ≥ 251 ms (32). Although the DJ is considered a fast SSC task, it is not always executed with a GCT ≤ 250 ms. This is partly to do with task instruction (38), with focus placed on maximizing JH leading to a “countermovement” DJ technique (characterized by longer GCT and sometimes referred to as a depth jump) and focus on minimizing GCT leading to a “bounce” DJ technique (5, 33). A recent study compared RSI values between these two DJ techniques (from drop heights of 15-60 cm) and reported that RSI was always higher for the “bounce” DJ approach (referred to simply as DJ hereafter), but that GCTs ≤ 250 ms were only achieved from the 15 and 30 cm drop heights (33). Research shows that reducing

GCT, by increasing leg stiffness, leads to greater RSI (1, 20) which is synonymous with larger ground reaction forces (GRFs). Thus larger GRFs are achieved when performing the DJ with shorter GCTs, even when drop height is constant (6). Similarly, shorter GCTs and larger GRFs, thus greater RSI, can be expected when performing the DJ versus the CMJ (6). This is because the CMJ is initiated while the feet are on the ground (i.e. no initial impact force) which requires the athlete to undergo an unweighting phase before the GRF increases beyond bodyweight as the braking phase begins (thus prolonging TTT).

Although the mechanical demands of each jump differ, and the CMJ is described as a slow SSC task whereas the DJ is described as a fast SSC task (32), a higher CMJ RSI_{mod} is still reflective of a faster and more forceful jump (21, 25). Consequently, one might expect those with better reactive strength characteristics to attain a higher RSI irrespective of the type of jump performed. To the authors' knowledge, only ten published studies have calculated RSI_{mod} to date (3, 5, 12, 21, 25-27, 35-37), but surprisingly none of them have established whether RSI_{mod} and the original RSI metric are correlated. Doing so would enable practitioners to make informed decisions and determine whether they produce reliable information. For example, it may be that CMJ RSI_{mod} is more suitable for monitoring weaker athletes due to the lower mechanical demand, whereas DJ RSI is better suited to monitoring stronger athletes (4, 5). Therefore, it might be that the RSI variant used to monitor athletes could be selected based on their current training status and evolve with their training cycle (i.e. as they progress from a maximal strength through to a speed-strength training cycle, or simply as their reactive strength increases). This would only be warranted, however, if RSI variants were able to yield reliable information.

Comparing and correlating RSI and RSI_{mod} values attained during a DJ and CMJ, respectively, would inform practitioners of the reliability/interchangeability of these values and allow them to make an informed decision about the most appropriate jump test, and thus

RSI variant, for a given sport or athlete. The aim of this study, therefore, was to explore both the differences and relationships between RSI and RSI_{mod} values in rugby league players. This sporting group were of particular interest due to the varied physical and match demands noted within a squad. It was hypothesized that RSI values would be greater than RSI_{mod} values because the DJ yields a slightly lower JH but a much shorter GCT. However, it was also hypothesized that they would share a positive relationship.

METHODS

Experimental Approach to the Problem

This study employed a within-session repeated measures design whereby subjects performed multiple CMJs and DJs on a force platform, enabling differences and correlations between RSI variants, JH and GCT/TTT to be determined.

Subjects

Professional male rugby league players ($n = 21$ [11 forwards and 10 backs], age = 20.8 ± 2.3 years, height = 1.82 ± 0.06 m and body mass = 94.3 ± 8.4 kg) from the English Super League attended a single testing session at the start of the preseason training period. All subjects had previous experience of performing CMJs and DJs in line with the protocols discussed in the procedures section. Written informed consent was provided prior to testing, the study was pre-approved by the institutional review board and conformed to the World Medical Association's Declaration of Helsinki.

Procedures

Following a brief warm-up consisting of dynamic stretching and sub-maximal jumping (single effort and repeated CMJs), subjects performed three CMJs to a self-selected depth

followed by three DJ from a 30 cm high box. Jumps were separated by a one-minute rest period, with three minutes of rest between CMJs and DJs. Subjects were instructed to perform the jumps as fast (or to minimize GCT for the DJ trials) and as high as possible, whilst keeping their arms akimbo. Any jumps that were inadvertently performed with the inclusion of arm swing or leg tucking during the flight phase (tester observation) were omitted and additional jumps were performed after one minute of rest.

Jump GRFs were recorded at 1000 Hz using a Kistler type 9286AA force platform and Bioware 5.11 software (Kistler Instruments Inc., Amherst, NY, USA). It should be noted that the force platform was 3 cm high so the effective drop height for the DJs was 27 cm. Subjects were instructed to stand still for the initial (CMJ) or final (DJ) one second of data collection (29, 30) to enable the subsequent determination of body weight (vertical GRF averaged over 1 s). Raw vertical force-time data were exported as text files and analyzed using a customized Microsoft Excel spreadsheet (version 2016, Microsoft Corp., Redmond, WA, USA).

Center of mass velocity was determined by dividing vertical GRF (minus body weight) by body mass and then integrating the product using the trapezoid rule (29). CMJ start was identified in line with current recommendations (30). Touchdown (DJ only) and take-off was identified when vertical GRF exceeded and fell below five times the standard deviation of the flight phase force, respectively (26, 27, 29). Vertical velocity at touchdown was estimated for the DJ based on drop height (2). JH was derived from vertical velocity at take-off (29). RSI and RSI_{mod} was calculated as JH divided by GCT and TTT, respectively (12, 38).

Statistical Analyses

A two-way random-effects model intraclass correlation coefficient (ICC) was used to determine the relative between-trial reliability of each variable. The ICC values were interpreted according to previous research where values ≥ 0.75 are considered excellent (16).

Absolute between-trial variability of each variable was calculated using the coefficient of variation (calculated in this study as the standard deviation divided by the mean) expressed as a percentage (%CV). A CV of $\leq 10\%$ was considered to be reflective of acceptable variability in line with previous recommendations (10).

Both RSI variants, JH and GCT met parametric assumptions, but TTT did not. Mean differences in RSI variants and JHs were therefore compared using independent t-tests whereas GCT and TTT were compared using the Wilcoxon test. Effect size (ES) calculations (Cohen's *d*) provided measure of the magnitude of the differences in each variable and they were interpreted as trivial (< 0.35), small (0.35-0.80), moderate (0.80-1.5), and large (> 1.5), respectively (31). Relationships between RSI variants and JH were explored using the Pearson correlation coefficient, whereas relationships between GCT and TTT were explored using the Spearman correlation coefficient. Correlation coefficients were interpreted as trivial (0.0-0.1), small (0.1-0.3), moderate (0.3-0.5), large (0.5-0.7), very large (0.7-0.9), and nearly perfect (0.9-1.0) (18). All statistical tests were performed using SPSS software (version 23; SPSS Inc., Chicago, IL, USA) with the alpha level set at $P \leq 0.05$. Post-hoc statistical power was determined using G.Power 3.1 (13).

RESULTS

All variables demonstrated excellent reliability and acceptable variability between-trials (Table 1). RSI was significantly greater than RSI_{mod} (power = 1.00, large ES) because the DJ produced significantly lower JH (power = 0.64, small ES), and a significantly shorter GCT (power = 1.00, large ES) (Table 1).

INSERT TABLE 1 ABOUT HERE

As shown in Figure 1, there was a large relationship between RSI and RSI_{mod} ($r = 0.524$, $P = 0.007$, power = 0.86), whereas very large relationships were noted between JH ($r = 0.762$, $P < 0.001$, power = 1.00) and both GCT and TTT ($\rho = 0.705$, $P < 0.001$, power = 1.00).

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DISCUSSION

The aim of this study was to explore differences and relationships between RSI and RSI_{mod} values. The results show that DJ-derived RSI yields much larger values than CMJ-derived RSI_{mod} but a large relationship was noted between the two variants, supporting our hypotheses. Nevertheless, only 22% of the variance in RSI could be explained by RSI_{mod} suggesting that these RSI variants are somewhat distinct. RSI was almost twice as high as RSI_{mod} due to the large difference between GCT and TTT, given that JH showed only a small difference between jumps (Table 1). Interestingly, DJ and CMJ height and GCT and TTT demonstrated very large relationships with one another (Figure 1). This suggests that there is a general trend for the constituent parts of the RSI variants to positively correlate but these associations diminish slightly when expressed as a ratio of JH to GCT/TTT.

The present results seem to support a better cross-over of JH between jump types (largest explained variance and small difference between jumps) than GCT/TTT, but JH only describes the output of the jump rather than the strategy employed on the ground which is thought to be more important from a neuromuscular/SSC perspective (17, 25, 37). The better cross-over of JH between jump types might be due to most subjects performing the DJ with a “countermovement” rather than “bounce” technique (only 3 of the 21 subjects achieved a GCT of ≤ 250 ms said to be reflective of a fast SSC action (32) as illustrated in bottom graph of

Figure 1), despite being instructed to minimize GCT whilst maximizing JH. The DJ technique utilized by the subjects tested in this study generally leads to a greater JH (34, 39), and, as the name implies, there are typically greater temporal and kinematic similarities between the “countermovement” DJ technique and the CMJ (39), which may have contributed to these results.

As reported in Table 1, JH was the most reliable variable calculated for the CMJ and GCT was the most reliable variable calculated for the DJ from an ICC perspective. A much larger spread of DJ-derived RSI scores, which increases the likelihood of the ICC being greater (rank order more likely to be maintained for an inhomogeneous data set), likely contributed to the higher ICC. The between-trial variability (%CV) was slightly larger for all DJ variables, suggesting the CMJ-derived RSI_{mod} might be more sensitive at detecting changes in neuromuscular function for this group due to subjects demonstrating a more consistent performance during the CMJ between trials. This may have been due to the subjects being more familiar with the CMJ, despite them having also performed the DJ in previous testing and training sessions. Overall, these results suggest there is a more variable strategy for the DJ in rugby league players whereas the CMJ was performed with desired technique (i.e. TTT was quite short and RSI_{mod} was quite high compared to the literature (25, 36)), but DJ GCT were more variable (22).

Despite the higher overall variability reported for RSI and its constituent parts in this study, previous studies have reported a higher reliability for RSI derived from DJs performed from a 30 cm high box in collegiate athletes (15) and from higher boxes in trained hurlers (7) and professional basketballers (22). Additionally, when GCT is restricted to ≤ 250 ms, as was enforced in a recent study (22), the DJ assesses fast SSC ability (32). This information taken together suggests that if athletes are capable of consistent DJ execution (with minimal GCT; ≤ 250 ms) and monitoring of fast SSC ability is of interest to their coaching team, then DJ-derived

RSI should be the test of choice. If athletes are incapable of consistent DJ execution (i.e. large between-trial variability) and GCTs exceed 250 ms then this could be due to: a) the box from which they have dropped is too high (4), b) they require additional coaching to adopt the required “bounce” DJ strategy (5, 33) or c) they simply have poor reactive strength and so require longer-term training to improve this. So long as athletes do not execute the DJ ground contact phase with unsafe landing mechanics (e.g. knee valgus), it is acceptable for them to perform the DJ test to allow their reactive strength to be evaluated even if they perform the jump with undesirable technique.

Alternatively, the CMJ is the most common jump test, is less demanding than the DJ (involves smaller GRFs (6) and eliminates the skill of landing after dropping from a box [and, indeed, the requirement of a box] and then immediately jumping) and has been shown to provide valuable insight into athletes’ neuromuscular and SSC function (17, 25, 37). Therefore, if athletes routinely perform the CMJ test and/or slow SSC ability is of interest to their coaching team, then CMJ-derived RSI_{mod} could still yield some insight into reactive strength characteristics. For example, a recent study reported that a higher RSI_{mod} in rugby league players was associated with greater braking and propulsion force, velocity and power (24). Nevertheless, the present results clearly show that there is a distinct lack of shared variance between CMJ-derived RSI_{mod} and the higher scoring DJ-derived RSI, in a similar group of athletes. With this in mind, CMJ-derived RSI_{mod} is likely appropriate for monitoring all athletes due to its lower mechanical demand, but better information about reactive strength characteristics would be yielded from DJ-derived RSI values. The CMJ-derived flight time: contraction time ratio, which has been reported to provide useful insight into neuromuscular fatigue (17), is calculated in a very similar way to RSI_{mod} . The alternate use of RSI_{mod} (and its constituent parts) as a potential means to assess neuromuscular fatigue could, therefore, form

a future study that would generate useful information for strength and conditioning practitioners.

It is worth noting that the subjects of this study were tested at the start of pre-season, where one might expect fast SSC (tested via DJ-derived RSI) to be more diminished than the slow SSC (tested via CMJ-derived RSI_{mod}). This may explain the greater variability in RSI and longer than desirable GCTs reported here. Reactive strength characteristics and jump ability will change throughout a training cycle/season (9, 23), thus future studies should consider comparing these RSI variants during different training/competition phases to check whether their associations also change. Also, subdividing a larger sample of forwards and backs to identify the association between RSI variants for each group would be insightful owing to positional differences in body mass and match sprint distances (24, 28), which have different relationships with DJ and CMJ ability (8, 11, 19, 33). Position-specific correlations between RSI variants were not explored in the present study due to the low sample size used. Future research avenues should also include testing RSI via DJs performed from a range of box heights and consider lower-body strength capacity given the likely influence on resultant values (4) and associations with CMJ-derived RSI_{mod} (5).

PRACTICAL APPLICATIONS

The DJ-derived RSI yields much larger values than the CMJ-derived RSI_{mod} and although a large relationship was noted between them, it equated to just 22% shared variance. These results suggest that the two RSI variants do not assess or explain the same reactive jump qualities. Though excellent for both variants, variability was larger for RSI given that a range of DJ strategies were demonstrated by the athletes tested in this study, despite consistent task instruction. Nevertheless, if coaches wish to quantify rugby league athletes' reactive strength

characteristics, the present results support the use of the DJ-derived RSI due to the much higher values attained. Cohort-specific between-session reliability for, and relationships between, both RSI variants should, however, be ascertained across different phases of the sporting season to inform appropriate test selection to detect intervention-induced changes in reactive strength characteristics.

REFERENCES

1. Arampatzis A, Schade F, Walsh M, and Brüggemann GP. Influence of leg stiffness and its effect on myodynamic jumping performance. *J Electromyogr Kinesiol* 11: 355-364, 2001.
2. Baca A. A comparison of methods for analyzing drop jump performance. *Med Sci Sport Exerc* 31: 437-442, 1999.
3. Bailey CA, Suchomel TJ, Beckham GK, Sole CJ, and Grazer JL. A Comparison of Baseball Positional Differences with Reactive Strength Index-Modified. Presented at XXXIInd International Conference of Biomechanics in Sports, Johnson City, TN, July 12-16, 2014.
4. Beattie K, Carson BP, Lyons M, and Kenny IC. The Relationship between Maximal-Strength and Reactive-Strength. *Int J Sports Physiol Perform* 12: 548-553, 2017.
5. Beckham GK, Suchomel TJ, Bailey CA, Sole CJ, and Grazer JL. The relationship of the reactive strength index-modified and measures of force development in the isometric mid-thigh pull. Presented at XXXIInd International Conference of Biomechanics in Sports, Johnson City, TN, July 12-16, 2014.

6. Bobbert MF, Huijing PA, and Van Ingen Schenau GJ. Drop jumping. I. The influence of jumping technique on the biomechanics of jumping. *Med Sci Sport Exerc* 19: 332-338, 1987.
7. Byrne DJ, Browne DT, Byrne PJ, and Richardson N. The Inter-Day Reliability of Reactive Strength Index and Optimal Drop Height. *J Strength Cond Res* 31: 721-726, 2017.
8. Carr C, McMahon JJ, and Comfort P. Relationships between jump and sprint performance in first-class county cricketers. *J Trainology* 4: 1-5, 2015.
9. Carr C, McMahon JJ, and Comfort P. Changes in strength, power and speed across a season in English County Cricketers. *Int J Sports Physiol Perform* 12: 50-55, 2017.
10. Cormack S, J., Newton R, U., McGuigan M, R., and Doyle T, L. A. Reliability of Measures Obtained during Single and Repeated Countermovement Jumps. *Int J Sports Physiol Perform* 3: 131-144, 2008.
11. Cunningham D, West D, Owen N, Shearer D, Finn C, Bracken R, Crewther B, Scott P, Cook C, and Kilduff L. Strength and power predictors of sprinting performance in professional rugby players. *J Sports Med Phys Fitness* 53: 105-111, 2013.
12. Ebben WP and Petushek EJ. Using the Reactive Strength Index Modified to Evaluate Plyometric Performance. *J Strength Cond Res* 24: 1983-1987, 2010.
13. Faul F, Erdfelder E, Buchner A, and Lang AL. Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behav Res Methods* 41: 1149-1160, 2009.
14. Flanagan EP and Comyns TM. The use of contact time and the reactive strength index to optimize fast stretch-shortening cycle training. *Strength Cond J* 30: 32-38, 2008.
15. Flanagan EP, Ebben WP, and Jensen RL. Reliability of the Reactive Strength Index and Time to Stabilization During Depth Jumps. *J Strength Cond Res* 22: 1677-1682, 2008.

16. Fleiss JL. Reliability of Measurement, in: *The Design and Analysis of Clinical Experiments*. John Wiley & Sons, Inc., 1999, pp 1-32.
17. Gathercole R, Sporer B, Stellingwerff T, and Sleivert G. Alternative Countermovement-Jump Analysis to Quantify Acute Neuromuscular Fatigue. *Int J Sports Physiol Perform* 10: 84-92, 2015.
18. <http://www.sportsci.org/resource/stats/effectmag.html>. Accessed January 25/2017.
19. Kale M, AsÃ§i A, Bayrak C, and AÃ§ikada C. Relationships among jumping performances and sprint parameters during maximum speed phase in sprinters. *J Strength Cond Res* 23: 2272-2279, 2009.
20. Kipp K, Kiely M, T., Giordanelli M, D., Malloy P, J., and Geiser C, F. The Reactive Strength Index Reflects Vertical Stiffness During Drop Jumps. *Int J Sports Physiol Perform*, Publish Ahead Of Print.
21. Kipp K, Kiely MT, and Geiser CF. Reactive Strength Index Modified Is a Valid Measure of Explosiveness in Collegiate Female Volleyball Players. *J Strength Cond Res* 30: 1341-1347, 2016.
22. Markwick W, J., Bird S, P., Tufano J, J., Seitz L, B., and Haff GG. The Intraday Reliability of the Reactive Strength Index Calculated from a Drop Jump in Professional Men's Basketball. *Int J Sports Physiol Perform* 10: 482-488, 2015.
23. McGuigan MR, Doyle TLA, Newton M, Edwards DJ, Nimphius S, and Newton RU. Eccentric utilization ratio: effect of sport and phase of training. *J Strength Cond Res* 20: 992-995, 2006.
24. McLellan CP, Lovell DI, and Gass GC. Performance analysis of elite rugby league match play using global positioning systems. *J Strength Cond Res* 25: 1703-1710, 2011.

25. McMahon JJ, Jones PA, Suchomel TJ, Lake J, and Comfort P. Influence of Reactive Strength Index Modified on Force- and Power-Time Curves. *Int J Sports Physiol Perform*, Publish Ahead of Print.
26. McMahon JJ, Murphy S, Rej SJ, and Comfort P. Countermovement-Jump-Phase Characteristics of Senior and Academy Rugby League Players. *Int J Sports Physiol Perform* 12: 803-811, 2017.
27. McMahon JJ, Rej SJ, and Comfort P. Sex Differences in Countermovement Jump Phase Characteristics. *Sports* 5: 8, 2017.
28. Meir R, Newton R, Curtis E, Fardell M, and Butler B. Physical fitness qualities of professional rugby league football players: determination of positional differences. *J Strength Cond Res* 15: 450-458, 2001.
29. Moir GL. Three Different Methods of Calculating Vertical Jump Height from Force Platform Data in Men and Women. *Meas Phys Educ Exerc Sci* 12: 207-218, 2008.
30. Owen NJ, Watkins J, Kilduff LP, Bevan HR, and Bennett MA. Development of a Criterion Method to Determine Peak Mechanical Power Output in a Countermovement Jump. *J Strength Cond Res* 28: 1552-1558, 2014.
31. Rhea MR. Determining the Magnitude of Treatment Effects in Strength Training Research Through the Use of the Effect Size. *J Strength Cond Res* 18: 918-920, 2004.
32. Schmidtbleicher D. *Training for Power Events*. Oxford: Blackwell, 1992.
33. Smirniotou A, Katsikas C, Paradisis G, Argeitaki P, Zacharogiannis E, and Tziortzis S. Strength-power parameters as predictors of sprinting performance. *J Sports Med Phys Fitness* 48: 447-454, 2008.
34. Struzik A, Juras G, Pietraszewski B, and Rokita A. Effect of drop jump technique on the reactive strength index. *J Hum Kinet* 52: 157-164, 2016.

35. Suchomel TJ, Bailey CA, Sole CJ, Grazer JL, and Beckham GK. Using Reactive Strength Index-Modified as an Explosive Performance Measurement Tool in Division I Athletes. *J Strength Cond Res* 29: 899-904, 2015.
36. Suchomel TJ, Sole CJ, Bailey CA, Grazer JL, and Beckham GK. A Comparison of Reactive Strength Index-Modified Between Six U.S. Collegiate Athletic Teams. *J Strength Cond Res* 19: 1310-1316, 2015.
37. Suchomel TJ, Sole CJ, and Stone MH. Comparison of Methods That Assess Lower-body Stretch-Shortening Cycle Utilization. *J Strength Cond Res* 30: 547-554, 2016.
38. Young W. Laboratory Strength Assessments of Athletes. *New Stud Athlet* 10: 86-89, 1995.
39. Young WB, Pryor JF, and Wilson GJ. Effect of Instructions on characteristics of Countermovement and Drop Jump Performance. *J Strength Cond Res* 9: 232-236, 1995.

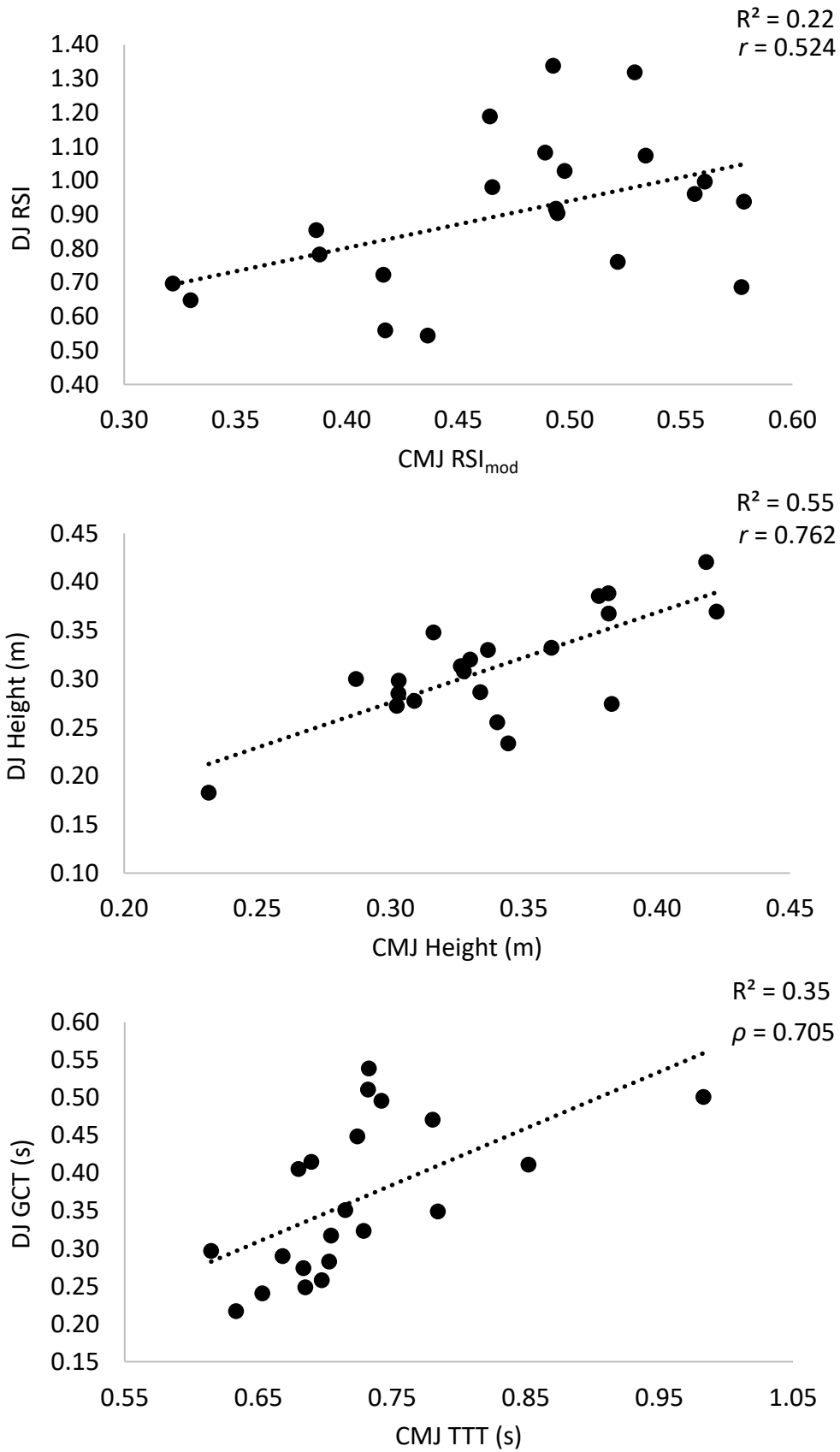


Figure 1: Relationships between drop jump (DJ) and countermovement jump (CMJ) derived variables. *RSI* = reactive strength index, *RSI_{mod}* = reactive strength index modified, *GCT* = ground contact time, and *TTT* = time to take-off.

Table 1: A comparison of traditional and modified reactive strength index values.

Variables	CMJ				DJ				<i>P</i>	<i>d</i>
	Mean	SD	ICC	%CV	Mean	SD	ICC	%CV		
Jump Height (m)	0.34	0.05	0.923	3.4	0.31	0.06	0.850	6.8	0.004	0.53
TTT/GCT (s)	0.723	0.080	0.779	4.3	0.364	0.101	0.925	6.6	<0.001	3.95
RSI _{mod} /RSI (ratio)	0.47	0.08	0.823	5.6	0.90	0.22	0.861	8.2	<0.001	2.57

CMJ = Countermovement Jump; DJ = Drop Jump; SD = Standard Deviation; ICC = Intraclass Correlation Coefficient; %CV = Percentage Coefficient of Variation; TTT = Time to Take-off; GCT = Ground Contact Time; RSI = Reactive Strength Index; RSI_{mod} = Reactive Strength Index Modified