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Etiology of neuromuscular fatigue in hamstring and quadriceps muscles following simulated soccer match-play

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INTRODUCTION:
Our previous study demonstrated greater fatigue resistance in hamstring compared to quadriceps muscles during isolated muscle exercise (1). However, the mechanisms of fatigue and recovery in hamstring vs quadriceps muscles during whole-body soccer match-play is currently unknown.
METHODS:
Eleven male soccer players (18.7±1.6 years) from an elite French academy took part in this study and performed a simulated soccer match-play (2x45 min). Maximal isometric voluntary contraction (MVC) was used to assess neuromuscular fatigue before, during and immediately after exercise on quadriceps and hamstring muscles. Central and peripheral fatigue levels were quantified via changes in preexercise to postexercise voluntary activation (VA) and potentiated twitch force (Ptw), respectively, as evoked by supramaximal nerve (quadriceps) or direct muscle (hamstring) electrical stimulation. External load during the match was documented using GPS in order to estimate fatigue (2).
RESULTS:
During the match, MVC decreased in a non-linear fashion. After 15 min of exercise, MVC already decreased ($P<0.01$) by 10±7% and 11±11% in quadriceps and hamstring muscles respectively. At the end of the match, MVC was reduced by 20±10% and -25±10% in quadriceps and hamstring muscles, respectively, compared to preexercise values ($P<0.001$). Specifically, peripheral fatigue was greater in hamstring (-28±23%) compared to quadriceps (16±8%, $P<0.01$). Conversely, central fatigue was greater in quadriceps muscles (-20±12% vs -10±16%) compared to hamstring, $P<0.01$). No correlation was observed between neuromuscular fatigue (ΔMVC) and 'fatigue' metrics derived from GPS such as the Dynamic Stress Load (quadriceps: $r^2=0.10$, $P=0.31$; hamstring: $r^2=0.06$, $P=0.48$) or the Fatigue Index (quadriceps: $r^2=0.09$; $P=0.38$; hamstring: $r^2=0.07$, $P=0.43$) during the soccer match-play.
CONCLUSION:
The present study documented substantial differences in neuromuscular fatigue etiology between quadriceps and hamstring muscles during a soccer match-play. Indeed, hamstring developed more peripheral fatigue, and less central fatigue, compared to quadriceps muscles. Moreover, 'fatigue' metrics provided by GPS were not correlated with our direct measurements of neuromuscular fatigue, which shows their irrelevance to estimate neuromuscular fatigue. These results might be relevant for practitioners involved in training prescription and muscle injury prevention in soccer.
References
1. Massamba et al., Med Sci Sports Exerc 54 (12): 2099-2108, 2022
2. Beato et al., Front Physiol 10:780, 2019

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