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HIGH INTENSITY SHORT DURATION SOCCER FATIGUE SIMULATION REDUCED HAMSTRING ECCENTRIC STRENGTH IN ELITE U19 PLAYERS

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ABSTRACT

Previous studies found most soccer injuries occur during the latter stage of match-play suggesting fatigue as an important factor contributing to injuries. The purpose of this study is to investigate the effects of a high intensity, short duration soccer-specific fatigue simulation on hamstring eccentric strength among elite U19 soccer players. Twelve (n=12; age 18.3 ± 0.5 years; weight 62.3 ± 6.4 kg; height 171 ± 6.6 cm) elite U19 soccer players completed a soccer-specific fatigue simulation (SFS[5]) and isokinetic dynamometer protocol. Before exercise (time 0 min), immediately after SFS[5] (time 5 min) and after 15 mins SFS[5] (time 15 min), participants performed three maximal dominant limbs at 120°s-1 for eccentric hamstring muscle actions. A one-way repeated measures ANOVA was used to identify significant differences between conditions and over time, with α=0.05. A significant time dependent reduction in hamstring eccentric at time 5 min (9.5%) and time 20 min (9.7%) was observed. These findings suggest eccentric training during fatigue state should be a primary consideration in injury prevention program. Our findings also recommended the inclusion of a short duration, high intensity soccer-specific fatigue simulation as part of pre-season hamstring strain injury risk screening and return to play assessment to ensure the effectiveness in identifying the markers of hamstring strain injury risk in soccer players.

Keywords: *fatigue, hamstring, muscle strength, eccentric, soccer*

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INTRODUCTION

Soccer is one of the most popular sport played in the world with approximately estimated by International Federation of Football Associations (FIFA) about 270 million people are playing this sport with 56.3% of all registered players are youth of under 19 years. Playing soccer can induced health benefits related with the development and enhancement of musculoskeletal, metabolic, and cardiovascular functions (Thorborg et al., 2017). However, soccer also has the highest injury rate compare to other sports. According to Silvers-Granelli, Bizzini, Arundale, Mandelbaum, and Snyder-Mackler (2017) injuries happened in soccer most commonly occur in a game situation and most commonly involve the lower extremity. With rising number of active participation, the incidence of injuries are also increasing and therefore an understanding the mechanism of injuries for injury prevention is crucial (Dönmez et al., 2018).

Hamstring strains injuries (HSI) are common injuries in sports and the most common in soccer related muscle injuries accounting for 13–17% of all other injuries (Arnason, Andersen, Holme, Engebretsen, & Bahr, 2007; Lord, Blazevich, Drinkwater, & Ma'ayah, 2018). Most HSI are characterized by kicking, maximal sprinting, and immediate accelerations such sprinting. The symptoms of HSI are perpetual, slow in healing, and the number of reinjury is high. The truly effects of this may cause remarkable time loss from training and competition, on average, 18 days and 3–3.5 matches missed per HSI (Arnason et al., 2007; Petersen & Hölmich, 2005; Woods et al., 2004)

Brito et al., (2010) has indicate muscular imbalance one of the common referred native factors in sports injury. They have been investigated and suggest that normalization of isokinetic parameters might significantly decrease the risk of HSI by improving the strength balance between agonist and antagonist muscles groups around the knee joint and thigh. According to Lee et al. (2018), intrinsic risk factors that affected the rising of HSI risk may be classify into factors such as decreased in hamstring strength, decreased in quadriceps strength, poor hamstring to quadriceps (H/Q) strength ratio, bilateral difference in hamstring strength, and bilateral difference in hamstring fascicle length. a Dyk et al., 2016) recommended that interactions between different muscle groups (quadriceps and hamstring) and strength characteristics (concentric/eccentric), expressed as the hamstring-to-quadriceps (H: Q) ratio, have also been associated with an increased risk of HSI. Therefore, the purpose of this study is to investigate whether a high intensity, short duration soccer-specific fatigue simulation affects hamstring eccentric strength in elite U19 soccer players.

METHODS

Participants

Twelve (n = 12) male U19 elite soccer players has been recruited in this study. Participants trained 5 to 6 days per week, for 1 to 2 hours per training session and competed in a professional youth soccer league. Participants has clarified on their injury history, they were free from any other lower limb injuries especially knee or thigh injury 6 months prior to testing. The participant information sheets, background questionnaire to screen for health status (PAR-Q+), and an informed consent form were read and sign by all players prior to the beginning of the study and the study were performed in accordance with the university ethics committee guidelines.

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Experimental Design

Participants attend the laboratory having been requested to perform no vigorous exercise or consume any alcohol or caffeine in the 24 hours prior to testing. During the familiarisation session, participants were familiarised with isokinetic assessment, and performed soccer-specific fatigue simulation (SFS^5) at submaximal effort. During the testing session, and after completing a 15 min dynamic warm-up, participants were assigned to perform SFS^5 at maximal effort. Before exercise (time 0 min), immediately after SFS^5 (time 5 min) and after 15 mins SFS^5 (time 15 min), participants perform maximal hamstrings eccentric contraction strength test.

Fatigue Simulation Participants required to perform the SFS^5 within 85 – 90% of their heart rate maximum. The simulation procedure has been shown to produce similar physiological responses during an intense bout of match-play (Bossuyt et al., 2015; Mohd Noh et al, 2019). The SFS^5 will start with upwards, backwards "up-jog" or sideways running "side" around the second cone. Followed with forward running and sidestep cutting around the middle pole. The speed is between "jog" and "stride" pace. Upon the arrival at the first pole, second instruction will be given. The second instruction will be either "sprint" or "agility ladder" which means running forward with one foot per square, sprint and performed maximal shooting task with a ball at a target 5m away using dominant leg. Participant are required to perform a standardized kick by using the laces of the foot. After that the participant are required to perform heading exercises (six times) with a ball at maximum jump height or ball passing exercises. During ball passing exercises, all participant required to perform ten (dominant limb) ball passing (using the inside foot) towards a target 10 m away. The movement intensity and activity performed by the participants was maintained using verbal ques on an audio recording. Heart rate (Polar heart rate system, Electro, Finland) was monitored continuously throughout the protocol.

Hamstring Eccentric Strength Assessment

Participants performed eccentric hamstrings (Hecc) contractions on an isokinetic dynamometer (EasyTech, Italy). Participants performed three maximal voluntary eccentric hamstring muscle actions. The assessment was performed on the participant's dominant leg through a range of 0–90° knee extension (with 0° being full knee extension). The muscle actions completed at an isokinetic angular velocity of (120° s^{-1}). This test velocity was selected because it has been acceptable as a safest and reliable for eccentric hamstring muscle contractions (Greig, 2008).

Statistical Analysis

Descriptive statistics of outcome measures (peak torques) included means and standard deviations. A one-way repeated measure analysis of variance (ANOVA) was used to investigate the influence of SFS5 on each dependent variable using statistical software package SPSS (Version 23; SPSS Inc., USA). Mauchly's test of sphericity was used to check for equality of variance between simulations and different times.

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RESULTS

A significant time dependent reduction in Hecc peak torques during fatigue simulation was observed. Analysis of the Hecc peak torques data revealed a significant decrement (9.5%; $P < 0.05$) at time 5 min (129.33 ± 25.82) compared with time 0 min (142.92 ± 26.82). No significant changes in Hecc peak torques was observed at time 20 min (129.08 ± 27.67) (Figure 2).

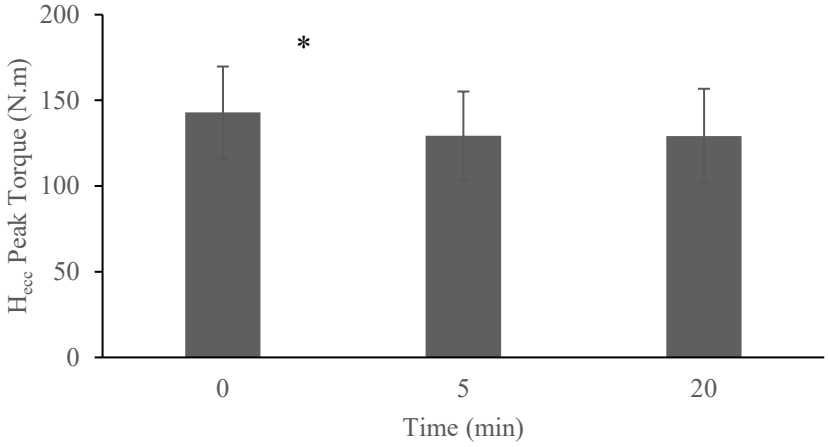

Figure 2. Hamstrings eccentric peak torques during SFS[5]. *Indicate significant difference from pre-simulation (time 0 min).

DISCUSSION

The result from this study indicated that high intensity short duration soccer-specific fatigue simulation (SFS[5]) showed a significant change on hamstring eccentric peak torques, (approximately 9.5% greater reduction) after 5 minutes of simulation.

This finding may be due to the greater efforts of the hamstrings in the control of running activities and for stabilizing the knee joint during foot contact with the ground. These findings were also similar with other studies (Cohen et al., 2014; Delextrat et al., 2010; Small et al., 2010) and may indicate that the fatigue simulation is representative of a soccer match exertion. A significant time-dependent reduction in hamstring eccentric peak torques at time 5 min (9.5%) and time 15 min (9.7%) was observed which has previously considered indicative of a greater risk of injury specific times (Lee et al., 2018; Greig, 2008). To be added, the hamstrings musculature contracts primarily eccentrically during sprinting to decelerate the movement of the thigh and leg before foot contact (Sun et al., 2015). These findings suggest the importance of injury prevention programme focusing on eccentric training for the hamstrings at the end of training session as it has been shown to be beneficial to maintain Hecc peak torques. On the other part, we observed the negative influence of the passive half time interval. During the 15 minutes interval after the simulation, players remained seated, reflecting typical behaviour during competition during half time. Our study revealed that in 15 minutes they failed to recover hamstring eccentric strength to pre-simulation values and failed to mediate the effect imposed during the 5 min soccer simulation. Other studies investigating performance following

half-time have similarly observed impaired physical performance such as muscle strength (Small et al., 2010) and altered sprint (Small, McNaughton, Greig, & Lovell, 2009) and side cutting mechanics (Greig, 2009). These findings suggested that during the half-time interval, inclusion of active rewarm-up would benefit the physiological effects associated with activity before the second half (Lovell et al., 2013) and potentially reduce the increased risk of injury observed during the early stages of the second half.

CONCLUSION

These findings suggest that eccentric training for hamstring during fatigue state should be a primary consideration in injury prevention programs. Our findings also recommended the inclusion of high intensity, short duration soccer-specific fatigue simulation as part of pre-season hamstring strain injury risk screening and return to play assessment to ensure the effectiveness in identifying the markers of hamstring injury risk in youth soccer players.

Authors' contributions
Raja Mohammed Firhad Raja Azidin was responsible for the preliminary reviews of soccer match-play simulations, and for the review of earlier versions of the manuscript.
Mohamad Azraie Mohd Faozi was responsible for reviewing the characteristics of simulated soccer match-play and writing up the manuscript.

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