

Chapter 2 Method

2.1 Participants

Two male and four female trained badminton players (five right handed, one left handed), age 20.5 ± 4.6 yrs, weight 67.33 ± 7.99 kg agreed to take part in this study. The sample size in this research was in line with previous similar studies (Febbraio & Stewart, 1996; Kirwan et al., 1998; Kirwan, et al., 2001a; Kirwan et al., 2001b). The study design was a repeated measures design. A repeated measures design requires fewer subjects compared to that of an independent groups study. This is due to the fact that a repeated measures design is more likely to identify a true treatment effect on a dependent variable due to the lesser amount of between subject's variability (Winter, Eston & Lamb, 2001).

Subjects were recruited from local badminton clubs or were players who currently play on national and/or provincial teams in Ireland. All subjects play in the Irish senior 1 division badminton league. All subjects were trained badminton players. During the badminton season subjects would undergo such tests that are being carried out in this study. Therefore all subjects were sufficiently fit enough to complete the aerobic tests and competent to complete the skills tests. Prior to the study each subject was given written information concerning the nature and purpose of the study (appendix 1 & 2), a health screening form (appendix 3) and a consent form (appendix 4). Written informed consent was obtained from all subjects prior to commencement of the study. All subjects were injury free and not suffering from any serious health problems including diabetes or high blood pressure, did not suffer from any serious sport injury, or any other injury that would affect their normal training ability. The study protocol was approved by the University of Chester's Research Ethics Committee (appendix 13).

2.2 Dietary and physical activity control

Subjects were required to record their dietary intake and any physical activity for 1 day prior to commencing the first trial. Dietary (appendix 5) and physical activity diaries (appendix 6) were not assessed as part of this study, they were solely to aid memory. Subjects then replicated these before commencing the subsequent trial. Each subject was required to abstain from alcohol, caffeine and heavy physical activity the day before each trial.

2.3 Experimental design

Subjects participated in two experimental trials. Each trial was completed over a one day period. Two experimental trials were carried out on separate days separated by at least 7 days. One of two meals was ingested 60 minutes prior to the experimental trial. During periods of tournament play it is quite common for players to have a very limited time frame in which to consume a meal. It is quite common for players to have 1 hour and in some cases less to get a meal on board before recommencing play. It is also believed that many players do not follow a pre-exercise nutritional regime and that many players attend training sessions having consumed their pre-exercise meal in the hour prior to training and playing. Therefore a 60 minute postprandial period was used in order to simulate conditions of tournament play and mimic the pre-exercise habits of many players.

Following consumption of the test meal subjects performed a multistage fitness (section 2.5) test to exhaustion, an on court simulated badminton performance test (section 2.6) at maximal effort and an on court badminton skills test (section 2.7). The multistage fitness test and simulated badminton performance test were

chosen to reproduce the physiological demands of badminton play. Each subject was allowed to use their own badminton racket together with Yonex AS-30 feather shuttlecock. Subjects did not perform a familiarisation session prior to the first trial.

On the day of each trial subjects were required to arrive at the test location following a 12 hour overnight fast. On arrival at the test centre subjects handed in their completed activity and food diaries prior to commencement of each trial. An additional copy was made, the copy was retained by the researcher and an original was given to each subject to replicate prior to the second trial. Baseline data; weight, blood glucose and blood lactate samples were taken upon arrival.

After an initial blood sample (blood glucose and blood lactate), subjects consumed the pre-trial meal. In the 60 minutes prior to the first experimental tests subjects were required to remain rested. Sixty minutes postprandial and following a second blood glucose sample subjects were transferred to the badminton court where they performed a very gentle warm up. Each subject performed their own individual warm up which consisted of gentle running followed by a number of stretches. Subjects had 5 minutes to complete this. After the warm up subjects performed a multistage fitness test to exhaustion (appendix 7). On completion of multistage fitness test subjects then performed 4 x 1 minute intervals of maximal effort simulated badminton play (shadowing) to all corners of the badminton court with a 2 minute rest interval between intervals (appendix 8). To encourage subjects to work to maximal intensity subjects were given verbal encouragement by assessors throughout the multistage fitness test and simulated badminton performance test. Following completion of the shadowing test subjects then performed a badminton specific skills test (appendix 9). In addition to the basal blood glucose sample, a further four samples were

obtained 60 minutes postprandial and immediately following each test. In addition to the basal blood lactate sample, a further two blood lactate samples were taken following completion of the multistage fitness test and the simulated badminton performance test. Subjects were provided with and encouraged to drink water throughout the trial to maintain levels of hydration.

2.4 Test meals

Subjects were assigned one of two test meals; a high GI (HGI) or low GI (LGI) of different glycemic indices in a randomised crossover design. Each meal consisted of cereal, fruit and dairy. Cereal contributed 55%, fruit 30% and dairy 15% to the total carbohydrate content of each test meal. The HGI meal included Cornflakes (Kellogg's Ltd[®], Ireland), banana and low fat milk (Avonmore[®]) with a total meal GI of 65. The LGI meal included All Bran (Kellogg's Ltd[®], Ireland), apple and low fat milk (Avonmore[®]) with a total meal GI of 32.7. The glycemic index of each meal (Table 3) was calculated according to the methods described in Wolever, Jenkins, Jenkins & Josse (1991). Each test meal provided 1 g CHO•kg⁻¹ body mass (appendix 10). This is in line with current CHO recommendations for a pre-exercise meal 1 hour prior to exercise (Bean, 2003; Hargreaves, Hawley & Jeukendrup, 2004). The type of carbohydrate contained in the HGI and LGI meals were the same, with starch, fructose and lactose being the main carbohydrate type for cereal, fruit and dairy respectively.

Table 3. Characteristics of HGI and LGI test meals.

CHGI Meal	% of Total Meal CHO	Food GI	Meal GI
Cornflakes (Kellogg's Ltd, Ireland)	55	81	44.6
Banana	30	52	15.6
Low fat Milk (Avonmore, Super Milk)	15	32	4.8
Total	100		65

LGI Meal	% of Total Meal CHO	Food GI	Meal GI
All Bran (Kellogg's)	55	30	16.5
Apple	30	38	11.4
Low fat Milk (Avonmore, Super Milk)	15	32	4.8
Total	100		32.7

Calculated by method described in Wolever, et al. (1991) with GI values taken from Foster-Powell, Holt & Brand-Miller (2002)

2.5 Multistage fitness test

The multistage fitness test was used as a performance indicator and to fatigue participants prior to completing the skills test. The multistage fitness test or progressive shuttle run test was used to predict each subject's maximum oxygen uptake ($\dot{V}O_2\text{max}$). Subjects were asked to perform the multistage fitness test (Loughborough University and sports coach UK, 2001) to volitional fatigue.

The multistage shuttle run involved the subjects running between two lines exactly 20 metres apart, keeping in time with a series of audio signals. Each subject started the test at level 1 running at a very slow speed, after each minute the running speed progressively increased. Subjects enter a new level each minute to coincide with this change in running speed. Volitional fatigue was determined when the subjects could no longer maintain their running speed or failed to reach the line before the audio signal on three occasions. The subjects test level and number of shuttles into the level was recorded as subjects withdrew from the test. Maximum oxygen uptake was obtained by consulting the specific test tables (Loughborough University and sports coach UK, 2001). Timing of audio signal on the cassette was calibrated prior to commencement of the experimental trials.

2.6 Simulated badminton performance test

The simulated badminton performance test was used as a performance indicator and to fatigue participants prior to completing the skills test. This test was adapted from a similar test carried out on squash players in a study by Bottoms et al., (2006). Subjects performed shadowing at maximal intensity for 4 x 1 minute periods followed by a 2 minute rest. Subjects started from the middle of the court and ran (using correct badminton footwork) to each corner of the court and to the sides playing an imaginary shot at each location (Figure 2). Subjects performed; a lunge at both corners to the front of the court, playing an imaginary drop shot, a scissors kick at both corners to the back of the court, playing an imaginary clear and an imaginary jump smash to each position to the side of the court. Completion of the 6 imaginary shots constituted one repetition. The score recorded was the total number of repetitions covered.

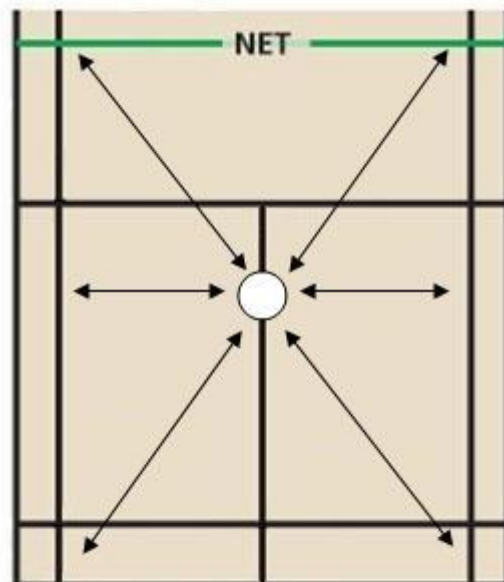


Figure 2 Simulated badminton performance test

2.7 Badminton skills test

The badminton skills test was used to assess three skills; long serve (Figure 3. target area 1), clear (Figure 3. target area 2) and drop (Figure 3. target area 3). This test was used in a previous study of badminton players in a study by Blomquist, Luhtanen and Laakso (2000). Two target areas were used for each test, a large target and a smaller target. Points were awarded for each shot landing in the large (5 points) and small (10 points) target area. Subjects performed 3 practice trials and 10 test trials for all test shots.

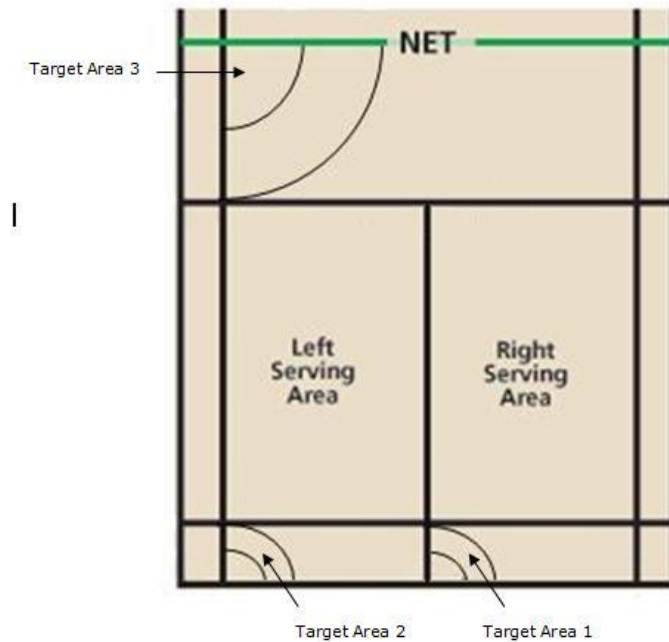


Figure 3 Skills test target area for right handed player

2.8 Blood analysis

Blood sampling was used throughout each trial in order to obtain small amounts of blood for measurement of glucose and lactate. Blood glucose samples were taken at different points throughout each trial to measure and assess subject's blood glucose response to LGI and HGI meals.

Blood lactate production and accumulation is accelerated as exercise intensity increases (McArdle et al., 2006). Blood lactate samples were taken to measure and assess the level of exercise intensity during the multistage fitness test and the simulated badminton performance test.

Blood glucose and blood lactate was measured using the Accutrend[®] Plus meter (Roche Diagnostics). Blood samples were taken using a finger-prick method of analysis (appendix 11). To ensure reliability a plausibility check was done after each blood glucose measurement. The reaction area on the test strip was compared to the colour field scale on the label of the test strip container. The colour area on the test strip must match the colour assigned to each measurement result on the test strip container. If there was any deviation between the measurement recorded and the assigned measurement on the label of the test strip container the measurement was repeated using a new test strip. Blood sampling protocols used was in accordance with the University of Chester's, policy on blood, saliva and urine handling (appendix 12).

2.9 Statistical analysis

SPSS 14.0 for windows was used for statistical analysis of data. Paired t-test and Wilcoxon test was used to examine the differences in the metabolic (blood glucose and blood lactate) and physiological (multistage fitness test, simulated badminton performance test and skills tests) response to LGI and HGI meal. The data from the 2 trials were analysed using a paired t-test for $\dot{V}O_2\text{max}$ and simulated badminton performance tests as data for $\dot{V}O_2\text{max}$ and simulated badminton performance tests passed normality while a Wilcoxon test for blood glucose, blood lactate and skills test was performed as data for blood glucose,

blood lactate and skills test failed normality. To reduce the risk of committing a type 1 error where multiple comparisons were carried out, a Bonferroni adjustment was performed ($0.05 \div \text{number of tests}$). Statistical significance was set at ($0.05 \div 38$) $P < 0.0013$. Data is reported as mean \pm standard deviation (SD) in the text and in the tables.