INTRODUCTION
With the continued popularity and prevalence of football turf surfaces, it is essential that we understand the potential differences in players’ responses to football turf compared to traditional grass surfaces. When the characteristics of match play are considered, it appears that there are very few differences when matches on both surfaces are compared. However, there are still perceptions that football turf has a different feel to grass and some players have reported that grass seems to cause less fatigue when used as the playing surface. It is important that we attempt to quantify objectively how playing surface impacts on the body’s responses to football exercise. This is not possible during match play, as the tactical and technical aspects of the game mean that no two matches will ever be the same. The following article reports on a preliminary project that was carried out to investigate whether playing surface influences fatigue and the physiological responses that result from the performance of a simulated football exercise procedure.

PROCEDURES
A standardised football simulation procedure was performed by 16 young males (aged 16-18 years) who were academy players with an English Premiership club. The procedure was previously developed to be an accurate simulation of football match-play. This exercise test involved alternating stages of walking, jogging and running, all at controlled and constant movement speeds. These stages were carried out within 20-metre long “lanes”, which were marked out by cones on the playing surfaces. Audio signals were continually played to the players in order to ensure that they walked, jogged and ran at exactly the correct speed for each stage of the test. In addition to the walking, jogging and running phases, players were also required to perform three repeated 15-metre sprints at maximal speed once every two minutes (see figures 1 and 2) in an adjoining “lane”. The procedure was performed for a total of 20 minutes, giving a total of 30 sprints. Players were divided into two groups, so half of the players performed their first test on football turf, the second on grass and vice versa for the other group. All tests were performed on the same day, with players receiving exactly four hours of recovery between tests.

Throughout the test the heart rate response of the players was recorded. Upon completion of the test, blood samples were taken from the players in order to allow for measurement of lactic acid in the blood. Both the heart rate and lactic acid (lactate) measures were used in order to investigate whether there were different levels of physical stress and fatigue due to the playing surface. In addition to these physiological measures, the time taken to perform each 15-metre sprint was recorded using a high-precision telemetry timing gates system which allowed data to be recorded and subsequently analysed after the testing. Figure 2 shows three players performing the test.

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Effects of playing surface in football activity

FIGURE 1. Diagram representing the order of activities performed in the exercise test.

FIGURE 2. Three players performing the simulated football test.
The exercise procedure allowed us to simulate the physiological stresses of football play in a controlled manner, thus allowing for comparisons of the influence of playing surface to be made. Using these procedures, we were able to address three vital issues that had previously not been investigated. Firstly, do the physiological demands of simulated football play differ according to the playing surface? Secondly, do the fatigue characteristics differ between playing surface? Thirdly, are the sprint times affected by the playing surface? All of these questions required specific types of data analysis procedures and in each case standard statistical tests were used in order to detect whether any differences in the responses to the test were significant or merely attributable to random variation in the results. The graphs which accompany the following text show mean values of the results concerned and the small vertical lines are representative of the range of values obtained within the group.

**FINDINGS**

1) *Do the physiological demands of simulated football play differ according to the playing surface?*

The heart rate and lactic acid measurements were used to answer this question. The average heart rate during the procedure was 166 beats per minute on football turf and 167 beats per minute on grass. The blood lactic acid concentrations were 3.0 millimoles per litre (mmol/l) for football turf and 3.5 mmol/l for grass. In both cases, the statistical tests concluded that there was no significant difference in the physiological responses to the football test due to the playing surface used. Additionally, the heart rate and blood lactic acid values were similar to the values that would be expected during a similar period of football play so we were confident that the intensity of the test was comparable to football play (see figures 3 and 4).
2) Do the fatigue characteristics differ due to the playing surface used?

In addition to the physiological characteristics of exercise, it is also important to be able to quantify the fatigue that may be experienced during the test. To do this, we assessed the results from the 30 sprints performed by the players. These sprints were done in blocks of three and because the three sprints were followed only by around four seconds of recovery, we believed that this would be a good way to assess any differences in fatigue due to playing surface. So, the first, second and third sprints for each of the ten blocks of the test were averaged together and the results are shown in figure 5. The results show that the times taken to cover 15 metres do tend to increase when the later sprints are compared against the first sprint, but that this effect does not differ between grass and football turf. Once again, these findings are supported by statistical tests. So, the fatigue characteristics were not different between the two surfaces.

3) Are the sprint times different between the playing surfaces?

Although this is not a truly physiological measure, it is important to know the answer to this question as differences in sprint times could have an impact on the physiological responses to football play and on the technical elements of the game. To address this question we compared all of the sprint times that were taken from grass and football turf. The outcome of this analysis was that the grass tended to give slightly slower 15-metre sprint times. This difference was only 0.04 seconds but the statistical tests confirmed that this was a difference which could be attributed to the playing surface and not to random variation in the results. The average sprint time for grass was 2.63 seconds, compared to 2.59 seconds for football turf. When this difference between the two surfaces is expressed as a distance it is around 21 cm (close to the diameter of a football) or, as a percentage, it is a difference of around 1.4 per cent.
DISCUSSION AND SUMMARY OF FINDINGS

It could be considered a limitation of the present study that the movements used did not include some of football’s key activities, such as dribbling, tackling, heading and use of the football. The experiment deliberately considered only walking, jogging, running, sprinting and changes in direction. This was because we wanted to use exercise that was absolutely standardised in order to focus on the issue of the playing surface alone. If more technical and complex activities were used it would have been far more difficult to control the procedures.

In summary, the findings from this preliminary project suggest that variations in playing surface have little impact on the physiological responses to football exercise. Additionally, there was no measurable difference in the fatigue experienced by the players in this test whether fatigue was evaluated on the basis of physiological measures (i.e., lactic acid) or the rate of decline in sprint times as the test progressed. The following persons were part of the project management team on the physiology study:

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All from the Cardiff School of Sport at the University of Wales Institute, Cardiff. FIFA would like to thank the staff and players at Chelsea Football Club for their participation and assistance.