THE EFFECT OF A COMPETITIVE SEASON ON THE EXPLOSIVE PERFORMANCE CHARACTERISTICS OF COLLEGIATE MALE SOCCER PLAYERS

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INTRODUCTION: Monitoring fitness characteristics through pre- and post-season testing periods may provide valuable information to sport scientists, strength and conditioning practitioners, and coaches. This information may be used in conjunction with other data to determine if the previous training methodologies were successful in maintaining an athlete's or team's performance. A sport that requires the maintenance of performance over the course of a season is collegiate soccer. Collegiate men's soccer teams may play up to 24 matches over the course of four months. Although a regulation match lasts 90 minutes, it is possible that teams may play two additional 10 minute periods if the match remains tied. Because soccer requires repeated explosive changes of direction, jumping, and sprinting during long duration matches (Stølen et al., 2005), a large physical toll may be placed on the athletes. Therefore, the ability to maintain a team's performance over the course of the season may be challenged.

Previous research has examined changes in performance characteristics over the course of a season in sports such as soccer (Kraemer et al., 2004), handball (Gorostiaga et al., 2006), and softball (Nimphius et al., 2012). Although some of the previous studies measured countermovement jump (CMJ) height, no previous studies have examined allometrically-scaled peak power (PPa), reactive strength index-modified (RSImod) (Suchomel et al., 2014), and average rate of force development (RFD; during the amortization phase) changes. Although these variables may reflect similar performance characteristics, it is unclear how these variables change in relation to one another over the course of a soccer season. Because soccer requires frequent explosive efforts, further information regarding the change in explosive performance over the course of a competitive season is warranted. Therefore, the purpose of this study was to examine the effect of a competitive season on explosive performance characteristics in collegiate male soccer players.

METHODS: Seventeen NCAA Division I male soccer players (pre-season body mass = 77.1 ± 9.5 kg; post-season body mass = 77.3 ± 10.2 kg; height = 179.9 ± 7.1 cm) participated in this study. Athletes ranged in age from 18 – 23 years old. This retrospective study was approved by the East Tennessee State University Institutional Review Board.

Each athlete participated in a pre- and post-season testing session as part of an ongoing athlete monitoring program. Prior to testing, each athlete completed a standardized warm-up that consisted of 25 jumping jacks, one set of five mid-thigh clean pull repetitions with a 20kg barbell, and three sets of five mid-thigh clean pull repetitions with 60kg. After completing the general warm-up, each athlete performed a warm-up CMJ at 50% and 75% of their perceived maximum effort while holding a near weightless PVC pipe (< 1kg) across their shoulders. Following one minute of rest, athletes performed two maximum effort CMJs with 30 seconds of rest between each jump. Using the same rest periods and CMJ warm-up procedures, this sequence was repeated for CMJs performed with an 11kg barbell and 20kg barbell.

All CMJs were performed on a force platform (91cm x 91cm, Rice Lake Weighing Systems, Rice Lake, WI) sampling at 1,000 Hz. The test-retest reliability (ICC) pre- and post-season values for JH, PPa, RSImod, and RFD ranged 0.84 – 0.99 and 0.90 – 0.99, respectively. The pre-season CV% ranged from 10.2 – 14.3% for JH and PPa, 19.4 – 24.3% for RSImod, and 42.8 – 45.5% for RFD. The post-season CV% ranged 9.2 – 12.9% for JH and PPa, 29.0 – 32.3% for RSImod, and 46.0 – 50.0% for RFD. A series of 2 (season) x 3 (load) repeated measures ANOVA were used compare changes in JH, PPa, RSImod, and average RFD. When necessary, *post hoc* analyses were performed using the Bonferroni technique. In addition, partial factorial ANOVAs were used to investigate statistically significant interaction effects. Effect sizes (*d*) were calculated for all pairwise comparisons. All statistical analyses were performed using

SPSS 22 (IBM, New York, NY) and statistical significance for all analyses was set at $p \leq 0.013$ due to the use of multiple repeated measures ANOVAs.

RESULTS: The descriptive pre-season and post-season data are displayed in Table 1. The team played 20 matches over 13 weeks for an average of 1.54 matches per week.

Table 1. Performance variable descriptive data (mean ± SD; n = 17).

Load	Pre-Season				Post-Season			
	JH (m)	PPa ($W/kg^{0.67}$)	RSImod	RFD (N/s)	JH (m)	PPa ($W/kg^{0.67}$)	RSImod	RFD (N/s)
PVC (<1kg)	0.35 ± 0.05	224.4 ± 25.7	0.46 ± 0.09	6528.2 ± 2970.0	0.33 ± 0.04	212.2 ± 23.1	0.42 ± 0.13	5786.3 ± 2770.2
11kg	0.32 ± 0.04	221.9 ± 24.2	0.37 ± 0.09	5385.6 ± 2331.4	0.30 ± 0.03	214.2 ± 19.7	0.31 ± 0.10	4896.0 ± 2447.5
20kg	0.28 ± 0.04	221.4 ± 22.6	0.31 ± 0.06	5162.7 ± 2209.5	0.27 ± 0.03	220.6 ± 28.4	0.31 ± 0.09	4390.6 ± 2021.2

JH = jump height; PPa = allometrically-scaled peak power; RSImod = reactive strength index-modified; RFD = rate of force development

Statistically significant season main effect differences existed for JH ($p = 0.003$), but not for RSImod ($p = 0.016$), PPa ($p = 0.081$), or RFD ($p = 0.086$).

Statistically significant load main effect differences existed for JH ($p < 0.001$), RSImod ($p < 0.001$), and RFD ($p < 0.001$), but not for PPa ($p = 0.369$). *Post hoc* analysis of RSImod indicated that unloaded CMJs produced statistically greater values as compared to RSImod at 11kg ($p < 0.001$, $d = 0.95$) and 20kg ($p < 0.001$, $d = 1.35$). Finally, *post hoc* analysis of RFD indicated that unloaded CMJs produced statistically greater values compared to CMJs at 11kg ($p < 0.001$, $d = 0.39$) and 20kg ($p < 0.001$, $d = 0.55$).

There were statistically significant season x load interaction effects existed for JH ($p = 0.009$), PPa ($p = 0.028$), but not for RSImod ($p = 0.179$) or RFD ($p = 0.637$). The statistically significant JH interaction effect ($p = 0.006$) indicated that the change from 11kg to 20kg was greater during pre-season ($d = 0.94$) compared to post-season ($d = 0.71$). However, *post hoc* analysis of PPa revealed no statistically significant partial interactions.

DISCUSSION: This study examined the effect of a competitive soccer season on CMJ performance variables in collegiate men. There were three main findings of this study. Statistical main effect differences in JH existed from pre- to post-season testing, while measures of PPa, RSImod, and RFD were not statistically different. Statistically significant load main effect differences existed for JH, RSImod, and RFD, while PPa failed to reach statistical significance. Statistically significant season x load interaction effects existed for JH and PPa, but not for RSImod or RFD.

From pre- to post-season, JH, PPa, RSImod, and RFD decreased 5.2%, 3.2%, 9.1%, and 12.5%, respectively. These changes in performance all resulted in small practical changes (Cohen, 1988). Despite the performance decrements at the end of the season, the soccer team won their conference championship and played in the first round of the NCAA tournament. The results of this study are similar to previous studies who investigated changes in JH (Gorostiaga, et al., 2006; Kraemer, et al., 2004). This is the first study to investigate the changes in PPa, RSImod, and RFD over the course of season. Because PPa, RSImod, and RFD have been described as explosive performance measures (Suchomel, et al., 2014), future research may consider investigating changes in these variables over the course of a season.

By examining CMJs at multiple loads, sport scientists can assess contributions of strength on performance characteristics, but this may also provide an indication of how athletes perform under simulated fatigue conditions (Bailey et al., 2013). The interaction effects of JH were statistically significant in this study and further analysis revealed that the interaction occurred between JH changes from 11kg to

20kg. Pre-season differences in JH between 11kg and 20kg resulted in a large effect, while post-season JH differences displayed a moderate effect (Cohen, 1988). These results reflect a decrement in explosive performance at a lighter load, while strength may have remained unaffected. Given the decreased magnitudes of the remaining variables over the course of a season, this finding is not surprising. However, further research should consider examining the effect of strength on these measurements.

A Division I NCAA men's soccer team produced small practical decrements in JH, PPa, RSImod, and RFD following the completion of a season. Magnitudes of JH, RSImod, and RFD may depend on the load of the CMJs performed. It is recommended that future research should examine JH, PPa, RSImod, and RFD and CMJs at multiple loads to assess performance changes.

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