THE EFFECT OF PROLONGED INTERMITTENT HIGH-INTENSITY EXERCISE ON THE PERFORMANCE OF SOCCER-SPECIFIC SKILLS
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ABSTRACT

The aim of the study was to examine the effect of accumulated fatigue, developed from the performance of prolonged intermittent high-intensity exercise, on the performance of soccer shooting and dribbling skill. Nine semi-professional soccer players volunteered to participate in the study. Their mean (± SD) age, body mass and height were 20.7 ± 1.4 years, 177.7 ± 6.1 cm and 73.5.1 ± 7.6 kg respectively. Participants completed a slalom dribble test and a Loughborough Soccer Shooting Test (LSST) prior to and directly following the performance of a 45 minute modified version of the Loughborough Intermittent Shuttle Test (LIST). The LIST was designed to simulate the minimum physical demands experienced by soccer players during competitive math-play. Performance of the soccer dribbling and shooting skill deteriorated by 4.2 ± 3.6% (P < 0.05) and 31.61 ± 25.21% (P < 0.05) respectively, following the performance of the LIST. Mean heart rates (155 ± 11 bpm, 155 ± 13 bpm and 156 ± 12 bpm) and mean 15m sprint performance times (2.54 ± 0.15 s, 2.56 ± 0.14 s and 2.58 ± 0.14 s) remained unchanged across the performance of the three LIST activity bouts (P > 0.05). The results of the study demonstrate that soccer skill performance deteriorates after the completion of a prolonged intermittent high-intensity soccer-specific exercise, replicating the physiological demands of one half of soccer match-play. The findings demonstrate a need for trainers and coaches to include soccer-specific fatiguing exercises with skills training to aid players in coping with the demands of soccer match-play.
CHAPTER I

INTRODUCTION
1.1 An Overview of Fatigue in Soccer

Soccer is one of the most popular sports in the world, being played by men, women and children with a diverse range of playing abilities, performing at various levels of expertise. Stolen et al. (2005) described that the performance of soccer is dependent upon many factors, involving technical, tactical, mental and physiological areas.

The physiological aspects of soccer have been studied intensively in recent years, especially in elite male participants (Bangsbo, 1994; Bangsbo et al., 2006; Reilly et al., 1996). Described as a multi-sprint sport, soccer has been observed to encompass periods of high-intensity exercise with periods of lower-intensity exercise (Svensson & Drust, 2005), with phases of support running and recovery combined with short periods of sprinting (Nicholas et al., 2000). Additionally, players have been estimated to cover distances of 9 to 12km during a game (Mohr et al., 2005), performing 1000 - 1400 changes in playing actions (changing every 4 – 6 seconds), consisting mainly of short activities (Mohr et al., 2003a; Reilly and Thomas, 1976), including: tackling, jumping, acceleration and turning actions (Bangsbo, 1994).

The intermittent nature of soccer causes both the aerobic and anaerobic systems to be highly taxed during match-play. This is evident with mean heart rates of 85% of heart rate max (Bangsbo et al., 2006), and mean and maximum blood lactate levels of 5.23 and 11.63mM respectively (Smith et al., 1993), being reported. Edwards et al. (2003) asserted that ideally soccer players should be able to maintain the same level of performance throughout a game. However, during the 90-minute duration of a soccer match and particularly towards the end of play, Appriantono et al. (2006)
described that players will suffer from muscle fatigue, largely as a result of the repeated performance of the aforementioned intensive bursts of game activities.

The development of muscle fatigue has previously been found to be detrimental to performance, with Rhanama et al. (2003) emphasising that while players are able to continue to exercise, they do so at lower intensities, through having a reduced ability to perform maximally. In relation to top class soccer, studies have observed a decline in work rate and a decrease in the total distance covered (5%) between first and second halves of a game (Rhanama et al., 2003), as well as a reduced sprint performance (Krustrup et al., 2006). Additionally, sprint performance and the amount of high-intensity running was found to decline in the last 15 minutes of the game in both lower standard male (Mohr et al., 2003a) and elite female soccer players (Mohr et al., 2003b).

Ekblom (1994) explained that resistance to muscle fatigue is a key factor which determines the effectiveness of a player’s ability to continually perform efficient and precise movements within soccer. Lyons et al. (2006a) highlighted that the development of fatigue may be the determining factor of success and failure, the difference between winning and losing. In addition, soccer at the elite level is characterised not only by a player’s ability to perform repeated high intensity work but also the maintenance of an efficient performance of skills when in possession, such as passing, dribbling and shooting, especially towards the end of play (Mohr et al., 2003a; Rhanama et al., 2003).
Despite a plethora of fatigue related literature, an abundance of previous research relative to soccer has been focused on the effects of fatigue on physical performances, including repeated sprint ability and muscle force production (e.g. Appriantono et al., 2006; Balsom et al., 1992; Krstrup et al., 2006). Additionally, in spite of the acknowledged importance of fatigue in soccer, Lyons et al. (2006b) highlighted that ecologically sound studies investigating fatigue and its effects on soccer-specific skills are surprisingly rare.

Regardless of the paucity of studies within soccer, a number of investigations have focused on this aspect of performance within other team sports. Royal et al. (2006) observed a 43% ± 24% decrease in skill proficiency between pre-test and high-fatigue conditions in water polo. Additionally, Lyons et al. (2006a) reported a potential decrease in basketball passing accuracy following a short bout of high-intensity exercise.

While several investigations have assessed the effects of fatigue on the performance of soccer skills, several limitations are apparent. Studies have either utilised a very brief fatiguing protocol, where fatigue is localised and largely anaerobic in nature, and one which has not accurately replicated the physiological demands of match-play (Lyons et al., 2006b), or have utilised competitive match-play to induce fatigue, which causes large variability in the total work volume and intensity of exercise performed by players, and ultimately, the level of fatigue experienced (Rampinini et al., 2007a). McGregor et al. (1999) studied the effects of fluid ingestion on soccer-specific skills and observed a 5% deterioration in dribbling skill following a standardised 90 minute performance of the Loughborough Intermittent Shuttle Test
(LIST), when no fluids were permitted. The study represents the limited volume of ecologically valid studies into the effects of prolonged soccer-specific exercise on soccer skill performance. However, the study provides no information on the impact of accumulated fatigue evident after the first half period on skill performance, as well as a neglect of its impact on essential soccer skills such as shooting (Lago, 2007).

1.2 Research Problem

Recognising limitations of current research, the study aims to examine the effect of accumulated fatigue, induced through the performance of a 45 minute intermittent high-intensity soccer-specific exercise protocol (Nicholas et al., 2000), simulating the physiological demands of one half of a soccer match, on the technical performance of shooting and dribbling skill. In addition, the study will relate to previous research with the aim of identifying whether the fatiguing protocol utilised, and the fatigue developed from its performance, influences sprint performance.

1.3 Null Hypotheses

The following hypotheses have been identified for the study:

\( H_{01} \): Sprint performance does not decrease during the 45 minute soccer-specific intermittent shuttle run test (LIST).

\( H_{02} \): The development of accumulated fatigue has no influence on the ability of players to perform the soccer-specific skills of shooting and dribbling, immediately post 45 minute soccer-specific shuttle run test (LIST).
CHAPTER III

METHOD
3.1 Participants

The study was conducted with 9 male semi-professional soccer players (age 20.7 ± 1.4 years, stature 177.7 ± 6.1 cm, body mass 73.5 ± 7.6 kg), playing in the MacWhirter Welsh Division 2 League for UWIC Football club. The participants were from a range of outfield playing positions and were involved in regular training and match-play. Goalkeepers were not included in the study as the testing carried out was not specific to their role in a game. All players voluntarily participated in the study and gave informed consent (Appendix A), being notified of the nature and demands of the study as well as their right to withdraw at any time (Appendix B). Participants also completed health questionnaires in order to ascertain their current health status (Appendix C).

3.2 Experimental Design

All testing was completed at the National Indoor Athletic Centre (NIAC) at the University of Wales Institute, Cardiff (UWIC), or, on the adjacent Astroturf soccer pitch. The experimental design required all participants to complete a slalom dribble test (Reilly & Holmes, 1983) and the Loughborough Soccer Shooting Test (LSST, Ali et al., 2007a) prior to and after the performance of the Loughborough Intermittent Shuttle Test (LIST, Nicholas et al., 2000).
3.3 Skill Assessment

3.3.1 General Apparatus

All soccer balls utilised during both the shooting and dribbling assessments were FIFA approved ERREA (Size 5) Garra match balls.

3.3.2 Slalom dribble

The slalom dribble test (Reilly & Holmes, 1983) assesses total body movement, requiring participants to dribble around a set obstacle course as quickly as possible, plastic cones were used as the obstacles (Figure 1). Two parallel lines were initially drawn as reference guides 4.57m apart with intervals of 1.83m being marked along each line. Diagonal connections of alternate marks measuring 4.88m in length were then made, with five cones being placed at the end of each connection and a sixth being placed 7.32m from the final cone and 9.14m from the starting line. On the starters command the subjects dribbled the ball from behind the start line to the right of the first cone and then alternately around the outside of the remaining 5 cones in a zig-zag path. The subject stopped and left the ball at the sixth cone before travelling in a straight line across the finish line (Figure 1).

The subjects were accustomed to the course prior to testing, first through a demonstration by the tester and secondly through the performance of 2 trial runs. The time taken to negotiate the obstacle course was measured and recorded using Smart Speed timing gates (Fusion Sport, Brisbane, Australia). The subjects were required to perform the slalom dribble twice, with a rest of 1 minute between trails, with the mean time of both trails representing the subjects’ score.
Figure 1. A schematic representation of the slalom dribble test

(Reilly and Holmes, 1983)
3.3.3 Loughborough Soccer Shooting Test

Shooting accuracy was assessed using the Loughborough Soccer Shooting Test (Ali et al., 2007a). All boundary lines of test were marked on the floor using 5 cm grey tape. A square “shooting zone” measuring 8.5 x 8.5m was marked with the nearest line being 16.5m from the goal line. Four standard cones were placed on each corner of the shooting zone and a standard gymnasium bench was placed on the middle of the far side of the zone to act as a rebound board (Figure 2).
Figure 2. A schematic representation of the Loughborough Soccer Shooting Test

(Ali et al., 2007a)
3.3.3.1 The Goal

A full size soccer goal measuring 2.44 x 7.32m was split into various scoring zones and was marked using 5cm grey tape and luminous orange rope measuring 1cm in diameter (Figure 2). The study did not utilise the life-size goalkeeper made of plywood and the SpeedChek sports radar to measure shot speed as detailed by Ali et al. (2007a). Ali et al. (2007a) argue that the use of the static goalkeeper enhances ecological validity; consequently the method utilised in the present study may lack the advantages of its use. However, the authors do acknowledge that introducing high ecological validity could have reduced the reliability of the test. Furthermore, the authors reported a low correlation ($r = 0.36$) between shot speed and points scored suggesting that there is no relationship between shot speed and shooting accuracy and that the two factors are independent, negating the use of measuring shot speed.

3.3.3.2 Role of the Investigators

Two investigators were used during the test and were located at positions “A” and “B” in Figure 2. The role of investigator A was to initially instruct the player to move to either the left or the right cone and then to ensure that the shot was taken within the marked shooting area. Secondly investigator A had to observe the shot to determine the points scored, in addition to recording all relevant information. The role of Investigator B was to time the movement of the player from the initial call from investigator A to the time when they passed the finish line.
### 3.3.3.3 Procedure for the LSST

The test began with the ball being placed on the marked circle located in the centre of the shooting zone. The participant’s initial position was to stand facing away from goal towards the bench, within playing distance of the ball. After the call of investigator A, the player was required to sprint to the cone he had been directed to move to, touch the top of it, and then return to the ball in the centre of the square. After playing a rebound pass off the bench, the player then controlled the ball if necessary, turned, and shot at the goal within the shooting area. The player was required to follow the shot by sprinting between two cones positioned 5.5m away from and directly in front of the goal. Each participant performed a single trial consisting of 10 shots, with a rest period of 30 seconds between each shot sequence. There were 10 trial orders that were randomly selected for each player.

### 3.3.3.4 Scoring the LSST

The scoring areas marked out within the goal reflect the optimal placement of a shot to beat an opposing keeper (Ali et al., 2007a). Ali et al. (2007a) identified that a player with a greater shooting ability will be able to shoot with either foot; therefore of the 10 shots being performed for each trial, five were performed using the right foot and five with the left. The performance score achieved was the total cumulative points scored from all the shots on target. Any shots that were taken from outside the designated shooting zone or took more than 8.5 seconds to complete were discounted. The time taken to complete each shot sequence was measured using a Casio Digital stopwatch (HS-30W-1V, Casio Electronics Co, Ltd, London, UK). The score
achieved for each shot sequence was recorded manually using a LSST score sheet (Appendix D).

3.4 Fatiguing Protocol

All participants performed a modified version of part A of the LIST (Nicholas et al., 2000) as used previously by Edwards et al. (2003), in NIAC at UWIC, under standard environmental conditions. Participants were required to run between two lines, 20m apart, at various speeds. The running and walking speeds during each 20m of the test were dictated by a combination of a verbal countdown to an audio signal (to assist pace judgment), pre-recorded onto a compact disc. The speeds used to represent walking; jogging and cruising were not individualised (Edwards et al., 2003) and were not based on percentage estimates of preliminary participant Vo2max measurements (Drust et al., 2000).

The speeds chosen for each activity pattern were comparable to those used by Drust et al. (2000) and were as follows: walking 5 km·h⁻¹, jogging 9 km·h⁻¹, cruising 14 km·h⁻¹ with sprinting being the maximal running speed of each participant. Activity speeds were based upon the speeds observed by Van Gool et al. (1988) for each specific movement type during soccer match-play. Edawrds et al. (2003) illustrate that this protocol reflects the different application of the procedure as a single and automated soccer-specific fitness test for multiple testing at one time (Edawrds et al., 2003). 15m sprint times performed during the LIST were measured and recorded in one direction using Smart Speed timing gates (Fusion Sport, Brisbane, Australia).
The exercise protocol utilised consisted of 15 minute activity blocks. The activity blocks were identical to the model used by Nicholas et al. (2000) and consisted of a set pattern of intermittent running and walking. The pattern of exercise was intermittent high (sprint and cruise) and low (jog and walk) intensity activity, with the sequence being as follows:

- 3 x 20m at a walking pace of 5 km·h⁻¹
- 1 x 15m at maximal running speed
- 4s recovery
- 3 x 20m at a running speed of 9 km·h⁻¹
- 3 x 20m at a running speed of 14 km·h⁻¹

This pattern of exercise, lasting for 90 seconds, was repeated ten times forming a 15 minute block which was then followed by a rest period of 3 minutes. Although the activity blocks consisted of a set pattern identical to the model used by Nicholas et al. (2000), the number of identical activity blocks was reduced from 5 to 3 to represent the first half of a soccer match (Drust et al., 2000; Edawrds et al., 2003). The 4 second recovery period that followed the maximal sprint activity was used to accommodate for the variations in maximal running speed. Backwards and sideways movements and actions with the ball were not included in the study because of the technical impracticalities when using the LIST (Drust et al., 2000).
3.5 Experimental Protocol

The participants visited the testing site on two separate occasions, participating in two testing sessions. Two days prior to the first testing session, each player was given pre-test instructions for diet, exercise and clothing for both testing sessions, to ensure participants could exercise maximally and safely.

3.5.1 Preliminary Measurements and Familiarisation

Preliminary data was obtained with all participants reporting to NIAC at UWIC for the first session of testing. The session required participants to firstly complete the slalom dribble test (Reilly & Holmes, 1983) followed by the LSST (Ali et al., 2007a). A standardised warm-up, consisting of jogging, stretching and striding, was performed by each participant for 15 minutes. Prior to each skills test participants

Figure 3. A schematic representation of the activity pattern performed during the Loughborough Intermittent Shuttle Test

(Edwards et al., 2003)
were given an opportunity to accustom themselves to the protocols. Participants performed two trials of the slalom dribble test and one trial of the Loughborough Soccer Shooting Test. The participants then performed the LIST test (Nicholas et al., 2000) for 15 minutes in order to familiarise themselves with the required running speeds and experimental procedures.

3.5.2 Main Trial

All participants then performed the second test session; however, due to time and facility constraints they did so on different occasions in groups of three. Three of the nine participants were randomly selected to report to NIAC at UWIC for the second testing session. Prior to testing, participants were asked to abstain from consuming large amounts of beverages or food. All experiments were arranged so that each individual performed the skills tests at the same time of day to control for circadian influences (Sunderland and Nevill, 2005). Height was measured without shoes to the nearest 0.1 cm at a mid inspiration using a fixed stadiometer (Holtain, LTD, Crymych, Pembrokeshire, Wales, UK). Body mass was measured to the nearest 0.1 kg, in light athletic apparel and without shoes, on a Seca digital electronic scale (Model 770, SECA, Vogel & Halke, Hamburg, Germany). A standardised warm-up, consisting of jogging, stretching and striding, was then performed by each participant for 15 minutes.
Participants then performed 45 minutes (three 15 minute activity blocks) of the LIST. During each trial the investigators ensured that the participants performed the exercise correctly by placing at least one foot on or over the lines marking the 20m distance. During the LIST protocol and soccer skills tests, participants were verbally encouraged to perform maximally. Directly after the LIST had finished, participants repeated both the slalom dribble test and the LSST. Heart rates were monitored and recorded throughout the performance of the LIST using Polar heart rate monitors (Polar Electro Oy, Pfessorintie 5, Finland). A standardised 10 minute cool-down followed the testing sessions.

3.6 Statistical Analysis

One-way repeated measures ANOVA’s were used to analyse mean 15m sprint times and heart rates during the 45 minutes LIST exercise. Post-hoc Bonferroni tests were performed to identify where any differences that were found lay. The assumption of sphericity was explored in order to ensure that the repeated measures demonstrated homogeneity of variance. Paired sample t – tests were used to analyse the data obtained from the soccer-specific skills tests performed pre and post LIST. A comparison was also made between LSST trials, with any points excluded as consequence of not achieving performance time criteria being included for pre and post LIST trials.
A comparison was then made between the frequencies (pre and post LIST) with which players scored 5, 3, 2 and 1 points during the LSST trials. However, the statistics needed to analyse the differences in these frequencies is beyond the scope of the current study and requires complex statistical procedures with;

“Variables representing proportions or frequencies requiring root or arcsine-root transformation before you give them the usual repeated-measures analysis. The more exact approach is to use binomial or Poisson regression” (Hopkins, 1997).

All data are presented as the mean ± standard deviation (SD) from the mean and are based on a sample of nine participants unless otherwise stated. The significance level was set at $P < 0.05$. All statistical analysis was calculated using SPSS 12.0, with graphical data being calculated using Microsoft Excel and SPSS 12.0.
CHAPTER IV

RESULTS
4.1 Heart Rate

The mean heart rates achieved during the performance of the first, second and third activity bouts of the LIST were 155 ± 11 bpm, 155 ± 13 bpm and 156 ± 12 bpm, respectively, corresponding to 78.0 ± 5.3%, 77.7 ± 6.4% and 78.2 ± 6.1% of predicted maximum heart rate. The mean heart rate response over the three activity bouts for the nine participants was averaged at 5 second intervals and is shown in figure 4. A one-way repeated measures ANOVA reported that the average heart rates for the nine participants was not significantly different between the first, second and third activity bouts of the LIST ($P > 0.05$).
Figure 4. A trace of the mean heart rate response for all participants during the performance of the first, second and third activity bouts of the LIST
4.2 Sprint Performance

Mean sprint times for each LIST bout was calculated using the mean of the 10 sprint times recorded for each participant. The mean 15m sprint times for the first, second and last 15 minute activity bouts were 2.54 ± 0.15 s, 2.56 ± 0.14 s and 2.58 ± 0.14 s, respectively. Despite a visual analysis of the mean times taken to complete the 15m sprint suggesting a slight increase in sprint times, a comparison of the three exercise bouts revealed that there was no significant difference in sprint performance as exercise progressed ($P > 0.05$). In addition, there was no trend for sprint times to differ during each bout of activity (Figure 5).
Figure 5. Average time taken to complete the 15-m sprints for all participants during the performance of the three Loughborough Intermittent Shuttle Test activity bouts
4.3 Skill Performance

4.3.1 Slalom Dribbling Times

A comparison of mean dribbling skill performance time’s recorded pre and post exercise, showed that there was a significant increase in the time taken to complete the slalom dribble test following the performance of the three 15-minute LIST activity bouts ($P < 0.05$). The results of the paired t-test substantiate the claim that there is a significant decline in dribbling skill performance ($4.2 \pm 3.6\%$) as a consequence of the 45 minute LIST performance. Figure 6 presents the means and standard deviations for the slalom dribble times performed pre-and-post LIST.

![Figure 6. Mean Slalom Dribble performance times from pre-LIST and post-LIST trials](image-url)
4.3.2 Loughborough Soccer Shooting Test Scores

An examination of descriptive data indicates that the mean point scores of the participants for pre and post LIST Loughborough Soccer Shooting test trials were 20.56 ± 6.7 points and 13 ± 3.0 points, respectively (Figure 7). A statistical analysis of the LSST trials revealed that there was a significant decrease (31.61 ± 25.21%) in mean points scored following the performance of the LIST ($P < 0.05$).

![Figure 7](image.png)

**Figure 7.** Mean points scored for the Loughborough Soccer Shooting Test completed pre- and-post LIST performance
Further analysis of the pre and post exercise LSST trials was then performed with the inclusion of any points that were excluded from an individual’s total scores (achieved for pre and post LIST trails), as a consequence of not achieving the 8.5 second performance criteria for a specific shot sequence. No significant difference was observed between the mean points scored for the pre and post LSST trials despite a mean decrease of $18.67 \pm 24.71\%$ for total points scored ($P >0.05$, Figure 8).

**Figure 8.** Mean Loughborough Soccer Shooting Test point scores for pre- and-post LIST performance, with the inclusion of points omitted as a consequence of not achieving the 8.5s performance criteria
An additional comparison was also made between the frequencies with which the participants scored points from each scoring zone, with the means and standard deviations being presented in table 5. Such a comparison was performed with a view that the number of high scoring shots (5 and 3 points) may have decreased as consequence of performing the 45 minute LIST, providing additional evidence to verify the reduction in shooting accuracy. An examination of the descriptive data reveals a 47.4% reduction in the number of shots that achieved a five point’s score and a 71.4% decrease in the number of shots that achieved a three point’s score during the LSST from pre-to-post LIST performances. Such a large decrease in the number of 5 and 3 point scores achieved may further emphasise the influence of accumulated fatigue on soccer shooting skill performance.

Table 5. Mean frequency of point score locations during the LSST, pre and post LIST performance

<table>
<thead>
<tr>
<th>Points Score</th>
<th>Pre LIST</th>
<th>Post LIST</th>
<th>Percentage Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>19</td>
<td>21</td>
<td>9.6</td>
</tr>
<tr>
<td>2</td>
<td>25</td>
<td>20</td>
<td>-20.1</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>2</td>
<td>-71.4</td>
</tr>
<tr>
<td>5</td>
<td>19</td>
<td>10</td>
<td>-47.4</td>
</tr>
</tbody>
</table>
CHAPTER VI

CONCLUSION
6.1 Major Findings

The results of the study demonstrate that despite a maintenance of sprint performance, there is a significant decrease in soccer skill proficiency following the performance of a prolonged intermittent high-intensity exercise, replicating the demands of one half of a soccer match.

The reduction in skill performance when fatigued may have significant implications for competitive match-play performance, particularly in relation to detriments in shooting accuracy, as the ability of a team to score goals is the ultimate determinant of success (Lago, 2006). Ultimately, the exact mechanism of fatigue development during a game, or after the first half period and the subsequent decrement in performance remains to be elucidated. However, it is unlikely to be due to low muscle glycogen, hypoglycaemia dehydration or hyperthermia as skill performance declined after only 45 minutes.

Future ecologically sound studies into the effects of soccer-specific fatigue development on soccer skill performance should concentrate on utilising a wider range of soccer skills; using tests that are able demonstrate both high reliability and high ecological validity. Additionally, future research should aim to clarify the nature, level and site of fatigue in order to reveal the mechanisms of performance deteriorations during soccer matches and ultimately, their direct influences on skill performance.


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APPENDICES
APPENDIX A
Informed Consent Form

Project Title: The effect of fatigue on the performance of soccer specific skills; shooting and dribbling

Lead Researcher: Keeron Stone
Contact Details: Email: K.J.Stone@uwic.ac.uk Tel: 07811143415

Please complete all the details below. This information is required solely for laboratory records.

Name (Print):

Contact Telephone:

I have read the information sheet concerning this project and I am aware of the purpose of the tests and what will be involved. All my questions have been answered to my satisfaction. I understand that I am free to request further information.

I know that:

- My participation is entirely voluntary. I know that I am not obliged to complete the tests and I am free to stop the test at any point and for any reason without disadvantage.

- I will be required to attend two sessions to complete the project.

- As part of the study I will have personal data recorded (height, weight, age, sex) as well as being required to complete soccer specific skills tests and a prolonged intermittent shuttle test (LIST).

- The test results will only be used for the purpose of the dissertation. All information and data collected will be held securely at the university. The results of the study may be published but my anonymity will be preserved.

Signature of Participant: …………………………………………………

Date: ……………………………………………………………………
Information Sheet

Dear Participant,

I’m currently carrying out an investigation that aims to examine the effect of accumulated fatigue, induced through the completion of the Loughborough Intermittent Shuttle test (LIST) designed to simulate a soccer match, on the performance of the soccer specific skills of dribbling and shooting.

Prior to participating in the study, you as the subject must provide informed consent, acknowledging that; i) you have been informed of the test procedures, ii) are participating voluntarily and iii) you know that you can withdraw at any point, for any reason, without disadvantage.

Selection criteria

You have been selected to participate in the study, due to your current participation in semi-professional competitive football. Additionally, your skill level, athletic ability and the fact that you are accustomed to the type and levels of fatigued experienced during a competitive soccer match, allows any potential health/illness problems whilst performing the LIST to be minimised. Any findings of the current study may be beneficial in terms of providing you with an insight to your current fitness status, identifying strengths and weaknesses of performance, with a view to the development specific practices.

Testing protocol

If you should agree to participate in this study, you will be required to attend two sessions to complete the project. All testing will be performed at the National Indoor Athletics Centre (NIAC) at University of Wales in Cardiff (U.W.I.C) or on the adjacent Astroturf soccer pitch. Two days prior to the first testing session you will be given pre-test instructions for diet, exercise and clothing for both testing sessions. Prior to testing, you will be asked to abstain from consuming large amounts of beverages or food.

The first testing session will initially involve you completing informed consent forms and pre-test health screening questionnaires, lasting approximately 10 minutes. Your height and weight will then be measured, with the height measurement requiring you to remove your shoes and the weight measurement requiring you to wear light athletic clothing (shorts and t-shirt). During this session you will then be asked to complete the slalom dribble test, which requires a ball to be dribbled around a set obstacle course in the quickest possible time. In addition, you will also perform the shooting accuracy test (Loughborough Soccer Shooting Test), requiring you to shoot at marked targets within a full size goal from a set distance.

The second testing session requires you to perform a Modified version of the Loughborough Intermittent Shuttle Test (LIST). The LIST comprises of a set activity
pattern that replicates the demands observed during competitive soccer match-play. The activity pattern consists of intermittent high (sprint and cruise), medium (jog) and low intensity (walk) activity being performed in repeated shuttles over a 20m distance, with the order and total number of shuttles for each pattern being as follows:

- Walking – 3 shuttles (60m)
- Maximal Sprint – 1 shuttle (15m)
- Jogging – 3 shuttles (60m)
- Cruising – 3 shuttles (60m)

This activity pattern lasts for a total of 90 seconds and will be repeated 10 times to represent one activity block lasting 15 minutes. You will undertake three activity blocks to represent a 45 minute first half period. Directly after the LIST has been completed you will be required to repeat the slalom dribble and shooting accuracy tests in order to determine whether fatigue has an influence over skill performance.

Confidentiality

As a participant in the study, any information recorded will remain confidential, and your name will not be written anywhere within the investigation write-up. Additionally, during the research process, only I and my dissertation supervisor (Jon Oliver) will have access to any results recorded. The pre-test health screening questionnaires are designed for your safety, and are used in order to assess if you are fit and capable of completing the testing protocols.

Potential Risks

In order to ensure your safety during the investigation and testing sessions several methods will be implemented. Your heart rate will be monitored throughout the performance of the LIST using Polar heart rate monitors, to ensure that you are not exercising at a dangerous level. Additionally, to limit the possibility of injury a full and comprehensive 15 minute warm-up will be imposed prior to any physical activity or testing, as well as the inclusion of a warm down post test.

Should any incidences arise where you sustain an injury or feel unwell, the test will be stopped immediately and qualified first aider personnel will be on hand to treat you. In addition, a phone will be on hand to contact the emergency services should you require it.

Finally, I remind you that you are free to withdraw from the study for any reason at all, at any point, without disadvantage.

If you have any questions about the research process please contact me on 07811143415 or my supervisor Jon Oliver (J.L.Oliver@uwic.ac.uk).
APPENDIX C
Physical Activity Readiness Questionnaire (PAR-Q)

Participants Name: ……………………………………….

*Please circle the answers to the following questions:*

Do you have asthma or any breathing problems?  YES / NO

Has your doctor ever said that you have a heart condition?  YES / NO

Do you ever feel pain in your chest?  YES / NO

Do you ever feel faint or have spells of dizziness?  YES / NO

Has your doctor ever said you have a joint problem (also back problem) such as arthritis that has been aggravated by exercise or could be made worse by exercise?  YES / NO

Has your doctor ever told that you have high blood pressure?  YES / NO

Are you currently taking any medication of which the instructor should be made aware?  YES / NO

If so, what? ………………………………………………………………………………………………

Is there any other reason why you should not participate in a fitness test?  YES / NO

Are you unaccustomed to vigorous exercise?  YES / NO

Have you performed any form of physical activity in the last 24 hours?  YES/ NO

**IF YOU HAVE ANSWERED YES TO ONE OR MORE QUESTIONS, please add details below. Similarly, if there are any situations which will prevent you from exercising write them here (or let us know if they arise through the experiment)**

If your situation changes regarding your responses to these questions, please notify the appropriate research member.

Signed (participant): ……………………………………….

Signed (Investigator): ………………………………………

Date:……………………………………
APPENDIX D
Loughborough Soccer Shooting Test score sheet

**Player No.: ………….**

**Right Foot:**

<table>
<thead>
<tr>
<th>Shot No.</th>
<th>Score</th>
<th>Inside Shooting area</th>
<th>Within 8.5 seconds</th>
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Sub Total: ____________________________

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Sub Total: ____________________________

**Total Score: ______**