A COMPARISON OF BASEBALL POSITIONAL DIFFERENCES WITH REACTIVE STRENGTH INDEX-MODIFIED

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The purpose of this study was to examine positional differences amongst 29 baseball players using the Reactive Strength Index-modified (RSImod) values during unloaded and loaded countermovement jumps (CMJ). A secondary purpose was to determine the relationship between other jump performance characteristics and RSImod values. All athletes underwent CMJ testing and RSImod values were compared between pitchers and position players. The loaded condition CMJ produced statistically different RSImod values between the two groups. Scaled peak force was somewhat more strongly related to RSImod than rate of force development (RFD). The current study indicates that position players may possess higher reactive strength capabilities than pitchers and scaled peak force may be more important than RFD in determining reactive strength characteristics.

KEYWORDS: countermovement jump, explosiveness, performance characteristics

INTRODUCTION: Recently, both researchers and strength and conditioning practitioners have used the reactive strength index (RSI) as a method of monitoring and assessment (Flanagan and Comyns 2008). RSI can be calculated by dividing the jump height attained during a drop jump by the ground contact time (McClymont 2005). RSI has previously been described as the ability to quickly perform changes from the eccentric to concentric portion of muscular contractions (Young 1995). Thus, RSI can be used as a method of evaluation for explosiveness and stretch-shortening cycle performance (Flanagan and Comyns 2008, Young 1995).

RSI can serve as a useful tool for strength and conditioning practitioners as well as in athlete monitoring in that it can be calculated form a simple countermovement jump (CMJ), and may remove some of the limitations of only measuring either jump height or ground contact time by themselves. For example, if jump height is the only variable evaluated, athletes may focus on increasing power while prolonging ground contact time. On the other hand, if contact time is the only variable evaluated, athletes may attempt to influence time to takeoff while sacrificing jump performance (Flanagan and Comyns 2008).

While most of the current RSI research deals with the drop jump, recent modifications have been made to allow for its application to all vertical jumping assessments. This modification divides jump height by time to takeoff instead of ground contact time. This modification has been termed RSImod (Ebben and Petushek 2010). While this modification has been shown to be reliable and previous versions of RSI have been related to performance, the possibility of positional differences within sports has not yet been evaluated. Therefore, the purpose of this investigation was to examine positional differences amongst baseball players using RSImod values during unloaded and loaded countermovement jumps (CMJ). A secondary purpose was to determine the relationship between other jump performance characteristics and RSImod values in baseball players.

METHODS: Subjects for this study included 29 NCAA Division I collegiate baseball players (n = 29; height = 182.1 ± 6.2 cm, body mass 88.0 ± 9.0 kg). The sample consisted of 13 pitchers and 16 position players. Subject ages ranged from 18-23. Data were collected as part of an ongoing athlete monitoring program. This retrospective study was approved by the Institutional Review Board at East Tennessee State University.

Each athlete underwent a standardized warm-up prior to CMJ evaluation. The warm-up involved 25 jumping jacks, one set of five repetitions of mid-thigh pulls with a 20 kg bar, and three sets of five repetitions with a 60 kg load. After the standardized warm-up, athletes performed two submaximal CMJs at 50% and 75% of their perceived maximal effort, which served as a specific warm-up. Following the warm-up, athletes completed two maximal effort CMJs with approximately 30 seconds of rest between each trial. During the unloaded CMJs, athlete's held a nearly weightless (< 1kg) PVC pipe behind the neck near the 7th cervical vertebrae, similar to the high-bar squat position. This was done in an effort to eliminate any contributions from an arm swing. Approximately one minute following the unloaded CMJs, athletes performed warm-up and familiarization trials for the loaded condition again at 50% and 75% of their perceived maximal effort. Loaded jumps were completed with a 20 kg barbell in the same position as the unloaded jumps. Again, two maximal effort jumps were completed with approximately 30 seconds rest allotted between each trial.

Jump testing was completed on a force plate (91 cm x 91 cm, Rice Lake Weighing Systems, Rich Lake, WI, USA) sampling at a frequency of 1000 Hz. A custom designed LabVIEW program (Version 10.0, National Instruments Co., Austin, TX, USA) was utilized to collect and analyze all jumps. A low-pass Butterworth filter with a cutoff frequency of 10 Hz was used to remove electrical noise form the signal.

RSImod was calculated by the same procedures used by Ebben and Petushek (2010).

$$RSImod = \frac{CMJ\ height\ (m)}{time\ to\ takeoff\ (s)}$$

All statistical analyses were completed using SPSS version 21 (IBM, New York, NY, USA). Prior to comparison, a Levene's test for homogeneity of variance was completed to evaluate the variance equality between the two groups. Reliability was evaluated with Intraclass Correlation Coefficients (ICC) and coefficient of variation (CV) to produce relative and absolute measures of reliability. The comparisons between pitchers and position players were completed with independent samples t-tests. Statistical significance was set at 0.05. Cohen's *d* effect sizes were calculated to provide effect size estimates and were interpreted using the scale provided by Hopkins (2014). Hopkins' scale states that an effect size of 0.0-0.19 is trivial, 0.2-0.59 is small, 0.6-1.19 is moderate, 1.2-1.99 is large and above 2.0 is very large. Pearson zero order, product-moment correlations were used to assess the relationships between RSImod and other jump performance characteristics. Along with RSImod, other jump performance characteristics evaluated included rate of force development (RFD) and allometrically scaled peak force (PFa). Allometric scaling of peak force was achieved by dividing peak force during the propulsions phase by body mass raised to the 2/3 power. Relationship strength was again interpreted using a scale provided by Hopkins (2014), where: 0.0-0.09 is trivial, 0.1-0.29 is small, 0.3-0.49 is moderate, 0.5-0.69 is large, 0.7-0.89 is very large, 0.9-0.99 is nearly perfect and 1 is perfect.

RESULTS: Levene's test for homogeneity of variance was not statistically significant therefore equal variances were assumed. Concerning RSImod, the trials produced good relative reliability with ICC values of 0.910 during the unloaded condition and 0.938 during the loaded condition. Absolute reliability was also good, producing CV values of 12.7% for the unloaded condition and 14.2% for the loaded condition. Only the loaded condition of RSImod produced statistically significant differences between pitchers and position players with a *p* value of 0.027, while the unloaded condition produced a *p* value of 0.170. The effect size estimate for the unloaded condition was small (0.52), while the loaded condition produced a moderate effect size (0.81). There were no statistically significant differences between either group for RFD or PFa during either jump condition, although moderate effect sizes were observed in both conditions of PFa (*d*=0.66 for 0 kg CMJ; *d*=0.71 for 20 kg CMJ).

Table 1. Results from independent samples t-test and Cohen's d effect size estimates between pitchers and position players.

	RSI 0 KG	RSI 20 KG	RFD 0 KG	RFD 20 KG	PFa 0 kg	PFa 20 kg
t test	0.170	0.027	0.932	0.856	0.078	0.056
Cohen's *d*	0.52	0.81	0.03	0.07	0.66	0.71

Note: * indicates statistical significance (p≤0.05)

RSImod was moderately related to RFD for the unloaded jump condition (*r* = 0.48) and strongly correlated to the loaded jump condition (*r* = 0.56). An example of this relationship is shown as a scatterplot in the figure below. RSImod also produced a moderate correlation with the loaded condition of PFa (*r* = 0.44), but the unloaded condition did not reveal a similar relationship (*r* = 0.18).

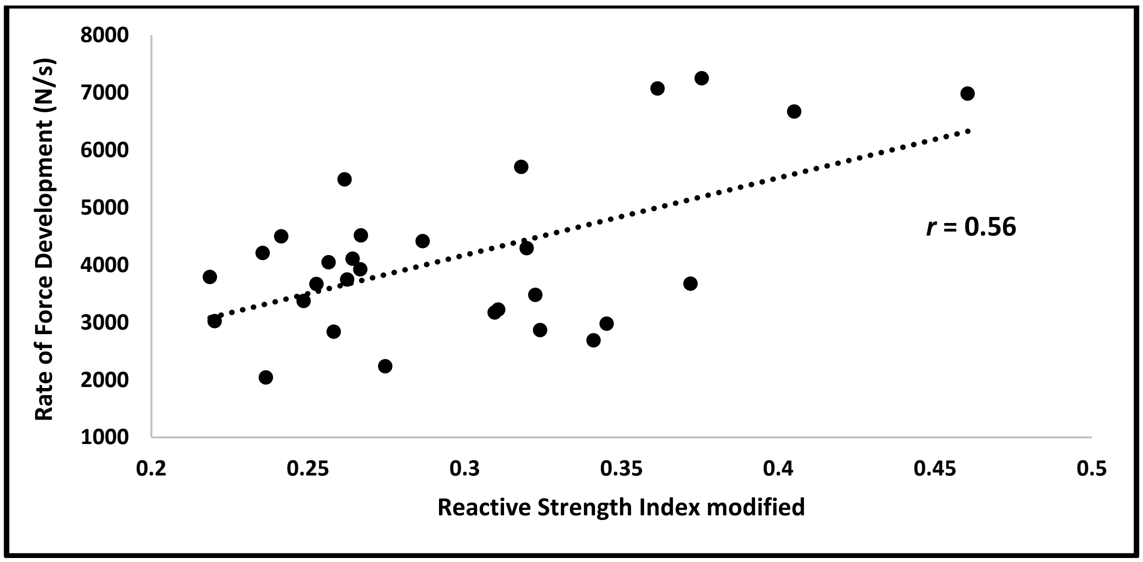

Figure 1. Example of RSImod relationship with RFD during the loaded countermovement jump.

DISCUSSION: This study examined the positional differences in RSImod between position players and pitchers of a Division I collegiate baseball team. The primary finding of this study was the statistical difference between pitchers and position players RSImod values during the loaded CMJ with a moderate effect size estimate. The unloaded jump condition did not achieve statistical significance in RSImod and had a small effect size estimate. Increasing the size of the sample would likely increase the chance for achieving statistical significance. It should be noted that no form of type I error correction was applied as this study was somewhat exploratory in nature. Application of a type I error correction may have removed any possibility for statistical significance in the current investigation, but future studies with larger sample sizes may be benefitted by such applications. Based on these results, expecting larger RSImod values for position players may be reasonable, especially when a load is applied, but further research is needed support this notion. These findings are in contrast to Srinivasan et al. (2013), who did not find statistically significant RSI differences between various positions in high school baseball players. It should be noted that the aforementioned study did not use RSImod, but used RSI collected from depth jumps of various heights. Statistically significant differences were not observed in RFD or PFa either. Based on work by Blackwelder (1982), RFD can be considered statistically similar between pitchers and position players as *p* values for both were above 0.5 and also had only trivial effect sizes. This may indicate that using these particular measures of

RFD would not be sufficient to distinguish between pitchers and position players, whereas using RSImod may be more appropriate, especially with loaded jumps. Similar to RSImod, PFa approached statistical significance with moderate effect size estimates.

A secondary finding of this study was that RSImod moderately to strongly correlated with RFD and moderately correlated with the loaded PFa condition. Although RFD did not discriminate between baseball pitchers and position players, this seems to provide justification for the use of reactive strength as an evaluation of explosiveness as previously mentioned (Flanagan and Comyns 2008, Young 1995). The presence of moderate to strong correlations between RSImod and PFa may further indicate the importance of relative strength in jumping performances.

CONCLUSION: The RSImod values of position players were greater than those of pitchers. It is likely that differences in strength contributed to the greater RSImod values of position players. Based on the findings of the current study, differences in RSImod values and jump characteristics may be expected along with differences in sport position, but further research is warranted in order to fully define these differences. RSImod was shown to be related to both RFD and PFa in baseball players, further justifying the use of RSImod as tool for monitoring and evaluation of jumping performance.

Currently there is a lack of research comparing positional differences of many sports reactive strength characteristics. Different sports have different physical demands and it is conceivable that different positions within a given sport do also. This study combined all position players into one group, but future studies should examine differences between infielders, outfielders and catchers as well. It is possible that strength and power are key factors for given performance tasks, making monitoring of these variables important for sport scientists and coaches alike.

REFERENCES:

Ball, N.B., Zanetti, S. (2012). Relationship between reactive strength variables in horizontal and vertical drop jumps. *Journal of Strength and Conditioning Research*, 26(5):1407-1412.

Blackwelder, W.C. (1982). Proving the null hypothesis in clinical trials. *Controlled Clinical Trials*, 3(4):345-353.

Ebben, W. P., & Petushek, E. J. (2010). Using the reactive strength index modified to evaluate plyometric performance. *J Strength Cond Res, 24*(8), 1983-1987.

Flanagan, E.P., Comyns, T.M. (2008). The use of contact time and the reactive strength index to optimize fast stretch-shortening cycle training. *Strength and Conditioning Journal*, 30(5):32-38.

Hopkins, W. G. (2014). A scale of magnitude for effect statistics. Retrieved from http://sportsci.org/resource/stats/effectmag.html

McClymont, D. (2005). The use of the reactive strength index as an indicator of plyometric training conditions.In: *Science and Football V: The Proceedings of the Ffth World Congress on Sport Science and Football. Lisbon, Portugal*.

Srinivasan, K., Ferrell, R., Damrath, P. et al. (2013). Positional comparison of reactive strength index in high school baseball players. *Journal of Strength and Conditioning Research*, 27(10): S75-S76.

Young, W. (1995). Laboratory strength assessment of athletes. *New Stud Athletics*, 10:88-96.