MALE FOOTBALL PLAYERS WITH HIP-RELATED PAIN DEMONSTRATE DIFFERENT SAGITTAL PLANE KINETICS DURING RUNNING WHEN COMPARED TO HEALTHY CONTROL PARTICIPANTS

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The purpose of this study was to evaluate the differences in sagittal and frontal plane hip kinematics and kinetics between male football players with and without hip-related pain (HRP). A total of 10 men with HRP and 10 control participants were recruited from larger longitudinal cohort studies. During stance, football players with HRP demonstrated a significantly larger peak external hip flexion moment and impulse compared to healthy control participants. Football players with HRP appear to adopt a movement strategy during running that imparts greater loads on the hip joint; however, the cross-sectional nature of the study cannot determine a causal relationship. This preliminary finding indicates that further investigation of running biomechanics in a larger sample of football players with HRP is warranted.

KEYWORDS: Hip, Running, Biomechanics

INTRODUCTION:

While the burden of hip and groin pain on participation and quality of life is well documented in football populations, there is growing awareness of hip-related pain (HRP) as a cause of hip and groin pain in football players (Orchard 2015). A football player's biomechanics during functional tasks may influence the magnitude and direction of hip joint forces and could play a role in the development and persistence of symptoms in HRP. Previous studies investigating HRP patients have concentrated on low load tasks such as stair ascent and walking, and not high impact sporting tasks (King et al. 2018). To date, no studies have investigated running biomechanics in football players with HRP. The primary aim of our study was therefore to determine the sagittal and frontal plane hip kinematics and kinetics during running in male football players with and without HRP.

METHODS:

<u>Study design and participants:</u> A cross-sectional study design was utilised to investigate sagittal and frontal plane hip biomechanics in men with and without HRP. Participants with HRP were recruited from an ongoing larger prospective cohort study that is investigating sub-elite football (soccer and Australian Rules football) players (Crossley et al. 2018). Healthy control football players (soccer or Australian Rules) were recruited from a second, concurrent large prospective cohort study. Ethical approval for these studies was obtained from La Trobe University Human Ethics Committee (registration numbers HEC015-019 and HEC 016-045).
Male football players were eligible for inclusion in the study if they were engaged in a non-professional, sub-elite, structured football competition and aged 18-50 years. For inclusion, the HRP group were required to report greater than six months of either unilateral or bilateral hip and/or groin pain, and have a positive flexion/adduction/internal rotation (FADIR) test. Nine out of 10 participants in the HRP group reported bilateral symptoms, therefore the most and least painful hip were defined for analysis. Control participants were included if they had no history of lower limb or lumbar spine injury or surgery, and a negative FADIR test.

<u>Data collection:</u> Eligible participants attended the La Trobe University gait laboratory for experimental data collection. Demographic data including age, height and body mass were recorded for all participants on the day of testing. Symptom severity and disability were quantified for each participants most symptomatic hip by using all subscales of the

Copenhagen Hip and Groin Outcome Score (HAGOS), a valid and reliable tool for assessing hip and groin pain in active adults (Thorborg et al. 2015).

Biomechanical assessment: All participants wore running shorts and Teva Original Universal sandals (Deckers Brands, Goleta, CA) to allow exposure of bony landmarks for marker placement. Small reflective markers were placed on specific bony landmarks according to a previously published protocol for this cohort (Crossley et al. 2018). Marker trajectories were collected using a 10-camera motion capture system (Oxford Metrics, Oxford, UK) sampling at a frequency of 100Hz. Ground reaction force (GRF) data were collected from an embedded force plate (Advanced Mechanical Technology Inc., Watertown, MA) in the laboratory floor sampling at 1000Hz. All biomechanical data were recorded using Vicon Nexus Version 1.8.5 software (Oxford Metrics, Oxford, UK). A static trial was obtained in order to calibrate anatomical landmarks and estimate joint centres (Schache and Baker 2007). For the over-ground running trials, participants were asked to run at a comfortable pace, with the goal of achieving a steady-state speed of between 3 and 3.5 m/s. Timing gates and verbal feedback were used to ensure that correct speed and whole-foot force plate contact were attained for three trials on each limb.

Data analysis: Marker trajectories and GRF data were filtered with a low-pass fourth-order Butterworth filter with a cut-off frequency of 10Hz. Using previously defined anatomical coordinate systems (Schache and Baker 2007), a 7-segment biomechanical model (pelvis, left/right thigh, left/right shank, left/right foot) was generated using Vicon BodyBuilder software version 3.6.2 (Oxford Metrics, Oxford, UK). Hip joint angles were calculated using a joint coordinate system convention (Grood and Suntay 1983). Hip joint moments were calculated using a standard inverse dynamics approach, and expressed in the same non-orthogonal joint coordinate system as the calculated hip joint angles (Schache and Baker 2007). The convention adopted in this study was to report the external joint moment, which is the moment created by all of the external forces acting about the joint (i.e., GRF, inertia, and gravity). For participants with HRP, one trial for each limb was arbitrarily selected for analysis. A single limb was chosen for control participants. Stance phase data were time-normalised to 101 points (0% to 100% of stance phase). All demographic data, patient reported outcome measures and biomechanical variables of interest were assessed for normality and were then summarised using means and standard deviations (SD). Between group comparisons were made between the healthy control participants and both hips for the symptomatic players. Between limb comparisons were also investigated in the football players with HRP. Independent t-test, paired t-tests and Mann-Whitney U tests were used as appropriate. All statistical analyses were completed in SPSS v24 and level of significance was set at 0.05.

RESULTS:

Ten male football players with HRP and 10 control participants were included for data analysis. There were no significant differences between groups with respect to age, height and body mass (P = 0.13-0.88). Football players with HRP demonstrated significantly worse self-reported HRP and disability as measured by the HAGOS (P < 0.001).

Table 1: Comparison of male football players with HRP and control participants

Units: Age in years (yr), Height in meters (m), Body mass in kilograms (kg).

	Hip-related pain (n = 10) Mean (SD)	**Controls (n = 10)** Mean (SD)	***P* value**
Age (yr)	24.4 (3.8)	27.4 (4.7)	0.88
Height (m)	1.8 (0.06)	1.83 (0.07)	0.70
Body mass (kg)	81.8 (9.2)	83.7 (11.4)	0.13

Between groups comparison

The results of the between group comparisons are reported in Table 2. No significant differences in the biomechanical variables of interest were found between the most symptomatic hip of the football players with HRP and the healthy control participants.

Table 2: Comparison of HRP group (most and least symptomatic hips) & control participants for frontal & sagittal plane kinematics & kinetics.
Kinematic data in degrees (°); Kinetics expressed as peak external moment normalised to body weight (N.m/kg); impulses expressed in Newton metre seconds normalised to body weight (N.m.s/kg); * indicates P < 0.05)

Variable	**Most symptomatic hip (n=10)** Mean (SD)	**Least symptomatic hip (n=10)** Mean (SD)	**Control (n=10)** Mean (SD)	**Mean difference most symptomatic hip & control** (95% CI)	***P* value**	**Mean difference least symptomatic hip & control** (95% CI)	***P* value**
Peak hip flexion angle (°)	46.25 (3.67)	48.02 (4.13)	44.05 (6.57)	2.20 (-2.80, 7.20)	0.37	3.97 (-1.18, 9.13)	0.12
Peak hip extension angle (°)	-0.99 (2.98)	-2.02 (4.43)	0.23 (7.6)	-1.22 (-4.21, 6.64)	0.64	-2.25 (-8.10, 3.60)	0.43
Peak hip adduction angle (°)	12.17 (4.15)	11.73 (3.3)	10.91 (2.97)	1.26 (-2.13, 4.65)	0.44	0.82 (-2.13, 3.78)	0.57
Peak hip flexion moment (N.m/kg)	1.43 (0.39)	1.56 (0.37)	1.16 (0.34)	0.27 (-0.079, 0.61)	0.12	0.40 (0.067, 0.73)	**0.021***
Peak hip extension moment (N.m/kg)	0.89 (1.18)	0.86 (1.20)	0.61 (0.32)	0.28 (-0.53, 1.10)	0.47	0.25 (-0.57, 1.08)	0.52
Peak hip adduction moment (N.m/kg)	1.87 (0.46)	1.89 (0.26)	2.04 (0.32)	-0.17 (-0.55, 0.19)	0.32	-0.16 (-0.43, 0.11)	0.24
Hip flexion impulse (N.m.s/kg)	0.16 (0.090)	0.17 (0.083)	0.10 (0.045)	0.06 (-0.01, 0.12)	0.093	0.067 (0.003, 0.13)	**0.04***
Hip adduction impulse (N.m.s/kg)	0.25 (0.057)	0.26 (0.037)	0.028 (0.038)	-0.03 (-0.076,0.015)	0.17	-0.017 (-0.05, 0.018)	0.33

Differences in sagittal plane kinetics (Figure 1) were found when comparing the less symptomatic hip of the football players with HRP and healthy control participants. The less symptomatic hip demonstrated a significantly larger peak external hip joint flexion moment (mean difference, 0.40 N.m/kg; 95% CI: 0.067, 0.73; P = 0.021) and hip flexion moment impulse (mean difference, 0.067 N.m.s/kg; 95% CI: 0.003, 0.13; P = 0.04) when compared to healthy controls. No other significant differences were found between groups.

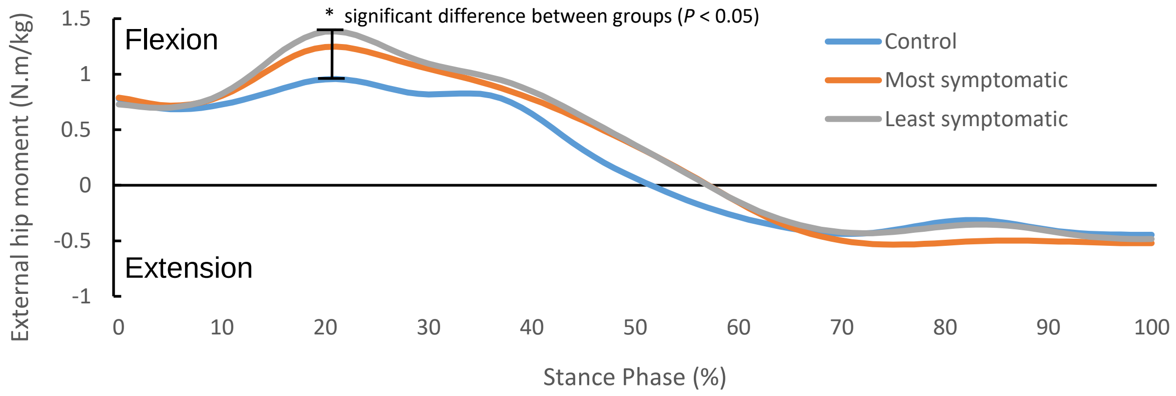

Figure 1. Comparison of sagittal plane kinetics between football players with and without HRP.

Between limb comparison (HRP group only)

In the HRP group, the least symptomatic hip was in a significantly greater degree of hip flexion when compared to the most symptomatic hip at the time of peak vertical ground reaction force during stance phase (mean difference, 2.02°; 95% confidence interval [CI]: 0.014, 4.03; P=0.049). No other statistically significant differences were found between limbs.

DISCUSSION:

In football players with HRP, the least symptomatic hip demonstrated a significantly larger peak external hip flexion moment when compared to control participants. Football players with HRP appear to adopt a movement strategy during running that imparts greater loads on the hip joint when compared to football players without pain. Due to the cross-sectional nature of the study design, we are unable to determine how this finding relates to the development of symptoms.

The significantly larger peak external hip flexion moment and moment impulse infer that the loads on the hip extensor muscles in participants with HRP are larger during running than those participants without pain. Muscles are the main contributors to joint loading, and gluteus maximus is an important hip extensor that provides the second largest contribution to superior hip joint contact force during running (Schache et al. 2018). Joint loads (i.e. contact forces) have the potential to influence symptoms and structural disease progression (Andriacchi and Mündermann 2006). Movement retraining strategies that reduce hip joint loads during running may be a target for clinicians, however the effect of this requires further investigation.

Visual inspection of Figure 1 would suggest that the most symptomatic limb also experiences an increased peak hip flexion moment when compared to controls; however, this comparison did not reach statistical significance. Bilateral movement pattern changes have previously been demonstrated in men with unilateral femoroacetabular impingement syndrome (Lewis, Khuu, and Loverro 2018), suggesting that differences in movement strategies between symptomatic and healthy men is likely to be person-specific rather than limb-specific. It is possible that the small sample size of the study may have contributed to the lack of significant difference between the most symptomatic hip and control participants.

CONCLUSION:

During the stance phase of submaximal running, football players with HRP demonstrate a larger peak external hip flexion moment and moment impulse when compared to asymptomatic controls. Our pilot data highlight that different movement strategies may exist in the presence of pain and further investigation of hip, knee and ankle joint biomechanics in a larger sample is therefore warranted.

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