Letter to the Editor: "Acute Effects of a Fatiguing Protocol on Peak Force and Rate of Force Development of the Hamstring Muscles in Soccer Players"

Bettariga and colleagues [1] highlighted the acute effect of a fatiguing protocol on peak force and rate of force development (RFD) of the hamstrings during an isometric assessment involving semi-professional soccer players. However, we would like to raise an issue and question some of the results identified within the study, as isometric hamstring assessments are growing in popularity within practise, and potential erroneous results may confuse practitioners and impact the uptake of the described methods which could have merit in fatigue monitoring. The authors of the study identify that the assessment of hamstring peak force and RFD should be evaluated to help to identify and minimise hamstring strain injury risk during the terminal swing phase of running [1-4]. They describe fatigue and delayed onset muscle soreness as limitations of other methods for hamstring strength assessment including isokinetic dynamometry and the Nordbord [1], hence the aim of the study was to observe the use of a isometric knee flexion (KF) assessment using force plates. However, they suggest there is no literature available exploring these assessments, which is an oversight by the authors. To our knowledge there are currently six published studies using force plates to assess isometric hamstring strength [5-10], including one published study which includes a co-author included in the study by Bettariga and colleagues [1]. This lack of attention to detail and understanding of previous literature could potentially explain some of the erroneous results.

On inspection of the results presented by Bettariga et al. [1] the peak forces identified are highly speculative, with peak forces for the dominant and non-dominant limbs being 1245.46 ± 223.89 and 1233.89 ± 218.17 N, respectively. This is considerably higher than the body mass identified (74±5.3 kg or 729.94 N), this would have resulted in an inability to keep the hips in contact with the ground, as the hamstrings were producing between 1.70-1.72 times body mass. The limited methods described by Bettariga et al. [1] identify the joint angle of the knee and rest periods, however the authors reference McCall et al. [5] which clearly states that the "buttocks, hands and head should remain on the mat", with no identification of fixation of the hips in either study. This highlights that there may be some discrepancy in the methods used to perform the isometric hamstring assessment, which could add to the confusion to the issue. When compared to the same methods used previously, the peak forces reported by Bettariga et al. [1] are substantially greater than what has been reported for peak isometric force in the 30° KF assessment (30-KF), with peak forces of 310±43 and 294±41 N for the dominant limb (DL) and non-dominant limb (NDL), 158.15±23.32 and 158.00±23.64 N for the left and right limb and 5.8±1.5 N/Kg for summed left and right limb for French professional soccer players [5], semi-professional female footballers [9], and, English youth academy soccer players [6], respectively. Therefore, it is questionable that semi-professional footballers were able to produce 820-1086 N or 290-787% greater than previously published using the same test. When compared to the 90-90° (90-90-KF) and 90-20° (90-20-KF) isometric assessments, a difference of between 769-1055 N [5-7, 9], and 991 N [7], respectively, could lead to further speculation. The 30-KF assessment does attain the appropriate hip flexion (HF) and KF for the hamstrings to produce greatest isometric KF forces (HF 45-90°, KF <45°) [11]. This could help explain why the values presented by Bettariga et al. [1] are greater than the other isometric assessments (i.e., 90-90-KF and 90-20-KF). When using anatomical data [12], Figure 1 highlights the potential for erroneous results, similarly the estimated isometric KF torques are substantially greater than existing reference values for isometric KF for athletes [13], mean±95% confidence

interval (CI) for absolute (relative) isometric KF for athletes 169.7±107.9-231.4 N·m (1.54±1.18-1.88 N·m/kg).

****INSERT FIGURE 1 ABOUT HERE****

Figure 1. Absolute and net forces and estimated isometric knee flexion torque based off the mean body mass and height reported by Bettariga et al. [1].

While the authors claim this to be the first publication to include reliability, four of the previously published studies report intraclass correlation coefficients (ICC) [5, 8, 9]. Two studies included the 30-KF assessment as performed by Bettariga et al. [1], ICC values of 0.86 (90% confidence limit :0.69-0.94), 0.93 (90% confidence limit:0.84-0.97) and 0.762 (95% CI: 0.290-0.815), 0.857 (95% CI: 0.638-0.941), were reported for peak force by McCall et al. [5] and Cuthbert et al. [9], respectively. Bettariga et al. [1] reported greater ICC values for peak force than both previous studies (0.94 (95% CI: 0.86-0.98), 0.96 (95% CI: 0.90-0.97)), although this could be explained if the athletes had extensive familiarisation.

Three of the published studies have also reported the effect of competitive or simulated match play. McCall et al. [5] identified that following a competitive match a reduction in isometric peak force in the 30-KF isometric test was between 47.9 N (15.5%) and 23.9 N (8.1%) for the DL and NDL, respectively. In English youth academy soccer players, Constantine et al. [6] observed a reduction of 1.2 N/kg (87.8 N, 20.7%) in the 30-KF isometric test following competitive match play. Reductions in the 90-90-KF and 90-20-KF isometric assessments were also observed from simulated match play, within the 90-90-KF test peak force reduced by 43 N (15.5%) and 36 N (13.6%) for the DL and NDL, respectively [7]. For the 90-20-KF peak force was reduced by 51 N (20.1%) and 49 N (20.3%) for the DL and NDL, respectively [7]. These results are far lower than the reductions observed following the repeated sprint protocol employed by Bettariga et al. [1] with reductions in the peak force of 249.69 N (20.0%) and 194.01 N (15.7%) for the DL and NDL, respectively. Although, to have near identical percentage reductions in peak force could demonstrate a computational error that the authors may be able to fix easily and consequently update their study.

Based on the above, we feel that what Bettariga et al. [1] present is potentially erroneous and requires further investigation. We would like to state that this letter is not intended to detract from the importance of hamstring assessments as part of regular monitoring in soccer players. Especially considering the limitations of other methods highlighted and lack of compliance of eccentric modalities in elite soccer [14]. It is our hope that this letter can highlight and resolve some of the potential erroneous issues, with the goal of achieving clarity for practitioners when using this test.

1. Bettariga F, Bishop C, Martorelli L, Turner A, Lazzarini SG, Algeri C, et al. Acute Effects of a Fatiguing Protocol on Peak Force and Rate of Force Development of the Hamstring Muscles in Soccer Players. Journal of Science in Sport and Exercise. 2023.
2. Kenneally-Dabrowski C, Brown NAT, Warmenhoven J, Serpell BG, Perriman D, Lai AKM, et al. Late swing running mechanics influence hamstring injury susceptibility in elite rugby athletes: A prospective exploratory analysis. J Biomech. 2019 May 31.

3. Chumanov ES, Heiderscheit BC, Thelen DG. Hamstring musculotendon dynamics during stance and swing phases of high-speed running. Med Sci Sports Exerc. 2011 Mar;43(3):525-32.
4. Heiderscheit BC, Hoerth DM, Chumanov ES, Swanson SC, Thelen BJ, Thelen DG. Identifying the time of occurrence of a hamstring strain injury during treadmill running: a case study. Clin Biomech (Bristol, Avon). 2005 Dec;20(10):1072-8.
5. McCall A, Nedelec M, Carling C, Le Gall F, Berthoin S, Dupont G. Reliability and sensitivity of a simple isometric posterior lower limb muscle test in professional football players. Journal of Sports Sciences. 2015.
6. Constantine E, Taberner M, Richter C, Willett M, Cohen DD. Isometric Posterior Chain Peak Force Recovery Response Following Match-Play in Elite Youth Soccer Players: Associations with Relative Posterior Chain Strength. Sports. 2019;7(218):1-12.
7. Matinlauri A, Alcaraz PE, Freitas TT, Mendiguchia J, Abedin-Maghanaki A, Castillo A, et al. A comparison of the isometric force fatigue- recovery profile in two posterior chain lower limb tests following simulated soccer competition. PLos ONE. 2019;14(5):1-16.
8. Goodwin JE, Bull AM. Novel Assessment of Isometric Hip Extensor Function: Reliability, Joint Angle Sensitivity, and Concurrent Validity. Journal of Strength and Conditioning Research. 2022;36(10):2762-70.
9. Cuthbert M, Comfort P, Ripley N, McMahon JJ, Evans M, Bishop C. Unilateral vs. bilateral hamstring strength assessments: comparing reliability and inter-limb asymmetries in female soccer players. Journal of Sports Sciences. 2021;39(13):1481-8.
10. !!! INVALID CITATION !!! .
11. Kellis E, Blazevich AJ. Hamstrings force-length relationships and their implications for angle-specific joint torques: a narrative review. BMC Sports Science, Medicine and Rehabilitation. 2022;14(166):1-34.
12. Plagenhoef S, Gaynor Evans F, Abdelnour T. Anatomical Data for Analyzing Human Motion. Res Q Exerc Sport. 1983;54(2):169-78.
13. Šarabon N, Kozinc Z, Perman M. Establishing Reference Values for Isometric Knee Extension and Flexion Strength. Frontiers in Physiology. 2021;12(767941):1-10.
14. Ekstrand J, Bengtsson H, Walden M, Davison M, Hagglund M. Still poorly adopted in male professional football: but teams that used the Nordic Hamstring Exercise in team training had fewer hamstring injuries – a retrospective survey of 17 teams of the UEFA Elite Club Injury Study during the 2020–2021 season. British Medical Journal Open Sport & Exercise Medicine. 2022;8(e001368):1-8.