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Effect of Functional Fatigue on Knee Force Sense in Amateur Adult Female Football Players

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Background

- **Sensorimotor control of knee functional joint stability**
 - **Joint stability:** the ability of a joint to remain in or promptly return to ideal alignment
 - Ligament injury = loss of joint stability (i.e. excessive motion away from ideal alignment)
 - **Sensorimotor control:** the control of joint alignment, posture, and movement



Clark & Lephart 2015; Clark et al 2015; Riemann & Lephart 2002



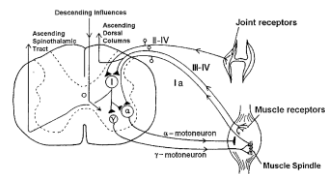
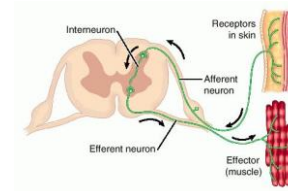
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Background

- **Sensorimotor control of knee functional joint stability**
 - **Proprioception:** sense of joint position (joint position sense), kinaesthesia, force (force sense)
 - **CNS processing:** processing of sensory information and generation of motor commands
 - **Neuromuscular control:** activation of the dynamic restraints (skeletal muscles) in response to sensory stimuli



Pickar 2002

Clark & Lephart 2015; Clark et al 2015; Riemann & Lephart 2002



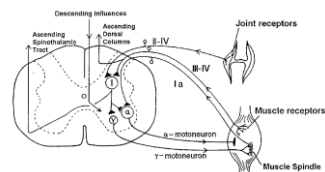
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Background

- **Sensorimotor control of knee functional joint stability**
 - Impaired proprioception from muscle-tendon mechanoreceptors could result in impaired neuromuscular control of knee functional joint stability
 - Fatigue impairs knee extension force sense in adult male footballers
 - Clark and Rolleston 2017
 - Effects of fatigue on knee force sense and resulting implications for injury prevention practice have not been studied for adult female footballers



Pickar 2002



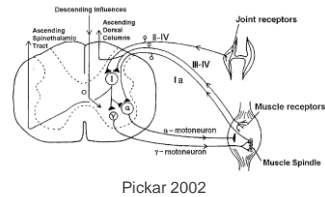
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Background

- **Aim**
 - To determine the effect of functional fatigue on knee flexion force sense in amateur adult female football players
- **Null hypothesis**
 - There would be no significant difference between pre- and post-fatigue knee flexion force sense mean absolute error



Methods

- **Pre-/post-intervention repeated measures study**
 - Amateur adult female football players from local community
 - Surrey, England
- **21 players volunteered**
 - Age 23.3 ± 3.5 yr;
height 164.1 ± 6.4 cm;
mass 62.6 ± 6.4 kg
- **Data collected in one session**
 - University sensorimotor control and biomechanics laboratory



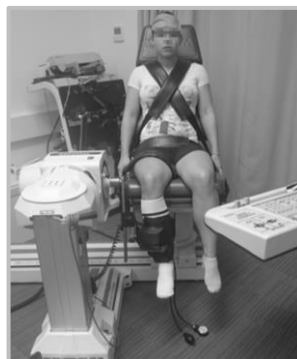
Methods

- **Study protocol**

- Informed consent
- Warm-up
- Maximal voluntary isometric effort
- Force sense practice trials
- Pre-intervention force sense measured trials
- Intervention: functional fatigue procedure
- Post-intervention force sense measured trials

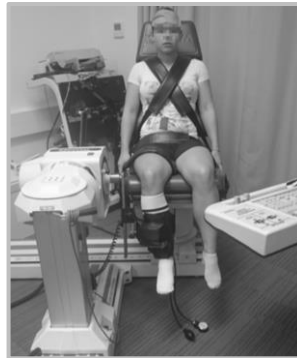
Methods

- **Isokinetic dynamometer**
 - KinCom 125AP
- **Dominant leg**
 - Preferred stance leg when kicking
- **Players performed knee flexion force sense trials 45° knee flexion**
 - Minimally load capsuloligamentous mechanoreceptors and preferentially stimulate muscle-tendon mechanoreceptors
 - Clark et al 2016



Methods

- **Dominant leg**
 - Preferred stance leg when kicking
- **Warm-up**
 - 1 × 10 of knee extension-flexion cycles (unstrapped) from 90-0° flexion
 - Clark et al 2016
 - 1 × 3 isometric knee extensions (strapped), 45° knee flexion, 50% self-estimated maximal voluntary isometric effort (MVIE)



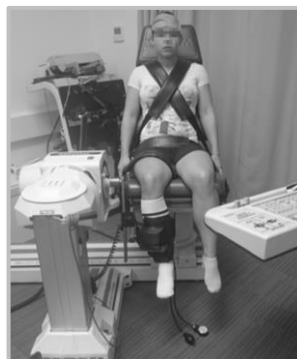
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Methods

- **MVIE**
 - 1 × 1, 100% MVIE, strong verbal encouragement, 5 seconds, measured in N
- **Force sense trials**
 - 30% MVIE was calculated as the target force
 - Nagai et al 2007
 - A cotton sock and blood pressure cuff (40mmHg) was placed between players' skin and the dynamometer
 - Callaghan et al 2002



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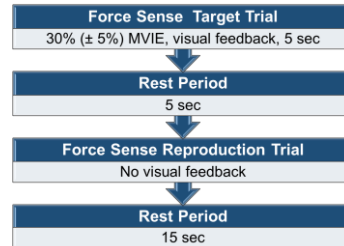


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Methods

Force sense trials

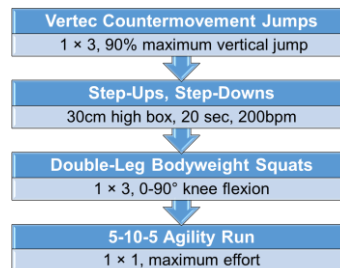
- Practice trials: 1 × 2, 5 sec per trial, with visual feedback from the dynamometer display
- Measured trials: 1 × 3 of a target trial (with visual feedback)-reproduction trial (without visual feedback) sequence, 5 sec per trial, 15 sec rest between sequences
- Reliability: ICC (2,k) 0.73-0.86, SEM 2.6-3.2 N



Methods

Functional fatigue intervention

- Functional Agility Short-Term Fatigue Protocol (FAST-FP)
 - Cortes et al 2013
- Warm-up: 10 minutes, static bicycle, dynamic stretching, maximum effort vertical jumps (1 × 3; mean calculated)
- Criteria for fatigue: when a participant did not attain 90% of maximum vertical jump for all three jumps for two consecutive FAST-FP cycles

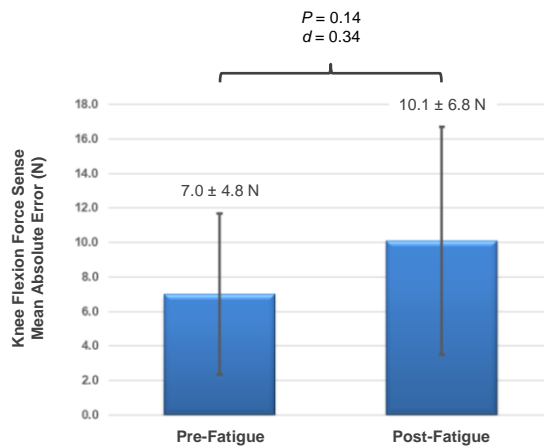


Methods

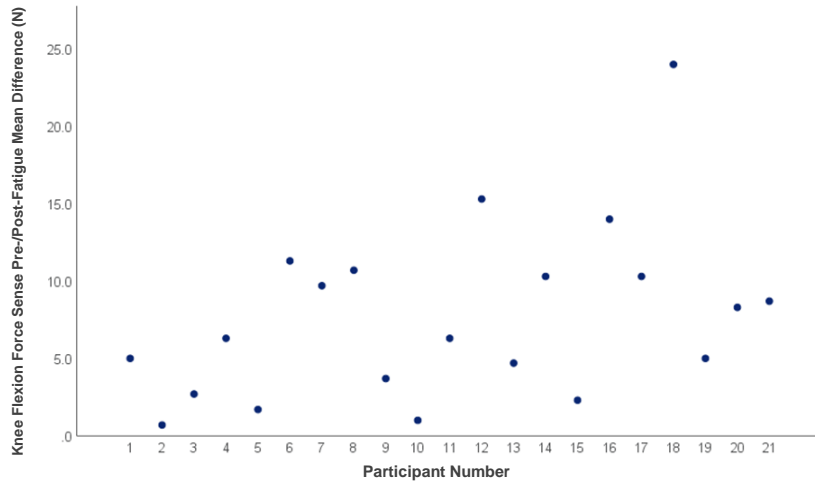
- **Data management**
 - Target trial-reproduction trial difference was calculated for all measured trials and designated the absolute error (AE)
 - Mean AE of all measured trials was calculated and used for pre- vs. post-fatigue analyses
- **Data analysis**
 - Normality assessment
 - Paired *t*-test: pre-fatigue mean AE vs. post-fatigue mean AE (alpha set *a priori* 0.05)
 - Effect size (Cohen's *d*): pre-fatigue mean AE vs. post-fatigue mean AE
 - Pre- vs. post-fatigue mean AE differences inspected **by individual**



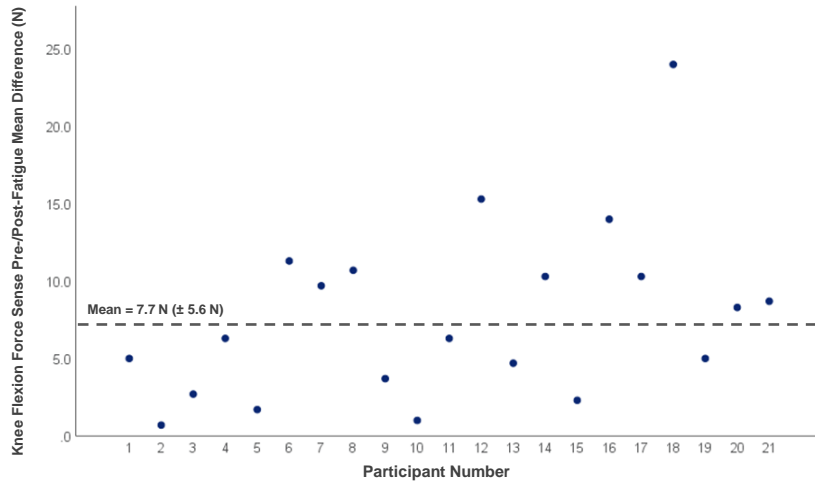
Results



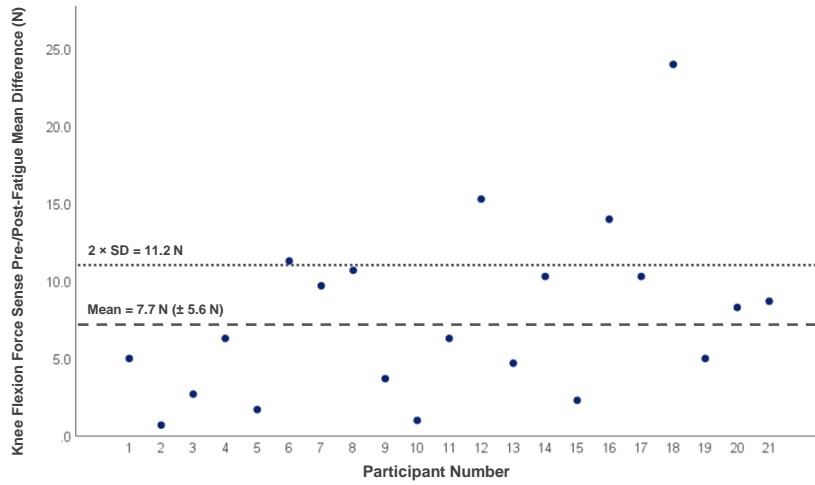
Results



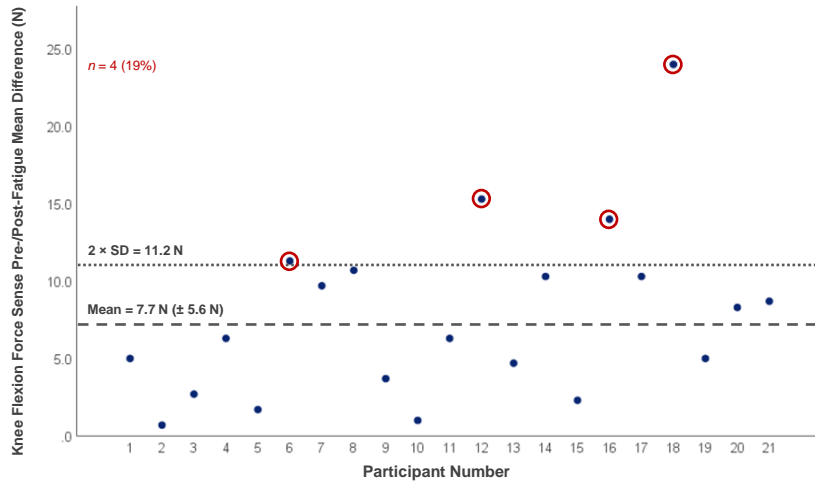
Results



Results



Results



Conclusion

- Group mean knee flexion force sense did not significantly change after functional fatigue
- Approximately one-fifth of players' ($n = 4$) knee flexion force sense deteriorated substantially ($> 2 \times SD$) after functional fatigue was induced
- Some players may be more in need of **fatigue-resistance training** than others to **maintain optimal knee flexion force sense and neuromuscular control of knee functional joint stability**



Individual aerobic + anaerobic capacity training



Team anaerobic capacity training



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Thank You



Title

Effect of functional fatigue on knee force sense in amateur adult female football players.

Authors' Names and Affiliations

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Women in Sport and Exercise (WiSE) Annual Conference. April 19-22, 2021.

University of Worcester, England, United Kingdom.

Background

Intact proprioception (joint position sense, kinaesthesia, force sense (FS)) is critical for optimal neuromuscular control of knee functional joint stability. Fatigue impairs knee FS in adult male footballers. The effect of fatigue on knee FS and resulting implications for injury prevention practice have not been studied for adult female footballers.

Aim

Determine the effect of functional fatigue on knee flexion FS (KF-FS) in amateur adult female football players.

Methods

Twenty-one players participated (mean±SD: age 23.3±3.5yr; height 164.1±6.4cm; mass 62.6±6.4kg). Functional fatigue was defined/induced using the Functional Agility Short-Term Fatigue Protocol (FAST-FP). The FAST-FP incorporated acceleration-deceleration tasks typical of football training/match-play. Dominant leg (preferred stance leg) KF-FS was measured (Newtons (N)). Players sat on an isokinetic dynamometer in isometric mode, the knee flexed 45°. A knee flexion target trial-reproduction trial sequence was repeated three times, the difference between trials designated the absolute error (AE), the mean AE used for data analyses. Force sense measurements occurred before and immediately after the FAST-FP.

Results

Force sense AE did not significantly change following fatigue (pre-fatigue = 7.0±4.8N; post-fatigue = 10.1±6.8N; pre-/post-difference = 7.7±5.6N; P = 0.14; Cohen's d = 0.34). Four players' (19%) post-fatigue FS deteriorated by more than twice the group's pre-/post-difference standard deviation.

Conclusion

Despite functional fatigue, group mean KF-FS did not significantly change. However, one-fifth of players' KF-FS deteriorated substantially after functional fatigue was induced. Some players, therefore, may be more in need of fatigue-resistance training than others to maintain optimal KF-FS and neuromuscular control of knee functional joint stability.