Soccer players are frequently exposed to a high frequency of games and, consequently, short recovery. This high physical demand can increase the risk of injury (Carling et al., 2015). Relative to the limited number of substitutions permitted in soccer, increased player interchanges in other intermittent sports have been associated with a lower physiological load (Moss et al., 2015) and reduced risk of knee flexor (KF) strain injuries (Orchard et al., 2012).

Previously rule changes in soccer have typically focused on reducing contact injuries (Junge and Dvonèk 2015). However, more recently, in an attempt to reduce non-contact injuries and improve soccer as a spectacle, the International Football Association Board approved the use of an unlimited "return sub" ruling at the grassroots level and the use of a fourth substitution during extra time of elite soccer. Given the potential beneficial effects associated with the increased use of player interchanges, the aim of this study was to assess the influence of a player interchange strategy on the cumulative and residual physical fatigue response to a soccer-specific exercise protocol (ISSEP) Page et al. (2015).

### Method

Thirteen male semi-professional soccer players (mean ± SD; age 23 ± 4.5 years, height 181.4 ± 9.3 cm, body mass 80.4 ± 7.8 kg) participated in the study during the competitive soccer season. The participants completed a total of five trials comprising a familiarisation trial, two experimental trials, and two isokinetic dynamometer-based (KD) follow-up assessments. The two counterbalanced experimental trials (separated by a minimum of 96 hours) comprised the completion of a treadmill based ISSEP (Page et al., 2015). As identified in figure 1, the control trial (CONT) comprised 6 x 15min bouts with a 15min passive half-time interval. The interchange trial (INT) comprised the completion of 4 x 15min bouts of activity each interspersed by a 15min period of passive recovery.

The two follow up KD assessments were completed 48 hours after the completion of each experimental trial and comprised the completion of dominant leg eccentric KF strength assessments at 130, 300, and 60 deg·s⁻¹, with passive knee flexion at 60 deg·s⁻¹ between each repetition, and a rest period of 30s between each set.

The peak KF strength at 60 deg·s⁻¹ was measured 48 hours after each of the experimental trials, and was expressed as the average of four trials, with two trials on each leg. The peak KF strength values were expressed as the average of two trials, with two trials on each leg. The peak KF strength values were expressed as the average of two trials, with two trials on each leg.

### Results

With the exception of PL_0, the repeated measures general linear model (GLM) identified a significant (P < 0.05) main effect for all variables. Values for PL_0 were consistent at 21.7 ± 1.78%.

### Summary and conclusion

The inclusion of player interchanges in soccer has potential benefits for reducing the cumulative physiological (HR and HRpeak) and perceptual (RPE) response to soccer-specific activity. Prior knowledge of the substitution strategy may result in players making anticipatory modifications to their running technique, with the interchange trial eliciting a running technique more mechanically suited to the HI bouts and less economical during the low intensity bouts of exercise. The interchange trial targeted fatigue induced increases in the heart rate (HR), and increased HRpeak, which is a potential biomarker for reduced injury risk and improved performance (Bradley et al., 2009) during the latter stages of match-play. However, the intervening periods of passive recovery were not of sufficient duration to recover BF muscle activity.

The post-exercise rate of recovery associated with the moderate and fast speed eccentric PT data was greater in the interchange trial, with implications for training periodization and injury management, and supporting observations of Orchard and colleagues (Orchard et al., 2012). The use of player interchanges would be particularly beneficial during periods of congested match-play (Dupon et al., 2010).

Due to the novel nature of the current study there is scope for future research to investigate different durations and frequencies of interchanges. Moreover, future research could also focus on the implementation of acute recovery strategies during the intervening recovery periods. Although the current data has been recorded using male semi-professional soccer players, the observations have implications for novice, youth, and female soccer players.