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THE INFLUENCE OF ARTIFICIAL TURF WITH DIFFERING MECHANICAL PROPERTIES ON TURNING MOVEMENTS

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Various mechanical tests are made to ensure artificial surfaces fulfil the regulations of the sports governing bodies. There is little available research regarding differences in player response between surfaces with different mechanical properties or similar surfaces under different environmental conditions. The aim of this study was to gain insight into the player response in a game-sports specific movement on an artificial turf with under different conditions (temperature and mechanical properties). Five footballers completed three shuttle sprints on two artificial turfs. Trial times were recorded (timing gates) and ankle kinematics were measured (CODA motion analysis). Players were significantly faster on the higher temperature, softer surface with higher rotational resistance. No differences were found in contact times and joint kinematics. These findings highlight the differences between surfaces.

KEY WORDS: kinematics, rotational resistance, force reduction, surface

INTRODUCTION: Artificial turfs are used in a variety of different games-sports, for example football, rugby, hockey, American and Australian football. The number of artificial turf pitches is steadily increasing due to the advantages they offer, including greater usage, long-term economic benefits, all weather capability and more stable playing conditions (Fleming, 2011). To certify an artificial turf for official playing use, various parameters must be fulfilled, all of which are tested mechanically. These measures include shock absorption, vertical deformation, rotational resistance and the Head Injury Criterion (HIC). Despite determining a surface's suitability for games-sports, there is little knowledge about the differences in player response between surfaces of different mechanical properties and environmental conditions. Studies examining the player response on different surfaces have largely investigated hard court surfaces or natural turf (e.g. Pedroza et al., 2010, Stiles et al., 2011, Dura et al., 2011). To the authors' best knowledge only one published study has investigated different artificial turfs and tested them mechanically (Lake & Underdown, 2011). Knowledge of how a specific Turf responds to environmental changes in terms of both mechanical properties and player surface interaction, is desirable for the users, manufactures and scientists. The aim of this study was to gain insight into the player response in a game-sports specific movement on artificial turfs under different climate conditions eliciting different mechanical properties.

METHODS: Five semi-professional football players (182 ± 6.0 cm; 78.6 ± 7.14 kg; 20.4 ± 0.8 years) participated in the study. All players were free from injuries at the time of testing and had no serious lower limb injuries in the past 12 months. The tests were held on two identical artificial turfs (3G, 65 mm pile height), on two consecutive days, under different climatic conditions. Both artificial turfs fulfil the standards for use of rugby and football and similar types of artificial turfs are widely used all over the world. The mechanical properties of the surfaces were tested by an independent testing institute (Labosport Ltd, UK). Following a standardised warm up, active markers (CODA Sport) were placed on the shank and the standardised football boot (Adidas, Copa Mundial). The positions of the markers of the shank were the tuberosity of the tibia, the medial ankle and lateral ankle. Markers on the football boot were placed on the first metatarsophalangeal joint, the fifth metatarsophalangeal joint and the heel. The participants performed maximum shuttle sprints between two lines that were marked on the surface 6 m apart. During the trial, the players shuttled five times between the lines with their times measured by a light gate system (SmartSpeed, UK). The

180 degree turns at one end of the shuttle sprint were recorded by a motion analysis system (CODA Sport, 200 Hz). Each player performed three maximal trials and the middle three turning movements were recorded for each trial. All analyses were undertaken using Matlab (The MathWorks Inc., USA, version R2008b), this resulted the quantification of a full 3D ankle kinematics. The marker positions were filtered using a Butterworth low pass filter at 20 Hz and ground contact times (GCT) were calculated using an algorithm developed in a pilot study. A t-test was used to determine differences between these surfaces with an alpha level set to 0.01.

RESULTS: Table 1 displays the results of the mechanical properties of the two turfs measured by the independent test institute. Turf 2 showed higher values in both force reduction and deformation. Additionally it had a higher rotational resistance (38 Nm) than Turf 1 (33 Nm).

Table 1: Mechanical properties of the two artificial turfs tested

	Force reduction [%]	Deformation [mm]	HIC [m]	Rotational resistance [Nm]	Temperature [°C]
Artificial turf 1	47.6	5.1	1.0	33	2.4
Artificial turf 2	62.2	8.8	1.4	38	15.2

Table 2: Mean ± SD of the trial time and the ground contact time (GCT)

	Trial time [s]	GCT [s]
Artificial turf 1	8.80 ± 0.25	0.41 ± 0.06
Artificial turf 2	8.35 ± 0.19*	0.39 ± 0.05

*****p<0.01

The results for trial time and GCT are displayed in Table 2. The players achieved significantly lower trial times on Turf 2, but there was no significant difference in ground contact times between the two turfs. The descriptive analysis of the ankle movement shows a higher dorsiflexion during mid-stance but a lower plantarflexion during the push-off on Turf 1 (Figure 1). The rotation of the foot is similar in a slightly outer rotational position with approximately the same maximal values (Figure 2). The inversion of the foot during the turning movement does not show a difference in the maximal inversion between the two turfs. Turf 2 appears to have a higher total range of inversion motion (Figure 3).

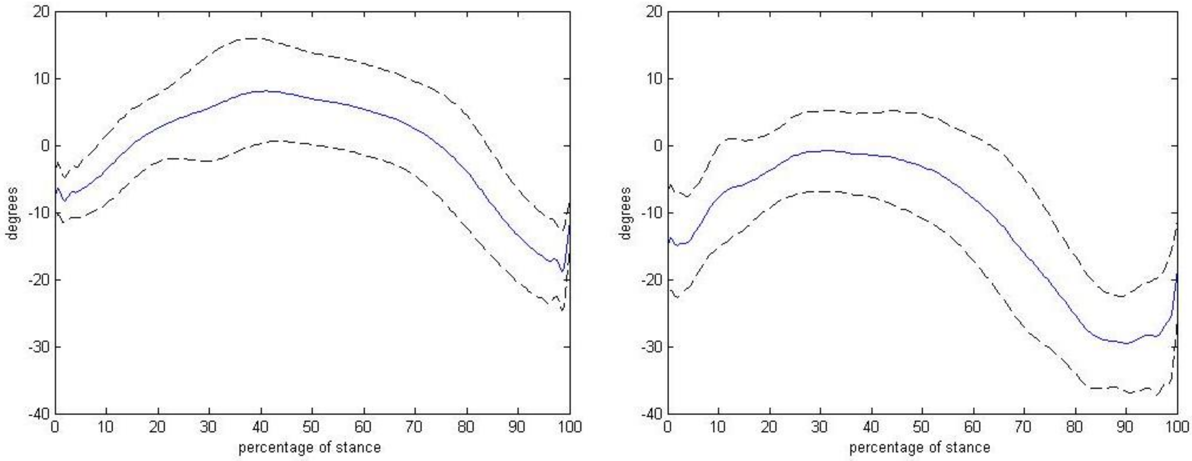

Figure 1: Mean ± SD of the plantarflexion (negative values) and dorsiflexion (positive values) of the ankle. Artificial turf 1 on the left and Artificial Turf 2 on the right side

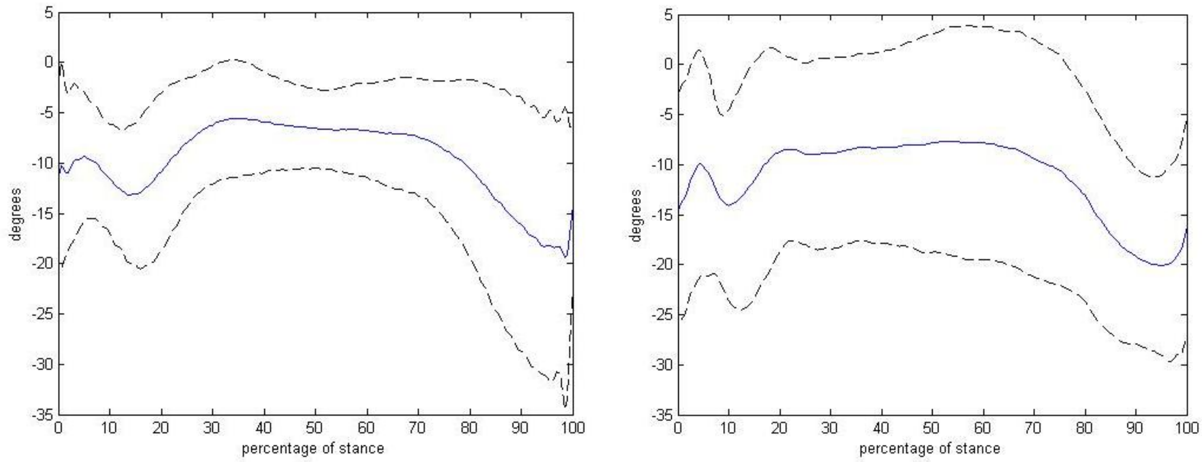

Figure 2: Mean ± SD of the inner rotation (positive values) and outer rotation (negative values) of the ankle. Artificial turf 1 on the left and Artificial Turf 2 on the right side

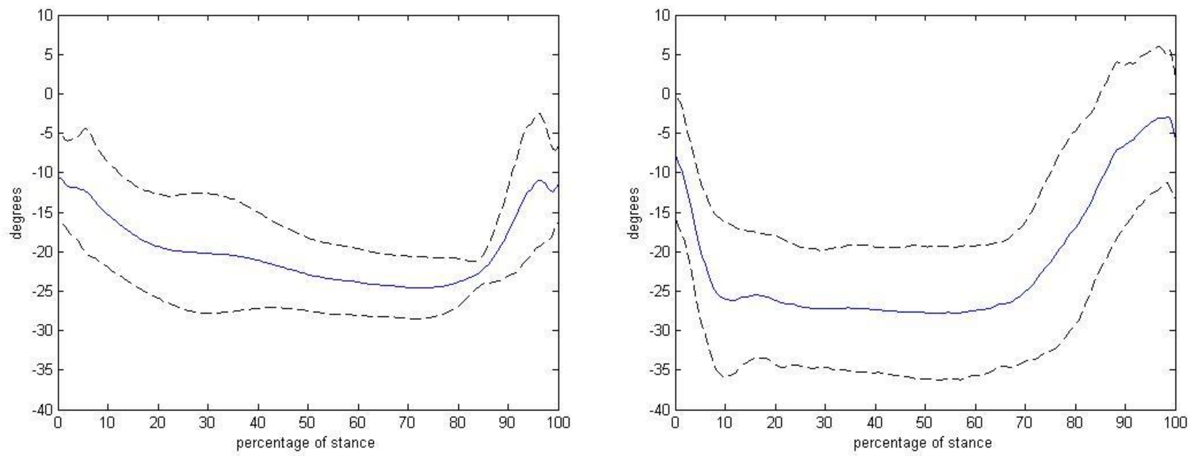

Figure 3: Mean ± SD of the inversion (negative values) and eversion (positive values) of the ankle. Artificial turf 1 on the left and Artificial Turf 2 on the right side

DISCUSSION: Globalisation of artificial surfaces may be influenced by the differing climatic condition. The aim of this study was to gain insight into the player response in a game-sports specific movement on artificial turfs under different climate conditions eliciting different mechanical properties.

The results of the mechanical test indicate that Turf 1 was the harder surface and therefore returns more energy. Turf 1 also had the lowest rotational resistance. This could be the result of a reduced sinking of the studs due to the increased hardness of the surface. Although no significant GCT differences were found for the turning movement, the players' trial times were significant quicker on the second turf. These findings are similar to the results of Dura et al. (2011), who also found no difference in the turning movement of a shuttle sprint on solid surfaces with different coefficients of friction. The differences in the trial times of the movement were explained by differences in the breaking phase before the turn. Kinematics of this phase were not investigated in this study because the field of view of the measurement system only allowed recording the kinematics of the turning movement. Ekstrand et al. (2011) came to the conclusion that it is more likely to sustain ankle sprains on artificial turfs. Therefore, it would be interesting to statistically compare the maximal angular velocity of the ankle inversion during the movement found in the present study. The differences observed in this study are likely to be explained by the temperature difference of the two test conditions. One of the advantages artificial turfs should offer is the higher resistance to different climatic

conditions. In this study a temperature difference of only 12.8 degrees resulted in clear disparities of the testing results, despite the two artificial turfs tested being the same type. This key issue must be a consideration for surface user, manufactures and researchers.
CONCLUSION: Players were significantly faster during a shuttle sprint on the softer artificial turf with higher rotational resistance. No differences could be found in the ground contact time and kinematics of the ankle during the turning movement. The implications of these initial observations suggest that for one specific surface type climatic conditions can influence both mechanical properties and player performance.

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