Fitness Evaluation of Gaelic Football Players

By

Patrick Stephens, B Sc

A thesis submitted in partial fulfilment of the requirements for the degree of

M Sc. Exercise Physiology

Dublin City University

I, the undersigned, declare that the project material, which I now submit, is my own work, that any data presented is accurate and were collected and analysed by myself. Any assistance received by way of borrowing from the work of others has been cited acknowledged within the work. I make this declaration in the knowledge that a breach of the rules pertaining to project submission may carry serious consequences. I am aware that the project will not be accepted unless this form has been handed in along with the project.

Signed : Patrick Stephens **Date: 24/9/2004**

Acknowledgements

I would like to thank the following

Dr Niall M Moyna for his invaluable assistance throughout my time spent here in DCU I would also like to apologise to Dr Moyna for any loss of hair, or change in hair colour, which he experienced during the course of supervising this thesis

Paddy Carr, in his capacity as manager of Louth Senior Footballers and all the other managers for making their players available for fitness assessments Without your interest and support this thesis would not have been possible

All of my fellow DCU Sport Science and Health postgraduates for helping me through the good times as well as the bad times!

Javier Monedero, Paul O'Connor and Owen McEaneaney for your professional assistance during the course of any fitness assessments I performed as part of my research

Aisling Scally for always making time to help me out with life's little problems

And last but not least, my family for their constant support and encouragement during the completion of this thesis and my entire education to date

Abstract

Title Fitness Evaluation of Gaelic Football Players

Purpose A prospective observational study design was used to assess selected fitness parameters in club level (CL) and county level (CO) Gaelic football players and, to determine the accuracy of the 20 m shuttle run test (20 MST) in predicting VO_2max in Gaelic football players

Methods A total of 213 Gaelic football players (95 CL, 118 CO) were recruited to part in the study Subjects underwent a number of laboratory and field-based tests to assess physical characteristics, flexibility, power, speed, agility and aerobic capacity The validity and reliability of the 20 MST as a predictor of VO_2max was assessed on a random sample of 32 players representing CO and CL Each player undertook in random order 2 separate 20 MST tests and, 2 continuous incremental treadmill exercise tests to assess maximal aerobic capacity

Results CO had higher ($p<0.05$) levels of flexibility, lower ($p<0.05$) percent body fat and smaller ($p<0.01$) waist circumference than CL There was no difference in any of the other measured physical characteristics between CO and CL County level players outperformed club players in all indices of speed and agility evaluated Vertical jump scores, anaerobic power, anaerobic capacity, VO_2max , maximal heart rate or maximal ventilation and $\%VO_2$ at ventilatory threshold were similar in CO and CL There was a significant positive relation ($r = 0.654$, $p<0.01$) between the number of shuttle runs completed during the MST and measured VO_2max, and between the estimated VO_2max and directly measured VO_2max ($r = 0.673$, $p< 0.01$)

Conclusion Physical characteristics are similar in CO and CL With the exception of indices of speed and agility, fitness levels are similar in CO and CL The 20 MST is a modest predictor of VO_2max in CO and CL

Table of Contents

Table of Contents

Appendices

Appendices cont

List of Tables

List of Tables continued

List of Figures

Chapter 1

Rationale

Gaelic football (GF) is the most popular sport in Ireland It can best be described as a hybrid of soccer, rugby and basketball, although it predates all of these games It is played between two teams of 15 players on a rectangular grass surface approximately 137m long and 82m wide There are approximately 2,600 Gaelic football clubs in Ireland, catering for over 500,000 players and 20,000 teams The All-Ireland championship series is the most prestigious competition and attracts attendances of 80,000

Optimal performance in Gaelic football requires that players develop the appropriate fitness attributes that allow them to cope with the physical demands of the game while maintaining technique and skill levels Players are required to undertake multiple short duration intermittent bouts of high intensity exercises interspersed with short-duration recovery periods In addition, they must possess the strength and flexibility attributes that allow them to obtain and maintain possession of the ball, optimally execute skills and tackle opponents Relatively few studies have been undertaken to assess the fitness characteristics of Gaelic football players

In recent times, efforts to improve Gaelic football performance have focused on physical conditioning at the expense of skill technique and tactical development There is however, relatively little information available to coaches regarding the fitness levels required for optimal performance at different levels of competition In addition, there is a lack of normative data to assist coaches in evaluating test results

Intercounty players can cover distances of 8 km or greater during the course of a game (1) The ability to cover large distances and perform multiple sprints during a game requires a high reliance on the aerobic energy system Maximal aerobic capacity (VO_2max) is the gold

standard measure of aerobic capacity It is an integrative measure of the ability of lungs to supply oxygen, the cardiovascular system to pump and transport oxygenated blood to the exercising muscle and, the ability of the working muscle to use oxygen (2) Measurement of VO_2max involves the use of sophisticated equipment in specialized laboratories The equipment has high acquisition and operational costs and requires highly trained and skilled personnel Due to the practical limitations of laboratory based testing a number of field-based tests have been developed to estimate VO_2max The 20M Shuttle Test (20 MST) is one of the most commonly used field test to estimate aerobic capacity in Gaelic football players To our knowledge no studies have validated the 20 MST as a predictor of VO_2max in Gaelic football players The aim of the study is to assess the anthropometric characteristics and fitness levels of Gaelic football players and, to determine the accuracy of the 20 MST in predicting VO_2max in Gaelic football players

Hypothesis

1 A clear range of anthropometric and physiological performance prerequisites exists for players of differing levels of competition and different playing positions

2 The 20M Shuttle Test (20MST) run is an accurate predictor of aerobic capacity in Gaelic football players

Chapter 2

Literature Review

Gaelic football is the most popular sport in Ireland Attendances at provincial and national competitions can range from 30,000 to 80,000 It is played between two teams on a grass field 137 metres x 82 metres (Appendix 1) Teams are comprised of 15 players, a goalkeeper, six defenders, two midfielders and six forwards The exact positioning of each player may vary depending on the tactics employed by team management Matches are comprised of two 35 minute periods, and are officiated by a referee, assisted by two sideline officials and four umpires Each team is permitted up to five substitutions during the course of a game

Gaelic football is played with a ball, similar in size but slightly heavier than that used in soccer The ball can be played over any distance by foot or hand and can be carried using the accepted solo running technique This involves kicking the ball from foot to hand while stationary or moving Goalposts with a crossbar are located on both end-lines The objective of the game is to score more than the opposition and concede as few scores as possible A team is awarded a point when the ball is kicked or hand/fist-passed between the posts and over the crossbar A goal is awarded when the ball crosses the goal end-line between the goal posts and under the crossbar Three points are awarded for a goal

Parish or community based clubs form the basic unit of the GAA Competitions are organized at underage age (< 18 years old) and senior level The winners of the county senior club championship contest the provincial, and ultimately the All-Ireland club series Like any sporting organization there is a hierarchical competitive structure Top level players are selected to represent their county team The All-Ireland inter-county football series is the premier football competition and is played between the months of May and September The inter-provincial

competition is an annual competition played between representative teams from the four provinces Elite players are selected to represent Ireland in a hybrid game of Gaelic Football and Australian Rules Football, called Compromise Rules

The movement patterns in Gaelic football are based directly or indirectly on the concept of space and time The primary objective of the team in possession is to create and exploit space in order to score In contrast, when the opposition has possession the primary aim is to decrease the time and space available to them By denying time and space, the team achieves the broad defensive objectives of preventing the opposition from scoring and regaining possession of the ball

The physiological demands of any sport are determined in large part by the activity patterns of the game Gaelic football is characterised by irregular changes of pace and anaerobic efforts superimposed on a backdrop of light to moderate aerobic activity (3) Players must be able to execute a number of skills within an environment of explosive speed and intense physical contact In addition, they must possess high levels of upper and lower body strength in order compete for and maintain possession of the ball (4) Optimal performance requires that players develop specific fitness attributes that will enable them to cope with the physiological demands and maintain their technical standard throughout the course of a game

The fitness requirements of most team sports vary according to player position and the overall tactical plan The distance covered during the game may also vary according to a player's position on the team (1) Elite players in many team sports tend to have a higher level of fitness (5,6) and greater technical ability than sub-elite players

Anthropometric Characteristics

Anthropometric characteristics of players may vary with positional and/or tactical role assigned by the coach Knowledge of a players physical characteristics are commonly used in team selection and tactical roles The tallest players on the squad are usually positioned in midfield In contrast, smaller more agile players are assigned wide positions where acceleration and agility are important for optimal performance

Anthropometric characteristics and physical fitness are determinants of success in Gaelic football (7) Watson reported that inter-county players (CO) had a greater muscle mass and lower fat mass than club level players (CL) (5) Gaelic footballers are similar in height and weight to soccer and rugby league players and rugby union defenders (Table 2 1) Furthermore CO players are on average shorter and lighter than American football and Australian Rules players (5)

Table 2 1 - Height of players in different sports

Source	Standard	N	Height (cm)
Reilly and Doran (1999) (82)	Mayo Seniors	32	179±7 0
Keane et al (1997) (6)	County players	37	181±4 0
Keane et al (1997) (6)	Club players	40	175±6 0
Watson (1995) (5)	Munster Senior Inter-county Champions 1994	32	181 4±8 2
Florida James & Reilly (1995) (4)	U-21 English club footballers, university level	11	176±5 8
Young and Murphy (1994) (57)	Ulster Inter-county senior Champions 1993	21	179±5 0
Kirgan and Reilly (1993) (35)	Lancashire county league	15	174±5 0
Scott et al (2002) (83)	Pro Rugby Union Forwards	13	190 2±2 2
Scott et al (2002) (83)	Pro Rugby Union Backs	15	179 5±1 3
Casajus (2001) (84)	Spanish Pro Soccer Team	15	180±7 0
Gabbett, TJ (2000) (65)	Amateur rugby league forwards	19	178 4±7 8
Gabbett, TJ (2000) (65)	Amateur rugby league backs	16	178±5 2

Table 2 2 – Weight of players in different sports

Source	Standard	N	Weight (kg)
Reilly and Doran (1999) (82)	Mayo Seniors	32	79 9±8 2
Keane et al (1997) (6)	County players	37	82 6±4 8
Keane et al (1997) (6)	Club players	40	76 5±6 7
Watson (1995) (5)	Munster Champions 1994	32	81 9±6 9
Florida James & Reilly (1995) (4)	U-21 English club footballers, university level	11	70 7±7 7
Young and Murphy (1994) (57)	Ulster Champions 1993	21	81 2±7 1
Kirgan and Reilly (1993) (35)	Lancashire county league	15	73 3±9 3
Scott et al (2002) (83)	Pro Rugby Union Forwards	13	104±2 4
Scott et al (2002) (83)	Pro Rugby Union Backs	15	86 3±1 7
Casajus (2001) (84)	Spanish Pro Soccer Team	15	78 6±6 6
Gabbett, TJ (2000) (65)	Amateur rugby league forwards	19	90 8±4 6
Gabbett, TJ (2000) (65)	Amateur rugby league backs	16	79 7±5 0

Body mass and body composition may influence a number of performance parameters Excessive body fat impedes mobility and agility and adds to energy costs of exercise (8) Excess fat also impedes the efficiency of heat dissipation during exercise (9)

Table 2 3 – Percentage Body fat of players in different sports

Source	Standard	N	% Body Fat
Reilly and Doran (1999) (82)	Mayo Seniors	32	12 3± 2 9
Watson (1995) (5)	Munster Champions 1994	32	15± 4 2
Florida James & Reilly (1995) (4)	U-21 English club footballers, university level	11	12 2± 2 1
Young and Murphy (1994) (57)	Ulster Champions 1993	21	11 4± 2 9
Kirgan and Reilly (1993) (35)	Lancashire county league	15	14 5± 2 2
Casajus (2001) (84)	Spanish Pro Soccer Team	15	18 7±4 2
Scott et al (2002) (83)	Pro Rugby Union Forwards	13	12 8±0 8
Scott et al (2002) (83)	Pro Rugby Union Backs	15	9 7±0 6
Gabbett, TJ (2000) (65)	Amateur rugby league forwards	19	19 9± 3 4
Gabbett, TJ (2000) (65)	Amateur rugby league backs	16	17 5± 5 0

Energy Systems

Gaelic football is characterised by irregular changes of pace and anaerobic efforts superimposed on a backdrop of light to moderate aerobic activity (3). The movement patterns during a game are complex and involve activities such as walking, jogging, running sideways, jogging backwards, walking backwards, low speed running, high speed running, and moving at speed while in possession of the ball. The percent of total match time devoted to these movement patterns varies considerably. (Fig 2.1) (1)

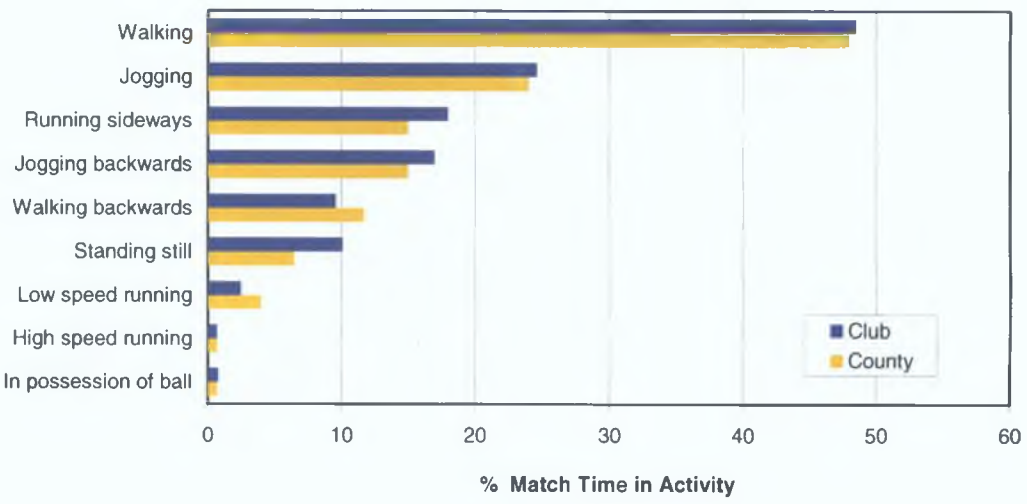


Figure 2.1 Intercounty and club level activities

CL and CO players cover an average distance of 8.5km during a game at an average intensity of 71% VO_2max (1;3;3). In contrast, CL players cover approximately 7.0 km during a game (10). The majority of time is spent jogging and walking. Less than 1.7% of total playing time involves sprinting (1). Consequently, the aerobic energy system contributes significantly to the total energy release during the course of a game.

Maximal aerobic capacity ($\dot{V}O_2$max) defines the upper limit of the cardiopulmonary system. It is determined by the capacity to increase heart rate, augment stroke volume, and

direct blood flow to the working muscle According to the Fick Principle, oxygen uptake is the product of cardiac output and arteriovenous oxygen across the body This implies that both central (oxygen delivery) and peripheral (oxygen extraction) factors are important in ensuring that the muscle receives an adequate supply of oxygen during exercise Maximal aerobic capacity is the most commonly used laboratory test to assess aerobic capacity It is an integrative measure of the ability of the lungs to supply oxygen, the cardiovascular system to pump and transport oxygenated blood to the exercising muscle, and the ability of the working muscles to utilize oxygen (2)

No studies have examined the relation between VO_2max and Gaelic football performance Studies examining the relation between aerobic capacity and performance in soccer have been equivocal The VO_2max of elite soccer players range from 55 0 to 65 0 ml kg $^{1}min^{1}$ (11-16) with a few individuals having values greater than 70 0 ml kg $^{1}min^{1}$ There is evidence of a relation between VO_2max and the total distance covered (17,17,18) and the total number of sprints undertaken (17,19,20) during a soccer game Successful professional soccer teams have a higher aerobic fitness level than teams that are less successful (21,22) In contrast, others have found that a high level of aerobic fitness does not equate with performance No relation was found between VO_2max and the final position in the Italian league (23) Faina et al , (24) observed that amateur soccer players had a higher aerobic power than professional players (64 1 vs 58 9 ml kg ^{1} min ^{1}) VO_2 max values among regular and non-regular elite soccer players suggests that VO_2max may not necessarily be crucial to successful sporting performance in soccer (25) Time to exhaustion in a graded treadmill test was more highly correlated with running time during a match than VO_2max (26)

In addition to jogging and walking, players undertake multiple bouts of short duration high intensity activities such as sprinting, jumping, and tackling during the course of a game The

majority of sprints cover distances of less than 5 metres Only 5% of sprints are in excess of 40 metres (Fig 2 5) Short duration high intensity activities are fuelled primarily by the phosphagen stores, and the breakdown of carbohydrates during anaerobic glycolysis The relative contribution of each energy system is dependent in large part on the intensity and duration of the high intensity activity, the recovery interval and the ability to consume oxygen (27) Phosphocreatine is a high-energy compound that is stored in skeletal muscle The energy released from the breakdown of PCr is immediately available and, is biochemically coupled to the resynthesis of ATP (86) The resting levels of PCr in skeletal muscles is in the range of 70-80 mmol kg dry mass ^{1}, enough to provide energy for high 2-5 sec of high intensity exercise (86) In contrast, the oxidative energy system and anaerobic glycolysis are the primary energy sources for actions longer than 2-5 seconds in duration (26)

Creatine phosphate stores are replenished during recovery in coupled reactions from the energy released during ATP hydrolysis (28) The ATP required for phosphagen restoration is provided primarily by the aerobic system from the oxygen consumed during the fast component of oxygen recovery (17,29-31) Phosphagen restoration is 70% complete in 30 sec and 100% complete in 3-5 min (17,32) A high level of aerobic fitness enhances recovery from intense intermittent exercise Players with a high aerobic capacity require less time to recover between high intensity bouts (33 34) and will be able to sustain a high work rate during a game

Surprisingly, few studies have assessed VO_2max in Gaelic football players (4,5,5,6,35) Results from laboratory based studies have reported values ranging from 47 6 ± 5 3 to 52 6 ± 4 0 ml kg ^{1} min ^{1} (4) in English based Gaelic CL players using a running based protocol (Table 2 4) In the only study performed on Irish based Gaelic footballers, average values of 58 6 ± 3 8 ml kg ^{1} min ^{1} were reported using a cycling based protocol (5) These values are similar to those reported for soccer and rugby (Table 2 5)

Table 2 4 – Lab-based maximal aerobic capacities of Gaelic football players

Source	Level of Competition	N	VO_2max
Reilly et al , (1999) (82)	Senior Intercounty team	32	58 8 ± 3 8*
Watson (1995) (5)	Senior Intercounty team	32	58 6 ± 3 8#
Young et al , (1994) (85)	Senior Intercounty team	21	57 1 ± 4 6*
Keane et al (1997) (6)	Intercounty players	37	54 1 ± 3 2*
Kirgan et al , (1993) (35)	Lancashire county league	15	47 6 ± 5 3
Kirgan et al , (1993) (35)	English club players	40	51 4 ± 5 8*
Florida James et al , (1995) (4)	U-21 English club footballers, university level	11	52 6 ± 4 0

* Estimated VO_2 max using the 20 MST # Measured directly on a bike

Table 2 5 – Lab-based maximal aerobic capacities of soccer and rugby players

Source	Level of Competition	N	VO_2max
Scott et al (2002) (83)	Pro Rugby Union Forwards	13	41 2±2 7
Scott et al (2002) (83)	Pro Rugby Union Backs	15	48 3±2 1
Casajus (2001) (86)	Spanish Pro Soccer Team	14	65 5± 8 0
Gabbett, TJ (2000) (65)	Amateur rugby league forwards	19	38 1± 5 4
Gabbett, TJ (2000) (65)	Amateur rugby league backs	16	40± 4 4
16Ramos et al (1994)	Spanish first division	12	61 1±6 7
16Malomsoki (1993)	Hungary National team	11	62 7±5 2
16Matkovic et al (1993)	Croatian First Division	44	52 1±10 7
16Puga et al (1993)	Italian First Division	19	59 6±4 5
16Rahkila et al (1991)	Finish National team	31	56 3±3 0

* Estimated VO_2 max using the 20 MST # Measured directly on a bike

Laboratory equipment is costly to use in terms of capital expense, time and trained personnel This equipment is predominantly confined to university laboratories or medical clinics and, is not practical for use with large groups To overcome these limitations a number of field-based tests have been developed to assess aerobic capacity The 20 metre multi-stage shuttle run test (20 MST), is the commonly used field test to assess aerobic fitness in Gaelic football players Compared to open circuit spirometry the 20 MST is easy to administer, can be used to evaluate large numbers simultaneously and does no require expensive laboratory equipment The 20 MST was developed in 1994 and consists of a number of stages or levels Each level

lasts approximately 1 min and comprises a number of 20m laps or shuttles, paced by a series of audio signals (bleeps) The required running speed increases at the beginning of each stage A stage includes seven or more laps, depending on the required running speed and exact protocol used Tests involving school children (36,36,37,37-39), college level students (40,40,41), healthy adults (42,43), athletes trained in sports with different physical demands (44,45) have shown that the 20 MST is a reliable and valid field test to estimate VO_2max (Table 2 6)

Table 2 6 Validity and Reliability studies performed on the 20MST

Source	Subjects	Reliability	Validity
St Clair Gibson (1998) (47)	10 male runners		0 67
St Clair Gibson (1998) (47)	10 squash players		0 61
Lie et al (1992) (38)	12 males	0 91*	0 72
Lie et al (1992) (38)	8 females	0 87*	
Mahoney et al (1992) (39)	10 males	0 73*	0 83
Mahoney et al (1992) (39)	10 females	0 88*	0 76
Boreham et al (1990) (36)	24 males and 24 females		0 87
Van Mechelen (1986) (75)	41 boys and 41 girls		0 76
McNaughton et al (1998) (41)	32 male		0 82
Grant et al (1995) (40)	22 males		0 86
Leger et al (1989) (37)	53 males and 24 females		0 9
Wilkinson et al (1999) (44)	20 males and female students		0 91
Ramsbottom et al (1988) (76)	36 males and 38 females		0 92
Palizzka (1987) (43)	9 males		0 93
Leger et al (1988) (37)	139 boys and girls	0 89*	
Leger et al (1988) (37)	81 men and women	0 95*	
Leger and Lambert (1982) (42)	59 males and 32 females	0 975*	

*Estimated VO_2max using the 20 MST performed twice

The 20MST is not always an accurate predictor of aerobic fitness In a study examining the validity of the 20MST in predicting VO_2max in a population of 20 physical education students, Sproule et al (46) found that the estimated VO_2max was significantly lower than the estimated value in 75% of the subjects The 20MST significantly under-predicted VO_2max in runners and

squash players (47) The efficacy of the 20 MST in predicting VO_2max may be sport specific To my knowledge no published findings have examined the validity of the 20MST to predict VO_2max in Gaelic football players

It is not uncommon during the course of a game for players to undertake repeated bouts of short duration high intensity activity with recovery periods that are too short to allow for adequate restoration of phosphagen stores In order to maintain the redox potential of the cell the hydrogen atoms are shifted from $NADH^+$ to pyruvate in the lactate dehydrogenase reaction and lactic acid is formed Lactic acid diffuses into the extracellular space and accumulates in the blood Because of its low pH, lactic acid dissociates resulting in an increase in H^+ levels, and a decrease in intracellular pH This in turn will have a deleterious effect on muscle function

Lactate accumulation in the blood is dependent on the balance between lactate production (appearance) by exercising muscles and lactate removal (disappearance) by liver and other tissues (48) The balance between appearance and disappearance is called turnover Lactate accumulates in blood when the rate of production exceeds the rate of removal The exercise intensity at which blood lactate exhibits an abrupt non-linear increase during dynamic exercise is called the lactate threshold (LT)

The LT represents a key metabolic transition point from aerobic metabolism to a progressively increased reliance on anaerobic metabolic pathways, and is a valid predictor of endurance exercise performance (49) At steady state conditions below the LT a dynamic equilibrium exists between the rate of pyruvate production and its subsequent oxidation by the pyruvate dehydrogenase complex (PDC) Above this threshold, pyruvate accumulation reaches a critical concentration where it will be preferentially reduced to lactate rather than pass through the PDC for further oxidization The lactate threshold occurs at approximately 50-60% VO_2 max in

untrained individuals Adaptive responses resulting from endurance training allow individuals to exercise at a higher intensity prior to the accumulation of lactate

The assessment of the LT requires the serial collection of blood samples at rest and periodically during incremental exercise The invasive nature of this procedure makes the determination of the LT impractical in large groups The H^+ that accumulate in muscle during high intensity exercise are immediately buffered by intracellular bicarbonate resulting in the production of CO_2 Small changes in PCO_2 activate peripheral chemoreceptors, which in turn signal the inspiratory center in the brain to increase ventilation (V_E) Eventually, minute ventilation increases disproportionately compared with increases in oxygen consumption The exercise intensity at which expired ventilation demonstrates a non-linear increase in relation to VO_2 is called the ventilatory threshold (VT) (49) To my knowledge no previous studies have assessed the VT in Gaelic football players

The rate of blood lactate production and removal can be significantly altered following a period of endurance training (50) It is not uncommon for the exercise intensity corresponding to the LT to increase following a period of endurance trained without a concomitant improvement in VO_2max Shifting the LT curve to the right will allow players to exercise at the same absolute workrate prior to accumulating lactate in the muscle In addition to aerobic capacity, there are other fitness components that are important for optimal performance in competition These include flexibility, speed and strength

Flexibility

Flexibility is the ability to move a joint through a complete range of motion (ROM) Anatomical limitations such as bone constraints (which provide protection and stability to a joint), large muscles, obesity and pregnancy affect the ROM about a joint Muscle spindles appear to have a set-point, beyond which the ROM is constricted The length and stiffness of a muscle can

also effect its ROM (51). Recent research suggests that the bonds between actin and myosin filaments may limit ROM (51). Muscle fibers may also have an intrinsic velocity that makes them stiff (51). Reductions in the numbers of sarcomeres are associated with increased muscle stiffness and decreased flexibility (51).

A number of mechanisms have been proposed to explain the beneficial effects of flexibility on performance. Greater flexibility allows joints to move through their full range of motion. This may allow muscles to produce greater force or velocity in the execution of a skill (52). Appropriate levels of flexibility may help to prevent injury and, reduce the level of muscle soreness following exercise (53). In contrast, extreme flexibility or hypermobility may predispose joints to injury especially in contact sports such as Gaelic football.

Relatively few studies have examined the flexibility of Gaelic football players. Watson (1995) (5) found large variations in flexibility among the members of a senior intercounty panel. Some panel members had flexibility scores comparable to elite track and field athletes while others had levels similar to those reported in untrained subjects.

Power

Power is the product of strength and speed and is important for optimal performance in high intensity activities such a jumping, and accelerating from a stationary position (54). Muscular power is commonly assessed by calculating the vertical displacement when jumping from a stationary position (21). Vertical jump performance involves critical timing of all body parts. The stretch shorten cycle, trunk extension and head movements are initiated prior to the jump to develop maximum elastic and contractile energy in the muscles. Upper body and abdominal strength are used to create good posture and act to conduct forces between the upper and lower body (55). A coordinated arm backswing is important to create vertical velocity (56).

Vertical jump performance is commonly used to assess leg power in Gaelic football players Distances between 50 cm and 60 cm have been reported (5,5,6,22,35,35,57) These scores are comparable to those reported in soccer and rugby league (Table 2 7) Vertical jump performance may vary with playing position Wisloff (1998) (6,21) reported that vertical jump height was significantly greater in Norwegian soccer defenders and strikers compared to midfield players The differences in performance may be due to the fact that midfield players are less involved in jumping and tackling

Table 2 7 Vertical jump of players in different sports

Source	Standard	N	Vertical Jump (cm)
Kirgan and Reilly (1993) (35)	Club Gaelic football players	15	48 6 ± 4 7
Keane et al (1997) (6)	Club Gaelic football players	40	51 6 ± 6 5
Keane et al (1997) (6)	County players	30	58 4 ± 6 4
Watson (1995) (5)	County players	32	50 3 ± 5 8
Reilly and Doran (unpublished)	County payers	33	58 3 ± 6 7
Wisloff et al (1998) (21)	Norwegian professional soccer players	29	54 9 ± 5 3
Casajus et al (2001) (86)	Spanish professional soccer team	15	47 8 ± 2 9
Gabbett (2000) (65)	Amateur rugby league backs	16	39 3
Gabbett (2000) (65)	Amateur rugby league forwards	19	37 1

The Wingate test is a commonly used laboratory test to assess indices of anaerobic power and capacity during a brief bout of high intensity exercise The standard Wingate protocol involves cycling at maximal effort for 30 seconds against a fixed resistance (6) Peak power output is the highest power output than can be generated during a test It normally occurs early in the test The fatigue rate is calculated as the percentage difference between the peak power output and the final power output (51) Values for peak power and mean power of 838±88 W and 518±59 W respectively have been recorded for English based club level Gaelic football players (35,51) These values are lower than those reported for age-matched university level soccer players (35)

Speed

Only 1.7% of active playing time involves sprinting. This accounts for 3.7% of the total distance covered during a match (1). The average sprint distance is 13.5 ± 3.0 metres, and only 20% of sprints performed in Gaelic football are greater than 20m (1). (Fig 2.2).

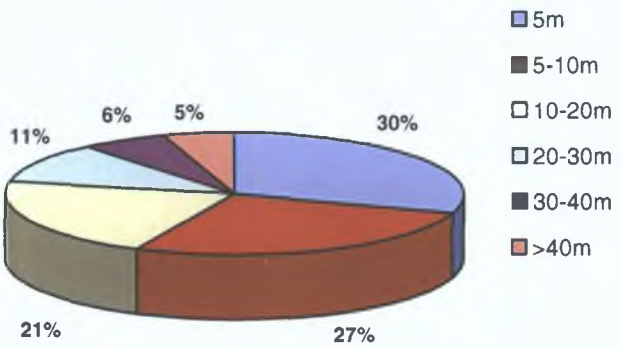


Figure 2.2 Distance sprinted during Gaelic football a match

Many coaches view speed simply as the ability to cover a specified distance in the shortest possible time. This rather narrow view fails to recognize the unique speed requirements of Gaelic games. The player who can complete 40 metres in the shortest time will not necessary be the fastest player in a game situation. Maximal sprinting speed although important, is only one aspect of the speed requirements for Gaelic games. Consider a player who can sprint 40 metres in 4.6 seconds. This is equal to an average speed of 8.69 metres per second (40 metres/4.6 sec). However, knowing that it takes 4.6 sec to run 40 metres provides no information regarding the speeds achieved at various stages during the 40 metre run.

Table 2.8 represents a breakdown of each 5 metre segment of the 40 metre sprint. The total time represents the accumulated time. The split time measures how long it takes to complete each 5 metres segment of the run. The 10 metre mark was reached in 1.66 seconds and the 15 metre mark in 2.25 seconds. Therefore, it took 0.59 seconds (2.25 - 1.66) to run that

particular 5 metre segment The fastest 5 second split time occurred between 35 and 40 metres, (0 43 sec)

Table 2 8 Sample 40 metre sprint demarcated into 5 metre segments

Interval	Total time (Sec)	Split time (sec)	Speed (metres/s)	Average speed	Acceleration (metres/s/s)
0	0 00	0 00	0 00	0 00	0 00
5	0 96	0 96	5 21	5 21	5 42
10	1 66	0 70	7 14	6 02	2 76
15	2 25	0 59	8 47	6 67	2 26
20	2 78	0 53	9 43	7 19	1 81
25	3 27	0 49	10 20	7 64	1 57
30	3 73	0 46	10 87	8 04	1 45
35	4 17	0 44	11 36	8 39	1 12
40	4 60	0 43	11 63	8 69	0 61

The speed (metres/sec) during any segment of the sprint is determined by dividing the distance covered by the split time This is a measure of the speed at an instance in time and is referred to as instantaneous speed In the example, speed continued to increase up to the 40 metres mark The largest increase in speed occurred during the first 20 metres

Acceleration is a measure of how fast the speed is changing It is calculated by subtracting the initial speed from the final speed and dividing by the time A player who goes from zero to 5 21 metres/sec in 0 96 seconds will have an acceleration of 5 42 metres per second every second (5 21-0)/0 96), i e , the speed is increasing by 5 42 metres per second every second Acceleration is greatest during the initial portion of the run Gaelic games require that players are able to rapidly accelerate over distances of 10-20 metres

Rarely during the course of a game is a player required to sprint for any significant distance without having to change speed, direction or both Players seldom run in a straight line at maximal speed for any significant distance without having to change speed direction or both The nature of the Gaelic football requires that players make frequent quick starts and sudden

stops, interspersed with constant changes of speed and direction This is referred to as directional speed

Speed of movement when in possession of the ball is referred to as possession speed A study involving Australian Rules players found that the time required to complete a specific distance increased 4-5% when the player has possession of the ball (57) Players who recorded the fastest time without possession were not necessarily the fastest when they had possession of the ball Although the impact of ball possession on the speed of Gaelic football players has never been examined it is desirable to develop speed attributes with and without possession of the ball

Speed is relative to the distance run and the nature of the game and/or competition In sports that require speed over distances of 10 to 20 metres players with the greatest acceleration will have the greatest speed As the distance gets longer maximal speed becomes more important Maximum speed is important when making overlapping support runs from deep positions

Agility

Players must be able to move backwards, sideways and forwards while constantly changing direction Agility refers to the ability to change body direction and position rapidly and can involve whole body change of direction in the horizontal plane, whole body change of direction in the vertical plane (jumping) and, rapid movement of body parts (58) Stationary and dynamic agility refer to the ability to rapidly change direction from a stationary or moving position respectively To my knowledge there are no standardized tests of agility for Gaelic football players

Chapter 3

Methodology

Design Overview

This was a prospective observational study Subjects visited the Centre for Sport Science and Health in a 4 h post absorptive state They were requested to refrain from vigorous physical activity and abstain from caffeinated beverages and alcohol for 24 h prior to the test Body weight, height, hip and waist circumference was measured, and double thickness subcutaneous skinfolds was determined Subjects then underwent a battery of tests to assess flexibility, power, speed, aerobic capacity and agility The tests were performed in the same order On arrival subjects were instructed to rest for 5 minutes and resting heart rate and blood pressure were recorded Anthropometrics including skinfolds were then taken followed by flexibility tests and vertical jump performance All these tests were performed without a warm up The subject was then instructed to warm up and stretch before completing the sprint and agility tests followed by the Wingate test Each subject then returned after two days recovery to complete the VO_2max test

Independent Variables Club and county level Gaelic football players of different playing positions

Dependent Variables Height (cm), weight (kg), BMI (kg/m^2), body fat (%), bicep, chest, waist and quadriceps girths (cm), flexibility (cm), vertical jump (cm), acceleration speed (m/s^2), 20m linear speed (m/s^2), forward and backward agility (m/s^2), VO_2max (ml/kg/min), % VO_2max corresponding to the VT (% VO_2max at VT)

Inclusion Criteria

Senior club level (CL) and county level (CO) Gaelic football players were eligible to participate in the study Club level players were classified as those who had played club football

in the previous 12 months County level players were classified as those who were currently members of a county senior or U21 team Subjects provided written informed consent as approved by the Institutional Review Committee at DCU

Exclusion Criteria

Subjects were excluded if they smoked, had diabetes, history of heart disease, liver dysfunction, or other medical conditions that may contraindicate exercise participation

Anthropometrics

Height and weight were measured using a stadiometer (Seca Model 220, GMBH, Hamburg, Germany) Subjects wore minimal clothing and no shoes Height was measured to the nearest cm and weight was measured to the nearest 0 1 kg Lange skinfold callipers (Cambridge Scientific Industries, MD) were used to measure double thickness subcutaneous adipose tissue on the right side of the body The following anatomical sites were measured, pectoralis, abdomen, thigh, triceps, subscapular, suprailiac and mid-axillary A minimum of two measurements was taken at each site If the measurements varied by more than 2 mm a third measurement was taken Body density was calculated using the Jackson and Pollock equation (59) Body fat was converted to percent body fat using the Siri equation (60)

Dominant biceps and upper thigh, waist, and chest circumferences were measured using a measuring tape (Gulick measuring tape, Creative Health Products, Inc , 5148 Saddle Ridge Road, Plymouth, MI 48170) The dominant biceps muscle was measured at the largest circumference while the subject actively flexed the muscle Thigh circumference was measured on the anterior thigh half-way between the hip and the knee cap The narrowest part of the torso as seen from the anterior aspect was used to measured waist circumference The measurement was taken after normal expiration Chest circumference was measured underneath the arms at

the widest point of the chest, generally in line with the sternum Measurements were taken to the nearest millimetre Repeated measurements were taken for accuracy and consistency

Blood Pressure

Subjects rested for 5 min in a sitting position before each measurement Systolic and diastolic blood pressure was manually determined using a mercury sphingomonometer (Accoson,Metpak 0114, London, UK) and an appropriate size cuff (Accoson, London UK)

Heart Rate

Subjects rested for 5 min in a sitting position before each measurement Heart rate was measured using a wireless Polar vantage heart rate monitor (Polar Vantage NV™ Polar, Port Washington, NY)

Flexibility

Hamstring flexibility was measured using a sit and reach test (Item 5111, Takei Physical Fitness test, Takei Scientific Instruments Co , Ltd, Tokyo 142, Japan) Subjects sat on a flat surface with their shoes removed and heels placed against the edge of the measuring box They were instructed to hyper-extend their knees and, to flex their trunk as far as possible The instructor's hands were pressed against the knees to prevent flexing Subjects remained in the final position for 3 sec Each subject performed 3 trials and measurements were recorded to the nearest cm

Vertical Jump

A Cranlea vertical jump mat (Item 5106, Takei Physical Fitness test, Takei Scientific Instruments Co Ltd, Tokyo 142, Japan) was used to measuring jumping ability Subjects were instructed to jump as high as possible and to land with both feet on the jump mat Use of the arms was permitted to provide momentum

Modified Wingate Test

A modified version of the Wingate test was used in the current study (Appendix 2) This involved cycling on a cycle ergometer (Monark 824 E Ergometer) at maximal effort for 10 s against a resistance equal to 9% body weight This was repeated 3 times and each test was followed by 30 s recovery period during which the subject remained stationary on the bike Peak power is the maximum power reached on trials 1,2 and 3 of the Wingate

Speed

Acceleration speed over 5 m and maximum speed over 20 m were determined using electronic photocells Subjects warmed up for 5 min using a standard protocol, which involved progression from jogging to sprinting This included all forms of movement including forwards, backwards and sidewards Subsequent to this, subjects stretched all the major muscle groups A free start was used in all runs in order to eliminate the influence of reaction time Subjects were instructed to run as fast as possible through the 20 metre gates Split-times were recorded at 5 m and 20 m Three trials were performed and the best trial was selected Each 20m run was followed by a 2 min recovery period Backward speed was assessed by instructing the subject to sprint backwards for 5 m Three trials were performed and the best trial was selected Each 5 m run was followed by a 1 min recovery period

Agility

Agility was assessed using a 50m forward and backward running course A free start was used in order to eliminate the influence of reaction time Subjects were instructed to run as fast as possible through the course outlined (Appendix 3) Three trials were performed and the best trial was selected Each 50-metre run was followed by a 2 min recovery period

Maximal Aerobic Capacity

Maximal aerobic capacity (VO_2max) was determined using a RAMP treadmill (Woodway ELG 55, Weil Am Rhein, Germany) exercise test Each test was voluntarily terminated when the subject could no longer continue to exercise because of fatigue Subjects were verbally encouraged to exercise to exhaustion Respiratory metabolic measures and heart rate were determined continuously throughout the session Maximal oxygen uptake was determined by averaging the two highest consecutive 30 s values Criteria for VO_2max was attainment of at least two of the following a plateau of VO_2max, as indicated by a difference in values between the last two stages of the test < 2 1 ml kg^{-1} min^{-1} respiratory exchange ratio (RER) ≥ 1 15, a rating of perceived exertion (RPE) of more than 17 (6-20 scale) or failure of heart rate to increase with further increases in exercise intensity (61)

20 Metre Shuttle Test

The validity and reliability of the 20 MST and VO_2max was assessed on a random sample of 32 players representing both club and county level Each player undertook two separate 20 MST tests and two laboratory based VO_2max tests in random order

The 20 MST test involved completing a number of stages (levels), each lasting 1 min in duration (Appendix 4) Subjects ran back and forth between two lines exactly 20 m apart keeping in time with a number of audio signals The required running speed increased by 0 14 m s^{-1} at the beginning of each stage The change in speed corresponding to a change in level was denoted by a triple bleep Subjects were verbally encouraged to give a maximal effort The test was terminated when a subject withdrew voluntarily, or was not longer complying to test regulations, i e , unable to maintain the set pace

Respiratory Metabolic Measures

Breath by breath expired oxygen, carbon dioxide, and ventilatory volume were determined using open circuit spirometry (Sensormedics Vmax 29 Metabolic Chart, SensorMedics Corp , Yorba Linda, CA) Prior to testing, the gas analyzers were calibrated with standard gases of known concentration

Ventilatory Threshold (VT)

Ventilatory threshold, was determined using the VE method This involves plotting the relation between expired VO_2 and expired ventilation (V_E) The H^+ that accumulates in muscle during high intensity exercise is immediately buffered by intracellular bicarbonate resulting in the production of CO_2 Small changes in PCO_2 activate peripheral chemoreceptors, which in turn signal the inspiratory centre in the brain to increase ventilation (V_E) The exercise intensity at which expired ventilation demonstrates a non-linear increase in relation to VO_2 is called the ventilatory threshold (VT) (49)

Statistics

Descriptive statistics are described as mean ± SD (Appendices 6 - 20) Comparisons between CL and CO players were made using Students independent t-tests A 2 x 4 [group (club vs county) x position (goalkeeper, defender, midfielder forward) ANOVA was used to compare within and between group differences Evidence of response validity was determined using Pearson correlation and simple linear regression This analysis separately regressed the final stage attained during the 20 MST and the estimated VO_2max attained during the 20 MST with the measured VO_2max Repeatability of both tests was determined using intraclass correlations

Chapter 4

Results

Normative data

Descriptive statistics and percentile tables using the results from the 213 players tested from different playing levels are presented in Tables 4 1, 4 2, 4 3 and 4 4 Normative data tables for general playing positions and playing levels are included in the Appendix (Appendix 6 – 20)

Competitive Level

CL had a higher percent body fat ($p<0\ 05$) and a greater waist circumference ($p<0\ 01$) than CO players (Table 4 5) There was no difference in any of the other measured physical characteristics between CL and CO players (Table 4 5) Compared to CL players, CO players had higher levels of hamstring flexibility (Fig 1) ($p<0\ 05$) Vertical jump scores were similar in both groups (Table 4 6) CO players outperformed CL players in all indices of speed and agility evaluated (Table 4 6) There were no differences in anaerobic power, anaerobic capacity (Table 4 7), VO_2max, % VO_2VT, maximal heart rate or maximal ventilation between the two groups, (Table 4 8)

Positional Comparisons - Club vs County

No comparisons were made between CL and CO goalkeepers due to the small sample size County level defenders had a higher BMI ($p<0\ 05$), larger bicep circumference ($p<0\ 05$), smaller waist circumference ($p<0\ 01$) and greater hamstring flexibility ($p<0\ 01$) than CL defenders (Table 4 9) There was no difference in any of the other physical characteristics between CL and CO defenders Absolute and relative oxygen uptake values (Table 4 12) were higher and forward and backward running times were better (Table 4 10) in CO defenders than CL defenders ($p<0\ 05$)

Waist circumference ($p<0.01$) was greater in CL than CO midfielders. There were no differences in any of the other physical characteristics between club level and county level midfield players. CO midfield players were faster over 20m than CL players. There was no difference in anaerobic power, anaerobic capacity (Table 4.11), % VO_2VT, VO_2max, maximal heart rate or maximal ventilation between the two groups (Table 4.12).

Club level forwards had a greater waist circumference ($p<0.01$) than CO forwards. There was no difference in any of the other physical characteristics between club level and county level forwards. Average agility times were slower ($p<0.05$) in CL forwards than CO forwards. Levels of fatigue were greater in club level than county level forwards during the first ($p<0.001$) and third ($p<0.01$) trials of the modified Wingate test. There were no differences in anaerobic power, anaerobic capacity (Table 4.11), % VO_2VT, VO_2max, maximal heart rate or maximal ventilation between CL and CO forwards (Table 4.12).

Positional Comparisons – Club Level

Midfield players were significantly taller and heavier than defensive and forward players. Chest, waist and quadriceps circumference were greater ($p<0.01$) in midfield players than defenders. There was no difference between positions in any of the other measured physical characteristics. There was no difference in flexibility, power, speed or agility between the various playing positions (Table 4.10). There was no difference in anaerobic power, anaerobic capacity (Table 4.11), % VO_2VT, VO_2max, maximal heart rate or maximal ventilation between playing positions (Table 4.12).

Positional Comparisons – County Level

Midfield players were taller ($p<0.01$) and heavier ($p<0.01$) than defensive and forward players. In addition, they had a larger biceps circumference ($p<0.05$) than forwards and a larger

waist circumference than defenders (p<0 01) and forwards (p<0 05) There was no difference between positions in any of the other measured physical characteristics There was no difference in flexibility, power, speed or agility between the various playing positions (Table 4 10) Midfield players fatigued to a greater extent than forwards (p<0 05) during trial 1 of the Wingate test (Table 4 11) County level defenders had a higher absolute and relative VO_2max than midfield and forward players (Table 4 12) There was no positional difference in anaerobic power, anaerobic capacity (Table 4 11), % VO_2VT, maximal heart rate or maximal ventilation (Table 4 12)

20 MST

The reliability of the directly measured VO_2max values, and the VO_2max values estimated from the results of the MST were assessed on a random sample of 32 players representing both club and county level Each player undertook two separate 20 MST tests and, two laboratory based VO_2max tests in random order (Appendix 5) There was a significant intraclass correlation (r=0 75,p<0 01) between the VO_2max measured during the first and second treadmill test and between the VO_2max estimated from the final level achieved in the first and the second 20 MST (r=88,p<0 01) There was a significant relation (r=0 654, p<0 01) between the number of shuttles successfully completed and measured VO_2max values and between the estimated and directly measured VO_2max (r = 0 673, p< 0 01) The largest drop-out rate during the first 20 MST occurred at the beginning of a new level The drop-out rate was highest during the mid to latter stages of a given level during the second 20 MST

Table 4 1 Anthropometric Characteristics of Combined CL and CO players

Components	Valid	Mean	Standard Deviation	Minimum	Maximum
Age (yrs)	203	23 2	4 1	16 0	40 0
Height (cm)	214	180 6	5 6	167 0	195 6
Weight (kg)	214	81 2	9 3	54 5	109 6
BMI (kg/m^2)	214	24 9	2 5	18 9	32 6
Resting heart rate (bpm)	167	62	10	40	88
Systolic blood pressure (mmHg)	168	127	11	102	160
Diastolic blood pressure (mmHg)	168	78	8	50	100

Body Composition

Components	Valid	Mean	Standard Deviation	Minimum	Maximum
Chest skinfold (mm)	204	10 5	4 5	4 0	28 0
Thigh skinfold (mm)	203	13 3	5 0	4 0	28 0
Abdomen skinfold (mm)	204	21 4	9 6	6 0	56 0
Sum of skinfolds (mm)	204	45 1	16 7	17 0	107 0
% Body Fat	204	15 8	7 5	4 1	46 4
Fat mass (kg)	204	13 2	7 5	0 0	48 9
Lean body masss (kg)	205	67 6	8 3	0 0	92 0

Physical Characteristics

Components	Valid	Mean	Standard Deviation	Minimum	Maximum
Chest circumference (cm)	212	95 9	5 5	80 0	112 0
Biceps circumference (cm)	211	32 7	2 4	25 8	39 5
Quadriceps circumference (cm)	212	57 2	5 2	31 6	69 0
Waist Circumference (cm)	212	88 0	7 7	68 0	112 0

Vertical Jump and Hamstring Flexibility

Components	Valid	Mean	Standard Deviation	Minimum	Maximum
Vertical Jump (cm)	212	53 1	6 3	39 0	74 0
Hamstring flexibility (cm)	202	22 3	6 9	6 0	39 0

Table 4 2 Percentiles of Anthropometric Characteristics of Combined CL and CO players

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Age (yrs)	19 0	20 0	20 2	21 6	23 0	24 0	25 0	26 0	28 0	40 0
Height (cm)	173 5	176 2	177 5	179 0	181 0	182 0	183 5	185 0	188 0	195 6
Weight (kg)	70 4	73 7	75 5	78 0	80 3	82 8	85 4	88 1	95 1	109 6
BMI (kg/m^2)	22 1	22 8	23 4	24 1	24 6	25 3	26 0	26 9	28 1	32 6
Resting heart rate (bpm)	50 0	54 0	57 0	60 0	62	65	68	71	75	88
Systolic blood pressure (mmHg)	114	120	120	122	126	130	130	136	142	160
Diastolic blood pressure (mmHg)	68	70	74	76	78	80	82	86	90	100

Body Composition

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest skinfold (mm)	6 0	6 5	7 0	9 0	10 0	11 0	12 0	14 0	16 0	28 0
Thigh skinfold (mm)	7 5	9 0	10 0	11 0	13 0	14 0	15 0	17 0	20 0	28 0
Abdomen skinfold (mm)	11 0	13 5	15 3	18 0	19 0	22 0	25 0	29 0	34 5	56 0
Sum of skinfolds (mm)	26 5	30 0	34 0	39 0	43 0	47 0	52 0	59 0	69 5	107 0
% Body Fat	7 4	8 9	10 8	12 7	14 7	16 7	18 6	21 6	27 3	46 4
Fat mass (kg)	5 6	7 0	8 3	9 7	11 4	13 2	15 4	19 1	24 0	48 9
Lean body masss (kg)	59 5	62 3	64 6	65 7	67 2	69 1	71 7	73 8	76 3	92 0

Physical Characteristics

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest circumference (cm)	89 5	91 5	93 0	94 0	95 5	96 5	98 2	100 1	103 5	112 0
Biceps circumference (cm)	30 0	30 7	31 5	32 0	32 5	33 0	33 9	34 5	35 8	39 5
Quadriceps circumference (cm)	52 5	54 3	55 5	56 1	57 2	58 3	59 5	61 1	62 9	69 0
Waist Circumference (cm)	78 2	81 0	83 5	85 5	88 0	89 8	91 5	94 0	99 0	112 0

Vertical Jump and Hamstring Flexibility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Vertical Jump (cm)	45 0	48 0	49 0	51 0	53 0	54 0	56 0	58 0	61 0	74 0
Hamstring flexibility (cm)	13 0	16 0	19 0	21 0	22 0	23 8	26 0	28 4	32 0	39 0

Table 4 3 Performance Characteristics of Combined CL and CO players

Cardiorespiratory response at maximal exercise

Components	Valid	Mean	Standard Deviation	Minimum	Maximum
Max VT in one breath (l)	163	2 99	0 45	1 93	5 08
Max respiratory rate (l/min ^{1})	164	55	7	41	72
Max ventilation rate (l/min ^{1})	164	120	16	70	152
Respiratory exchange ratio	163	1 13	0 06	0 96	1 31
Vol of CO2 Expired (l/min ^{1})	164	4 73	0 60	3 02	6 31
Absolute vol of O2 uptake (l/min ^{1})	164	4 28	0 53	2 85	5 52
Relative vol O2 upake (ml/kg ^{1}/min ^{1})	165	52 6	6 2	35 6	67 5
Ventilatory threshold (ml/kg ^{1}/min ^{1})	138	45 1	5 2	32 5	58 4
Ventilatory threshold (% VO2 max)	138	85 2	6 0	67 5	99 1
Heart Rate Max (bpm)	151	194	9	160	210

Anaerobic Power and Capacity

Components	Valid	Mean	Standard Deviation	Minimum	Maximum
Max absolute power (watts)	78	953 2	139 7	704 6	1379 2
T1 - Peak power per kg bwt (watts)	78	11 7	1 5	9 2	17 6
T2 - Peak power per kg bwt (watts)	78	10 0	1 3	7 1	14 8
T3 - Peak power per kg bwt (watts)	78	8 7	1 4	5 6	15 6
T1 - Percentage Fatigue (%)	78	24 3	8 0	11 9	60 1
T2 - Percentage Fatigue (%)	78	28 2	9 1	15 0	53 4
T3 - Percentage Fatigue (%)	78	27 6	9 4	10 0	61 5
T1 - Avrg power per kg bwt (watts)	78	9 7	1 0	6 1	11 9
T2 - Avrg power per kg bwt (watts)	78	8 2	0 9	5 9	10 3
T3 - Avrg power per kg bwt (watts)	78	7 2	1 0	4 5	9 2

Speed and Agility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
5 metre time (sec)	115	1 10	0 07	0 95	1 29
5 metre speed (m s ^{1})	114	4 58	0 27	3 87	5 29
5 metre acceleration (m s ^{2})	114	4 22	0 49	3 00	5 60
20 metre time (sec)	114	3 15	0 14	2 26	3 48
20 metre speed (m s ^{1})	114	6 37	0 33	5 74	8 85
20 metre acceleration (m s ^{2})	114	2 03	0 23	1 65	3 92
50m Forward Backward time (sec)	74	14 86	0 86	12 46	16 73
5m backwards time (sec)	74	1 39	0 10	1 25	1 82
5m backward speed (m s ^{1})	74	3 61	0 24	2 75	4 01
5m backward acceleration (m s ^{2})	74	2 61	0 34	1 51	3 21

Table 4 4 Percentiles of Performance Characteristics of Combined CL and CO players

Cardiorespiratory response at maximal exercise

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max VT in one breath (l)	2 47	2 63	2 72	2 83	2 92	3 06	3 18	3 35	3 55	5 08
Max respiratory rate (l/min ^{1})	46	48	51	52	54	56	58	60	64	72
Max ventilation rate (l/min ^{1})	101	107	111	117	120	126	129	133	141	152
Respiratory exchange ratio	1 06	1 08	1 10	1 11	1 13	1 14	1 16	1 18	1 21	1 31
Vol of CO2 Expired (l/min ^{1})	4 07	4 23	4 43	4 56	4 68	4 87	5 03	5 23	5 52	6 31
Absolute vol of O2 uptake (l/min ^{1})	3 58	3 90	4 02	4 14	4 26	4 37	4 55	4 70	4 98	5 52
Relative vol O2 upake (ml/kg ^{1}/min ^{1})	44 4	47 2	49 2	51 2	52 8	54 2	55 8	57 5	60 5	67 5
Ventilatory threshold (ml/kg ^{1}/min ^{1})	38 5	40 5	42 5	44 3	45 4	46 6	48 1	49 4	51 6	58 4
Ventilatory threshold (% VO2 max)	76 9	80 2	82 0	84 0	85 0	86 9	88 8	90 4	92 7	99 1
Heart Rate Max (bpm)	180	188	191	193	194	197	199	202	206	210

Anaerobic Power and Capacity

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max absolute power (watts)	765 5	836 0	857 0	893 7	952 1	976 0	1003 4	1068 8	1142 7	1379 2
T1 - Peak power per kg bwt (watts)	10 3	10 6	10 8	11 1	11 5	11 7	12 1	12 5	13 9	17 6
T2 - Peak power per kg bwt (watts)	8 5	9 0	9 3	9 5	9 8	10 1	10 4	10 9	11 3	14 8
T3 - Peak power per kg bwt (watts)	7 2	7 7	8 1	8 4	8 7	9 0	9 2	9 7	10 0	15 6
T1 - Percentage Fatigue (%)	15 5	18 0	19 6	22 1	23 8	24 6	26 5	29 9	33 7	60 1
T2 - Percentage Fatigue (%)	16 9	19 9	22 6	25 0	27 0	28 3	33 3	36 6	41 7	53 4
T3 - Percentage Fatigue (%)	16 0	20 3	23 1	24 9	26 7	28 4	31 3	33 2	39 5	61 5
T1 - Avrg power per kg bwt (watts)	8 5	9 1	9 4	9 6	9 9	10 0	10 1	10 5	10 8	11 9
T2 - Avrg power per kg bwt (watts)	6 9	7 5	7 8	8 0	8 2	8 5	8 6	9 0	9 1	10 3
T3 - Avrg power per kg bwt (watts)	6 0	6 3	6 8	7 0	7 2	7 5	7 7	8 0	8 4	9 2

Speed and Agility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
5 metre time (sec)	1 02	1 05	1 07	1 08	1 09	1 10	1 12	1 14	1 20	1 29
5 metre speed (m s ^{1})	4 17	4 39	4 45	4 54	4 60	4 65	4 69	4 79	4 92	5 29
5 metre acceleration (m s ^{2})	3 47	3 86	3 97	4 13	4 22	4 32	4 40	4 58	4 85	5 60
20 metre time (sec)	3 00	3 07	3 09	3 12	3 13	3 17	3 21	3 26	3 32	3 48
20 metre speed (m s ^{1})	6 03	6 14	6 24	6 31	6 38	6 42	6 48	6 52	6 67	8 85
20 metre acceleration (m s ^{2})	1 82	1 88	1 94	1 99	2 04	2 06	2 10	2 13	2 22	3 92
50m Forward Backward time (sec)	13 89	14 17	14 44	14 60	14 88	15 11	15 36	15 64	15 97	16 73
5m backwards time (sec)	1 29	1 31	1 33	1 36	1 38	1 40	1 43	1 47	1 53	1 82
5m backward speed (m s ^{1})	3 27	3 40	3 51	3 58	3 63	3 69	3 77	3 81	3 87	4 01
5m backward acceleration (m s ^{2})	2 14	2 31	2 46	2 57	2 64	2 72	2 85	2 90	3 00	3 21

Table 4 5 Physical characteristics of inter-county level and club level players

	Competitive Level	
Component	**County**	**Club**
Age (yr)	22 9 ± 3 4	23 5 ± 4 9
Height (cm)	180 4 ± 5 6	180 8 ± 5 7
Weight (kg)	81 3 ± 8 4	81 2 ± 10 5
BMI (m/kg ^{2})	25 ± 2 3	24 8 ± 2 7
Resting Heart Rate (bpm)	62 8 ± 9 1	61 ± 11 3
Systolic blood pressure (mmHg)	127 8 ± 12	126 6 ± 9 2
Diastolic blood pressure (mmHg)	77 3 ± 8 9	79 4 ± 6 9
Percent body fat	14 9 ± 7 3	17 0 ± 7 6 †
Bicep circumference (cm)	33 ± 2 2	32 3 ± 2 5
Chest circumference (cm)	96 ± 5 0	95 8 ± 6 0
Waist circumference (cm)	85 4 ± 6 2	91 2 ± 8 3 ‡
Quadriceps circumference (cm)	57 3 ± 4 7	57 1 ± 5 7

Values are means ± SD, ‡ P < 0 001, # P < 0 01, † P < 0 05

Table 4 6 Measures of power, speed and agility of inter-county level and club level players

	Competitive Level	
Component	**County**	**Club**
Vertical Jump	52 9 ± 6 3	53 3 ± 6 4
5m Speed (m s ^{1})	4 647 ± 0 222	4 508 ± 0 299 #
20m Speed (m s ^{1})	6 459 ± 0 354	6 256 ± 0 248 ‡
5m Backward Speed (m s ^{1})	3 639 ± 0 221	3 424 ± 0 286 #
Flexibility	23 6 ± 6 9	20 4 ± 6 5 ‡
Fastest agility time (sec)	14 756 ± 0 852	15 485 ± 0 638 #
Average agility time (sec)	15 208 ± 0 819	16 166 ± 0 584 ‡

Values are means ± SD, ‡ P < 0 001, # P < 0 01, † P < 0 05

Table 4 7 – Anaerobic power and capacity of inter-county level and club level players

	Competitive Level	
Component	**County**	**Club**
Max Power (watts)	954 ± 136 9	951 5 ± 147 5
Peak Power 1 (watts kg ^{1})	11 7 ± 1 3	11 6 ± 1 7
Peak Power 2 (watts kg ^{1})	9 9 ± 1 2	10 1 ± 1 4
Peak Power 3 (watts kg ^{1})	8 6 ± 1 6	8 7 ± 1 0
Average Power 1 (watts kg ^{1})	9 9 ± 0 9	9 4 ± 1 3
Average Power 2 (watts kg ^{1})	8 1 ± 0 9	8 2 ± 0 9
Average Power 3 (watts kg ^{1})	7 1 ± 1 1	7 2 ± 0 9
Percent Fatigue Trial 1	23 6 ± 7 8	25 6 ± 8 6
Percent Fatigue Trial 2	27 3 ± 8 4	29 9 ± 10 2
Percent Fatigue Trial 3	26 3 ± 8 5	30 ± 10 6

Values are means ± SD, ‡ P < 0 001, # P < 0 01, † P < 0 05

Percent fatigue trial 1 = ((max power trial 1) - (min power trial 1)/ (max power trial 1)) x 100

Table 4 8 – Cardiorespiratory response during maximal and submaximal exercise

	Competitive Level	
Component	**County**	**Club**
Maximal ventilation (l min ^{1})	120 9 ± 16 0	119 2 ± 15 4
VO_2max (l min ^{1})	4 28 ± 0 53	4 26 ± 0 53
VO_2max (ml kg ^{1} min ^{1})	53 1 ± 6 1	51 5 ± 6 2
VT% VO_2	85 6 ± 5 8	84 2 ± 6 4
Maximal heart rate	194 7 ± 9 5	191 9 ± 8 9

Values are means ± SD, ‡ P < 0 001, # P < 0 01, † P < 0 05

Table 4 9 Physical characteristics of inter-county level and club level players by position

	Goalkeeper		Defender		Midfielder		Forward	
Component	**Intercounty**	**Club**	**Intercounty**	**Club**	**Intercounty**	**Club**	**Intercounty**	**Club**
Age (yr)	23 4 ± 4 3	23 2 ± 3 8	22 7 ± 2 5	23 5 ± 5 1	23 3 ± 4 4	25 1 ± 4 5	22 9 ± 3 5	22 4 ± 5 0
Height (cm)	181 5 ± 6	180 0 ± 5 3	178 3 ± 4 8	179 4 ± 4 8	186 2 ± 4 7#df	186 4 ± 4 5‡df	179 5 ± 4 8	179 7 ± 5 6
Weight (kg)	80 1 ± 8 2	85 9 ± 14 4	79 7 ± 6 9	77 5 ± 7 4	87 7 ± 7 9#df	90 3 ± 9 5 ‡d#f	79 8 ± 8 8	80 3 ± 11 0
BMI (m/kg)2	24 3 ± 1 6	26 5 ± 4 0	25 1 ± 1 9†pl	24 1 ± 2 1	25 3 ± 2 2	26 0 ± 2 8	24 8 ± 2 8	24 8 ± 2 8
Resting heart rate (b min ^{1})	67 7 ± 11 7	62 7 ± 17 5	63 ± 9 7	62 ± 12	62 1 ± 8 7	61 1 ± 9 6	62 2 ± 8 3	59 2 ± 10 9
Systolic blood pressure (mmHg)	134 6 ± 15 1	132 ± 5 3	126 6 ± 11 3	126 1 ± 11	125 6 ± 9 8	128 2 ± 7 8	128 9 ± 13 1	125 5 ± 7 6
Diastolic blood pressure (mmHg)	82 9 ± 8 6	78 7 ± 9 5	77 6 ± 8 6	79 6 ± 6 7	75 2 ± 8 7	78 4 ± 8 4	77 2 ± 9 3	79 9 ± 6 8
% Body Fat	13 5 ± 8	22 4 ± 8 7	13 6 ± 6 4	14 8 ± 6 2	15 9 ± 8 7	19 4 ± 9 4	15 6 ± 7 3	17 8 ± 7 5*
Bicep circumference (cm)	31 9 ± 2 2	34 3 ± 4 0	32 9 ± 1 9†pl	31 9 ± 2 1	34 3 ± 2 1†f	33 3 ± 2 4	32 6 ± 2 2	32 0 ± 2 7
Chest circumference (cm)	96 2 ± 3 9	101 0 ± 7 3	95 5 ± 4 5	93 6 ± 3 9	98 7 ± 5 2	99 8 ± 5 5#d	95 1 ± 5 3	95 7 ± 7 0
Waist circumference (cm)	85 9 ± 6 8	97 4 ± 12 7	83 7 ± 4 7#pl	88 0 ± 7 0	89 6 ± 6 3#pl#d†f	96 1 ± 5 8#d	84 9 ± 6 5‡pl	91 7 ± 8 7
Quadricep circumference (cm)	57 2 ± 4 8	60 0 ± 6 1	56 6 ± 4 9	55 5 ± 6 3	59 1 ± 3 7	60 4 ± 4 0†d	57 1 ± 5 1	56 8 ± 4 7

Values are means ± SD, ‡ P < 0 001, # P < 0 01, † P < 0 05, pl, club level player vs county level player of same position, d,different to defender of equal playing level, m, different to midfielder of equal playing level, f, different to forward of equal playing level

Table 4 9 Physical characteristics of inter-county level and club level players by position

	Goalkeeper		Defender		Midfielder		Forward	
Component	**Intercounty**	**Club**	**Intercounty**	**Club**	**Intercounty**	**Club**	**Intercounty**	**Club**
Age (yr)	23 4 ± 4 3	23 2 ± 3 8	22 7 ± 2 5	23 5 ± 5 1	23 3 ± 4 4	25 1 ± 4 5	22 9 ± 3 5	22 4 ± 5 0
Height (cm)	181 5 ± 6	180 0 ± 5 3	178 3 ± 4 8	179 4 ± 4 8	186 2 ± 4 7#df	186 4 ± 4 5‡df	179 5 ± 4 8	179 7 ± 5 6
Weight (kg)	80 1 ± 8 2	85 9 ± 14 4	79 7 ± 6 9	77 5 ± 7 4	87 7 ± 7 9#df	90 3 ± 9 5 ‡d#f	79 8 ± 8 8	80 3 ± 11 0
BMI (m/kg)2	24 3 ± 1 6	26 5 ± 4 0	25 1 ± 1 9†pl	24 1 ± 2 1	25 3 ± 2 2	26 0 ± 2 8	24 8 ± 2 8	24 8 ± 2 8
Resting heart rate (b min ^{1})	67 7 ± 11 7	62 7 ± 17 5	63 ± 9 7	62 ± 12	62 1 ± 8 7	61 1 ± 9 6	62 2 ± 8 3	59 2 ± 10 9
Systolic blood pressure (mmHg)	134 6 ± 15 1	132 ± 5 3	126 6 ± 11 3	126 1 ± 11	125 6 ± 9 8	128 2 ± 7 8	128 9 ± 13 1	125 5 ± 7 6
Diastolic blood pressure (mmHg)	82 9 ± 8 6	78 7 ± 9 5	77 6 ± 8 6	79 6 ± 6 7	75 2 ± 8 7	78 4 ± 8 4	77 2 ± 9 3	79 9 ± 6 8
% Body Fat	13 5 ± 8	22 4 ± 8 7	13 6 ± 6 4	14 8 ± 6 2	15 9 ± 8 7	19 4 ± 9 4	15 6 ± 7 3	17 8 ± 7 5*
Bicep circumference (cm)	31 9 ± 2 2	34 3 ± 4 0	32 9 ± 1 9†pl	31 9 ± 2 1	34 3 ± 2 1†f	33 3 ± 2 4	32 6 ± 2 2	32 0 ± 2 7
Chest circumference (cm)	96 2 ± 3 9	101 0 ± 7 3	95 5 ± 4 5	93 6 ± 3 9	98 7 ± 5 2	99 8 ± 5 5#d	95 1 ± 5 3	95 7 ± 7 0
Waist circumference (cm)	85 9 ± 6 8	97 4 ± 12 7	83 7 ± 4 7#pl	88 0 ± 7 0	89 6 ± 6 3#pl#d†f	96 1 ± 5 8#d	84 9 ± 6 5‡pl	91 7 ± 8 7
Quadricep circumference (cm)	57 2 ± 4 8	60 0 ± 6 1	56 6 ± 4 9	55 5 ± 6 3	59 1 ± 3 7	60 4 ± 4 0†d	57 1 ± 5 1	56 8 ± 4 7

Values are means ± SD, ‡ P < 0 001, # P < 0 01, † P < 0 05, pl, club level player vs county level player of same position, d,different to defender of equal playing level, m, different to midfielder of equal playing level, f, different to forward of equal playing level

Table 4 10 Measures of Power, speed and agility of inter-county level and club level players grouped by position

	Goalkeeper		Defender		Midfielder		Forward	
Component	**Intercounty**	**Club**	**Intercounty**	**Club**	**Intercounty**	**Club**	**Intercounty**	**Club**
Flexibility	23 9 ± 9 8	20 4 ± 4 0	24 8 ± 6 6#pl	20 2 ± 6 1	24 5 ± 7	20 8 ± 8 8	21 8 ± 6 4	20 5 ± 5 9
Fastest agility time (sec)	14 702 ± 1 042	15 966	14 779 ± 0 856	15 486 ± 0 730	14 458 ± 0 735	15 469 ± 0 04	14 856 ± 0 888	15 373 ± 0 855
Average agility time (sec)	15 057 ± 1 2	16 68	15 227 ± 0 802	15 951 ± 0 242	15 029 ± 0 794	15 991 ± 0 384	15 282 ± 0 825†pl	16 340 ± 0 904
Vertical Jump	53 5 ± 5 8	54 8 ± 7 7	53 2 ± 5 1	53 7 ± 5 4	54 8 ± 8 1	54 3 ± 7 5	51 6 ± 6 4	51 8 ± 6 7
5m Speed ($m\ s^{-1}$)	4 656 ± 0 418	4 467±0 267	4 639 ± 0 211	4 520 ± 0 219	4 724 ± 0 235	4 473 ± 0 295	4 624 ± 0 197	4 522 ± 0 392
20m Speed ($m\ s^{-1}$)	6 319 ± 0 214	6 187±0 287	6 402 ± 0 178†pl	6 274 ± 0 211	6 742 ± 0 818	6 200 ± 0 220	6 44 ± 0 156	6 282 ± 0 303
5m Backward Speed ($m\ s^{-1}$)	3 765 ± 0 204	3 571 ± 0	3 628 ± 0 258†pl	3 311 ± 0 388	3 667 ± 0 195	3 607 ± 0 016	3 618 ± 0 189	3 408 ± 0 274

Values are means ± SD, † P < 0 05, # P < 0 01, ‡ P < 0 001, club level player vs county level player, a, different to county level goalkeeper, b, different to county level defender, c, different to county level midfielder, d, different to county level forward, e, different to club level goalkeeper, different to club level, f, defender, g, different to club level midfielder, h, different to club level forward

Table 4 11 Measures of Anaerobic Power and Capacity of inter-county level and club level players grouped by position

	Goalkeeper		Defender		Midfielder		Forward	
Component	**Intercounty**	**Club**	**Intercounty**	**Club**	**Intercounty**	**Club**	**Intercounty**	**Club**
Max Power (watts)	881 6 ± 63 1	992 9	932 7 ± 96 7	918 7 ± 166 4	1061 7 ± 158 1	984 4 ± 71 6	930 3 ± 143 9	987 3 ± 150 5
Peak Power 1 (watts kg ^{1})	10 6± 0 1†pl(1v3)	9 9	11 7 ± 0 9	11 4 ± 1 2	12 3 ± 2 1	10 9 ± 0 9	11 7 ± 1 1	12 4 ± 2 6
Peak Power 2 (watts kg ^{1})	9 ± 0 4	7 7	10 1 ± 1 1	10 5 ± 1 4	10 4 ± 1 6	9 8 ± 0 6	9 5 ± 1 1	10 1 ± 1 5
Peak Power 3 (watts kg ^{1})	8 3 ± 0 2†pl(n=3)	6 6	8 6 ± 1	9 1 ± 0 7	9 7 ± 2 4	8 7 ± 0 6	8 2 ± 1 4	9 2 ± 1 5
Average Power 1 (watts kg ^{1})	8 9 ± 0 9	8	10 ± 0 8	9 4 ± 1 1	9 8 ± 1	9 3 ± 0 5	9 9 ± 0 8	9 7 ± 1 8
Average Power 2 (watts kg ^{1})	7 6 ± 0 7	6 3	8 3 ± 1	8 4 ± 0 5	8 3 ± 0 9	7 9 ± 0 8	7 9 ± 0 9	8 2 ± 1 2
Average Power 3 (watts kg ^{1})	6 5 ± 0 4	5 5	7 3 ± 0 9	7 5 ± 0 7	7 6 ± 1 1	7 4 ± 0 5	6 8 ± 1 1	7 ± 1 2
Percent Fatigue Trial 1	19 4 ± 12 5	34	23 ± 4 7	21 8 ± 4 9	29 9 ± 11 7†f	22 3 ± 4 9	21 5 ± 7 8‡pl	32 9 ± 9 6
Percent Fatigue Trial 2	25 3 ± 10 3	34 2	26 3 ± 8 2	29 1 ± 11 2	33 1 ± 8 6	29 1 ± 9 3	25 6 ± 7 5	31 4 ± 10 2
Percent Fatigue Trial 3	33 5 ± 7 7	26 1	24 4 ± 7 4	27 8 ± 9 5	31 4 ± 11	27 ± 9 5	24 4 ± 6 9#pl	35 9 ± 12 7*

Values are means ± SD, † P < 0 05, # P < 0 01, ‡ P < 0 001, club level player vs county level player, a, different to county level goalkeeper, b, different to county level defender, c, different to county level midfielder, d, different to county level forward, e, different to club level goalkeeper, f, different to club level defender, g, different to club level midfielder, h, different to club level forward

Table 4 12 Cardiorespiratory response at maximal exercise of inter-county level and club level players grouped by position

	Goalkeeper		Defender		Midfielder		Forward	
Component	**Intercounty**	**Club**	**Intercounty**	**Club**	**Intercounty**	**Club**	**Intercounty**	**Club**
Maximal ventilation (l min ^{1})	123 5 ± 20 1	119 2 ± 13 3	124 1 ± 15 1	119 1 ± 18 1	124 3 ± 16 4	122 2 ± 8 2	115 3 ± 14 9	117 7 ± 15 7
Respiratory exchange ratio	1 13 ± 0 05	1 13 ± 03	1 15 ± 0 07	1 13 ± 0 06	1 13 ± 0 05	1 11 ± 0 04	1 12 ± 0 06	1 11 ± 0 06
VCO2 (l/min)	4 73 ± 0 85	4 78 ± 0 42	4 92 ± 0 59	4 66 ± 0 65	4 89 ± 0 57	4 92 ± 0 52	4 51 ± 0 51	4 59 ± 0 61
VO_2 (l/min)	4 11 ± 0 67	4 27 ± 0 34	4 44 ± 0 53	4 21 ± 0 58	4 4 ± 0 55	4 47 ± 0 34	4 09 ± 0 45	4 23 ± 0 59
VO_2max (ml kg ^{1} min ^{1})	51 5 ± 7 3	51 9 ± 8 4	55 4 ± 5 3	52 9 ± 5 9	51 9 ± 5 7	48 0 ± 6 0	51 5 ± 6 3	51 4 ± 6 2
VT as % VO_2max	86 8 ± 6 6	84 3 ± 11 5	84 7 ± 4 9	83 3 ± 6 6	86 0 ± 8 0	85 9 ± 3 1	86 2 ± 5 7	84 4 ± 7 2
Heart rate maximum	200 3 ± 7 7†pl	184 ± 9 9	193 9 ± 9 4	192 ± 8 3	193 4 ± 7 7	188 4 ± 7 7	195 3 ± 10 6	194 7 ± 9 9

Values are means ± SD, , † P < 0 05, # P < 0 01, ‡ P < 0 001, club level player vs county level player, a, different to county level goalkeeper, b, different to county level defender, c, different to county level midfielder, d, different to county level forward, e, different to club level goalkeeper, f, Different to club level defender, g, different to club level midfielder, h, different to club level forward

Reliability and Validity of the 20 MST

Table 4 13 Reliability and Validity of the 20 MST

Component	Mean values ± SD (N=32)	Range (Min – Max)
1st and 2nd VO_2max		
1st VO_2max	52 6 ± 5 7	40 6-63 1
2nd VO_2max	54 5 ± 6 0	42 9-67 2
Average VO_2max	53 6 ± 1 0	42 3-64 3
Difference between 1st & 2nd VO_2max	1 9 ± 0 7	-12 6-8 0
1st 20 MST		
1st estimated VO_2max (20MST)	54 0 ± 0 7	47 4-61 4
Level reached on 1st 20MST	11 6 ± 0 2	10-14
Shuttle reached in 1st 20MST	5 9 ± 0 6	1-12
Total shuttle runs completed on 1st 20MST	103 4±2 5	81-129
2nd 20 MST		
2nd estimated VO_2max (20MST)	53 8 ± 0 7	47 1-61 6
Level reached on 2nd 20MST	11 5 ± 0 2	10-14
Shuttle reached in 2nd 20MST	6 0 ± 0 6	1-13
Total shuttle runs completed on 2nd 20MST	102 1±2 3	80-129
Average 20MST scores		
Average estimated VO_2max	53 9 ± 0 7	47 9-61 5
Average level reached in 20MST	11 6 ± 1 1	10 0-14 0
Average shuttle reached in 20MST	2 9 ± 3 6	-3 ± 10 5
Average total number of runs completed	102 8 ± 2 3	83-129
Difference between VO_2max and 20MST		
Difference between average level reached	0 1 ± 0 6	-1 0 ± 1 0
Difference between average shuttle reached	0 2 ± 4 3	-9 ± 9
Difference between 1st and 2nd 20MST	0 2 ± 0 3	-3 2-5 3
Difference between number of runs completed	1 3 ± 1 3	-10 0-19 0
Difference between VO_2max and 20MST	-3 3±0 7	-8 5-9 3

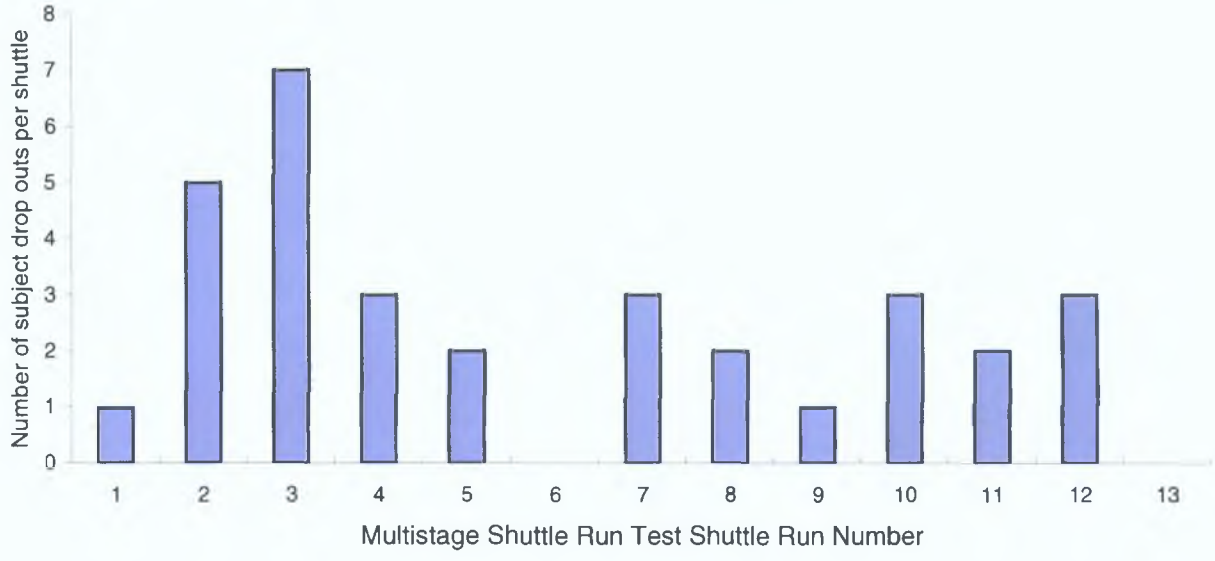


Figure 4.1 Number of subjects who dropped out at each shuttle run number – Test 1

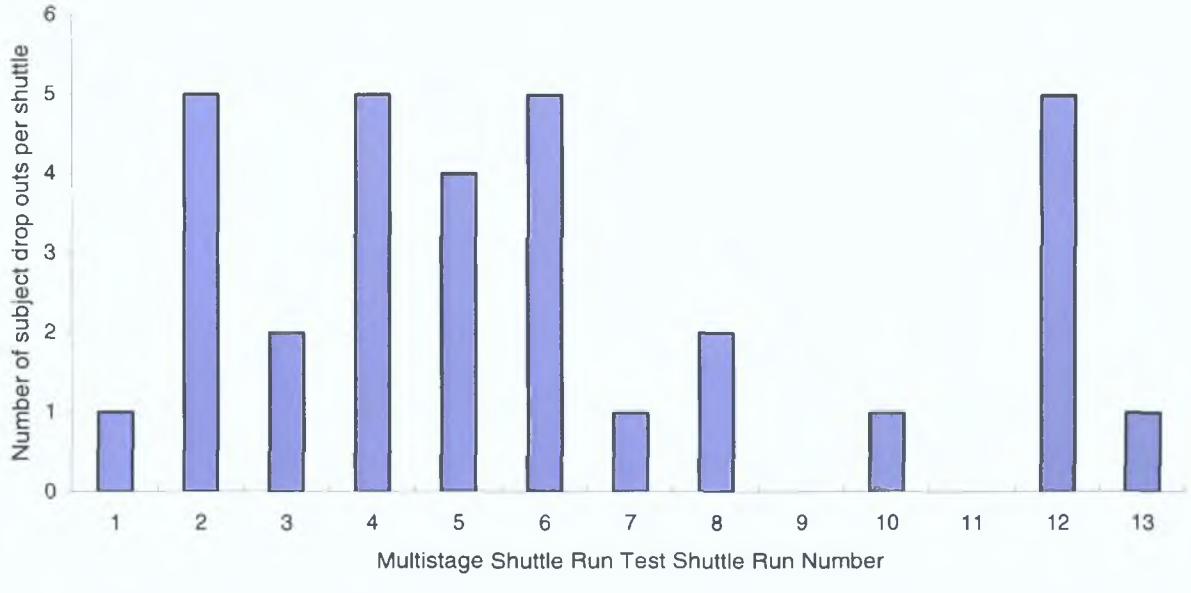


Figure 4.2 Number of subjects who dropped out at each shuttle run number – Test 2

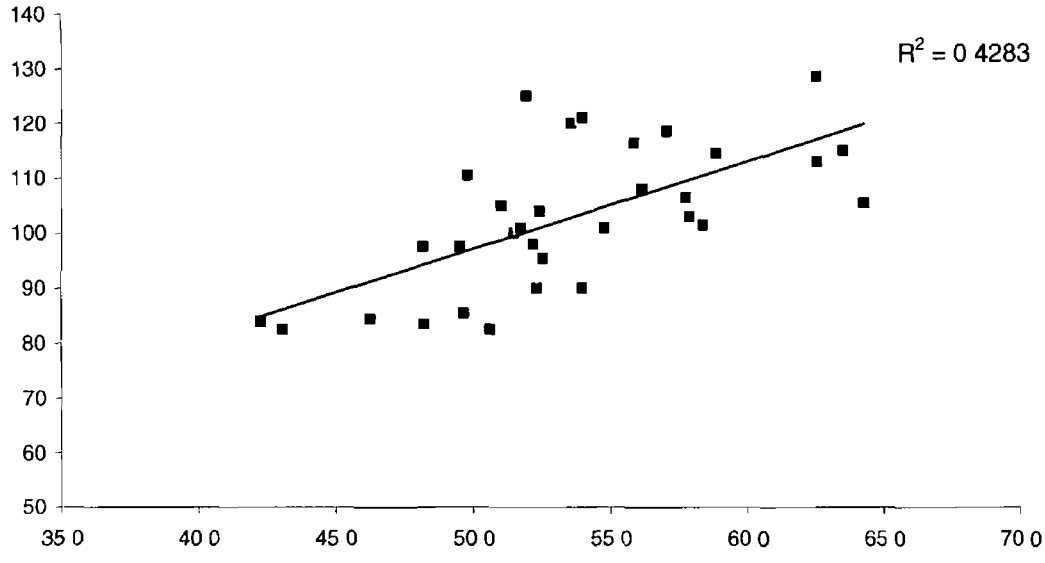


Figure 4 3 Regression analysis of measured VO_2max versus number of 20MST runs completed

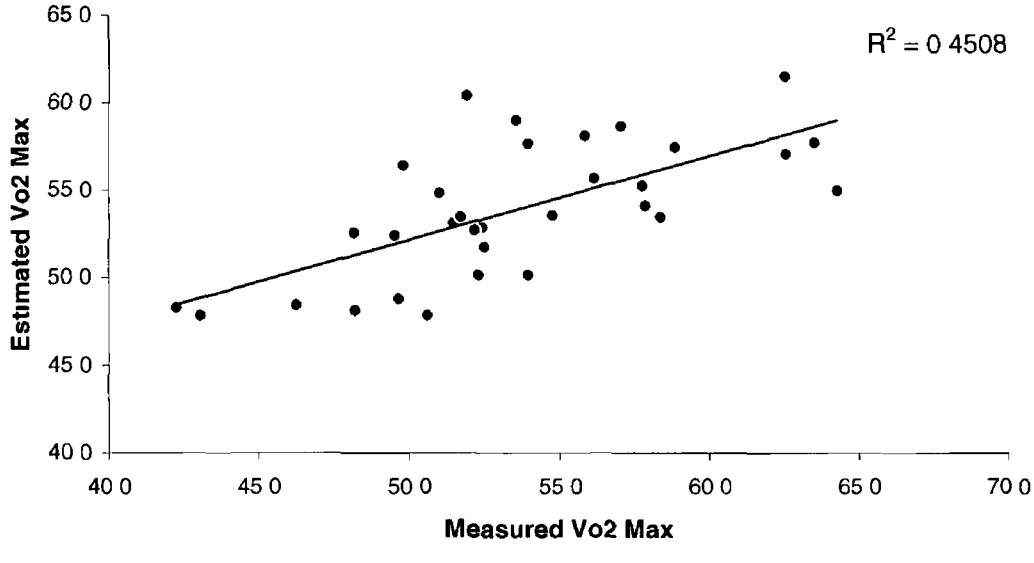


Figure 4 4 Regression analysis of estimated VO_2max versus measured VO_2max

Chapter 5

Discussion

The primary aim of the study was to assess the anthropometric characteristics and fitness levels of CO and CL Gaelic football players In addition, the study examined the accuracy of the 20 MST in predicting VO_2max in Gaelic football players Anthropometric characteristics and physical fitness may determine success in Gaelic football (5) In addition, knowledge of physical characteristics may be used to assist with team selection and tactical roles Taller players are usually positioned in midfield where height is a distinct advantage In contrast, smaller more agile players are assigned to wide positions where acceleration and agility are important attributes for optimal performance

Both CO and CL midfield players were taller and heavier than defenders and forward players The higher percent body fat and greater waist circumference in CL than CO can be attributed in part to the smaller number of training sessions and lower intensity of play during club level competitions Studies in Gaelic football (4) and other team sports (34,62-66) have reported positional differences in physical characteristics Waist circumference was greater in CL than CO defenders, midfield players and forwards players CO defenders had a higher BMI, larger bicep circumference, and greater hamstring flexibility than club level defenders Chest, waist and quadriceps circumference were greater in CL midfield players than CL defenders CO midfield players had a larger biceps circumference ($p<0.05$) than forwards and a larger waist circumference than defenders and forwards It is not known whether these small anthropometric differences are due to training adaptations or if they have any impact on performance during competition

Estimated body fat values in CO players are similar to those reported by others (3,5) These values are greater than those reported for endurance athletes The relatively high percent body fat in CL players is of some concern and may reflect a less intensive training regime and poorer dietary habits than CO players Club mentors should encourage players to attain body fat levels close to 15% Average BMI values for both CO players and CL players were similar to that observed for players of a *successful senior intercounty team* (5) In sports, weight bearing activities, non-functional weight such as excess body fat may have a deleterious effect on performance It was not surprising to find that CO players outperformed CL players in components of speed, agility and flexibility

Power is the amount of work a muscle or muscle group can produce per unit time (67) It is generated on a neuromuscular level and is influenced by motor unit activation and motor unit synchronisation, (68,69) The vertical jump is a commonly used test to assess leg power Vertical jump performance was lower in Gaelic football players than other sports such as basketball, volleyball and the high-jump where there is an increased emphasis on jumping It could be argued that with the exception of mid-field players, the ability to jump vertically is no longer an important fitness attribute for optimal performance in the modern game

The higher vertical jump performance scores found in other sports may be attributed to the fact that more time is devoted to developing both power and jumping technique in these sports There is evidence that *improvements in timing and coordination* abilities, and in the capacity to benefit from effective use of the stretch shorten muscle cycle will improve vertical jump performance (56,70) The unique fitness requirements of Gaelic football necessitates that players develop a number of fitness components simultaneously (71) There is evidence that concurrent strength/power and endurance training may have a negative impact on power development (21,71,72)

There was no difference in anaerobic power and anaerobic capacity between CO and CL players To my knowledge this was the first study to assess maximal anaerobic power in GF players domiciled in Ireland using the Wingate gate Maximum power outputs for both CO and CL were similar to those found in English based CL Gaelic football players (35) It was expected that indices of anaerobic power and anaerobic capacity would be higher in CO than CL due to the training regimens and playing intensities associated with intercounty football It is possible that the testing modality may have influenced the results Specificity of testing is an important factor to consider when assessing fitness An appropriate running test may be a more valid measure of anaerobic performance in Gaelic football players

Since inter-county competitions are played at a much higher intensity than club level competitions, it was no surprise to find that the indices of forward and backward running speed evaluated were greater in CO than CL players Since innate running speed is an important physical attribute when selecting intercounty players it is likely that the difference in running speed between CO and CL players result from a self-selection bias

The aerobic fitness levels VO_2max of GF players were comparable with the lower range of values reported for elite soccer players (11-13,15,21,62), (12-16) but higher than values reported for English club level GF players (4) Although the data was collected during the pre-season it was expected that CO players would have a higher level of aerobic fitness than CL players, due to the training regimens and playing intensities associated with inter-county football (73) The data would suggest that CO players loose most of or all of their aerobic fitness during the off-season More studies are needed to investigate the training and/or detraining patterns of CO and CL players during the off-season Furthermore, studies are required to evaluate the volume and intensity of training *that is required to maintain* aerobic fitness during the off-season

Considering that mid-field players cover the greatest distance during the course of game (1) it was expected that they would have the highest VO_2max values However, the absolute and relative VO_2max values were higher in CO defenders than CO midfield players and forward players Unlike midfield players and forward players the activity levels and recovery times of defenders are for the most part not self-selected but are controlled externally This may result in higher physiological demands placed on defenders during both competitive games and training

The 20 MST is a commonly used field-test to assess aerobic capacity in Gaelic football players However, no published study has examined the validity of the 20 MST as an accurate predictor of maximal aerobic capacity The results from the present study suggest that the 20 MST is a modest predictor of VO_2max in GF players Results from a number of studies that have assessed the validity of the 20 MST as an accurate predictor of VO_2max have been equivocal (37,40-47,74,75) Correlation coefficients ranging from 0 76 to 0 93 have been reported in school children (37,38) college level students (40,41) healthy adults attending fitness class (42,43) and, athletes (44,45) Ramsbottom et al (1988) (76) reported a strong correlation (r=0 92) between the final level attained during the 20 MST and measured VO_2max in 36 men and 38 women across a range of fitness levels (76) A similar result was found in 12 to 15 year old American children (38) Paliczka et al (1987) (43) found the 20 MST to be a valid predictor of both VO_2max and running performance over 10km, in 9 healthy young male (43) The use of the 20MST as a valid predictor of VO_2max in all sports is questioned by the findings of St Clair Gibson (1998) (47), who concluded that the 20MST is not as reliable when used on athletes who have trained in a particular manner for the specific demands of their sport She found a poor correlation between predicted VO_2max values and measured VO_2max values in squash players (r=0 61) but not in runners (r =0 71)

The largest drop-out rate during the first 20 MST occurred at the beginning of a new level This supports earlier findings that verbal cueing and the knowledge that speed requirements are increased at the beginning of each new level will influence the subjects motivation during the 20MST, and may have a negative impact on overall performance scores (44) The drop-out rate was highest during the mid to latter stages of a given level during the second 20 MST Players knew the result of their initial trial and although they were not informed of the purpose of the retest, some players admitted setting a target of improving on the results of their initial test

The ability of players to set a goal or target score prior to the test is a limitation of the 20 MST A modified 20 MST has been developed that negates goal setting by removing the verbal cues at the beginning of each level and increases running speed in an incremental manner throughout a given level rather than at the beginning of the level (44) Performance during the modified 20 MST has been shown to be a valid predictor (r = 0 91) of VO_2max (44)

Maximal aerobic capacity provides little information regarding the metabolic responses during submaximal exercise Significant improvements in endurance exercise performance can occur despite little or no change in VO_2max (50) Alterations in blood lactate levels during submaximal exercise may be a better indicator of training induced improvements in endurance performance that are changes in VO_2max (77) Indeed, the VO_2 or workload at which blood lactate exhibits an abrupt nonlinear increase above resting level called the lactate threshold (LT), has been found to be a better predictor of endurance performance than is VO_2max (78,79)

The detection of the lactate threshold requires the collection of blood samples Endogenous buffering of lactic acid during exercise results in an increased production of

VCO_2 and a concomitant increase in minute ventilation (Ve) The exercise intensity at which Ve and VCO_2 increase more rapidly than VO_2 is called the ventilatory threshold (VT) This threshold provides a sensitive non-invasive method of determining the LT Surprisingly, the % VO_2, corresponding to the VT was similar in both CO and CL players This is a surprising finding as it was expected that CO players would exhibit a higher VT This should raise concerns about the efficacy of the training programs currently undertaken by CO players To my knowledge this is the first study to examine indices of submaximal endurance performance in GF players

Conclusion

The fact that the majority of anthropometric and fitness characteristics were similar in CO and CL players suggests that a significant detraining effect occurs in CO players during the off-season In order to ascertain the extent of detraining it is recommended that fitness assessments are undertaken toward the end of the competitive season Fitness levels could be developed and maintained more effectively if an appropriate off-season training programme was implemented This would help to attenuate the loss in fitness levels that occur during the off-season

Players, both CO and CL tended to perform well in some components of fitness, and poor in others Large ranges in fitness levels were evident among players in the same position and playing level despite having similar playing demands This would indicate that the system of group training or "one size fits all approach" currently employed by coaches fails to account for intra-individual differences, and position specific fitness requirements

There is no ideal training blueprint for Gaelic football The one size fits all approach that is currently adapted by the majority of intercounty teams fails to take account of the individual differences in various fitness components, or the specific requirement of each

playing position Ideally, training programmes should take into account the level of competition and the position specific bioenergetic demands The findings in the present study are based on data collected in the preseason It is recommended that tracking studies be undertaken to fitness levels over a number of years In addition, there is an urgent need to develop valid and reliable field tests to assess the various fitness components that are important for success in Gaelic football The development of normative data tables for each fitness components would greatly assist coaches in developing short and long- term training programmes

Limitations

Due to time and resource constraints a limited number of tests were performed Each test has its own limitations For example, although the vertical jump and sprint tests are categorised as anaerobic power tests they may not be the most accurate measures of anaerobic power (70) In addition, the vertical jump protocol was unable to assess a player's ability to take a run up and jump off one foot Flexibility assessment was limited to measurement of hamstring and lower back flexibility and only one component of agility was assessed

The Wingate test is not ideal for assessing anaerobic power in weight bearing activities Likewise, the treadmill test that was used to assess VO_2max does not reflect the intermittent nature of Gaelic football A number of field tests have been validated to assess fitness levels in soccer (25,80,81), a sport which has similar playing demands to Gaelic football Similar validation studies should be undertaken in Gaelic football players Comprehensive time and motion analysis studies that identify the typical demands of a given playing position would help to improve our understanding of the training and physical fitness requirements for different levels of competition

Reference List

1 Keane S, Reilly T, Hughes M Analysis of Work Rates in Gaelic Football Aust J Sci Med Sport 1993,100-2

2 American Thoracic Society ATS/ACCP Statement on Cardiopulmonary Exercise Testing Am J Respir Crit Care Med 2003,167 211-77

3 Reilly T, Doran D Science and Gaelic Football A review J Sport Sci 2001,19 181-93

4 Florida - James G, Reilly T The Physiological demands of Gaelic Football Br J Sp Med 2004,29 41-5

5 Watson AWS Physical and fitness characteristics of successful Gaelic footballers Br J Sports Med 1995,29 229-31

6 Keane S, Reilly T, Borne A A Comparrison of Fitness Characteristics of Elite and Non-Elite Gaelic Football Players, In Science and Footballl III, eds , Reilly,T , Bangsbo, J , Mughes, M , London E & FN Spon, 1997, 3-6

7 Hennessy L, Watson AWS Flexibility and posture assessment in relation to hamstring injury Br J Sports Med 1993,27 243-6

8 Reilly T Physiological profile of the player In Football (Soccer), ed Ekblom B, Oxford Blackwell Scientific, 1994 78-94

9 Pincivero, D M , Bompa,T O , A Physiological Review of American Football Sports Med 1997,23 247-60

10 Reilly T, Keane S The Effect of Carbohydrate Supplementation on the Work Rate of Gaelic Football Players In Science and Football IV, eds , Spinks, W ,Murphy,A , Reilly, T ,2002 234-8

11 Davis JA, Brewer J, Atkin D Pre-season physiological characteristics of English first and second division soccer players J Sport Sci 1992,10 541-7

12 Nowacki PE, Cai DY, Buhl C, Krummelbein U Biological performance of German soccer players (professionals and juniors) tested by special ergometry and treadmill methods In Science and Football, eds Reilly T, Davis K, Murphy WJ, London E & FN Spon, 1988 145-57

13 Rhodes EC, Mosher RE, McKenzie DC, Franks IM, Potts JE Physiological profiles of the Canadian Olympic soccer team Can J Appl Sport Sci 1986,11 31-6

14 Thomas V, Reilly T Fitness assessment of English League soccer players throughout the competitive season Br J Sports Med 1979,13 103-9

15 White JE, Emery TM, Kane JL, Groves R, Risman AB Pre-season fitness profiles of professional soccer players In Reilly T, Less A, Davis K, Murphy WJ, eds Science and Football London E & F N Spon , 1988 164-71

16 Zernicke RF, Loitz BJ In Football(Soccer) In Blackwell Scientific, 1994 77-95

17 Wadley G, Le Rossignol P The Relationship Between Repeated Sprint Ability and the Aerobic and Anaerobic Systems J Sci Med Sport 1998,1 100-10

18 Dawson B Physical and physiological characteristics of eight league footballers Sports Coach 1985,9 33-6

19 Hoff J, Wisloff U, Engen LC, Kemi OJ, Helgerud J Soccer specific aerobic endurance training Br J Sports Med, 2002,36 218-21

20 Smaros G Energy Usage During a Football Match In Vecchiet,L , editor Proceedings of the 1st International Congress on Sports Medicine Applied to Football, Rome, 1980 795-801

21 Wisloff U, Helgerud J, Hoff J Strength and Endurance of Elite Soccer Players Med Sci Sports Exerc 1998,30 462-7

22 Apor P Successful formulae for fitness training In Reilly T, Less A, Davis K, Murphy WJ, eds Science and Football London E & F N Spon , 1988 95-107

23 Roi GS, Pea G, De Rocca G et al Relationship between maximal aerobic power and performance of a professional soccer team In Reilly T, Larys J, Stibbe A, eds Science and Football II London E & F N Spon, 1993 146-50

24 Faina M, Gallozzi C, Lupo S, Colli R, Sassi R, Marini C Definition of the physiological profile of the soccer player In Reilly T, Less A, Davis K, Murphy WJ, eds Science and Football London E & F N Spon , 1988 158-63

25 Bangsbo J The physiology of soccer with special reference to intense intermittent exercise Acta Physiologica Scandinavica 1994,619 1-155

26 Noakes TD, Myburgh KH, Schall H Mean treadmill velocity during the VO2 max test predicts running performance J Sport Sci 1990,8 35-45

27 Gastin PB Energy System Interaction and Relative Contribution During Maximal Exercise Sports Med 2001,31 725-41

28 Bogdanis GC, Nevill ME, Boobis LH Recovery of power output and muscle metabolites following 30 s of maximal sprint cycling in man J Physiol 1995,482 467-80

29 Bonen A, Campbell C, Kirby R, Belcastro A Relationship between slow twitch muscle fibres and lactic acid removal Can J Appl Sport Sci 1978,3 160-2

30 Gaesser G, Brooks G Metabolism of lactate after prolonged exercise to exhaustion Med Sci Sports Exerc 1979,11

31 Harris R, Edwards R, Hultman E The time course of phosphocreatine resynthesis during recovery of the quadriceps muscle in man Pflugers Arch 1976,367 137-42

32 Hultman E, Bergstrom J, McLenan-Anderson N Breakdown and resynthesis of phosphorlycreatine and adenosine triphosphate in connection with muscular work in man Scand J Clin Invest 1967,19 56-66

33 Yoshida T, Watari H Metabolic consequences of repeated exercise in long duration runners Eur J Appl Physiol 1993,67 261-5

34 Tomlin DL, Wenger HA The Relationship Between Aerobic Fitness and Recovery from High Intensity Intermittent Exercise Sports Med 2001,31 1-11

35 Kirgan B, Reilly T A fitness evaluation of Gaelic football club players In Reilly T, Clarys J, Stibbe A, eds Science and Football II London E & FN Spon, 1993 59-61

36 Boreham CA, Palicza VJ, Nichols AK A comparrison of the PWC170 and 20 MST tests of aerobic fitness in adolescent school children J Sports Med Phys Fitness 1990,30 19-23

37 Leger LA, Mercier D, Gadoury C, Lambert J The multistage 20 metre shuttle run for aerobic fitness J Sport Sci 1988,6 93-101

38 Liu NY, Plowman SA, Looney MA The reliability and validity of the 20-meter shuttle test in American students 12 to 15 years old Res Q Exerc Sport 1992,63 360-5

39 Mahoney C 20 MST and PWC 170 validity in non-Caucasian children in the UK Br J Sports Med 1992,26 45-7

40 Grant S, Corbett K, Amjad AM, Wilson J, Aitchison T A comparison of methods of predicting maximum oxygen uptake Br J Sports Med 1995,29 147-52

41 McNaughton L, Hall P, Cooley D Validation of several methods of estimating maximal oxygen uptake in young men Percept Mot Skills 1998,87 575-84

42 Leger LA, Lambert J A maximal multistage 20-m shuttle run test to predict VO2 Max Eur J Appl Physiol Occup Physiol 1982,49 1-12

43 Paliczka VJ, Nichols AK, Boreham CA A multi-stage shuttle run as a predictor of running performance and maximal oxygen uptake in adults Br J Sports Med 1987,21 163-5

44 Wilkinson DM, Fallowfield JL, Myers SD A modified incremental shuttle run test for the determination of peak shuttle running speed and the prediction of maximal oxygen uptake J Sports Sci 1999,17 413-9

45 Lambert S, Chow C Direct Measurement of VO2 Max During a 20 Metre Shuttle Run in Sub-Elite Netball Players October 31, 99 A D , Sydney

46 Sproule J, Kunalan C, McNeill M, Wright H Validity of 20MST for predicting VO2 max of adult Singaporean athletes Br J Sports Med 1993,27 202-4

47 St Claire Gibson A, Broomhead S, Lambert M I , Hawley JA Prediction of maximal oxygen uptake from a 20m shuttle run as measured directly in runners and squash players J Sport Sci 1998,16 331-5

48 Helgerud J, Ingjer F, Stromme SB Sex differences in performance-matched marathon runners Eur J Appl Physiol 1990,61 433-9

49 Wasserman K The anaerobic threshold definition, physiological significance and identification Adv Cardiol 1986,35 1-23 1

50 Oyono-Enguelle S, Marbach J, Heitz A Lactate removal ability and graded exercise in humans J Appl Physiol 1990,905-11

51 Brooks GA, Fahey TD, White TA Muscle Strength, Power and Flexibility In Exercise Physiology,Human Bioenergetics and its Applications Mountain View, California Mayfield Publishing Company, 1996 384-409

52 Ciullo J, Zarins B Biomechanics of the musculotendinous unit 2 ed Philadelphia W B Saunders, 1983 71

53 Bloomfield J, Wilson G Flexibility in Sport In Elliott B, Mester J, eds Training in Sport Chichester John Wiley & Sons, 1998 279

54 Bangsbo J Physiological demands In Football (Soccer), ed Ekblom B, London Blackwell Scientific, 1994 43-59

55 Bobbert MF, Van Soest AJ Effects of muscle strengthening on vertical jump height a stimulation study Med Sci Sports Exerc 1994,26 1012-20

56 Harmen EA The effects of arms and countermovement on vertical jump Med Sci Sports Exerc 1990,22 825-33

57 Young W, Hawken M, McDonald L Relationship between speed, agility and strength qualities in Australian Rules football Strength and Conditioning Coach 2004,4 3-6

58 Draper JA, Lancaster MG The 505 Test A Test for Agility in the Horizontal Plane Aust J Sci Med Sport 1985,15-8

59 Jackson AS, Pollock ML Practical Assessment of body composition Physician Sports Med 1985,13 76-90

60 Siri WE Body composition from fluid spaces and density Univ Calif Donner Lab Med Phys Rep 1956

61 Franklin BA, Whaley MA, Howley ET Physical Fitness Testing and Interpretation In ACSM's Guidelines for Exercise Testing and Prescription 2000 67

62 Reilly T, Bangsbo J, Franks A Anthropometric and Physiological Predispositions for Elite Soccer J Sports Sci 2000,18 669-83

63 Reinzi E, Reilly T, Malkin C Investigation of anthropometric and work rate profiles of Rugby Sevens players J Sports Med Phys Fitness 1999,39 160-4

64 Rienzi E, Drust B, Carter JEL, Martin A Investigation of anthropometric and work rate profiles of elite South American international soccer players J Sports Med Phys Fitness 2000,162-9

65 Gabbett TJ Physiological and anthropometric characteristics of amateur rugby league players Br J Sports Med 2000,34 303-7

66 Meir R, Newton R, Curtis E, Fardell M, Butler B Physical Fitness Qualities of Professional Rugby League Football Players Determination of Positional Differences J Strength Cond Res 2001,15 450-8

67 Shorten MR Muscle elasticity and human performance Med Sci Sports Exerc 1987,25 18

68 Sale DG Neural adaptation to resistance training Med Sci Sports Exerc 1988,20 135-43

69 Wilson GJ, Newton RU, Murphy AJ, Humphries BJ The optimal training load for the development of dynamic athletic performance Med Sci Sports Exerc 1993,25 1279

70 Wagner DR, Kocak MS A Multivariate Approach to Assessing Anaerobic Power Following a Plyometric Training Program J Strength Cond Res 1997,11 251-5

71 Hennessy L, Watson AWS The Interference Effects of Training for Strength and Endurance Simultaneously J Strength Cond Res 1994,8 12-9

72 Doherty D, Sporer B A proposed model for examining the interference phenomenon between concurrent aerobic and strength training Sports Med 2000,30 385-94

73 Reilly T Football In Reilly T, ed Physiology of Sports London E & FN Spon , 1990 371-425

74 Leger L, Gadoury C Validity of the 20m shuttle run test with 1 min stages to predict VO2max in adults Can J Sport Sci 1989,14 21-6

75 Van Mechelen W, Hlobil H, Kemper HC Validation of two running tests as estimates of max aerobic power in children Eur J Appl Physiol Occup Physiol 1986,55 503-6

76 Ramsbottom R, Brewer J, Williams C A progressive shuttle run test to estimate maximum oxygen uptake Br J Sports Med 1988,22 141-4

77 Brooks GA Anaerobic threshold review of the concept and directions for future research Med Sci Sports Exerc 17(1), 22-34 1985

78 Tanaka KY et al Longitudinal associations between anaerobic threshold and distance running performance Eur J Appl Physiol Occup Physiol 55(3), 248-252 1986

79 Tanaka KH et al Marathon performance, anaerobic threshold, and onset of blood lactate accumulation *Eur J Appl Physiol* 57(3), 640-643 1984

80 Bangsbo, J and Lindquist, F Comparison of various exercise tests with endurance performance during soccer in professional players Int J Sports Med 13(2), 125-132 2004

81 Krustrup, P , Mohr, M Amstrup T , Rysgaard, T , Johansen, J , Steensberg, A , Pedersen, P K , and Bangsbo, J The Yo-Yo Intermittent Recovery Test Physiological Response, Reliability, and Validity Med Sci Sports Exerc 35(4), 697-705 2003

82 Reilly, T , and Doran, D , Kinanthropometric and performance profiles of elite Gaelic footballers *J Sports Sci* 17, 922, 1999

83 Scott, A C , Roe, N , Coats, A J C , Piepoli, M F , Aerobic exercise physiology in a professional rugby union team Int J Cardiol 2002

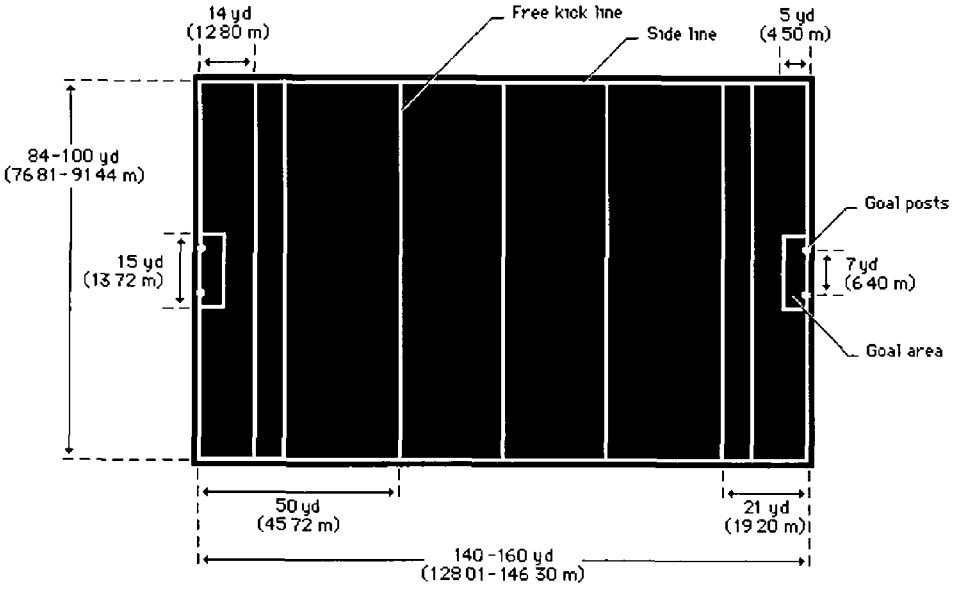
84 Casajus, J A , Seasonal variation in fitness variables in professional soccer players J Sports Med Phys Fitness 41(4), 463-469, 2001

85 Young, E , and Murphy, M H Off-season and pre-season fitness profiles of the 1993 Ulster Gaelic football champions, 12, 167-168, 1994

86 Maughan, R J , Gleeson, M , Greenhaff, P L , Biochemistry of exercise and training Oxford Oxford University Press, 1997

Appendix 1

Dimensions of Gaelic Football pitch



Appendix 2

Wingate Test Protocol

All subjects using this protocol were required to cycle against a resistance equivalent to 9% of their body weight for 3 bouts of 10 seconds in duration Each exercise bout was followed immediately by a non-active 30 second recovery interval

Before the subject undertakes the test it's important that he/she is adequately warmed up (5min cycling at above 70 rpm) and stretched The subject is instructed to pedal at ¾ pace against zero resistance (hold the weight up) and then the weight is dropped This familiarises the subject with what will happen during the test The subject is allowed to recover before the test starts

Commencement of test

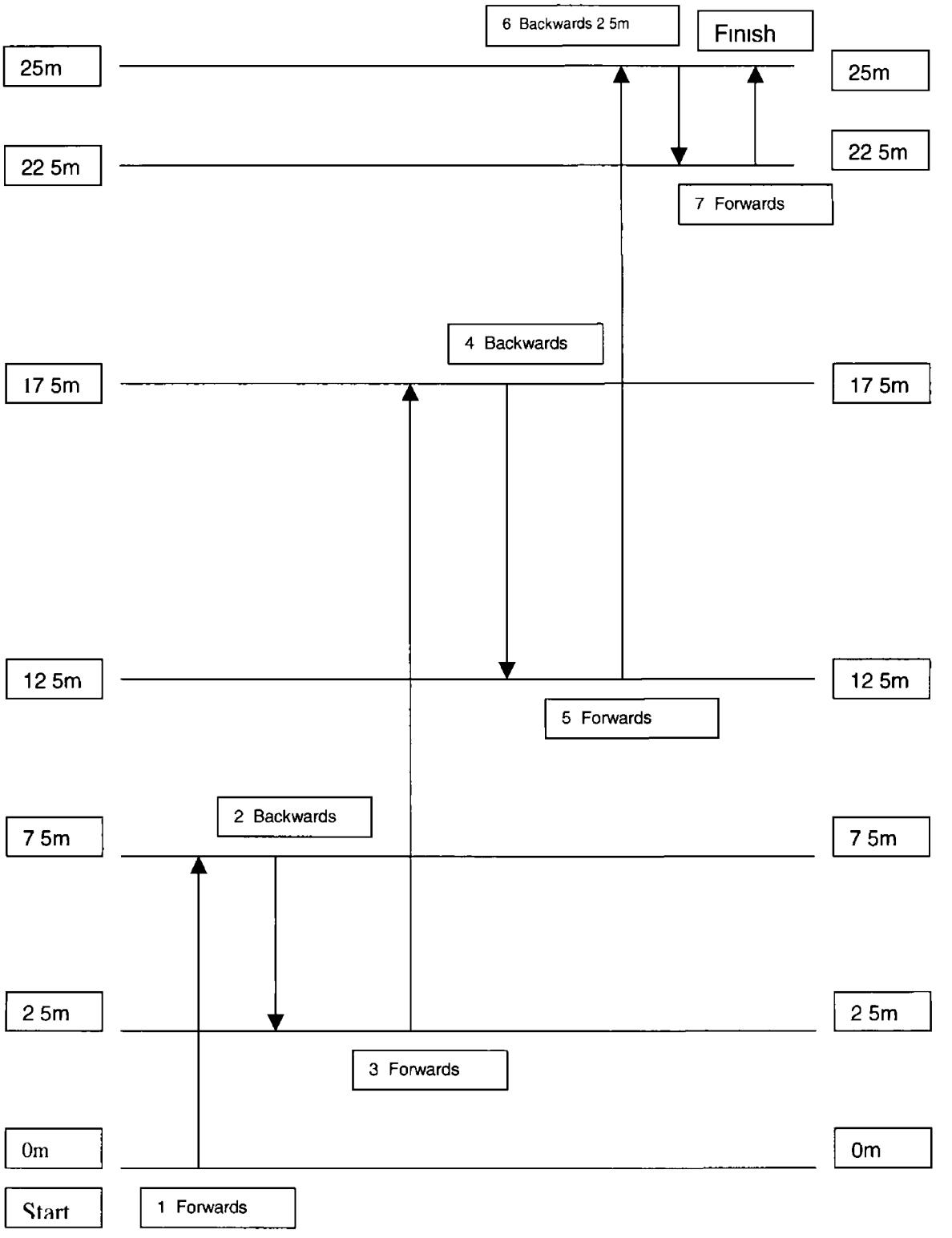
1 The subject pedals at maximum pace and indicates when he/she is at maximum, the resistance is then dropped and the test begins During the test, the time remaining in the stage is counted down Once the stage is over the subject is instructed to stop completely and the bike wheel is also stopped

2 The subject is allowed 30 seconds recovery before the next stage However the subject must ensure he/she is pedalling at maximum velocity just before the 30 seconds is up and resistance is added for the second exercise bout The same procedure is repeated for the second and third stage

On completion of the test most of the weights are removed and the subject to continue cycling at 70-80 rpm against the resistance provided by 1kg for a further period as an "active recovery' This serves to restrict pooling of the blood in the lower limbs which have been exercising

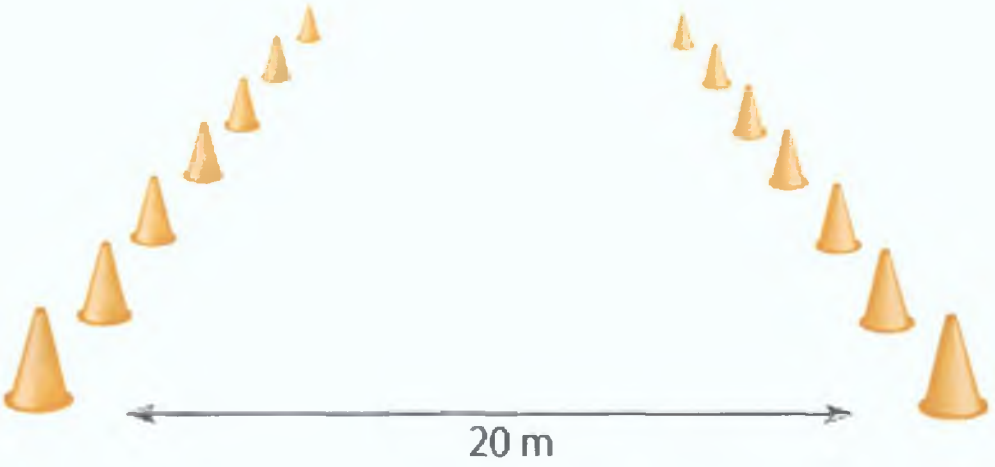
Appendix 3

Agility Run



Appendix 4

20 MST Test



This test involves continuous running between two lines 20m apart in time to recorded beeps. For this reason the test if also often called the 'beep' or 'bleep' test. The time between recorded beeps decrease each minute (level). There are several versions of the test, but one commonly used version has an initial running velocity of 8.5 km/hr, which increases by 0.5 km/hr each minute.

Score : The athlete's score is the level and number of shuttles reached before they were unable to keep up with the tape recording. This score is then converted to a VO2max equivalent score using regression equations which have previously been designed and validated (76).

Equipment required: Flat, non-slip surface, marking cones, 20m measuring tape, pre-recorded audio tape, tape recorder, recording sheets.

Appendix 5

20 MST Raw Data

Subject	1st VO2Max score	2nd VO2Max score	Difference between VO2Max	1st 20MST score	2nd 20MST score	Difference between 20MSTs	Runs in 1st 20MST	Runs in 2nd 20MST	Difference between number of runs	Average number of runs	Average VO2Max Scores	Average 20MST Scores	Difference between average scores
1	57 1	54 6	2 5	58 2	58 0	0 2	117 0	116 0	1 0	116 5	*55 9*	*58 1*	*-2 3*
2	50 1	52 8	2 7	52 5	53 7	-1 2	98 0	102 0	-4 0	*100 0*	*51 5*	*53.1*	*-1 7*
3	52 2	54 9	-2 7	59 0	59 0	0 0	120 0	120 0	0 0	120 0	*53 6*	*59 0*	*-5 5*
4	57 0	57 1	-0 1	58 5	58 8	-0 3	118 0	119 0	-1 0	118 5	*57 1*	*58 7*	*-1 6*
5	63 1	63 9	-0 8	57 7	57 7	0 0	115 0	115 0	0 0	115 0	*63.5*	*57 7*	*5 8*
6	61 1	63 9	-2 8	61 4	61 6	-0 2	128 0	129 0	1 0	128 5	*62.5*	*61 5*	*1 0*
7	51 0	52 4	-1 4	53 2	53 7	-0 5	100 0	102 0	2 0	101 0	*51 7*	*53 5*	*-1 8*
8	52 9	51 9	1 0	53 7	52 0	1 7	112 0	96 0	16 0	104 0	*52.4*	*52 9*	*-0 5*
9	51 3	53 3	-2 0	49 5	50 8	-1 3	88 0	92 0	-4 0	90 0	*52.3*	*50 2*	*2.2*
10	48 4	48 0	0 4	47 7	48 6	-0 9	82 0	85 0	-3 0	83 5	*48.2*	*48.2*	*0 0*
11	52 4	49 6	2 8	54 5	55 1	-0 6	104 0	106 0	-2 0	105 0	*51 0*	*54 8*	*-3.8*
12	*51 4*	*52 9*	-1 5	51 1	54 3	-3 2	93 0	103 0	-10 0	98 0	*52.2*	*52.7*	*-0 6*
13	*57 3*	*52.2*	5 1	52 3	54 8	-2 5	97 0	105 0	-8 0	101 0	*54 8*	*53 6*	*1 2*
14	*54 6*	*61 1*	-6 5	53 7	54 5	-0 8	102 0	104 0	-2 0	103.0	*57 9*	*54 1*	*3.8*
15	*43.5*	*56 1*	12 6	57 7	55 1	2 6	115 0	106 0	9 0	110 5	*49 8*	*56 4*	*-6 6*
16	*50 9*	*57 0*	-6 1	58 2	57 1	1 1	129 0	113 0	16 0	121 0	*54 0*	*57 7*	*-3 7*
17	*56 4*	*61 3*	-4 9	60 1	54 8	5 3	124 0	105 0	19 0	114 5	*58 9*	*57 5*	*1 4*
18	*55 5*	*52 4*	3 1	51 1	49 2	1 9	93 0	87 0	6 0	90 0	*54 0*	*50 2*	*3 8*
19	*45 2*	*51 1*	-5 9	54 3	50 8	3 5	103 0	92 0	11 0	97 5	*48 2*	*52 6*	*-4 4*
20	*49 1*	*52 1*	-3 0	47 7	48 0	-0 3	82 0	83 0	-1 0	82 5	*50 6*	*47 9*	*2 8*
21	*57 6*	*57 9*	-0 3	55 7	54 8	0 9	108 0	105 0	3 0	106 5	*57 8*	*55 3*	*2 5*
22	*49 9*	*49 1*	0 8	51 1	53 7	-2 6	93 0	102 0	-9 0	97 5	*49 5*	*52.4*	*-2 9*
23	*44 1*	*48 4*	-4 3	48 3	48 6	-0 3	84 0	85 0	-1 0	84 5	*46 3*	*48.5*	*-2 2*
24	*47 6*	*51 7*	-4 1	50 5	47 1	3 4	91 0	80 0	11 0	85 5	*49 7*	*48 8*	*0 9*
25	*56 5*	*48.5*	8 0	53 7	49 8	3 9	102 0	89 0	13 0	95 5	*52 5*	*51 8*	*0 8*
26	*41 6*	*42 9*	-1 3	47 4	49 2	-1 8	81 0	87 0	-6 0	84 0	*42 3*	*48.3*	*-6 1*
27	*57 0*	*59 7*	-2 7	53 2	53 7	-0 5	101 0	102 0	-1 0	101 5	*58.4*	*53 5*	*4 9*
28	*40 6*	*45 5*	-4 9	47 4	48 3	-0 9	81 0	84 0	-3 0	82 5	*43 1*	*47 9*	*-4 8*
29	*53 5*	*58.8*	-5 3	55 9	55 4	0 5	109 0	107 0	2 0	108 0	*56 2*	*55 7*	*0 5*
30	53 8	50 0	3 8	60 1	60 7	-0 6	124 0	126 0	-2.0	125 0	*51 9*	*60 4*	*-8 5*
31	*61 3*	*67 2*	-5 9	*54 8*	*55 1*	-0 3	105 0	*106 0*	-1 0	105 5	*64 3*	*55 0*	*9 3*
32	59 0	66 1	-7 1	56 5	57 6	-1 1	111 0	115 0	-4 0	113.0	*62.6*	*57 1*	*5 5*

Appendix 6

Combined - All positions - Descriptives

Anthropometrics

Components	Valid	Mean	Standard Deviation	Minimum	Maximum
Age (yrs)	203	23 2	4 1	16 0	40 0
Height (cm)	214	180 6	5 6	167 0	195 6
Average weight (kg)	214	81 2	9 3	54 5	109 6
BMI (Body mass index)	214	24 9	2 5	18 9	32 6
RHR (Resting heart rate)	167	62	10	40	88
SBP (Systolic blood pressure)	168	127	11	102	160
DBP (Systolic blood pressure)	168	78	8	50	100

Body Composition

Components	Valid	Mean	Standard Deviation	Minimum	Maximum
Chest skinfold (mm)	204	10 5	4 5	4 0	28 0
Thigh skinfold (mm)	203	13 3	5 0	4 0	28 0
Abdomen skinfold (mm)	204	21 4	9 6	6 0	56 0
Sum of skinfolds (mm)	204	45 1	16 7	17 0	107 0
% Body Fat	204	15 8	7 5	4 1	46 4
Fat mass (kg)	204	13 2	7 5	0 0	48 9
Lean body masss (kg)	205	67 6	8 3	0 0	92 0

Physical Characteristics

Components	Valid	Mean	Standard Deviation	Minimum	Maximum
Chest circumference (cm)	212	95 9	5 5	80 0	112 0
Biceps circumference (cm)	211	32 7	2 4	25 8	39 5
Quadriceps circumference (cm)	212	57 2	5 2	31 6	69 0
Waist Circumference (cm)	212	88 0	7 7	68 0	112 0

Vertical Jump and Hamstring Flexibility

Components	Valid	Mean	Standard Deviation	Minimum	Maximum
Vertical Jump (cm)	212	53 1	6 3	39 0	74 0
Hamstring flexibility (cm)	202	22 3	6 9	6 0	39 0

Combined - All positions - Percentiles

Anthropometrics

Percentiles

Components	10	20	30	40	50	60	70	80	90	100
Age (yrs)	19 0	20 0	20 2	21 6	23 0	24 0	25 0	26 0	28 0	40 0
Height (cm)	173 5	176 2	177 5	179 0	181 0	182 0	183 5	185 0	188 0	195 6
Avr weight (kg)	70 4	73 7	75 5	78 0	80 3	82 8	85 4	88 1	95 1	109 6
BMI (Body mass index)	22 1	22 8	23 4	24 1	24 6	25 3	26 0	26 9	28 1	32 6
RHR (Resting heart rate)	50	54	57	60	62	65	68	71	75	88
SBP (Systolic blood pressure)	114	120	120	122	126	130	130	136	142	160
DBP (Diastolic blood pressure)	68	70	74	76	78	80	82	86	90	100

Body Composition

Components	10	20	30	40	50	60	70	80	90	100
Chest skinfold (mm)	6 0	6 5	7 0	9 0	10 0	11 0	12 0	14 0	16 0	28 0
Thigh skinfold (mm)	7 5	9 0	10 0	11 0	13 0	14 0	15 0	17 0	20 0	28 0
Abdomen skinfold (mm)	11 0	13 5	15 3	18 0	19 0	22 0	25 0	29 0	34 5	56 0
Sum of skinfolds (mm)	26 5	30 0	34 0	39 0	43 0	47 0	52 0	59 0	69 5	107 0
% Body Fat	7 4	8 9	10 8	12 7	14 7	16 7	18 6	21 6	27 3	46 4
Fat mass (kg)	5 6	7 0	8 3	9 7	11 4	13 2	15 4	19 1	24 0	48 9
Lean body masss (kg)	59 5	62 3	64 6	65 7	67 2	69 1	71 7	73 8	76 3	92 0

Physical Characteristics

Components	10	20	30	40	50	60	70	80	90	100
Chest circumference (cm)	89 5	91 5	93 0	94 0	95 5	96 5	98 2	100 1	103 5	112 0
Biceps circumference (cm)	30 0	30 7	31 5	32 0	32 5	33 0	33 9	34 5	35 8	39 5
Quadriceps circumference (cm)	52 5	54 3	55 5	56 1	57 2	58 3	59 5	61 1	62 9	69 0
Waist Circumference (cm)	78 2	81 0	83 5	85 5	88 0	89 8	91 5	94 0	99 0	112 0

Vertical Jump and Hamstring Flexibility

Components	10	20	30	40	50	60	70	80	90	100
Vertical Jump (cm)	45 0	48 0	49 0	51 0	53 0	54 0	56 0	58 0	61 0	74 0
Hamstring flexibility (cm)	13 0	16 0	19 0	21 0	22 0	23 8	26 0	28 4	32 0	39 0

Combined - All positions - Descriptive Data

Cardiorespiratory response at maximal exercise

Components	Valid	Mean	Standard Deviation	Minimum	Maximum
Max VT in one breath (l)	163	2 99	0 45	1 93	5 08
Max respiratory rate (l/min)	164	55	7	41	72
Max ventilation rate (l/min)	164	120	16	70	152
Respiratory exchange ratio	163	1 13	0 06	0 96	1 31
Vol of CO2 Expired (l/min)	164	4 73	0 60	3 02	6 31
Absolute vol Of O2 uptake (l/min)	164	4 28	0 53	2 85	5 52
Relative vol O2 upake (ml/min/kg)	165	52 6	6 2	35 6	67 5
Ventilatory threshold (ml/kg/min)	138	45 1	5 2	32 5	58 4
Ventilatory threshold (% VO2 max)	138	85 2	6 0	67 5	99 1
Heart Rate Max (bpm)	151	194	9	160	210

Anaerobic Power and Capacity

Components	Valid	Mean	Standard Deviation	Minimum	Maximum
Max absolute power (watts)	78	953 2	139 7	704 6	1379 2
T1 - Peak power per kg bwt (watts)	78	11 7	1 5	9 2	17 6
T2 - Peak power per kg bwt (watts)	78	10 0	1 3	7 1	14 8
T3 - Peak power per kg bwt (watts)	78	8 7	1 4	5 6	15 6
T1 - Percentage Fatigue (%)	78	24 3	8 0	11 9	60 1
T2 - Percentage Fatigue (%)	78	28 2	9 1	15 0	53 4
T3 - Percentage Fatigue (%)	78	27 6	9 4	10 0	61 5
T1 – Average power per kg bwt (watts)	78	9 7	1 0	6 1	11 9
T2 – Average power per kg bwt (watts)	78	8 2	0 9	5 9	10 3
T3 – Average power per kg bwt (watts)	78	7 2	1 0	4 5	9 2

Speed and Agility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
5 metre time (sec)	115	1 10	0 07	0 95	1 29
5 metre speed (m/s)	114	4 58	0 27	3 87	5 29
5 metre acceleration (m/s/s)	114	4 22	0 49	3 00	5 60
20 metre time (sec)	114	3 15	0 14	2 26	3 48
20 metre speed (m/s)	114	6 37	0 33	5 74	8 85
20 metre acceleration (m/s/s)	114	2 03	0 23	1 65	3 92
50m Forward Backward time (sec)	74	14 86	0 86	12 46	16 73
5m backwards time (sec)	74	1 39	0 10	1 25	1 82
5m backward speed (m/s)	74	3 61	0 24	2 75	4 01
5m backward acceleration (m/s/s)	74	2 61	0 34	1 51	3 21

Combined - All positions - Percentiles

Cardiorespiratory response at maximal exercise

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max VT in one breath (l)	2 47	2 63	2 72	2 83	2 92	3 06	3 18	3 35	3 55	5 08
Max respiratory rate (l/min)	46	48	51	52	54	56	58	60	64	72
Max ventilation rate (l/min)	101	107	111	117	120	126	129	133	141	152
Respiratory exchange ratio	1 06	1 08	1 10	1 11	1 13	1 14	1 16	1 18	1 21	1 31
Vol of CO2 Expired (l/min)	4 07	4 23	4 43	4 56	4 68	4 87	5 03	5 23	5 52	6 31
Absolute vol of O2 uptake (l/min)	3 58	3 90	4 02	4 14	4 26	4 37	4 55	4 70	4 98	5 52
Relative vol O2 upake (ml/min/kg)	44 4	47 2	49 2	51 2	52 8	54 2	55 8	57 5	60 5	67 5
Ventilatory threshold (ml/kg/min)	38 5	40 5	42 5	44 3	45 4	46 6	48 1	49 4	51 6	58 4
Ventilatory threshold (% VO2 max)	76 9	80 2	82 0	84 0	85 0	86 9	88 8	90 4	92 7	99 1
Heart Rate Max	180	188	191	193	194	197	199	202	206	210

Anaerobic Power and Capacity

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max absolute power (watts)	765 5	836 0	857 0	893 7	952 1	976 0	1003 4	1068 8	1142 7	1379 2
T1 - Peak power per kg bwt (watts)	10 3	10 6	10 8	11 1	11 5	11 7	12 1	12 5	13 9	17 6
T2 - Peak power per kg bwt (watts)	8 5	9 0	9 3	9 5	9 8	10 1	10 4	10 9	11 3	14 8
T3 - Peak power per kg bwt (watts)	7 2	7 7	8 1	8 4	8 7	9 0	9 2	9 7	10 0	15 6
T1 - Percentage Fatigue (%)	15 5	18 0	19 6	22 1	23 8	24 6	26 5	29 9	33 7	60 1
T2 - Percentage Fatigue (%)	16 9	19 9	22 6	25 0	27 0	28 3	33 3	36 6	41 7	53 4
T3 - Percentage Fatigue (%)	16 0	20 3	23 1	24 9	26 7	28 4	31 3	33 2	39 5	61 5
T1 - Avrg power per kg bwt (watts)	8 5	9 1	9 4	9 6	9 9	10 0	10 1	10 5	10 8	11 9
T2 - Avrg power per kg bwt (watts)	6 9	7 5	7 8	8 0	8 2	8 5	8 6	9 0	9 1	10 3
T3 - Avrg power per kg bwt (watts)	6 0	6 3	6 8	7 0	7 2	7 5	7 7	8 0	8 4	9 2

Speed and Agility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
5 metre time (sec)	1 02	1 05	1 07	1 08	1 09	1 10	1 12	1 14	1 20	1 29
5 metre speed (m/s)	4 17	4 39	4 45	4 54	4 60	4 65	4 69	4 79	4 92	5 29
5 metre acceleration (m/s/s)	3 47	3 86	3 97	4 13	4 22	4 32	4 40	4 58	4 85	5 60
20 metre time (sec)	3 00	3 07	3 09	3 12	3 13	3 17	3 21	3 26	3 32	3 48
20 metre speed (m/s)	6 03	6 14	6 24	6 31	6 38	6 42	6 48	6 52	6 67	8 85
20 metre acceleration (m/s/s)	1 82	1 88	1 94	1 99	2 04	2 06	2 10	2 13	2 22	3 92
50m Forward Backward time (sec)	13 89	14 17	14 44	14 60	14 88	15 11	15 36	15 64	15 97	16 73
5m backwards time (sec)	1 29	1 31	1 33	1 36	1 38	1 40	1 43	1 47	1 53	1 82
5m backward speed (m/s)	3 27	3 40	3 51	3 58	3 63	3 69	3 77	3 81	3 87	4 01
5m backward acceleration (m/s/s)	2 14	2 31	2 46	2 57	2 64	2 72	2 85	2 90	3 00	3 21

Appendix 7

Combined - Goalkeepers - Descriptive Data

Anthropometrics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Age (yrs)	13	23 3	4 0	18 0	30 0
Height (cm)	13	180 9	5 6	167 4	187 0
Avr weight (kg)	13	82 3	10 8	63 2	103 3
BMI	13	25 1	2 8	21 6	31 6
RHR	10	66	13	48	84
SBP	10	134	13	120	160
DBP	10	82	9	68	96

Body Composition

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest skinfold	11	10 3	3 6	6 0	17 0
Thigh skinfold	11	14 0	5 7	5 0	25 0
Abdomen skinfold	11	22 5	12 2	7 0	41 0
Sum of skinfolds	11	46 7	20 1	18 0	83 0
% Body Fat	11	16 8	9 0	4 9	33 7
Fat mass (kg)	11	13 6	7 7	3 9	25 7
Lean body masss (kg)	11	66 7	9 8	50 7	79 6

Physical Characteristics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest circumference (cm)	13	98 0	5 7	89 0	112 0
Biceps circumference (cm)	13	32 8	3 1	27 6	39 5
Quadriceps circumference (cm)	13	58 2	5 3	50 0	67 0
Waist Circumference (cm)	13	90 3	10 7	74 7	112 0

Vertical Jump and Flexibility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Vertical Jump (cm)	13	54 0	6 3	46 0	67 0
Hamstring flexibility (cm)	13	22 5	8 0	10 0	37 0

Combined - Goalkeepers - Percentiles

Anthropometrics

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Age (yrs)	18 4	19 8	20 0	20 6	23 0	24 4	26 6	28 0	29 2	30 0
Height (cm)	169 8	177 1	178 4	181 1	183 0	183 5	184 7	185 3	186 7	187 0
Avr weight (kg)	67 4	74 4	75 6	78 7	80 3	83 9	86 5	90 3	102 0	103 3
BMI	21 8	22 5	23 9	24 2	24 3	25 0	25 9	26 9	30 8	31 6
RHR	48	51	55	62	71	72	73	80	84	84
SBP	120	123	126	127	129	135	139	146	159	160
DBP	68	72	76	81	82	84	86	89	95	96

Body Composition

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest skinfold	6 0	6 0	7 8	9 0	10 0	11 2	12 0	13 8	16 6	17 0
Thigh skinfold	5 4	8 6	11 0	11 8	14 0	15 4	17 4	18 6	23 8	25 0
Abdomen skinfold	7 6	10 8	13 2	17 2	18 0	23 8	31 0	38 8	40 8	41 0
Sum of skinfolds	19 8	27 8	30 2	37 4	47 0	53 0	58 6	66 4	80 4	83 0
% Body Fat	5 5	8 3	9 2	11 9	16 9	19 5	21 5	25 7	32 5	33 7
Fat mass (kg)	4 3	6 4	7 8	9 2	10 7	15 8	19 1	23 2	25 3	25 7
Lean body masss (kg)	51 0	55 4	61 0	64 5	67 9	70 7	74 5	76 8	79 1	79 6

Physical Characteristics

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest circumference (cm)	90 5	93 0	95 2	96 3	97 5	98 2	100 5	102 2	108 4	112 0
Biceps circumference (cm)	28 6	30 4	30 8	32 0	32 5	33 0	33 8	34 9	38 7	39 5
Quadriceps circumference (cm)	51 4	53 9	54 8	56 0	56 0	58 2	61 9	64 7	66 7	67 0
Waist Circumference (cm)	75 0	79 5	87 7	88 5	88 8	90 1	91 3	101 8	109 1	112 0

Vertical Jump and Flexibility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Vertical Jump (cm)	46 4	47 8	49 0	51 4	53 0	55 2	57 8	60 2	64 6	67 0
Hamstring flexibility (cm)	10 4	15 0	17 8	21 0	22 0	23 6	26 8	31 2	35 0	37 0

Combined - Goalkeepers - Descriptive Data

Cardiorespiratory response at maximal exercise

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max VT in one breath (l)	10	2 93	0 42	2 23	3 59
Max respiratory rate (l/min)	10	55	7	42	65
Max ventilation rate (l/min)	10	122	18	93	151
Respiratory exchange ratio	10	1 13	0 04	1 08	1 21
Vol of CO2 Expired (l/min)	10	4 74	0 72	3 26	5 68
Absolute vol of O2 uptake (l/min)	10	4 16	0 57	2 99	4 91
Relative vol O2 upake (ml/min/kg)	10	51 6	7 2	44 1	65 9
Ventilatory threshold (ml/kg/mm)	9	44 5	6 8	33 6	56 1
Ventilatory threshold (% VO2 max)	9	86 2	7 1	76 2	96 6
Heart Rate Max	9	197	10	177	210

Anaerobic Power and Capacity

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max absolute power (watts)	4	909 4	75 9	844 3	992 9
T1 - Peak power per kg bwt (watts)	4	10 4	0 4	9 9	10 7
T2 - Peak power per kg bwt (watts)	4	8 7	0 7	7 7	9 4
T3 - Peak power per kg bwt (watts)	4	7 9	0 9	6 6	8 6
T1 - Percentage Fatigue (%)	4	23 1	12 5	11 9	34 0
T2 - Percentage Fatigue (%)	4	27 5	9 5	16 4	36 6
T3 - Percentage Fatigue (%)	4	31 7	7 3	26 1	41 7
T1 - Avrg power per kg bwt (watts)	4	8 7	0 9	8 0	9 7
T2 - Avrg power per kg bwt (watts)	4	7 3	0 8	6 3	8 2
T3 - Avrg power per kg bwt (watts)	4	6 3	0 6	5 5	6 9

Speed and Agility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
5 metre time (sec)	7	1 10	0 08	0 97	1 22
5 metre speed (m/s)	7	4 58	0 35	4 12	5 13
5 metre acceleration (m/s/s)	7	4 21	0 64	3 39	5 27
20 metre time (sec)	7	3 20	0 12	3 06	3 36
20 metre speed (m/s)	7	6 26	0 24	5 96	6 54
20 metre acceleration (m/s/s)	7	1 96	0 15	1 78	2 14
50m Forward Backward time (sec)	5	14 95	1 07	13 64	15 97
5m backwards time (sec)	5	1 34	0 07	1 26	1 42
5m backward speed (m/s)	5	3 73	0 20	3 52	3 97
5m backward acceleration (m/s/s)	5	2 78	0 29	2 47	3 15

Combined - Goalkeepers - Percentiles

Cardiorespiratory response at maximal exercise

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max VT in one breath (l)	2 23	2 34	2 79	3 06	3 08	3 09	3 11	3 16	3 55	3 59
Max respiratory rate (l/min)	42 7	49	50 2	53 4	55	56 6	57 7	61 2	64 7	65
Max ventilation rate (l/min)	94	104	109	121	127	128	130	137	150	151
Respiratory exchange ratio	1 08	1 09	1 09	1 11	1 13	1 14	1 16	1 17	1 21	1 21
Vol of CO2 Expired (l/min)	3 34	4 15	4 46	4 68	4 77	4 91	5 14	5 55	5 68	5 68
Absolute vol of O2 uptake (l/min)	3 07	3 84	3 88	3 97	4 15	4 32	4 49	4 81	4 91	4 91
Relative vol O2 upake (ml/min/kg)	44 2	45 4	47 2	47 6	49 4	50 7	54 8	59 9	65 4	65 9
Ventilatory threshold (ml/kg/min)	33 6	40 1	40 2	40 5	43 5	47 6	48 8	50 2	56 1	56 1
Ventilatory threshold (% VO2 max)	76 2	76 2	83 9	84 2	85 2	89 1	92 2	92 4	96 6	96 6
Heart Rate Max	177	189	191	191	200	202	204	206	210	210

Anaerobic Power and Capacity

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max absolute power (watts)	844 3	844 3	845 2	846 0	900 3	954 5	973 7	992 9	992 9	992 9
T1 - Peak power per kg bwt (watts)	9 9	9 9	10 2	10 5	10 6	10 6	10 7	10 7	10 7	10 7
T2 - Peak power per kg bwt (watts)	7 7	7 7	8 2	8 7	8 9	9 0	9 2	9 4	9 4	9 4
T3 - Peak power per kg bwt (watts)	6 6	6 6	7 4	8 2	8 2	8 2	8 4	8 6	8 6	8 6
T1 - Percentage Fatigue (%)	11 9	11 9	12 3	12 6	23 2	33 8	33 9	34 0	34 0	34 0
T2 - Percentage Fatigue (%)	16 4	16 4	19 6	22 8	28 5	34 2	35 4	36 6	36 6	36 6
T3 - Percentage Fatigue (%)	26 1	26 1	26 3	26 5	29 5	32 4	37 1	41 7	41 7	41 7
T1 - Avrg power per kg bwt (watts)	8 0	8 0	8 0	8 0	8 6	9 2	9 5	9 7	9 7	9 7
T2 - Avrg power per kg bwt (watts)	6 3	6 3	6 6	6 9	7 3	7 6	7 9	8 2	8 2	8 2
T3 - Avrg power per kg bwt (watts)	5 5	5 5	5 8	6 1	6 4	6 6	6 8	6 9	6 9	6 9

Speed and Agility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
5 metre time (sec)	0 97	1 02	1 06	1 06	1 07	1 11	1 16	1 20	1 22	1 22
5 metre speed (m/s)	4 12	4 17	4 31	4 50	4 66	4 71	4 73	4 90	5 13	5 13
5 metre acceleration (m/s/s)	3 39	3 48	3 71	4 05	4 34	4 43	4 48	4 80	5 27	5 27
20 metre time (sec)	3 06	3 07	3 08	3 13	3 25	3 26	3 28	3 31	3 36	3 36
20 metre speed (m/s)	5 96	6 04	6 10	6 13	6 15	6 40	6 49	6 52	6 54	6 54
20 metre acceleration (m/s/s)	1 78	1 82	1 86	1 88	1 89	2 05	2 11	2 13	2 14	2 14
50m Forward Backward time (sec)	13 64	13 73	14 00	14 50	15 11	15 62	15 97	15 97	15 97	15 97
5m backwards time (sec)	1 26	1 27	1 28	1 31	1 36	1 38	1 40	1 42	1 42	1 42
5m backward speed (m/s)	3 52	3 53	3 56	3 62	3 69	3 81	3 90	3 95	3 97	3 97
5m backward acceleration (m/s/s)	2 47	2 49	2 54	2 62	2 72	2 90	3 05	3 12	3 15	3 15

Appendix 8

Combined - Defenders - Descriptive Data

Anthropometrics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Age (yrs)	82	23 0	3 8	18 0	40 0
Height (cm)	88	178 8	4 8	167 0	192 5
Avr weight (kg)	88	78 7	7 2	64 6	98 4
BMI	88	24 6	2 0	21 1	29 5
RHR	67	63	10	40	88
SBP	68	126	11	108	160
DBP	68	78	8	56	97

Body Composition

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest skinfold	81	9 2	3 5	4 0	19 0
Thigh skinfold	81	12 8	4 5	5 5	24 0
Abdomen skmfold	81	19 7	8 0	6 0	42 0
Sum of skinfolds	81	41 7	14 3	17 0	81 0
% Body Fat	81	14 2	6 3	4 3	32 1
Fat mass (kg)	81	11 4	5 8	2 9	27 8
Lean body masss (kg)	81	67 1	5 9	54 0	82 3

Physical Characteristics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest circumference (cm)	85	94 6	4 3	82 0	107 4
Biceps circumference (cm)	85	32 4	2 1	28 0	37 0
Quadriceps circumference (cm)	85	56 1	5 6	31 6	63 5
Waist Circumference (cm)	85	85 8	6 3	72 0	98 8

Vertical Jump and Flexibility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Vertical Jump (cm)	86	53 5	5 2	40 0	65 0
Hamstring flexibility (cm)	80	22 7	6 8	8 0	39 0

Combined - Defenders - Percentiles

Anthropometrics

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Age (yrs)	19 0	20 0	21 0	22 0	22 5	23 0	24 0	26 0	27 0	40 0
Height (cm)	172 3	175 2	176 9	177 8	178 9	180 1	181 8	182 8	184 1	192 5
Avr weight (kg)	70 0	71 4	74 6	76 8	78 0	80 2	83 0	85 1	87 7	98 4
BMI	22 1	22 6	23 4	23 9	24 6	24 9	25 6	26 2	27 3	29 5
RHR	46	53	57	60	64	67	69	71	74	88
SBP	110	118	120	122	126	128	130	135	140	160
DBP	70	72	75	77	78	80	80	86	90	97

Body Composition

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest skinfold	5 0	6 0	7 0	8 0	9 0	9 1	10 0	11 8	14 9	19 0
Thigh skinfold	7 6	9 0	10 0	11 0	12 0	13 2	15 0	16 6	19 0	24 0
Abdomen skinfold	10 0	12 0	14 0	16 0	18 0	21 0	23 0	27 0	30 0	42 0
Sum of skinfolds	25 0	28 0	31 0	36 0	41 0	45 0	49 0	52 0	61 8	81 0
% Body Fat	7 2	8 3	9 5	11 6	14 2	15 2	17 1	18 6	23 2	32 1
Fat mass (kg)	5 3	6 1	7 4	9 2	10 1	12 6	13 2	14 9	19 4	27 8
Lean body masss (kg)	59 5	62 3	64 6	65 4	67 0	67 8	71 0	72 4	74 3	82 3

Physical Characteristics

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest circumference (cm)	88 8	91 3	93 0	94 0	94 5	95 0	96 1	98 0	99 5	107 4
Biceps circumference (cm)	30 0	30 5	31 2	31 7	32 0	33 0	33 5	34 4	35 5	37 0
Quadriceps circumference (cm)	51 9	53 5	55 3	56 0	57 0	57 7	59 0	59 5	61 4	63 5
Waist Circumference (cm)	78 0	80 0	81 0	84 0	85 5	87 7	89 4	92 4	94 0	98 8

Vertical Jump and Flexibility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Vertical Jump (cm)	46 7	49 0	51 0	53 0	53 0	55 0	56 0	58 0	61 0	65 0
Hamstring flexibility (cm)	13 0	17 0	19 0	21 0	23 0	24 0	26 0	29 0	32 0	39 0

Combined - Defenders - Descriptives

Cardiorespiratory response at maximal exercise

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max VT in one breath (l)	66	3 04	0 38	2 13	4 10
Max respiratory rate (l/min)	67	55	7	41	70
Max ventilation rate (l/min)	67	122	16	70	152
Respiratory exchange ratio	66	1 14	0 06	1 02	1 31
Vol of CO2 Expired (l/min)	67	4 84	0 62	3 02	6 31
Absolute vol of O2 uptake (l/mm)	67	4 36	0 55	2 94	5 52
Relative vol O2 upake (ml/min/kg)	67	54 6	5 6	43 5	66 9
Ventilatory threshold (ml/kg/min)	58	46 3	4 9	33 1	58 4
Ventilatory threshold (% VO2 max)	58	84 3	5 5	72 8	95 5
Heart Rate Max	61	193	9	160	210

Anaerobic Power and Capacity

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max absolute power (watts)	32	926 6	129 6	704 6	1269 2
T1 - Peak power per kg bwt (watts)	32	11 6	1 0	9 7	14 1
T2 - Peak power per kg bwt (watts)	32	10 3	1 2	7 9	14 8
T3 - Peak power per kg bwt (watts)	32	8 8	0 9	5 6	10 2
T1 - Percentage Fatigue (%)	32	22 5	4 8	13 6	32 5
T2 - Percentage Fatigue (%)	32	27 5	9 6	15 0	53 4
T3 - Percentage Fatigue (%)	32	25 9	8 4	10 7	48 2
T1 - Avrg power per kg bwt (watts)	32	9 8	1 0	7 4	11 9
T2 - Avrg power per kg bwt (watts)	32	8 4	0 8	5 9	9 8
T3 - Avrg power per kg bwt (watts)	32	7 4	0 9	4 8	8 7

Speed and Agility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
5 metre time (sec)	47	1 09	0 05	0 98	1 24
5 metre speed (m/s)	46	4 59	0 22	4 03	5 11
5 metre acceleration (m/s/s)	46	4 22	0 40	3 24	5 23
20 metre time (sec)	46	3 15	0 10	2 95	3 48
20 metre speed (m/s)	46	6 35	0 20	5 74	6 78
20 metre acceleration (m/s/s)	46	2 02	0 13	1 65	2 30
50m Forward Backward time (sec)	31	14 87	0 86	12 98	16 53
5m backwards time (sec)	31	1 40	0 12	1 25	1 82
5m backward speed (m/s)	31	3 59	0 29	2 75	4 01
5m backward acceleration (m/s/s)	31	2 59	0 41	1 51	3 21

Combined - Defenders - Percentiles

Cardiorespiratory response at maximal exercise

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max VT in one breath (l)	2 59	2 74	2 82	2 92	2 98	3 14	3 25	3 39	3 47	4 10
Max respiratory rate (l/min)	45 8	49	51 4	52 2	54	57	59	61	64	70
Max ventilation rate (l/min)	101	108	113	117	124	128	131	137	144	152
Respiratory exchange ratio	1 07	1 09	1 11	1 13	1 14	1 17	1 18	1 20	1 22	1 31
Vol of CO2 Expired (l/min)	4 09	4 24	4 59	4 65	4 79	4 97	5 16	5 31	5 75	6 31
Absolute vol of O2 uptake (l/min)	3 68	3 92	4 13	4 22	4 34	4 42	4 57	4 87	5 20	5 52
Relative vol O2 upake (ml/min/kg)	47 6	49 3	51 2	52 8	53 6	55 8	57 5	59 6	62 5	66 9
Ventilatory threshold (ml/kg/mm)	40 2	42 8	44 0	45 0	45 7	47 2	48 7	50 0	52 0	58 4
Ventilatory threshold (% VO2 max)	76 1	79 9	81 5	83 4	84 3	85 0	87 4	89 8	91 9	95 5
Heart Rate Max	180	188	191	193	194	197	198	199	203	210

Anaerobic Power and Capacity

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max absolute power (watts)	745 0	803 2	883 9	895 8	934 0	954 7	976 2	1018 0	1107 2	1269 2
T1 - Peak power per kg bwt (watts)	10 4	10 7	11 0	11 4	11 6	11 7	12 1	12 3	12 9	14 1
T2 - Peak power per kg bwt (watts)	8 9	9 4	9 6	9 8	10 2	10 5	10 7	11 2	11 4	14 8
T3 - Peak power per kg bwt (watts)	7 8	8 1	8 4	8 7	9 0	9 1	9 2	9 6	9 9	10 2
T1 - Percentage Fatigue (%)	16 1	17 7	19 6	21 4	22 6	23 9	24 8	26 9	29 6	32 5
T2 - Percentage Fatigue (%)	15 9	19 5	22 2	24 0	26 3	27 9	29 4	33 9	41 9	53 4
T3 - Percentage Fatigue (%)	15 3	17 5	20 3	24 2	26 0	27 9	30 0	32 3	36 1	48 2
T1 - Avrg power per kg bwt (watts)	8 2	9 0	9 6	9 7	10 0	10 1	10 2	10 4	10 8	11 9
T2 - Avrg power per kg bwt (watts)	7 1	7 8	8 2	8 3	8 5	8 6	8 8	9 0	9 4	9 8
T3 - Avrg power per kg bwt (watts)	6 0	6 9	7 2	7 4	7 5	7 7	7 9	8 0	8 3	8 7

Speed and Agility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
5 metre time (sec)	1 02	1 05	1 07	1 08	1 09	1 10	1 12	1 13	1 18	1 24
5 metre speed (m/s)	4 31	4 43	4 45	4 56	4 60	4 64	4 69	4 76	4 90	5 11
5 metre acceleration (m/s/s)	3 72	3 93	3 97	4 16	4 24	4 30	4 39	4 54	4 80	5 23
20 metre time (sec)	3 05	3 08	3 10	3 12	3 14	3 16	3 18	3 22	3 29	3 48
20 metre speed (m/s)	6 07	6 21	6 28	6 32	6 37	6 41	6 44	6 50	6 57	6 78
20 metre acceleration (m/s/s)	1 84	1 93	1 97	2 00	2 03	2 06	2 08	2 11	2 16	2 30
50m Forward Backward time (sec)	13 32	14 31	14 47	14 53	14 84	15 10	15 36	15 70	15 99	16 53
5m backwards time (sec)	1 25	1 31	1 32	1 36	1 38	1 42	1 46	1 48	1 54	1 82
5m backward speed (m/s)	3 25	3 39	3 43	3 53	3 62	3 68	3 79	3 83	3 99	4 01
5m backward acceleration (m/s/s)	2 11	2 29	2 36	2 49	2 63	2 71	2 87	2 93	3 18	3 21

Appendix 9

Combined - Midfielders - Descriptive Data

Anthropometrics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Age (yrs)	39	24 1	4 5	18 0	33 0
Height (cm)	40	186 3	4 5	177 2	195 6
Avr weight (kg)	40	88 9	8 6	74 8	109 6
BMI	40	25 6	2 5	21 2	32 2
RHR	30	62	9	42	77
SBP	30	126	9	112	144
DBP	30	76	9	50	90

Body Composition

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest skinfold	39	11 9	5 3	4 0	26 0
Thigh skinfold	39	13 7	5 5	4 0	28 0
Abdomen skinfold	39	22 8	10 6	6 0	53 0
Sum of skinfolds	39	48 4	19 9	17 0	107 0
% Body Fat	39	17 5	9 1	4 1	46 4
Fat mass (kg)	39	16 1	9 7	3 2	48 9
Lean body masss (kg)	40	73 2	7 2	56 5	92 0

Physical Characteristics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest circumference (cm)	40	99 2	5 3	89 8	111 3
Biceps circumference (cm)	39	33 8	2 3	29 5	38 7
Quadriceps circumference (cm)	40	59 7	3 7	54 6	69 0
Waist Circumference (cm)	40	92 5	6 8	77 0	106 0

Vertical Jump and Flexibility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Vertical Jump (cm)	39	54 6	7 7	39 0	74 0
Hamstring flexibility (cm)	39	22 9	8 0	10 0	38 0

Combined - Midfielders - Percentiles

Anthropometrics

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Age (yrs)	19 0	20 0	20 0	22 0	24 0	24 0	26 0	30 0	31 0	33 0
Height (cm)	179 5	182 3	183 6	184 6	187 0	188 0	188 3	189 5	193 4	195 6
Avr weight (kg)	79 1	81 7	83 1	85 0	86 3	89 4	94 5	95 7	101 7	109 6
BMI	22 7	23 6	24 0	24 6	25 3	26 1	26 8	27 7	28 8	32 2
RHR	51	54	56	60	61	65	67	70	75	77
SBP	116	118	119	121	126	130	131	137	140	144
DBP	68	70	72	73	76	79	81	84	88	90

Body Composition

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest skinfold	5 0	7 0	8 0	9 0	11 0	14 0	15 0	16 0	19 0	26 0
Thigh skinfold	7 0	8 0	10 0	12 0	14 0	15 0	15 0	18 0	23 5	28 0
Abdomen skinfold	11 0	13 0	15 0	20 0	22 0	25 0	27 0	32 0	36 0	53 0
Sum of skinfolds	27 0	29 0	33 0	38 0	50 0	54 0	57 0	61 0	74 0	107 0
% Body Fat	7 7	9 5	10 6	13 6	18 3	19 3	21 3	22 8	28 8	46 4
Fat mass (kg)	6 6	7 7	8 8	12 7	15 3	16 7	18 3	22 7	30 2	48 9
Lean body masss (kg)	64 6	67 1	69 0	71 1	73 2	74 2	75 6	79 0	85 4	92 0

Physical Characteristics

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest circumference (cm)	92 6	94 0	95 2	96 5	98 6	101 5	102 7	103 6	106 0	111 3
Biceps circumference (cm)	31 0	32 0	32 6	33 2	33 8	34 1	35 0	35 8	37 5	38 7
Quadriceps circumference (cm)	55 0	56 0	57 0	58 0	60 2	61 0	61 5	63 1	64 3	69 0
Waist Circumference (cm)	83 6	87 1	88 6	90 5	92 5	93 8	95 5	100 3	103 0	106 0

Vertical Jump and Flexibility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Vertical Jump (cm)	44 0	48 0	51 0	53 0	55 0	56 0	58 0	60 0	64 0	74 0
Hamstring flexibility (cm)	11 0	14 0	17 0	21 0	24 0	25 0	27 0	30 0	34 0	38 0

Combined - Midfielders - Descriptive Data

Cardiorespiratory response at maximal exercise

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max VT in one breath (l)	29	3 24	0 57	2 36	5 08
Max respiratory rate (l/mm)	29	52	5	44	64
Max ventilation rate (l/min)	29	124	14	85	150
Respiratory exchange ratio	29	1 12	0 04	1 04	1 24
Vol of CO2 Expired (l/min)	29	4 90	0 55	3 96	5 86
Absolute vol of O2 uptake (l/mm)	29	4 42	0 49	3 11	5 21
Relative vol O2 upake (ml/min/kg)	30	50 8	6 0	35 6	60 7
Ventilatory threshold (ml/kg/min)	21	44 3	3 8	37 3	50 0
Ventilatory threshold (% VO2 max)	21	86 0	6 7	72 5	99 1
Heart Rate Max	27	192	8	179	210

Anaerobic Power and Capacity

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max absolute power (watts)	14	1039 6	140 7	832 7	1379 2
T1 - Peak power per kg bwt (watts)	14	11 9	1 9	10 0	17 6
T2 - Peak power per kg bwt (watts)	14	10 2	1 4	8 5	14 0
T3 - Peak power per kg bwt (watts)	14	9 4	2 0	7 2	15 6
T1 - Percentage Fatigue (%)	14	27 7	11 1	12 9	60 1
T2 - Percentage Fatigue (%)	14	32 0	8 6	16 5	46 9
T3 - Percentage Fatigue (%)	14	30 1	10 3	15 9	54 8
T1 - Avrg power per kg bwt (watts)	14	9 6	0 9	7 7	10 8
T2 - Avrg power per kg bwt (watts)	14	8 2	0 8	6 8	9 5
T3 - Avrg power per kg bwt (watts)	14	7 5	0 9	6 0	9 2

Speed and Agility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
5 metre time (sec)	20	1 09	0 07	0 99	1 21
5 metre speed (m/s)	20	4 59	0 29	4 14	5 07
5 metre acceleration (m/s/s)	20	4 22	0 54	3 43	5 13
20 metre time (sec)	20	3 13	0 24	2 26	3 39
20 metre speed (m/s)	20	6 44	0 62	5 89	8 85
20 metre acceleration (m/s/s)	20	2 09	0 46	1 74	3 92
50m Forward Backward time (sec)	11	14 64	0 77	13 41	15 64
5m backwards time (sec)	11	1 37	0 07	1 28	1 51
5m backward speed (m/s)	11	3 66	0 18	3 32	3 90
5m backward acceleration (m/s/s)	11	2 68	0 26	2 21	3 04

Combined - Midfielders - Percentiles

Cardiorespiratory response at maximal exercise

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max VT in one breath (l)	2 63	2 69	2 88	3 04	3 17	3 32	3 37	3 68	4 00	5 08
Max respiratory rate (l/min)	47	47	48	51	52	54	54	57	61	64
Max ventilation rate (l/min)	107	111	115	122	126	129	131	134	142	150
Respiratory exchange ratio	1 07	1 08	1 10	1 12	1 12	1 13	1 14	1 16	1 18	1 24
Vol of CO2 Expired (l/min)	4 22	4 35	4 48	4 58	4 87	5 12	5 36	5 47	5 57	5 86
Absolute vol of O2 uptake (l/min)	3 79	4 04	4 11	4 17	4 38	4 55	4 81	4 97	5 04	5 21
Relative vol O2 upake (ml/min/kg)	43 5	44 8	47 2	49 2	51 2	52 7	54 4	56 5	60 2	60 7
Ventilatory threshold (ml/kg/min)	38 7	40 3	41 8	43 2	44 8	45 3	46 8	48 3	49 3	50 0
Ventilatory threshold (% VO2 max)	78 9	79 5	81 7	84 0	85 7	86 6	89 1	92 4	96 7	99 1
Heart Rate Max	182	184	186	189	191	194	197	199	202	210

Anaerobic Power and Capacity

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max absolute power (watts)	839 4	885 5	973 3	1025 5	1049 8	1058 7	1100 4	1124 7	1267 4	1379 2
T1 - Peak power per kg bwt (watts)	10 1	10 3	10 7	11 1	11 5	12 1	12 6	12 9	15 3	17 6
T2 - Peak power per kg bwt (watts)	8 6	9 0	9 5	9 7	9 9	10 3	10 7	11 2	12 9	14 0
T3 - Peak power per kg bwt (watts)	7 5	8 0	8 3	8 5	9 0	9 3	9 9	10 0	13 1	15 6
T1 - Percentage Fatigue (%)	16 1	20 1	23 1	24 0	24 4	25 3	32 2	33 7	46 9	60 1
T2 - Percentage Fatigue (%)	19 3	24 5	25 4	28 0	33 7	34 3	37 2	39 8	45 0	46 9
T3 - Percentage Fatigue (%)	16 6	23 4	25 0	25 3	27 4	30 3	35 3	37 8	48 3	54 8
T1 - Avrg power per kg bwt (watts)	8 2	8 7	9 2	9 4	9 7	9 8	10 3	10 6	10 8	10 8
T2 - Avrg power per kg bwt (watts)	6 9	7 5	7 7	7 8	8 2	8 5	8 7	8 9	9 4	9 5
T3 - Avrg power per kg bwt (watts)	6 2	6 8	7 0	7 0	7 2	8 0	8 2	8 2	9 1	9 2

Speed and Agility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
5 metre time (sec)	0 99	1 02	1 05	1 07	1 11	1 12	1 14	1 15	1 20	1 21
5 metre speed (m/s)	4 17	4 34	4 40	4 45	4 50	4 67	4 78	4 92	5 05	5 07
5 metre acceleration (m/s/s)	3 48	3 77	3 87	3 97	4 05	4 36	4 57	4 84	5 10	5 13
20 metre time (sec)	2 93	3 01	3 09	3 11	3 17	3 24	3 27	3 27	3 32	3 39
20 metre speed (m/s)	6 03	6 11	6 12	6 18	6 31	6 43	6 48	6 65	6 82	8 85
20 metre acceleration (m/s/s)	1 82	1 87	1 87	1 91	1 99	2 07	2 10	2 21	2 33	3 92
50m Forward Backward time (sec)	13 49	13 87	13 99	14 40	14 66	14 87	15 41	15 47	15 61	15 64
5m backwards time (sec)	1 28	1 30	1 32	1 36	1 38	1 38	1 39	1 43	1 49	1 51
5m backward speed (m/s)	3 35	3 50	3 59	3 61	3 63	3 69	3 80	3 85	3 89	3 90
5m backward acceleration (m/s/s)	2 24	2 45	2 58	2 61	2 63	2 72	2 88	2 96	3 03	3 04

Appendix 10

Combined - Forwards - Descriptive Data

Anthropometrics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Age (yrs)	69	22 7	4 1	16 0	40 0
Height (cm)	73	179 6	5 1	167 4	189 2
Avr weight (kg)	73	80 0	9 7	54 5	100 5
BMI	73	24 8	2 8	18 9	32 6
RHR	60	61	9	41	82
SBP	60	128	12	102	160
DBP	60	78	9	60	100

Body Composition

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest skinfold	73	11 2	4 7	4 0	28 0
Thigh skinfold	72	13 6	5 1	4 0	27 0
Abdomen skinfold	73	22 5	10 0	7 0	56 0
Sum of skinfolds	73	47 0	16 5	18 0	84 0
% Body Fat	73	16 5	7 4	5 0	34 6
Fat mass (kg)	73	13 5	7 6	0 0	34 2
Lean body masss (kg)	73	65 2	9 6	0 0	79 6

Physical Characteristics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest circumference (cm)	74	95 4	6 1	80 0	109 2
Biceps circumference (cm)	74	32 3	2 4	25 8	38 0
Quadriceps circumference (cm)	74	56 9	4 9	37 8	67 2
Waist Circumference (cm)	74	87 8	8 2	68 0	108 0

Vertical Jump and Flexibility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Vertical Jump (cm)	74	51 7	6 4	39 0	67 0
Hamstring flexibility (cm)	70	21 3	6 2	6 0	36 0

Combined - Forwards - Percentiles

Anthropometrics

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Age (yrs)	18 0	19 0	20 0	21 0	22 0	24 0	25 0	26 0	28 0	40 0
Height (cm)	172 3	175 1	176 7	178 5	180 2	181 0	183 1	184 6	185 6	189 2
Avr weight (kg)	69 4	72 2	74 1	75 8	79 3	81 0	83 5	89 5	95 6	100 5
BMI	21 7	22 3	23 0	23 6	24 5	25 3	26 1	27 4	28 2	32 6
RHR	50	52	56	59	62	64	67	70	73	82
SBP	114	120	120	123	127	129	130	136	150	160
DBP	66	70	72	77	78	80	80	87	90	100

Body Composition

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest skinfold	6 0	7 0	8 0	9 8	11 0	11 7	12 9	14 1	18 5	28 0
Thigh skinfold	7 7	9 0	10 0	11 0	13 3	14 5	15 0	17 0	21 0	27 0
Abdomen skinfold	11 7	15 0	16 0	18 0	20 0	21 7	25 8	32 0	36 0	56 0
Sum of skinfolds	27 0	33 0	36 2	40 0	43 0	46 0	54 2	65 0	72 0	84 0
% Body Fat	8 1	10 5	11 5	13 4	14 5	16 1	19 8	25 0	28 4	34 6
Fat mass (kg)	5 3	7 5	8 4	9 9	11 4	13 1	16 2	21 8	24 5	34 2
Lean body masss (kg)	59 3	60 9	63 0	64 6	65 6	67 1	68 1	71 8	75 0	79 6

Physical Characteristics

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest circumference (cm)	88 8	90 3	91 5	92 8	95 1	96 2	98 8	100 1	103 5	109 2
Biceps circumference (cm)	29 0	30 5	31 3	31 8	32 3	32 8	33 5	34 1	35 5	38 0
Quadriceps circumference (cm)	51 3	54 0	54 7	56 0	57 1	58 0	59 5	61 0	62 8	67 2
Waist Circumference (cm)	77 9	81 0	82 9	84 0	87 1	89 5	91 3	96 0	100 4	108 0

Vertical Jump and Flexibility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Vertical Jump (cm)	42 5	46 0	49 0	49 0	51 0	53 0	54 5	58 0	60 5	67 0
Hamstring flexibility (cm)	13 0	16 0	19 0	20 4	22 0	22 0	23 7	27 0	29 0	36 0

Combined - Forwards - Descriptive Data

Cardiorespiratory response at maximal exercise

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max VT in one breath (l)	58	2 81	0 39	1 93	3 92
Max respiratory rate (l/min)	58	55	7	41	72
Max ventilation rate (l/min)	58	116	15	78	146
Respiratory exchange ratio	58	1 12	0 06	0 96	1 23
Vol of CO2 Expired (l/min)	58	4 53	0 54	3 02	5 52
Absolute vol of O2 uptake (l/min)	58	4 13	0 50	2 85	5 25
Relative vol O2 upake (ml/min/kg)	58	51 5	6 2	37 5	67 5
Ventilatory threshold (ml/kg/min)	50	44 2	5 6	32 5	56 4
Ventilatory threshold (% VO2 max)	50	85 8	6 0	67 5	95 4
Heart Rate Max	54	195	10	168	210

Anaerobic Power and Capacity

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max absolute power (watts)	28	946 6	145 4	744 6	1263 7
T1 - Peak power per kg bwt (watts)	28	11 9	1 6	9 2	16 5
T2 - Peak power per kg bwt (watts)	28	9 7	1 2	7 1	12 8
T3 - Peak power per kg bwt (watts)	28	8 5	1 5	6 2	12 2
T1 - Percentage Fatigue (%)	28	24 8	8 5	12 8	47 8
T2 - Percentage Fatigue (%)	28	27 2	8 6	16 5	48 2
T3 - Percentage Fatigue (%)	28	27 7	10 2	10 0	61 5
T1 - Avrg power per kg bwt (watts)	28	9 9	1 1	6 1	11 6
T2 - Avrg power per kg bwt (watts)	28	8 0	1 0	5 9	10 3
T3 - Avrg power per kg bwt (watts)	28	6 9	1 1	4 5	8 8

Speed and Agility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
5 metre time (sec)	41	1 10	0 07	0 95	1 29
5 metre speed (m/s)	41	4 58	0 30	3 87	5 29
5 metre acceleration (m/s/s)	41	4 21	0 54	3 00	5 60
20 metre time (sec)	41	3 14	0 12	2 89	3 42
20 metre speed (m/s)	41	6 37	0 24	5 85	6 92
20 metre acceleration (m/s/s)	41	2 03	0 15	1 71	2 39
50m Forward Backward time (sec)	27	14 93	0 89	12 46	16 73
5m backwards time (sec)	27	1 40	0 09	1 30	1 60
5m backward speed (m/s)	27	3 59	0 21	3 12	3 85
5m backward acceleration (m/s/s)	27	2 58	0 30	1 95	2 97

Combined - Forwards - Percentiles

Cardiorespiratory response at maximal exercise

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max VT in one breath (l)	2.46	2.52	2.60	2.69	2.75	2.86	2.91	3.09	3.39	3.92
Max respiratory rate (l/min)	45.9	47	51	54	55	56.4	59	60.2	65.2	72
Max ventilation rate (l/min)	97	103	107	112	117	119	122	130	137	146
Respiratory exchange ratio	1.05	1.08	1.09	1.10	1.12	1.13	1.15	1.18	1.20	1.23
Vol of CO2 Expired (l/min)	3.78	4.10	4.34	4.44	4.51	4.59	4.87	5.02	5.22	5.52
Absolute vol. of O2 uptake (l/min)	3.47	3.72	3.93	4.02	4.09	4.25	4.34	4.60	4.79	5.25
Relative vol. O2 upake (ml/min/kg)	43.2	45.3	47.9	50.8	52.5	53.9	55.3	56.4	58.3	67.5
Ventilatory threshold (ml/kg/min)	36.3	39.0	41.6	42.2	44.8	46.5	47.8	49.2	51.6	56.4
Ventilatory threshold (% VO2 max)	77.2	80.3	83.3	84.4	86.9	88.6	89.4	91.2	92.6	95.4
Heart Rate Max	178	188	193	194	196	198	202	204	207	210

Anaerobic Power and Capacity

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max absolute power (watts)	785.1	830.5	839.8	877.9	896.2	968.3	987.6	1092.9	1200.5	1263.7
T1 - Peak power per kg bwt (watts)	10.3	10.6	10.9	11.2	11.6	11.8	12.2	13.1	14.2	16.5
T2 - Peak power per kg bwt (watts)	8.3	9.0	9.1	9.3	9.5	9.7	10.2	10.5	11.1	12.8
T3 - Peak power per kg bwt (watts)	6.3	7.3	7.7	7.9	8.4	8.7	9.0	9.7	10.6	12.2
T1 - Percentage Fatigue (%)	15.4	17.8	18.7	19.9	23.8	26.1	28.7	30.6	38.1	47.8
T2 - Percentage Fatigue (%)	17.2	18.4	21.2	23.8	26.9	27.8	28.7	36.7	41.7	48.2
T3 - Percentage Fatigue (%)	15.6	21.4	22.9	23.6	25.3	28.8	31.4	33.0	39.8	61.5
T1 - Avrg power per kg bwt (watts)	8.8	9.3	9.4	9.6	9.9	10.0	10.3	10.8	11.5	11.6
T2 - Avrg power per kg bwt (watts)	6.9	7.2	7.6	7.8	8.0	8.3	8.6	9.0	9.1	10.3
T3 - Avrg power per kg bwt (watts)	5.1	6.2	6.5	6.7	6.9	7.0	7.3	7.7	8.5	8.8

Speed and Agility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
5 metre time (sec)	1.01	1.04	1.06	1.08	1.09	1.10	1.11	1.14	1.23	1.29
5 metre speed (m/s)	4.07	4.40	4.51	4.55	4.58	4.64	4.71	4.81	4.96	5.29
5 metre acceleration (m/s/s)	3.31	3.87	4.07	4.14	4.19	4.31	4.43	4.63	4.92	5.60
20 metre time (sec)	3.00	3.06	3.07	3.10	3.13	3.16	3.19	3.25	3.34	3.42
20 metre speed (m/s)	5.98	6.16	6.26	6.32	6.40	6.45	6.51	6.55	6.68	6.92
20 metre acceleration (m/s/s)	1.79	1.90	1.96	2.00	2.05	2.08	2.12	2.14	2.23	2.39
50m Forward Backward time (sec)	14.08	14.18	14.36	14.66	14.96	15.15	15.33	15.60	16.13	16.73
5m backwards time (sec)	1.32	1.33	1.34	1.34	1.37	1.41	1.43	1.47	1.56	1.60
5m backward speed (m/s)	3.20	3.40	3.49	3.55	3.66	3.72	3.75	3.77	3.79	3.85
5m backward acceleration (m/s/s)	2.05	2.32	2.44	2.52	2.68	2.77	2.81	2.85	2.88	2.97

Appendix 11

Club - All positions – Descriptive Data

Anthropometrics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Age (yrs)	85	23 5	4 9	16 0	40 0
Height (cm)	95	180 8	5 6	168 0	195 6
Avr weight (kg)	95	81 2	10 5	54 5	109 6
BMI	95	24 8	2 6	18 9	32 2
RHR	53	61 0	11 3	40 0	88 0
SBP	54	126 6	9 2	110 0	150 0
DBP	54	79 4	6 9	64 0	92 0

Body Composition

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest skinfold	94	11 5	4 4	5 0	26 0
Thigh skinfold	94	14 3	5 3	5 5	28 0
Abdomen skinfold	94	22 3	9 3	6 0	53 0
Sum of skinfolds	94	48 1	16 6	17 0	107 0
% Body Fat	94	17 0	7 6	4 3	46 4
Fat mass (kg)	94	14 0	7 8	0 0	48 9
Lean body masss (kg)	94	66 0	10 2	0 0	86 7

Physical characteristics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest circumference (cm)	96	95 8	6 0	80 0	112 0
Biceps circumference (cm)	96	32 3	2 5	25 8	39 5
Quadriceps circumference (cm)	96	57 1	5 7	36 0	69 0
Waist Circumference (cm)	96	91 2	8 3	68 0	112 0

Vertical Jump and Hamstring Flexibility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Vertical Jump (cm)	95	53 3	6 3	39 0	67 0
Hamstring flexibility (cm)	85	20 4	6 4	8 0	35 0

Club - All positions – Percentiles

Anthropometrics

Percentiles

Components	10	20	30	40	50	60	70	80	90	100
Age (yrs)	18 0	19 0	20 0	21 0	22 0	24 0	25 0	27 0	30 0	40 0
Height (cm)	173 5	176 2	178 0	179 2	181 2	182 8	184 1	185 0	188 0	195 6
Avr weight (kg)	69 5	72 5	74 7	76 9	79 5	83 2	86 1	90 8	95 7	109 6
BMI	21 9	22 3	22 9	23 8	24 6	25 3	26 1	27 2	28 1	32 2
RHR	46 0	51 8	54 0	57 0	60 0	65 4	68 0	72 0	75 2	88 0
SBP	117 0	120 0	122 0	122 0	125 0	128 0	130 0	132 0	141 0	150 0
DBP	70 0	72 0	78 0	78 0	80 0	80 0	82 0	86 0	90 0	92 0

Body Composition

Components	10	20	30	40	50	60	70	80	90	100
Chest skinfold	6 0	8 0	9 0	9 5	11 0	12 0	13 8	15 0	17 0	26 0
Thigh skinfold	8 0	10 0	11 0	13 0	14 0	15 0	15 8	18 0	23 5	28 0
Abdomen skinfold	12 0	14 0	16 3	18 0	20 8	23 0	26 5	29 0	34 0	53 0
Sum of skinfolds	29 0	33 0	38 5	42 0	46 0	50 0	55 5	61 0	72 0	107 0
% Body Fat	8 4	9 7	12 6	14 5	15 9	18 3	19 6	22 6	27 9	46 4
Fat mass (kg)	5 7	7 3	9 3	11 2	13 0	14 2	16 6	20 6	24 0	48 9
Lean body masss (kg)	57 1	59 5	62 6	65 0	65 8	67 3	71 2	73 1	76 3	86 7

Components	10	20	30	40	50	60	70	80	90	100
Chest circumference (cm)	88 9	90 7	93 0	94 0	95 3	96 7	99 0	101 3	103 5	112 0
Biceps circumference (cm)	29 0	30 4	31 0	31 5	32 5	33 0	33 5	34 4	35 5	39 5
Quadriceps circumference (cm)	51 4	54 0	55 5	56 0	57 5	59 0	59 5	61 2	63 0	69 0
Waist Circumference (cm)	80 4	83 7	88 5	90 0	91 8	93 5	94 3	98 3	101 8	112 0

Components	10	20	30	40	50	60	70	80	90	100
Vertical Jump (cm)	45 0	47 2	50 0	52 0	53 0	55 0	57 0	59 0	62 0	67 0
Hamstring flexibility (cm)	11 6	14 2	16 0	19 0	21 0	22 0	23 0	26 0	29 0	35 0

Club - All positions – Descriptive Data

Cardiorespiratory response at maximal exercise

Components	Valid	Mean	Std. Deviation	Minimum	Maximum
Max VT in one breath (l)	50	3.0	0.5	2.1	5.1
Max respiratory rate (l/min)	51	54.5	7.1	42.0	72.0
Max ventilation rate (l/min)	51	119.2	15.4	69.6	148.9
Respiratory exchange ratio	50	1.12	0.05	0.96	1.23
Vol of CO2 Expired (l/min)	51	4.69	0.60	3.02	5.74
Absolute vol. of O2 uptake (l/min)	51	4.26	0.53	2.94	5.38
Relative vol. O2 upake (ml/min/kg)	51	51.5	6.2	35.6	66.9
Ventilatory threshold (ml/kg/min)	38	44.0	5.6	33.1	56.4
Ventilatory threshold (% VO2 max)	38	84.2	6.3	67.5	95.5
Heart Rate Max	44	191.9	9.0	168.0	210.0

Anaerobic Power and Capacity

Components	Valid	Mean	Std. Deviation	Minimum	Maximum
Max absolute power (watts)	27	951.5	147.5	704.6	1269.2
T1 - Peak power per kg bwt (watts)	27	11.6	1.7	9.2	16.5
T2 - Peak power per kg bwt (watts)	27	10.1	1.4	7.7	14.8
T3 - Peak power per kg bwt (watts)	27	9.0	1.1	6.6	12.2
T1 - Percentage Fatigue (%)	27	25.6	8.6	12.9	47.8
T2 - Percentage Fatigue (%)	27	29.9	10.1	16.5	53.4
T3 - Percentage Fatigue (%)	27	30.0	10.6	10.7	61.5
T1 - Avrg power per kg bwt (watts)	27	9.4	1.3	6.1	11.6
T2 - Avrg power per kg bwt (watts)	27	8.2	0.9	5.9	9.4
T3 - Avrg power per kg bwt (watts)	27	7.2	0.9	4.9	8.8

Speed and Agility

Components	Valid	Mean	Std. Deviation	Minimum	Maximum
5 metre time (sec)	52	1.114	0.074	0.945	1.292
5 metre speed (m/s)	52	4.508	0.299	3.870	5.291
5 metre acceleration (m/s/s)	52	4.082	0.542	2.995	5.599
20 metre time (sec)	52	3.181	0.196	2.110	3.482
20 metre speed (m/s)	52	6.318	0.510	5.744	9.479
20 metre acceleration (m/s/s)	52	2.008	0.384	1.650	4.492
50m Forward Backward time (sec)	11	15.49	0.64	14.18	16.05
5m backwards time (sec)	11	1.471	0.137	1.320	1.818
5m backward speed (m/s)	11	3.424	0.286	2.750	3.788
5m backward acceleration (m/s/s)	11	2.360	0.374	1.513	2.870

Club - All positions – Percentiles

Cardiorespiratory response at maximal exercise

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max VT in one breath (l)	2 49	2 68	2 76	2 87	2 94	3 13	3 23	3 38	3 47	5 08
Max respiratory rate (l/min)	45 2	48 0	50 0	51 0	54 0	57 0	58 0	61 0	63 8	72 0
Max ventilation rate (l/min)	101 5	107 1	111 2	117 0	120 2	125 7	128 2	131 0	138 2	148 9
Respiratory exchange ratio	1 05	1 08	1 09	1 10	1 11	1 13	1 15	1 17	1 19	1 23
Vol of CO2 Expired (l/min)	3 97	4 20	4 44	4 55	4 69	4 82	5 00	5 25	5 49	5 74
Absolute vol of O2 uptake (l/min)	3 58	3 89	4 09	4 18	4 27	4 44	4 56	4 65	4 88	5 38
Relative vol O2 upake (ml/min/kg)	43 7	45 6	47 9	50 6	51 3	53 5	55 2	56 8	59 6	66 9
Ventilatory threshold (ml/kg/min)	36 8	38 6	40 6	43 3	44 5	45 1	46 8	48 4	51 3	56 4
Ventilatory threshold (% VO2 max)	75 9	78 1	81 8	83 5	84 3	85 8	87 7	89 9	92 5	95 5
Heart Rate Max	178 5	182 0	188 5	191 0	194 0	196 0	198 0	199 0	202 5	210 0

Anaerobic Power and Capacity

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max absolute power (watts)	752 6	834 9	871 2	889 7	950 3	966 1	1012 5	1074 5	1202 1	1269 2
T1 - Peak power per kg bwt (watts)	9 9	10 2	10 4	10 8	11 1	11 7	12 1	12 5	14 3	16 5
T2 - Peak power per kg bwt (watts)	8 3	9 2	9 4	9 8	10 0	10 3	10 4	10 9	11 6	14 8
T3 - Peak power per kg bwt (watts)	7 7	8 1	8 4	8 7	9 0	9 2	9 4	9 7	10 0	12 2
T1 - Percentage Fatigue (%)	16 8	18 5	19 5	21 4	22 6	25 6	31 1	33 0	38 5	47 8
T2 - Percentage Fatigue (%)	18 2	21 5	22 7	26 6	28 1	28 4	34 3	38 6	48 8	53 4
T3 - Percentage Fatigue (%)	15 9	23 7	25 4	27 8	28 7	31 1	32 7	37 1	46 0	61 5
T1 - Avrg power per kg bwt (watts)	7 6	8 4	9 0	9 2	9 4	10 0	10 0	10 4	11 1	11 6
T2 - Avrg power per kg bwt (watts)	6 8	7 7	7 8	8 2	8 5	8 6	8 6	8 9	9 1	9 4
T3 - Avrg power per kg bwt (watts)	5 9	6 5	6 9	7 2	7 4	7 7	7 7	7 9	8 2	8 8

Speed and Agility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
5 metre time (sec)	1 024	1 054	1 073	1 086	1 110	1 125	1 139	1 193	1 230	1 292
5 metre speed (m/s)	4 066	4 191	4 390	4 446	4 505	4 606	4 662	4 743	4 884	5 291
5 metre acceleration (m/s/s)	3 307	3 513	3 854	3 954	4 058	4 243	4 346	4 499	4 771	5 599
20 metre time (sec)	3 051	3 081	3 104	3 145	3 200	3 240	3 275	3 321	3 372	3 482
20 metre speed (m/s)	5 931	6 022	6 107	6 174	6 250	6 359	6 444	6 491	6 556	9 479
20 metre acceleration (m/s/s)	1 759	1 813	1 865	1 906	1 953	2 022	2 077	2 106	2 149	4 492
50m Forward Backward time (sec)	14 24	14 81	15 39	15 44	15 50	15 96	15 97	16 02	16 05	16 05
5m backwards time (sec)	1 331	1 378	1 387	1 398	1 442	1 474	1 489	1 557	1 773	1 818
5m backward speed (m/s)	2 828	3 213	3 358	3 391	3 467	3 576	3 604	3 629	3 758	3 788
5m backward acceleration (m/s/s)	1 604	2 066	2 256	2 300	2 405	2 558	2 598	2 634	2 825	2 870

Appendix 12

Inter-County Level - All positions – Descriptive Data

Anthropometrics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Age (yrs)	118	22 9	3 4	17 0	33 0
Height (cm)	119	180 4	5 6	167 0	194 9
Avr weight (kg)	119	81 2	8 4	63 2	105 0
BMI	119	25 0	2 3	19 8	32 6
RHR	114	62 8	9 1	41 0	84 0
SBP	114	127 8	12 0	102 0	160 0
DBP	114	77 3	8 9	50 0	100 0

Body Composition

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest skinfold	110	9 6	4 3	4 0	28 0
Thigh skinfold	109	12 5	4 5	4 0	25 0
Abdomen skinfold	110	20 7	9 7	6 0	56 0
Sum of skinfolds	110	42 6	16 4	17 0	87 0
% Body Fat	110	14 8	7 3	4 1	36 8
Fat mass (kg)	110	12 5	7 3	3 2	37 5
Lean body masss (kg)	111	69 0	6 1	52 5	92 0

Physical Characteristics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest circumference (cm)	116	96 0	5 0	85 0	109 2
Biceps circumference (cm)	115	33 0	2 2	27 6	38 7
Quadriceps circumference (cm)	116	57 3	4 7	31 6	67 2
Waist Circumference (cm)	116	85 4	6 2	74 7	103 0

Vertical Jump and Hamstring Flexibility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Vertical Jump (cm)	117	52 9	6 3	40 0	74 0
Hamstring flexibility (cm)	117	23 6	6 9	6 0	39 0

Inter-County Level - All positions – Percentiles

Anthropometrics

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Age (yrs)	19 0	20 0	21 0	22 0	23 0	24 0	24 0	26 0	27 1	33 0
Height (cm)	173 5	176 2	177 3	179 0	180 6	181 9	183 3	185 0	188 0	194 9
Avr weight (kg)	71 2	74 4	76 2	79 3	80 3	82 3	85 0	87 1	94 9	105 0
BMI	22 2	23 0	23 6	24 3	24 6	25 3	26 0	26 6	27 8	32 6
RHR	51 0	55 0	57 5	61 0	63 0	65 0	68 0	70 0	75 0	84 0
SBP	112 0	118 0	120 0	122 0	126 0	130 0	132 0	138 0	146 0	160 0
DBP	66 0	70 0	72 0	75 0	78 0	80 0	80 0	86 0	90 0	100 0

Body Composition

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest skinfold	5 0	6 0	7 0	7 0	8 0	10 0	11 0	12 0	16 0	28 0
Thigh skinfold	7 0	9 0	10 0	11 0	11 0	14 0	15 0	17 0	19 0	25 0
Abdomen skinfold	10 0	12 0	15 0	16 0	19 0	21 0	24 0	28 8	35 0	56 0
Sum of skinfolds	25 0	27 2	31 0	35 0	40 0	44 0	49 7	56 6	69 0	87 0
% Body Fat	7 3	8 6	9 6	11 0	13 4	15 1	17 4	20 8	27 0	36 8
Fat mass (kg)	5 3	6 8	7 7	9 0	10 0	12 3	13 9	17 0	24 7	37 5
Lean body masss (kg)	61 9	63 6	65 3	67 0	67 9	70 1	72 1	73 9	76 7	92 0

Physical Characteristics

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest circumference (cm)	90 0	92 0	93 4	94 5	95 5	96 0	98 0	100 1	103 5	109 2
Biceps circumference (cm)	30 4	31 0	31 8	32 0	32 6	33 5	34 0	34 9	35 9	38 7
Quadriceps circumference (cm)	53 2	54 5	55 5	56 5	57 1	58 0	59 5	61 2	62 7	67 2
Waist Circumference (cm)	77 9	79 9	81 5	83 5	84 9	86 9	88 5	90 1	94 0	103 0

Vertical Jump and Hamstring Flexibility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Vertical Jump (cm)	45 8	48 0	49 0	51 0	53 0	54 0	55 6	58 0	60 2	74 0
Hamstring flexibility (cm)	13 0	17 6	21 0	22 0	23 0	25 8	27 6	30 0	32 2	39 0

Inter-County Level - All positions – Descriptive Data

Cardiorespiratory response at maximal exercise

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max VT in one breath (l)	113	2 97	0 42	1 93	4 10
Max respiratory rate (l/min)	113	54 5	6 4	41 0	70 0
Max ventilation rate (l/min)	113	120 9	15 9	77 8	152 4
Respiratory exchange ratio	113	1 14	0 06	1 01	1 31
Vol of CO2 Expired (l/min)	113	4 75	0 60	3 02	6 31
Absolute vol of O2 uptake (l/min)	113	4 28	0 53	2 85	5 52
Relative vol O2 upake (ml/min/kg)	114	53 1	6 1	37 5	67 5
Ventilatory threshold (ml/kg/mm)	100	45 5	5 0	32 5	58 4
Ventilatory threshold (% VO2 max)	100	85 6	5 8	72 5	99 1
Heart Rate Max	107	194 7	9 5	160 0	210 0

Anaerobic Power and Capacity

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max absolute power (watts)	51	954 0	136 9	723 2	1379 2
T1 - Peak power per kg bwt (watts)	51	11 7	1 3	9 8	17 6
T2 - Peak power per kg bwt (watts)	51	9 9	1 2	7 1	14 0
T3 - Peak power per kg bwt (watts)	51	8 6	1 6	5 6	15 6
T1 - Percentage Fatigue (%)	51	23 6	7 8	11 9	60 1
T2 - Percentage Fatigue (%)	51	27 3	8 4	15 0	46 9
T3 - Percentage Fatigue (%)	51	26 3	8 5	10 0	54 8
T1 - Avrg power per kg bwt (watts)	51	9 9	0 8	7 7	11 9
T2 - Avrg power per kg bwt (watts)	51	8 1	0 9	5 9	10 3
T3 - Avrg power per kg bwt (watts)	51	7 1	1 0	4 5	9 2

Speed and Agility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
5 metre time (sec)	63	1 080	0 053	0 974	1 215
5 metre speed (m/s)	62	4 647	0 222	4 115	5 133
5 metre acceleration (m/s/s)	62	4 329	0 413	3 387	5 271
20 metre time (sec)	63	3 104	0 138	2 260	3 319
20 metre speed (m/s)	63	6 459	0 353	6 026	8 850
20 metre acceleration (m/s/s)	63	2 092	0 260	1 816	3 916
50m Forward Backward time (sec)	63	14 76	0 85	12 46	16 73
5m backwards time (sec)	63	1 379	0 088	1 248	1 641
5m backward speed (m/s)	63	3 638	0 221	3 047	4 006
5m backward acceleration (m/s/s)	63	2 657	0 317	1 857	3 210

Inter-County Level - All positions – Percentiles

Cardiorespiratory response at maximal exercise

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max VT in one breath (l)	2 46	2 63	2 69	2 82	2 91	3 05	3 16	3 33	3 57	4 10
Max respiratory rate (l/min)	46 0	48 0	51 0	53 0	54 0	56 0	58 0	60 0	64 0	70 0
Max ventilation rate (l/min)	99 9	107 0	110 5	116 8	119 3	126 0	130 6	136 2	141 6	152 4
Respiratory exchange ratio	1 07	1 09	1 10	1 12	1 13	1 15	1 17	1 19	1 22	1 31
Vol of CO2 Expired (l/min)	4 08	4 23	4 41	4 57	4 67	4 90	5 06	5 22	5 57	6 31
Absolute vol of O2 uptake (l/min)	3 59	3 90	4 00	4 10	4 26	4 37	4 55	4 80	5 02	5 52
Relative vol O2 upake (ml/mm/kg)	45 0	47 7	49 5	51 6	53 2	54 7	56 2	58 0	60 7	67 5
Ventilatory threshold (ml/kg/min)	39 3	41 6	42 5	44 5	45 6	47 0	48 3	49 9	51 6	58 4
Ventilatory threshold (% VO2 max)	77 5	80 3	82 2	84 2	85 2	87 5	88 9	91 1	93 2	99 1
Heart Rate Max	183 8	188 0	191 0	194 0	195 0	198 0	200 0	202 4	206 2	210 0

Anaerobic Power and Capacity

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max absolute power (watts)	789 2	835 8	846 0	897 7	953 8	978 8	1004 5	1077 7	1122 5	1379 2
T1 - Peak power per kg bwt (watts)	10 5	10 7	11 0	11 3	11 5	11 7	12 2	12 6	13 0	17 6
T2 - Peak power per kg bwt (watts)	8 5	9 0	9 2	9 4	9 6	9 8	10 5	10 8	11 4	14 0
T3 - Peak power per kg bwt (watts)	7 1	7 6	8 0	8 2	8 5	8 8	9 0	9 7	10 1	15 6
T1 - Percentage Fatigue (%)	15 2	17 4	19 4	22 5	23 8	24 4	25 5	28 6	32 3	60 1
T2 - Percentage Fatigue (%)	16 5	18 4	22 2	24 4	25 9	27 7	32 9	35 7	39 5	46 9
T3 - Percentage Fatigue (%)	15 9	20 1	22 5	23 5	24 7	27 1	29 4	32 3	37 8	54 8
T1 - Avrg power per kg bwt (watts)	8 7	9 2	9 5	9 7	9 9	10 1	10 2	10 6	10 8	11 9
T2 - Avrg power per kg bwt (watts)	6 9	7 5	7 7	8 0	8 2	8 3	8 6	9 0	9 4	10 3
T3 - Avrg power per kg bwt (watts)	5 8	6 2	6 7	6 9	7 0	7 4	7 7	8 2	8 6	9 2

Speed and Agility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
5 metre time (sec)	1 011	1 033	1 051	1 068	1 081	1 093	1 104	1 124	1 147	1 215
5 metre speed (m/s)	4 378	4 460	4 539	4 582	4 628	4 685	4 762	4 849	4 947	5 133
5 metre acceleration (m/s/s)	3 833	3 979	4 122	4 199	4 283	4 390	4 535	4 703	4 895	5 271
20 metre time (sec)	2 990	3 051	3 074	3 100	3 119	3 128	3 160	3 181	3 250	3 319
20 metre speed (m/s)	6 154	6 288	6 329	6 394	6 412	6 451	6 506	6 555	6 690	8 850
20 metre acceleration (m/s/s)	1 894	1 977	2 003	2 043	2 056	2 081	2 117	2 148	2 238	3 916
50m Forward Backward time (sec)	13 71	14 11	14 33	14 53	14 78	14 98	15 16	15 39	15 84	16 73
5m backwards time (sec)	1 284	1 308	1 323	1 337	1 364	1 382	1 414	1 450	1 516	1 641
5m backward speed (m/s)	3 297	3 448	3 537	3 618	3 666	3 740	3 780	3 822	3 895	4 006
5m backward acceleration (m/s/s)	2 175	2 377	2 502	2 618	2 687	2 798	2 858	2 921	3 034	3 210

Appendix 13

Club Level - Goalkeeper - Descriptive Data

Anthropometrics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Age (yrs)	5	23 2	3 8	18 0	28 0
Height (cm)	5	180 0	5 3	173 5	187 0
Avr weight (kg)	5	85 9	14 4	74 5	103 3
BMI	5	26 5	3 9	22 1	31 6
RHR	3	63	17	48	82
SBP	3	132	5	128	138
DBP	3	79	9	68	86

Body Composition

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest skinfold	4	12 5	4 1	9 0	17 0
Thigh skinfold	4	17 8	5 6	12 0	25 0
Abdomen skinfold	4	29 8	11 0	18 0	41 0
Sum of skinfolds	4	60 0	18 1	39 0	83 0
% Body Fat	4	22 4	8 7	12 6	33 7
Fat mass (kg)	4	18 4	7 4	9 4	25 7
Lean body masss (kg)	4	63 2	11 1	50 7	77 2

Physical Characteristics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest circumference (cm)	5	101 0	7 3	93 0	112 0
Biceps circumference (cm)	5	34 3	4 0	30 0	39 5
Quadriceps circumference (cm)	5	60 0	6 1	54 5	67 0
Waist Circumference (cm)	5	97 4	12 7	80 5	112 0

Vertical Jump and Flexibility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Vertical Jump (cm)	5	54 8	7 7	48 0	67 0
Hamstring flexibility (cm)	5	20 4	4 0	16 0	26 0

Club Level Goalkeepers - Percentiles

Anthropometrics

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Age (yrs)	18 0	18 6	20 4	22 2	24 0	24 6	25 6	27 4	28 0	28 0
Height (cm)	173 5	174 4	177 1	178 0	178 0	181 3	184 2	186 3	187 0	187 0
Avr weight (kg)	74 5	74 7	75 2	75 8	76 4	90 6	100 7	102 6	103 3	103 3
BMI	22 1	22 5	23 7	24 5	25 0	27 7	29 9	31 2	31 6	31 6
RHR	48	48	50	54	58	68	77	82	82	82
SBP	128	128	128	129	130	133	136	138	138	138
DBP	68	68	71	76	82	84	85	86	86	86

Body Composition

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest skinfold	9 0	9 0	9 0	9 0	12 0	15 0	16 0	17 0	17 0	17 0
Thigh skinfold	12 0	12 0	13 5	15 0	17 0	19 0	22 0	25 0	25 0	25 0
Abdomen skinfold	18 0	18 0	20 5	23 0	30 0	37 0	39 0	41 0	41 0	41 0
Sum of skinfolds	39 0	39 0	48 0	57 0	59 0	61 0	72 0	83 0	83 0	83 0
% Body Fat	12 6	12 6	16 6	20 7	21 7	22 8	28 3	33 7	33 7	33 7
Fat mass (kg)	9 4	9 4	12 5	15 6	19 2	22 8	24 3	25 7	25 7	25 7
Lean body masss (kg)	50 7	50 7	55 2	59 8	62 5	65 1	71 2	77 2	77 2	77 2

Physical Characteristics

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest circumference (cm)	93 0	93 6	95 4	98 0	101 0	102 2	104 8	110 2	112 0	112 0
Biceps circumference (cm)	30 0	30 4	31 6	32 2	32 5	35 5	37 9	39 1	39 5	39 5
Quadriceps circumference (cm)	54 5	54 8	55 7	56 0	56 0	62 2	66 4	66 9	67 0	67 0
Waist Circumference (cm)	80 5	82 1	86 9	93 5	101 0	103 3	106 2	110 6	112 0	112 0

Vertical Jump and Flexibility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Vertical Jump (cm)	48 0	48 2	48 8	50 6	53 0	55 4	59 0	65 0	67 0	67 0
Hamstring flexibility (cm)	16 0	16 2	16 8	18 6	21 0	21 6	22 8	25 2	26 0	26 0

Club Level Goalkeepers - Descriptive Data

Cardiorespiratory response at maximal exercise

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max VT in one breath (l)	3	2 98	0 26	2 68	3 17
Max respiratory rate (l/min)	3	51	10	42	62
Max ventilation rate (l/min)	3	119	13	104	128
Respiratory exchange ratio	3	1 13	0 03	1 10	1 15
Vol of CO2 Expired (l/min)	3	4 78	0 42	4 38	5 21
Absolute vol of O2 uptake (l/min)	3	4 27	0 34	3 88	4 52
Relative vol O2 upake (ml/min/kg)	3	51 9	8 4	44 1	60 7
Ventilatory threshold (ml/kg/min)	2	44 9	15 9	33 6	56 1
Ventilatory threshold (% VO2 max)	2	84 3	11 5	76 2	92 4
Heart Rate Max	2	184	10	177	191

Anaerobic Power and Capacity

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max absolute power (watts)	1	992 9		992 9	992 9
T1 - Peak power per kg bwt (watts)	1	9 9		9 9	9 9
T2 - Peak power per kg bwt (watts)	1	7 7		7 7	7 7
T3 - Peak power per kg bwt (watts)	1	6 6		6 6	6 6
T1 - Percentage Fatigue (%)	1	34 0		34 0	34 0
T2 - Percentage Fatigue (%)	1	34 2		34 2	34 2
T3 - Percentage Fatigue (%)	1	26 1		26 1	26 1
T1 - Avrg power per kg bwt (watts)	1	8 0		8 0	8 0
T2 - Avrg power per kg bwt (watts)	1	6 3		6 3	6 3
T3 - Avrg power per kg bwt (watts)	1	5 5		5 5	5 5

Speed and Agility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
5 metre time (sec)	3	1 12	0 07	1 06	1 19
5 metre speed (m/s)	3	4 47	0 27	4 21	4 74
5 metre acceleration (m/s/s)	3	4 00	0 48	3 54	4 49
20 metre time (sec)	3	3 24	0 15	3 07	3 36
20 metre speed (m/s)	3	6 19	0 29	5 96	6 51
20 metre acceleration (m/s/s)	3	1 92	0 18	1 78	2 12
50m Forward Backward time (sec)	1	15 97		15 97	15 97
5m backwards time (sec)	1	1 40		1 40	1 40
5m backward speed (m/s)	1	3 57		3 57	3 57
5m backward acceleration (m/s/s)	1	2 55		2 55	2 55

Club Level Goalkeepers - Percentiles

Cardiorespiratory response at maximal exercise

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max VT in one breath (l)	2 68	2 68	2 76	2 92	3 08	3 12	3 15	3 17	3 17	3 17
Max respiratory rate (l/min)	42	42	43 4	46 2	49	54 2	59 4	62	62	62
Max ventilation rate (l/min)	104	104	108	117	125	127	128	128	128	128
Respiratory exchange ratio	1 10	1 10	1 11	1 12	1 13	1 14	1 15	1 15	1 15	1 15
Vol of CO2 Expired (l/min)	4 38	4 38	4 45	4 60	4 74	4 93	5 12	5 21	5 21	5 21
Absolute vol of O2 uptake (l/min)	3 88	3 88	3 99	4 20	4 41	4 45	4 50	4 52	4 52	4 52
Relative vol O2 upake (ml/min/kg)	44 1	44 1	45 4	48 1	50 8	54 8	58 7	60 7	60 7	60 7
Ventilatory threshold (ml/kg/min)	33 6	33 6	33 6	38 1	44 9	51 6	56 1	56 1	56 1	56 1
Ventilatory threshold (% VO2 max)	76 2	76 2	76 2	79 4	84 3	89 2	92 4	92 4	92 4	92 4
Heart Rate Max	177	177	177	180	184	188	191	191	191	191

Anaerobic Power and Capacity

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max absolute power (watts)	992 9	992 9	992 9	992 9	992 9	992 9	992 9	992 9	992 9	992 9
T1 - Peak power per kg bwt (watts)	9 9	9 9	9 9	9 9	9 9	9 9	9 9	9 9	9 9	9 9
T2 - Peak power per kg bwt (watts)	7 7	7 7	7 7	7 7	7 7	7 7	7 7	7 7	7 7	7 7
T3 - Peak power per kg bwt (watts)	6 6	6 6	6 6	6 6	6 6	6 6	6 6	6 6	6 6	6 6
T1 - Percentage Fatigue (%)	34 0	34 0	34 0	34 0	34 0	34 0	34 0	34 0	34 0	34 0
T2 - Percentage Fatigue (%)	34 2	34 2	34 2	34 2	34 2	34 2	34 2	34 2	34 2	34 2
T3 - Percentage Fatigue (%)	26 1	26 1	26 1	26 1	26 1	26 1	26 1	26 1	26 1	26 1
T1 - Avrg power per kg bwt (watts)	8 0	8 0	8 0	8 0	8 0	8 0	8 0	8 0	8 0	8 0
T2 - Avrg power per kg bwt (watts)	6 3	6 3	6 3	6 3	6 3	6 3	6 3	6 3	6 3	6 3
T3 - Avrg power per kg bwt (watts)	5 5	5 5	5 5	5 5	5 5	5 5	5 5	5 5	5 5	5 5

Speed and Agility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
5 metre time (sec)	1 06	1 06	1 07	1 10	1 12	1 15	1 18	1 19	1 19	1 19
5 metre speed (m/s)	4 21	4 21	4 26	4 36	4 46	4 57	4 68	4 74	4 74	4 74
5 metre acceleration (m/s/s)	3 54	3 54	3 62	3 80	3 97	4 18	4 39	4 49	4 49	4 49
20 metre time (sec)	3 07	3 07	3 11	3 20	3 28	3 31	3 34	3 36	3 36	3 36
20 metre speed (m/s)	5 96	5 96	5 99	6 04	6 09	6 26	6 43	6 51	6 51	6 51
20 metre acceleration (m/s/s)	1 78	1 78	1 79	1 82	1 85	1 96	2 07	2 12	2 12	2 12
50m Forward Backward time (sec)	15 97	15 97	15 97	15 97	15 97	15 97	15 97	15 97	15 97	15 97
5m backwards time (sec)	1 40	1 40	1 40	1 40	1 40	1 40	1 40	1 40	1 40	1 40
5m backward speed (m/s)	3 57	3 57	3 57	3 57	3 57	3 57	3 57	3 57	3 57	3 57
5m backward acceleration (m/s/s)	2 55	2 55	2 55	2 55	2 55	2 55	2 55	2 55	2 55	2 55

Appendix 14

Club Level Defenders - Descriptive Data

Anthropometrics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Age (yrs)	37	23 5	5 1	18 0	40 0
Height (cm)	42	179 4	4 8	168 0	192 5
Avr weight (kg)	42	77 5	7 4	64 6	93 8
BMI	42	24 1	2 1	21 1	28 9
RHR	24	62	12	40	88
SBP	25	126	11	110	150
DBP	25	80	7	66	90

Body Composition

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest skinfold	42	9 8	3 1	5 0	17 0
Thigh skinfold	42	13 6	4 9	5 5	24 0
Abdomen skinfold	42	19 9	7 4	6 0	42 0
Sum of skinfolds	42	43 3	13 7	17 0	81 0
% Body Fat	42	14 8	6 2	4 3	32 1
Fat mass (kg)	42	11 6	5 5	2 9	27 5
Lean body masss (kg)	42	65 9	6 4	54 0	81 9

Physical Characteristics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest circumference (cm)	42	93 6	3 9	82 0	100 0
Biceps circumference (cm)	42	31 9	2 1	28 0	37 0
Quadriceps circumference (cm)	42	55 5	6 3	36 0	63 5
Waist Circumference (cm)	42	87 9	7 0	72 0	98 8

Vertical Jump and Flexibility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Vertical Jump (cm)	41	53 7	5 4	42 0	63 0
Hamstring flexibility (cm)	36	20 2	6 1	8 0	34 0

Club Level Defenders - Percentiles

Anthropometrics

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Age (yrs)	18 0	20 0	20 0	21 2	22 0	23 0	25 6	27 0	29 8	40 0
Height (cm)	172 7	175 6	177 0	178 5	179 0	181 1	182 1	183 0	185 0	192 5
Avr weight (kg)	67 7	70 7	71 3	75 5	77 0	78 4	82 9	84 7	87 1	93 8
BMI	21 7	22 2	22 5	22 9	23 8	24 5	25 2	26 0	27 2	28 9
RHR	43	52	55	59	63	66	71	74	74	88
SBP	112	120	120	121	122	126	128	130	149	150
DBP	70	73	78	78	79	80	82	86	90	90

Body Composition

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest skinfold	5 2	6 6	9 0	9 0	9 3	10 0	11 0	12 4	14 4	17 0
Thigh skinfold	7 7	9 6	11 0	12 1	13 0	14 0	15 0	17 7	22 0	24 0
Abdomen skinfold	10 6	13 8	15 0	17 6	18 5	20 8	23 0	27 6	30 0	42 0
Sum of skinfolds	26 3	29 6	35 9	39 4	42 0	45 8	50 1	54 2	61 7	81 0
% Body Fat	6 5	8 4	11 3	13 6	15 0	16 0	17 6	19 6	23 2	32 1
Fat mass (kg)	5 2	6 2	8 4	9 8	10 9	12 9	13 5	16 6	19 4	27 5
Lean body masss (kg)	56 0	60 1	62 7	64 6	65 2	66 8	70 3	72 6	74 2	81 9

Physical Characteristics

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest circumference (cm)	88 2	89 8	92 5	93 6	94 0	94 9	95 8	96 7	98 7	100 0
Biceps circumference (cm)	29 2	30 3	30 5	31 0	31 8	32 5	33 0	33 8	34 9	37 0
Quadriceps circumference (cm)	47 9	53 3	55 0	55 6	56 9	57 6	59 0	59 5	61 4	63 5
Waist Circumference (cm)	77 3	80 5	84 2	87 7	89 7	91 4	93 5	94 0	95 0	98 8

Vertical Jump and Flexibility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Vertical Jump (cm)	46 0	48 4	51 6	53 0	53 0	55 0	56 4	59 6	61 0	63 0
Hamstring flexibility (cm)	12 0	13 8	17 1	19 0	20 5	22 0	23 0	24 6	28 2	34 0

Club Level Defenders - Descriptive Data

Cardiorespiratory response at maximal exercise

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max VT in one breath (l)	21	2 98	0 41	2 13	4 02
Max respiratory rate (l/min)	22	55	6	43	64
Max ventilation rate (l/min)	22	119	18	70	149
Respiratory exchange ratio	21	1 13	0 06	1 03	1 23
Vol of CO2 Expired (l/min)	22	4 66	0 65	3 02	5 74
Absolute vol of O2 uptake (l/min)	22	4 20	0 57	2 94	5 38
Relative vol O2 upake (ml/min/kg)	22	53 0	6 0	43 5	66 9
Ventilatory threshold (ml/kg/min)	17	44 2	5 1	33 1	52 9
Ventilatory threshold (% VO2 max)	17	83 3	6 6	72 8	95 5
Heart Rate Max	19	192	8	178	210

Anaerobic Power and Capacity

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max absolute power (watts)	14	918 7	166 4	704 6	1269 2
T1 - Peak power per kg bwt (watts)	14	11 4	1 1	9 7	13 9
T2 - Peak power per kg bwt (watts)	14	10 5	1 4	9 1	14 8
T3 - Peak power per kg bwt (watts)	14	9 1	0 7	8 0	9 9
T1 - Percentage Fatigue (%)	14	21 8	4 9	15 7	32 5
T2 - Percentage Fatigue (%)	14	29 1	11 1	16 9	53 4
T3 - Percentage Fatigue (%)	14	27 8	9 5	10 7	48 2
T1 - Avrg power per kg bwt (watts)	14	9 4	1 1	7 4	11 0
T2 - Avrg power per kg bwt (watts)	14	8 4	0 5	7 6	9 1
T3 - Avrg power per kg bwt (watts)	14	7 5	0 7	6 0	8 4

Speed and Agility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
5 metre time (sec)	20	1 11	0 06	1 02	1 24
5 metre speed (m/s)	20	4 52	0 22	4 03	4 91
5 metre acceleration (m/s/s)	20	4 10	0 39	3 24	4 82
20 metre time (sec)	19	3 19	0 11	3 06	3 48
20 metre speed (m/s)	19	6 27	0 21	5 74	6 53
20 metre acceleration (m/s/s)	19	1 97	0 13	1 65	2 13
50m Forward Backward time (sec)	4	15 49	0 73	14 47	16 05
5m backwards time (sec)	4	1 53	0 20	1 38	1 82
5m backward speed (m/s)	4	3 31	0 39	2 75	3 64
5m backward acceleration (m/s/s)	4	2 22	0 49	1 51	2 65

Club Level Defenders - Percentiles

Cardiorespiratory response at maximal exercise

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max VT in one breath (l)	2 49	2 72	2 80	2 85	2 92	2 96	3 25	3 37	3 41	4 02
Max respiratory rate (l/min)	45	47 8	50	52 2	56 5	58	59 1	61	62 7	64
Max ventilation rate (l/min)	94	107	112	115	119	126	128	133	144	149
Respiratory exchange ratio	1 04	1 08	1 10	1 11	1 11	1 12	1 17	1 18	1 21	1 23
Vol of CO2 Expired (l/min)	3 62	4 19	4 36	4 63	4 72	4 85	5 00	5 24	5 47	5 74
Absolute vol of O2 uptake (l/min)	3 15	3 82	3 96	4 16	4 23	4 34	4 54	4 61	4 88	5 38
Relative vol O2 upake (ml/min/kg)	45 3	47 2	48 9	51 0	51 9	54 7	57 3	58 3	60 6	66 9
Ventilatory threshold (ml/kg/min)	36 3	39 6	43 0	43 5	44 4	44 7	46 9	49 2	51 5	52 9
Ventilatory threshold (% VO2 max)	73 7	76 2	78 6	81 8	84 3	84 9	87 0	89 3	93 6	95 5
Heart Rate Max	179	183	188	191	193	195	197	199	200	210

Anaerobic Power and Capacity

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max absolute power (watts)	723 2	755 3	796 4	842 0	912 8	950 3	961 5	1116 0	1205 3	1269 2
T1 - Peak power per kg bwt (watts)	9 9	10 4	10 6	11 1	11 3	11 7	12 1	12 5	13 3	13 9
T2 - Peak power per kg bwt (watts)	9 2	9 4	9 7	10 0	10 1	10 4	10 7	11 2	13 1	14 8
T3 - Peak power per kg bwt (watts)	8 1	8 2	8 5	8 9	9 2	9 4	9 6	9 8	9 9	9 9
T1 - Percentage Fatigue (%)	16 4	17 6	18 5	19 7	20 5	22 1	23 3	25 7	31 5	32 5
T2 - Percentage Fatigue (%)	18 5	21 2	22 1	22 9	26 7	28 1	28 4	38 9	52 3	53 4
T3 - Percentage Fatigue (%)	12 9	16 1	25 2	27 8	28 3	30 5	31 9	33 1	42 4	48 2
T1 - Avrg power per kg bwt (watts)	7 6	8 1	9 0	9 2	9 9	10 0	10 1	10 2	10 9	11 0
T2 - Avrg power per kg bwt (watts)	7 7	7 9	8 2	8 5	8 5	8 6	8 6	8 9	9 1	9 1
T3 - Avrg power per kg bwt (watts)	6 2	6 8	7 2	7 4	7 7	7 7	7 9	8 0	8 3	8 4

Speed and Agility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
5 metre time (sec)	1 05	1 07	1 07	1 08	1 10	1 12	1 13	1 14	1 21	1 24
5 metre speed (m/s)	4 15	4 40	4 44	4 46	4 56	4 63	4 67	4 69	4 74	4 91
5 metre acceleration (m/s/s)	3 44	3 87	3 95	3 98	4 17	4 28	4 37	4 40	4 50	4 82
20 metre time (sec)	3 07	3 10	3 12	3 14	3 17	3 19	3 23	3 25	3 39	3 48
20 metre speed (m/s)	5 91	6 15	6 19	6 27	6 32	6 38	6 42	6 45	6 51	6 53
20 metre acceleration (m/s/s)	1 74	1 89	1 92	1 97	1 99	2 03	2 06	2 08	2 12	2 13
50m Forward Backward time (sec)	14 47	14 47	14 95	15 43	15 71	15 99	16 02	16 05	16 05	16 05
5m backwards time (sec)	1 38	1 38	1 41	1 44	1 46	1 47	1 65	1 82	1 82	1 82
5m backward speed (m/s)	2 75	2 75	3 07	3 39	3 43	3 47	3 55	3 64	3 64	3 64
5m backward acceleration (m/s/s)	1 51	1 51	1 91	2 30	2 35	2 41	2 53	2 65	2 65	2 65

Appendix 15

Club Level Midfielders - Descriptive Data

Anthropometrics

Components	Valid	Mean	Std. Deviation	Minimum	Maximum
Age (yrs)	17	25.1	4.5	19.0	32.0
Height (cm)	18	186.4	4.5	178.0	195.6
Avr weight (kg)	18	90.3	9.5	74.9	109.6
BMI	18	26.0	2.8	22.0	32.2
RHR	9	61	10	50	76
SBP	9	128	8	116	140
DBP	9	78	8	64	90

Body Composition

Components	Valid	Mean	Std. Deviation	Minimum	Maximum
Chest skinfold	18	13.9	5.0	6.5	26.0
Thigh skinfold	18	14.5	5.4	7.0	28.0
Abdomen skinfold	18	24.0	11.2	8.5	53.0
Sum of skinfolds	18	52.5	20.2	28.0	107.0
% Body Fat	18	19.3	9.4	8.4	46.4
Fat mass (kg)	18	18.0	10.3	6.6	48.9
Lean body masss (kg)	18	72.3	7.7	56.5	86.7

Physical Characteristics

Components	Valid	Mean	Std. Deviation	Minimum	Maximum
Chest circumference (cm)	18	99.8	5.5	91.0	111.3
Biceps circumference (cm)	18	33.3	2.4	29.5	38.2
Quadriceps circumference (cm)	18	60.4	4.0	54.6	69.0
Waist Circumference (cm)	18	96.1	5.8	83.5	106.0

Vertical Jump and Flexibility

Components	Valid	Mean	Std. Deviation	Minimum	Maximum
Vertical Jump (cm)	18	54.3	7.5	39.0	66.0
Hamstring flexibility (cm)	17	20.8	8.8	10.0	35.0

Club Level Midfielders - Percentiles

Anthropometrics

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Age (yrs)	19 0	20 6	21 4	24 0	24 0	25 8	29 2	30 4	31 2	32 0
Height (cm)	180 7	182 3	183 5	184 6	186 0	188 0	188 6	189 8	193 7	195 6
Avr weight (kg)	78 7	81 1	84 0	86 9	89 5	93 5	94 7	99 8	105 8	109 6
BMI	22 6	23 5	24 0	25 1	25 9	26 5	27 2	27 9	31 7	32 2
RHR	50	51	54	54	60	65	68	72	76	76
SBP	116	120	122	126	130	132	134	134	140	140
DBP	64	70	74	76	80	82	82	88	90	90

Body Composition

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest skinfold	7 0	8 8	11 1	13 6	14 8	15 0	15 3	16 6	21 1	26 0
Thigh skinfold	7 9	8 8	11 7	13 6	14 5	15 0	15 3	17 6	24 0	28 0
Abdomen skinfold	10 8	13 4	16 4	20 2	23 0	26 4	28 3	30 0	43 1	53 0
Sum of skinfolds	28 9	30 8	38 0	50 0	52 5	55 4	57 0	61 6	85 4	107 0
% Body Fat	8 7	9 7	13 6	18 3	18 6	19 5	21 3	22 9	34 6	46 4
Fat mass (kg)	7 2	7 7	13 4	15 1	15 9	17 5	19 6	24 2	34 8	48 9
Lean body masss (kg)	63 1	66 6	67 9	69 3	71 6	72 7	75 2	80 3	85 9	86 7

Physical Characteristics

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest circumference (cm)	92 4	93 9	95 4	97 5	101 5	102 1	103 1	103 9	106 5	111 3
Biceps circumference (cm)	29 5	31 2	32 4	32 6	33 1	33 9	34 1	35 1	38 0	38 2
Quadriceps circumference (cm)	55 0	56 0	57 5	59 5	61 3	61 5	62 3	63 6	66 3	69 0
Waist Circumference (cm)	88 3	92 2	93 2	93 8	94 9	96 5	101 2	101 8	103 8	106 0

Vertical Jump and Flexibility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Vertical Jump (cm)	43 5	46 6	50 4	52 6	55 5	56 8	59 0	62 2	64 2	66 0
Hamstring flexibility (cm)	10 8	11 0	12 8	16 2	22 0	24 6	25 6	30 4	34 2	35 0

Club Level Midfielders - Descriptive Data

Cardiorespiratory response at maximal exercise

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max VT in one breath (l)	9	3 51	0 75	2 69	5 08
Max respiratory rate (l/min)	9	51	4	47	58
Max ventilation rate (l/min)	9	122	8	107	131
Respiratory exchange ratio	9	1 11	0 04	1 04	1 16
Vol of CO2 Expired (l/min)	9	4 92	0 52	3 96	5 55
Absolute vol of O2 uptake (l/min)	9	4 47	0 34	3 76	4 88
Relative vol O2 upake (ml/min/kg)	9	48 0	6 0	35 6	53 7
Ventilatory threshold (ml/kg/min)	7	43 1	3 5	38 4	48 4
Ventilatory threshold (% VO2 max)	7	85 9	3 1	81 9	90 5
Heart Rate Max	8	188	8	179	199

Anaerobic Power and Capacity

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max absolute power (watts)	4	984 4	71 6	885 5	1046 8
T1 - Peak power per kg bwt (watts)	4	10 9	0 9	10 1	12 1
T2 - Peak power per kg bwt (watts)	4	9 8	0 6	9 0	10 4
T3 - Peak power per kg bwt (watts)	4	8 7	0 6	8 0	9 3
T1 - Percentage Fatigue (%)	4	22 3	8 0	12 9	31 6
T2 - Percentage Fatigue (%)	4	29 1	9 3	16 5	37 7
T3 - Percentage Fatigue (%)	4	27 0	8 5	17 2	37 8
T1 - Avrg power per kg bwt (watts)	4	9 3	0 5	8 6	9 8
T2 - Avrg power per kg bwt (watts)	4	7 9	0 8	6 9	8 7
T3 - Avrg power per kg bwt (watts)	4	7 4	0 5	7 0	8 0

Speed and Agility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
5 metre time (sec)	11	1 12	0 07	0 99	1 21
5 metre speed (m/s)	11	4 47	0 29	4 14	5 06
5 metre acceleration (m/s/s)	11	4 02	0 54	3 43	5 11
20 metre time (sec)	11	3 23	0 11	3 00	3 39
20 metre speed (m/s)	11	6 20	0 22	5 89	6 68
20 metre acceleration (m/s/s)	11	1 92	0 14	1 74	2 23
50m Forward Backward time (sec)	2	15 47	0 04	15 44	15 50
5m backwards time (sec)	2	1 39	0 01	1 38	1 39
5m backward speed (m/s)	2	3 61	0 02	3 60	3 62
5m backward acceleration (m/s/s)	2	2 60	0 02	2 58	2 62

Club Level Midfielders - Percentiles

Cardiorespiratory response at maximal exercise

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max VT in one breath (l)	2.69	2.83	3.17	3.17	3.22	3.35	4.00	4.08	5.08	5.08
Max respiratory rate (l/min)	47	47	48	48	51	51	54	57	58	58
Max ventilation rate (l/min)	107	112	120	122	126	127	128	129	131	131
Respiratory exchange ratio	1.04	1.05	1.08	1.12	1.12	1.13	1.14	1.15	1.16	1.16
Vol of CO2 Expired (l/min)	3.96	4.51	4.58	4.77	5.00	5.12	5.36	5.47	5.55	5.55
Absolute vol. of O2 uptake (l/min)	3.76	4.17	4.36	4.52	4.54	4.55	4.64	4.81	4.88	4.88
Relative vol. O2 upake (ml/min/kg)	35.6	43.9	44.1	47.6	49.1	51.3	53.4	53.5	53.7	53.7
Ventilatory threshold (ml/kg/min)	38.4	39.5	40.4	41.3	43.2	44.5	45.5	46.9	48.4	48.4
Ventilatory threshold (% VO2 max)	81.9	82.8	83.7	84.5	85.7	85.9	88.0	89.8	90.5	90.5
Heart Rate Max	179	181	182	184	188	190	193	199	199	199

Anaerobic Power and Capacity

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max absolute power (watts)	885.5	885.5	932.7	979.8	1002.7	1025.5	1036.2	1046.8	1046.8	1046.8
T1 - Peak power per kg bwt (watts)	10.1	10.1	10.2	10.3	10.7	11.1	11.6	12.1	12.1	12.1
T2 - Peak power per kg bwt (watts)	9.0	9.0	9.4	9.8	9.9	9.9	10.2	10.4	10.4	10.4
T3 - Peak power per kg bwt (watts)	8.0	8.0	8.3	8.5	8.8	9.0	9.2	9.3	9.3	9.3
T1 - Percentage Fatigue (%)	12.9	12.9	16.1	19.3	22.3	25.3	28.5	31.6	31.6	31.6
T2 - Percentage Fatigue (%)	16.5	16.5	22.3	28.0	31.2	34.3	36.0	37.7	37.7	37.7
T3 - Percentage Fatigue (%)	17.2	17.2	21.2	25.2	26.6	27.9	32.9	37.8	37.8	37.8
T1 - Avrg power per kg bwt (watts)	8.6	8.6	8.9	9.2	9.3	9.4	9.6	9.8	9.8	9.8
T2 - Avrg power per kg bwt (watts)	6.9	6.9	7.4	7.8	8.0	8.2	8.5	8.7	8.7	8.7
T3 - Avrg power per kg bwt (watts)	7.0	7.0	7.0	7.0	7.2	7.4	7.7	8.0	8.0	8.0

Speed and Agility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
5 metre time (sec)	1.00	1.04	1.09	1.13	1.14	1.14	1.17	1.19	1.21	1.21
5 metre speed (m/s)	4.15	4.19	4.29	4.37	4.39	4.43	4.61	4.81	5.01	5.06
5 metre acceleration (m/s/s)	3.44	3.50	3.67	3.82	3.85	3.93	4.26	4.62	5.02	5.11
20 metre time (sec)	3.02	3.11	3.19	3.24	3.27	3.27	3.28	3.31	3.38	3.39
20 metre speed (m/s)	5.92	6.05	6.10	6.11	6.11	6.17	6.26	6.42	6.63	6.68
20 metre acceleration (m/s/s)	1.75	1.83	1.86	1.87	1.87	1.91	1.96	2.06	2.20	2.23
50m Forward Backward time (sec)	15.44	15.44	15.44	15.45	15.47	15.49	15.50	15.50	15.50	15.50
5m backwards time (sec)	1.38	1.38	1.38	1.38	1.39	1.39	1.39	1.39	1.39	1.39
5m backward speed (m/s)	3.60	3.60	3.60	3.60	3.61	3.61	3.62	3.62	3.62	3.62
5m backward acceleration (m/s/s)	2.58	2.58	2.58	2.59	2.60	2.61	2.62	2.62	2.62	2.62

Appendix 16

Club Level Forwards - Descriptive Data

Anthropometrics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Age (yrs)	26	22 4	5 0	16 0	40 0
Height (cm)	30	179 7	5 6	168 5	189 2
Avr weight (kg)	30	80 3	11 0	54 5	98 2
BMI	30	24 8	2 8	18 9	29 4
RHR	17	59	11	41	79
SBP	17	126	8	110	142
DBP	17	80	7	68	92

Body Composition

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest skinfold	30	12 4	5 0	6 0	23 0
Thigh skinfold	30	14 7	5 7	6 0	27 0
Abdomen skinfold	30	23 6	9 7	8 0	51 0
Sum of skinfolds	30	50 7	16 5	20 0	82 0
% Body Fat	30	17 8	7 5	5 0	32 6
Fat mass (kg)	30	14 3	7 9	0 0	30 2
Lean body masss (kg)	30	62 8	13 7	0 0	79 6

Physical Characteristics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest circumference (cm)	31	95 7	7 0	80 0	109 0
Biceps circumference (cm)	31	32 0	2 7	25 8	36 5
Quadriceps circumference (cm)	31	56 7	4 7	45 5	67 0
Waist Circumference (cm)	31	91 7	8 7	68 0	108 0

Vertical Jump and Flexibility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Vertical Jump (cm)	31	51 8	6 6	39 0	64 0
Hamstring flexibility (cm)	27	20 5	5 9	8 0	32 0

Club Level Forwards - Percentiles

Anthropometrics

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Age (yrs)	17 7	18 4	19 0	20 0	21 0	24 0	24 9	25 6	28 0	40 0
Height (cm)	170 5	174 1	176 5	179 1	181 0	182 6	184 4	184 9	185 3	189 2
Avr weight (kg)	65 1	72 6	73 8	74 8	78 8	82 7	87 8	92 6	96 0	98 2
BMI	21 5	22 3	22 9	24 3	24 8	25 6	26 9	27 8	28 3	29 4
RHR	43	50	53	56	57	60	67	71	77	79
SBP	116	121	122	122	124	127	128	130	140	142
DBP	70	73	78	78	80	80	82	86	92	92

Body Composition

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest skinfold	7 0	7 2	9 2	10 4	11 3	12 3	14 9	16 7	20 0	23 0
Thigh skinfold	7 6	10 0	10 3	13 0	14 3	14 8	16 0	19 6	24 9	27 0
Abdomen skinfold	13 1	15 1	18 0	18 4	21 3	24 6	28 7	33 0	35 7	51 0
Sum of skinfolds	31 1	35 2	41 6	44 4	46 0	50 6	61 8	71 2	74 0	82 0
% Body Fat	9 5	10 8	12 5	14 6	16 0	17 8	23 0	25 8	28 8	32 6
Fat mass (kg)	5 2	7 2	8 4	11 5	13 2	14 5	21 0	22 7	24 2	30 2
Lean body masss (kg)	54 0	58 8	59 9	62 1	64 9	66 0	67 3	71 6	76 1	79 6

Physical Characteristics

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest circumference (cm)	85 7	89 7	91 0	92 7	96 6	99 0	99 9	102 1	103 5	109 0
Biceps circumference (cm)	27 8	29 0	31 0	31 5	32 2	33 1	33 7	34 5	35 4	36 5
Quadriceps circumference (cm)	49 8	52 5	54 1	55 7	57 5	59 5	59 7	60 9	62 3	67 0
Waist Circumference (cm)	81 1	84 6	88 3	89 9	91 0	93 0	97 2	100 7	103 1	108 0

Vertical Jump and Flexibility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Vertical Jump (cm)	42 4	45 4	48 0	50 0	51 0	53 2	57 0	58 6	60 8	64 0
Hamstring flexibility (cm)	12 4	15 6	17 2	19 2	21 0	21 8	22 6	26 4	29 0	32 0

Club Level Forwards - Descriptive Data

Cardiorespiratory response at maximal exercise

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max VT in one breath (l)	17	2 88	0 39	2 11	3 48
Max respiratory rate (l/min)	17	57	8	44	72
Max ventilation rate (l/min)	17	118	16	91	146
Respiratory exchange ratio	17	1 11	0 06	0 96	1 20
Vol of CO2 Expired (l/min)	17	4 59	0 61	3 30	5 52
Absolute vol of O2 uptake (l/min)	17	4 23	0 59	3 07	5 25
Relative vol O2 upake (ml/min/kg)	17	51 4	6 1	40 6	63 0
Ventilatory threshold (ml/kg/min)	12	44 2	6 1	34 0	56 4
Ventilatory threshold (% VO2 max)	12	84 4	7 2	67 5	93 9
Heart Rate Max	15	195	10	168	206

Anaerobic Power and Capacity

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max absolute power (watts)	8	987 3	150 5	833 0	1214 7
T1 - Peak power per kg bwt (watts)	8	12 4	2 6	9 2	16 5
T2 - Peak power per kg bwt (watts)	8	10 1	1 5	8 2	12 8
T3 - Peak power per kg bwt (watts)	8	9 2	1 5	7 6	12 2
T1 - Percentage Fatigue (%)	8	33 0	9 6	18 7	47 8
T2 - Percentage Fatigue (%)	8	31 4	10 4	18 5	48 2
T3 - Percentage Fatigue (%)	8	35 9	12 7	21 5	61 5
T1 - Avrg power per kg bwt (watts)	8	9 7	1 8	6 1	11 6
T2 - Avrg power per kg bwt (watts)	8	8 2	1 2	5 9	9 4
T3 - Avrg power per kg bwt (watts)	8	7 0	1 2	4 9	8 8

Speed and Agility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
5 metre time (sec)	18	1 11	0 10	0 95	1 29
5 metre speed (m/s)	18	4 52	0 39	3 87	5 29
5 metre acceleration (m/s/s)	18	4 12	0 71	3 00	5 60
20 metre time (sec)	18	3 19	0 15	2 89	3 42
20 metre speed (m/s)	18	6 28	0 30	5 85	6 92
20 metre acceleration (m/s/s)	18	1 98	0 19	1 71	2 39
50m Forward Backward time (sec)	4	15 37	0 86	14 18	16 03
5m backwards time (sec)	4	1 47	0 11	1 32	1 59
5m backward speed (m/s)	4	3 41	0 27	3 14	3 79
5m backward acceleration (m/s/s)	4	2 33	0 38	1 97	2 87

Club Level Forwards - Percentiles

Cardiorespiratory response at maximal exercise

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max VT in one breath (l)	2 40	2 51	2 61	2 72	2 89	2 96	3 15	3 33	3 43	3 48
Max respiratory rate (l/min)	45 6	50	51	52 6	56	56 8	61 2	66 2	69 6	72
Max ventilation rate (l/min)	96	103	107	111	118	120	130	134	140	146
Respiratory exchange ratio	1 03	1 06	1 08	1 09	1 10	1 13	1 15	1 18	1 19	1 20
Vol of CO2 Expired (l/min)	3 59	4 15	4 42	4 46	4 50	4 55	4 91	5 26	5 52	5 52
Absolute vol of O2 uptake (l/min)	3 26	3 78	4 02	4 10	4 18	4 25	4 62	4 73	5 18	5 25
Relative vol O2 upake (ml/min/kg)	41 4	44 9	47 8	51 2	51 3	54 6	55 6	56 4	58 2	63 0
Ventilatory threshold (ml/kg/min)	35 0	38 1	39 3	43 7	45 5	46 5	47 2	48 3	54 0	56 4
Ventilatory threshold (% VO2 max)	70 4	79 8	82 1	83 5	84 1	86 5	89 6	91 0	93 4	93 9
Heart Rate Max	174	192	194	195	196	198	199	203	205	206

Anaerobic Power and Capacity

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max absolute power (watts)	833 0	856 0	880 6	891 6	928 0	995 6	1091 6	1202 1	1214 7	1214 7
T1 - Peak power per kg bwt (watts)	9 2	10 1	10 4	11 1	11 8	12 8	14 4	15 5	16 5	16 5
T2 - Peak power per kg bwt (watts)	8 2	8 3	9 1	9 8	10 2	10 5	10 8	11 3	12 8	12 8
T3 - Peak power per kg bwt (watts)	7 6	7 7	8 3	8 8	9 1	9 1	9 6	10 8	12 2	12 2
T1 - Percentage Fatigue (%)	18 7	21 8	27 3	31 4	33 1	35 1	38 9	42 9	47 8	47 8
T2 - Percentage Fatigue (%)	18 5	21 8	23 4	26 5	28 9	33 0	39 4	43 0	48 2	48 2
T3 - Percentage Fatigue (%)	21 5	24 8	28 5	30 9	32 2	35 4	41 1	48 6	61 5	61 5
T1 - Avrg power per kg bwt (watts)	6 1	8 3	9 3	9 4	9 7	10 3	10 9	11 5	11 6	11 6
T2 - Avrg power per kg bwt (watts)	5 9	6 9	7 6	8 3	8 6	8 8	9 0	9 2	9 4	9 4
T3 - Avrg power per kg bwt (watts)	4 9	6 0	6 5	6 7	7 1	7 4	7 6	7 9	8 8	8 8

Speed and Agility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
5 metre time (sec)	0 98	1 03	1 07	1 08	1 10	1 11	1 17	1 23	1 24	1 29
5 metre speed (m/s)	4 02	4 06	4 29	4 49	4 56	4 63	4 68	4 86	5 08	5 29
5 metre acceleration (m/s/s)	3 24	3 30	3 69	4 03	4 17	4 29	4 39	4 72	5 16	5 60
20 metre time (sec)	2 97	3 06	3 08	3 13	3 20	3 24	3 31	3 35	3 38	3 42
20 metre speed (m/s)	5 92	5 97	6 04	6 17	6 25	6 38	6 49	6 54	6 73	6 92
20 metre acceleration (m/s/s)	1 75	1 78	1 83	1 90	1 95	2 04	2 11	2 14	2 27	2 39
50m Forward Backward time (sec)	14 18	14 18	14 75	15 32	15 64	15 96	16 00	16 03	16 03	16 03
5m backwards time (sec)	1 32	1 32	1 40	1 48	1 49	1 50	1 55	1 59	1 59	1 59
5m backward speed (m/s)	3 14	3 14	3 23	3 32	3 35	3 38	3 58	3 79	3 79	3 79
5m backward acceleration (m/s/s)	1 97	1 97	2 09	2 21	2 25	2 29	2 58	2 87	2 87	2 87

Appendix 17

County Level Goalkeepers - Descriptive Data

Anthropometrics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Age (yrs)	8	23 4	4 3	19 0	30 0
Height (cm)	8	181 5	6 0	167 4	186 3
Avr weight (kg)	8	80 1	8 2	63 2	87 9
BMI	8	24 3	1 6	21 6	26 3
RHR	7	68	12	51	84
SBP	7	135	15	120	160
DBP	7	83	9	72	96

Body Composition

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest skinfold	7	9 0	2 9	6 0	12 0
Thigh skinfold	7	11 9	4 8	5 0	18 0
Abdomen skinfold	7	18 3	11 6	7 0	40 0
Sum of skinfolds	7	39 1	18 0	18 0	70 0
% Body Fat	7	13 5	8 0	4 9	27 5
Fat mass (kg)	7	10 9	6 9	3 9	23 5
Lean body masss (kg)	7	68 8	9 2	52 5	79 6

Physical Characteristics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest circumference (cm)	8	96 2	3 9	89 0	102 0
Biceps circumference (cm)	8	31 9	2 2	27 6	34 3
Quadriceps circumference (cm)	8	57 2	4 8	50 0	64 3
Waist Circumference (cm)	8	85 9	6 8	74 7	91 5

Vertical Jump and Flexibility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Vertical Jump (cm)	8	53 5	5 8	46 0	61 0
Hamstring flexibility (cm)	8	23 9	9 8	10 0	37 0

County Level Goalkeepers - Percentiles

Anthropometrics

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Age (yrs)	19 0	19 8	20 0	20 0	21 5	24 6	27 3	28 4	30 0	30 0
Height (cm)	167 4	177 5	181 3	182 5	183 3	184 1	185 0	185 3	186 3	186 3
Avr weight (kg)	63 2	71 7	78 3	80 3	81 7	83 9	85 8	87 0	87 9	87 9
BMI	21 6	22 4	23 5	24 1	24 3	24 6	25 3	26 1	26 3	26 3
RHR	51	52	59	70	72	72	73	77	84	84
SBP	120	121	124	126	126	137	145	153	160	160
DBP	72	73	76	80	82	85	88	92	96	96

Body Composition

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest skinfold	6 0	6 0	6 0	6 8	10 0	10 8	11 6	12 0	12 0	12 0
Thigh skinfold	5 0	6 2	8 6	11 0	11 0	13 4	15 8	17 4	18 0	18 0
Abdomen skinfold	7 0	8 8	10 8	12 4	14 0	17 2	23 4	32 2	40 0	40 0
Sum of skinfolds	18 0	23 4	27 8	29 4	31 0	43 8	50 0	59 2	70 0	70 0
% Body Fat	4 9	6 8	8 3	8 9	9 5	15 4	18 3	22 5	27 5	27 5
Fat mass (kg)	3 9	5 1	6 4	7 3	8 3	10 2	14 3	19 4	23 5	23 5
Lean body masss (kg)	52 5	58 1	64 2	68 3	70 1	72 6	75 1	77 6	79 6	79 6

Physical Characteristics

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest circumference (cm)	89 0	92 0	94 3	95 9	97 0	97 7	98 2	99 2	102 0	102 0
Biceps circumference (cm)	27 6	29 9	30 5	31 4	32 3	33 0	33 6	34 0	34 3	34 3
Quadriceps circumference (cm)	50 0	52 8	53 9	55 2	56 5	58 2	60 7	62 8	64 3	64 3
Waist Circumference (cm)	74 7	75 3	83 9	88 1	88 7	89 2	90 1	90 7	91 5	91 5

Vertical Jump and Flexibility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Vertical Jump (cm)	46 0	46 8	48 4	51 4	53 5	55 6	58 6	60 2	61 0	61 0
Hamstring flexibility (cm)	10 0	10 8	18 0	21 6	24 5	28 6	31 3	33 0	37 0	37 0

County Level Goalkeepers - Descriptive Data

Cardiorespiratory response at maximal exercise

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max VT in one breath (l)	7	2 92	0 50	2 23	3 59
Max respiratory rate (l/min)	7	56	5	49	65
Max ventilation rate (l/min)	7	123	20	93	151
Respiratory exchange ratio	7	1 13	0 05	1 08	1 21
Vol of CO2 Expired (l/min)	7	4 73	0 85	3 26	5 68
Absolute vol of O2 uptake (l/min)	7	4 11	0 66	2 99	4 91
Relative vol O2 upake (ml/min/kg)	7	51 5	7 3	45 0	65 9
Ventilatory threshold (ml/kg/min)	7	44 4	4 4	40 1	50 2
Ventilatory threshold (% VO2 max)	7	86 8	6 6	76 2	96 6
Heart Rate Max	7	200	8	189	210

Anaerobic Power and Capacity

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max absolute power (watts)	3	881 6	63 1	844 3	954 5
T1 - Peak power per kg bwt (watts)	3	10 6	0 1	10 5	10 7
T2 - Peak power per kg bwt (watts)	3	9 0	0 4	8 7	9 4
T3 - Peak power per kg bwt (watts)	3	8 3	0 2	8 2	8 6
T1 - Percentage Fatigue (%)	3	19 4	12 4	11 9	33 8
T2 - Percentage Fatigue (%)	3	25 3	10 3	16 4	36 6
T3 - Percentage Fatigue (%)	3	33 5	7 7	26 5	41 7
T1 - Avrg power per kg bwt (watts)	3	9 0	0 9	8 0	9 7
T2 - Avrg power per kg bwt (watts)	3	7 6	0 7	6 9	8 2
T3 - Avrg power per kg bwt (watts)	3	6 5	0 4	6 1	6 9

Speed and Agility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
5 metre time (sec)	4	1 08	0 10	0 97	1 22
5 metre speed (m/s)	4	4 66	0 42	4 12	5 13
5 metre acceleration (m/s/s)	4	4 36	0 77	3 39	5 27
20 metre time (sec)	4	3 17	0 11	3 06	3 27
20 metre speed (m/s)	4	6 32	0 21	6 12	6 54
20 metre acceleration (m/s/s)	4	2 00	0 14	1 87	2 14
50m Forward Backward time (sec)	4	14 70	1 04	13 64	15 97
5m backwards time (sec)	4	1 33	0 07	1 26	1 42
5m backward speed (m/s)	4	3 76	0 20	3 52	3 97
5m backward acceleration (m/s/s)	4	2 84	0 30	2 47	3 15

County Level Goalkeepers - Percentiles

Cardiorespiratory response at maximal exercise

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max VT in one breath (l)	2.23	2.25	2.58	3.05	3.07	3.09	3.11	3.31	3.59	3.59
Max respiratory rate (l/min)	49	51.4	53.4	54.4	56	56.8	57.6	60.8	65	65
Max ventilation rate (l/min)	93	100	110	120	128	131	136	144	151	151
Respiratory exchange ratio	1.08	1.09	1.09	1.10	1.13	1.16	1.17	1.19	1.21	1.21
Vol of CO2 Expired (l/min)	3.26	3.76	4.31	4.68	4.81	4.95	5.37	5.65	5.68	5.68
Absolute vol. of O2 uptake (l/min)	2.99	3.49	3.85	3.92	4.10	4.17	4.61	4.90	4.91	4.91
Relative vol. O2 upake (ml/min/kg)	45.0	46.3	47.2	47.4	48.3	50.1	54.1	60.3	65.9	65.9
Ventilatory threshold (ml/kg/min)	40.1	40.2	40.3	41.1	43.5	46.8	48.3	49.4	50.2	50.2
Ventilatory threshold (% VO2 max)	76.2	80.8	84.0	84.4	85.2	88.3	91.0	94.0	96.6	96.6
Heart Rate Max	189	190	195	200	202	204	205	208	210	210

Anaerobic Power and Capacity

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max absolute power (watts)	844.3	844.3	844.6	845.3	846.0	889.4	932.8	954.5	954.5	954.5
T1 - Peak power per kg bwt (watts)	10.5	10.5	10.5	10.6	10.6	10.6	10.7	10.7	10.7	10.7
T2 - Peak power per kg bwt (watts)	8.7	8.7	8.8	8.9	9.0	9.2	9.3	9.4	9.4	9.4
T3 - Peak power per kg bwt (watts)	8.2	8.2	8.2	8.2	8.2	8.4	8.5	8.6	8.6	8.6
T1 - Percentage Fatigue (%)	11.9	11.9	12.0	12.3	12.6	21.1	29.6	33.8	33.8	33.8
T2 - Percentage Fatigue (%)	16.4	16.4	17.7	20.2	22.8	28.3	33.8	36.6	36.6	36.6
T3 - Percentage Fatigue (%)	26.5	26.5	27.7	30.0	32.4	36.1	39.8	41.7	41.7	41.7
T1 - Avrg power per kg bwt (watts)	8.0	8.0	8.2	8.7	9.2	9.4	9.6	9.7	9.7	9.7
T2 - Avrg power per kg bwt (watts)	6.9	6.9	7.0	7.3	7.6	7.8	8.1	8.2	8.2	8.2
T3 - Avrg power per kg bwt (watts)	6.1	6.1	6.2	6.4	6.6	6.7	6.8	6.9	6.9	6.9

Speed and Agility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
5 metre time (sec)	0.97	0.97	1.02	1.06	1.07	1.07	1.14	1.22	1.22	1.22
5 metre speed (m/s)	4.12	4.12	4.39	4.66	4.69	4.72	4.93	5.13	5.13	5.13
5 metre acceleration (m/s/s)	3.39	3.39	3.87	4.34	4.40	4.45	4.86	5.27	5.27	5.27
20 metre time (sec)	3.06	3.06	3.08	3.10	3.17	3.25	3.26	3.27	3.27	3.27
20 metre speed (m/s)	6.12	6.12	6.14	6.15	6.31	6.46	6.50	6.54	6.54	6.54
20 metre acceleration (m/s/s)	1.87	1.87	1.88	1.89	1.99	2.09	2.11	2.14	2.14	2.14
50m Forward Backward time (sec)	13.64	13.64	13.87	14.09	14.60	15.11	15.54	15.97	15.97	15.97
5m backwards time (sec)	1.26	1.26	1.27	1.29	1.32	1.36	1.39	1.42	1.42	1.42
5m backward speed (m/s)	3.52	3.52	3.60	3.69	3.79	3.89	3.93	3.97	3.97	3.97
5m backward acceleration (m/s/s)	2.47	2.47	2.60	2.72	2.87	3.02	3.09	3.15	3.15	3.15

Appendix 18

County Level Defenders - Descriptive Data

Anthropometrics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Age (yrs)	45	22 7	2 5	18 0	28 0
Height (cm)	46	178 3	4 8	167 0	191 3
Avr weight (kg)	46	79 7	6 9	65 2	98 4
BMI	46	25 1	1 9	21 4	29 5
RHR	43	63	10	44	84
SBP	43	127	11	108	160
DBP	43	78	9	56	97

Body Composition

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest skinfold	39	8 6	3 8	4 0	19 0
Thigh skinfold	39	12 0	3 9	6 0	20 0
Abdomen skinfold	39	19 5	8 6	7 0	41 0
Sum of skinfolds	39	39 9	14 8	19 0	78 0
% Body Fat	39	13 6	6 4	5 2	31 0
Fat mass (kg)	39	11 2	6 2	3 4	27 8
Lean body masss (kg)	39	68 5	4 9	59 5	82 3

Physical Characteristics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest circumference (cm)	43	95 5	4 5	85 0	107 4
Biceps circumference (cm)	43	32 9	1 9	29 8	37 0
Quadriceps circumference (cm)	43	56 6	4 9	31 6	62 5
Waist Circumference (cm)	43	83 7	4 7	75 2	94 0

Vertical Jump and Flexibility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Vertical Jump (cm)	45	53 2	5 1	40 0	65 0
Hamstring flexibility (cm)	44	24 8	6 6	12 0	39 0

County Level Defenders - Percentiles

Anthropometrics

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Age (yrs)	19 0	20 2	21 0	22 0	23 0	23 0	24 0	24 8	26 0	28 0
Height (cm)	172 1	174 5	176 5	177 3	178 5	179 0	181 0	182 4	184 0	191 3
Avr weight (kg)	71 0	74 2	76 0	77 3	78 9	81 6	83 4	85 6	89 2	98 4
BMI	22 7	23 6	24 1	24 5	24 9	25 3	26 0	26 6	27 5	29 5
RHR	49	55	57	61	64	67	69	71	76	84
SBP	110	118	120	122	126	130	132	136	140	160
DBP	66	70	74	76	78	80	80	86	90	97

Body Composition

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest skinfold	5 0	6 0	6 0	7 0	7 0	8 0	9 0	11 0	16 0	19 0
Thigh skinfold	7 0	9 0	10 0	10 0	11 0	12 0	14 0	16 0	18 0	20 0
Abdomen skinfold	10 0	11 0	13 0	16 0	18 0	21 0	24 0	27 0	34 0	41 0
Sum of skinfolds	24 0	27 0	29 0	32 0	36 0	43 0	48 0	51 0	68 0	78 0
% Body Fat	7 3	8 0	8 9	10 4	11 6	15 0	16 8	18 0	26 1	31 0
Fat mass (kg)	5 3	5 9	7 1	8 6	9 4	12 4	13 0	14 0	23 7	27 8
Lean body masss (kg)	61 8	64 6	65 7	67 0	67 6	69 2	71 7	72 4	75 0	82 3

Physical Characteristics

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest circumference (cm)	90 2	92 0	93 5	94 3	95 0	95 9	97 4	98 6	101 7	107 4
Biceps circumference (cm)	30 7	31 2	31 6	32 0	32 3	33 5	34 1	35 0	35 8	37 0
Quadriceps circumference (cm)	53 0	53 5	55 6	56 2	57 0	57 7	59 0	59 9	61 8	62 5
Waist Circumference (cm)	78 0	79 0	80 6	82 2	84 0	85 2	85 7	88 0	90 2	94 0

Vertical Jump and Flexibility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Vertical Jump (cm)	47 0	49 0	50 0	52 0	53 0	55 0	56 0	57 0	60 0	65 0
Hamstring flexibility (cm)	15 0	18 0	22 0	23 0	24 5	27 0	29 0	32 0	33 5	39 0

County Level Defenders - Descriptive Data

Cardiorespiratory response at maximal exercise

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max VT in one breath (l)	45	3 07	0 37	2 33	4 10
Max respiratory rate (l/min)	45	55	7	41	70
Max ventilation rate (l/min)	45	124	15	99	152
Respiratory exchange ratio	45	1 15	0 07	1 02	1 31
Vol of CO2 Expired (l/min)	45	4 92	0 59	4 00	6 31
Absolute vol of O2 uptake (l/min)	45	4 44	0 52	3 43	5 52
Relative vol O2 upake (ml/min/kg)	45	55 4	5 3	45 9	66 6
Ventilatory threshold (ml/kg/min)	41	47 1	4 5	37 1	58 4
Ventilatory threshold (% VO2 max)	41	84 7	5 0	74 2	93 9
Heart Rate Max	42	194	9	160	209

Anaerobic Power and Capacity

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max absolute power (watts)	18	932 7	96 7	723 2	1086 7
T1 - Peak power per kg bwt (watts)	18	11 7	0 9	10 5	14 1
T2 - Peak power per kg bwt (watts)	18	10 1	1 1	7 9	12 0
T3 - Peak power per kg bwt (watts)	18	8 6	1 1	5 6	10 2
T1 - Percentage Fatigue (%)	18	23 0	4 7	13 6	29 8
T2 - Percentage Fatigue (%)	18	26 3	8 2	15 0	43 2
T3 - Percentage Fatigue (%)	18	24 4	7 4	12 7	42 2
T1 - Avrg power per kg bwt (watts)	18	10 0	0 8	8 5	11 9
T2 - Avrg power per kg bwt (watts)	18	8 3	1 0	5 9	9 8
T3 - Avrg power per kg bwt (watts)	18	7 3	1 0	4 8	8 7

Speed and Agility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
5 metre time (sec)	27	1 08	0 05	0 98	1 19
5 metre speed (m/s)	26	4 64	0 21	4 22	5 11
5 metre acceleration (m/s/s)	26	4 31	0 39	3 56	5 23
20 metre time (sec)	27	3 13	0 09	2 95	3 32
20 metre speed (m/s)	27	6 40	0 18	6 03	6 78
20 metre acceleration (m/s/s)	27	2 05	0 11	1 82	2 30
50m Forward Backward time (sec)	27	14 78	0 86	12 98	16 53
5m backwards time (sec)	27	1 39	0 10	1 25	1 64
5m backward speed (m/s)	27	3 63	0 26	3 05	4 01
5m backward acceleration (m/s/s)	27	2 64	0 37	1 86	3 21

County Level Defenders - Percentiles

Cardiorespiratory response at maximal exercise

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max VT in one breath (l)	2 62	2 75	2 84	2 96	3 07	3 16	3 25	3 41	3 55	4 10
Max respiratory rate (l/min)	46 6	49 2	51 8	52 4	54	56	59	61 8	65	70
Max ventilation rate (l/min)	104	109	114	118	126	130	133	139	145	152
Respiratory exchange ratio	1 07	1 09	1 13	1 14	1 15	1 17	1 18	1 20	1 24	1 31
Vol of CO2 Expired (l/min)	4 16	4 38	4 61	4 66	4 87	5 02	5 19	5 44	5 85	6 31
Absolute vol of O2 uptake (l/min)	3 77	3 96	4 14	4 30	4 37	4 50	4 61	4 90	5 28	5 52
Relative vol O2 upake (ml/min/kg)	49 2	50 6	51 9	53 4	54 3	56 0	58 2	60 1	64 2	66 6
Ventilatory threshold (ml/kg/min)	41 6	43 5	44 9	45 6	46 8	47 6	49 3	50 2	53 3	58 4
Ventilatory threshold (% VO2 max)	77 5	81 1	81 9	83 4	84 3	85 1	87 9	90 2	91 9	93 9
Heart Rate Max	181	189	192	194	196	197	199	200	204	209

Anaerobic Power and Capacity

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max absolute power (watts)	749 5	879 2	893 1	908 7	934 1	971 1	989 3	1014 7	1066 5	1086 7
T1 - Peak power per kg bwt (watts)	10 6	10 8	11 3	11 5	11 6	11 7	12 1	12 2	13 1	14 1
T2 - Peak power per kg bwt (watts)	8 4	9 3	9 6	9 8	10 4	10 5	10 8	11 2	11 6	12 0
T3 - Peak power per kg bwt (watts)	7 1	7 9	8 3	8 5	8 8	9 0	9 0	9 3	9 9	10 2
T1 - Percentage Fatigue (%)	15 3	17 6	21 4	22 6	23 9	24 6	25 0	28 6	29 1	29 8
T2 - Percentage Fatigue (%)	15 1	16 5	21 3	24 8	25 8	28 0	31 2	33 6	38 5	43 2
T3 - Percentage Fatigue (%)	15 6	17 6	19 9	21 3	23 5	25 5	27 9	30 4	35 6	42 2
T1 - Avrg power per kg bwt (watts)	8 8	9 5	9 7	10 0	10 1	10 1	10 2	10 6	10 9	11 9
T2 - Avrg power per kg bwt (watts)	6 7	7 5	8 1	8 2	8 4	8 7	9 0	9 1	9 7	9 8
T3 - Avrg power per kg bwt (watts)	5 6	6 7	7 1	7 5	7 5	7 5	8 0	8 0	8 6	8 7

Speed and Agility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
5 metre time (sec)	1 02	1 03	1 05	1 07	1 08	1 09	1 11	1 13	1 15	1 19
5 metre speed (m/s)	4 36	4 45	4 53	4 59	4 62	4 67	4 76	4 84	4 92	5 11
5 metre acceleration (m/s/s)	3 80	3 95	4 10	4 21	4 27	4 36	4 54	4 69	4 83	5 23
20 metre time (sec)	3 00	3 07	3 08	3 12	3 12	3 15	3 17	3 18	3 25	3 32
20 metre speed (m/s)	6 15	6 29	6 32	6 35	6 41	6 41	6 49	6 51	6 67	6 78
20 metre acceleration (m/s/s)	1 89	1 98	1 99	2 01	2 06	2 06	2 11	2 12	2 22	2 30
50m Forward Backward time (sec)	13 12	14 28	14 46	14 53	14 79	14 98	15 20	15 50	15 93	16 53
5m backwards time (sec)	1 25	1 30	1 31	1 33	1 38	1 39	1 44	1 48	1 54	1 64
5m backward speed (m/s)	3 26	3 39	3 47	3 60	3 63	3 76	3 80	3 84	4 00	4 01
5m backward acceleration (m/s/s)	2 12	2 29	2 41	2 60	2 63	2 83	2 89	2 95	3 19	3 21

Appendix 19

County Level Midfielders - Descriptive Data

Anthropometrics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Age (yrs)	22	23 3	4 4	18 0	33 0
Height (cm)	22	186 2	4 6	177 2	194 9
Avr weight (kg)	22	87 7	7 9	74 8	105 0
BMI	22	25 3	2 2	21 2	30 0
RHR	21	62	9	42	77
SBP	21	126	10	112	144
DBP	21	75	9	50	90

Body Composition

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest skinfold	21	10 1	5 1	4 0	21 0
Thigh skinfold	21	13 0	5 6	4 0	24 0
Abdomen skmfold	21	21 8	10 2	6 0	43 0
Sum of skinfolds	21	44 8	19 3	17 0	87 0
% Body Fat	21	15 9	8 7	4 1	36 8
Fat mass (kg)	21	14 4	9 0	3 2	37 5
Lean body masss (kg)	22	73 9	6 8	63 5	92 0

Physical Characteristics

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Chest circumference (cm)	22	98 7	5 2	89 8	108 2
Biceps circumference (cm)	21	34 3	2 1	30 3	38 7
Quadriceps circumference (cm)	22	59 1	3 4	54 7	66 5
Waist Circumference (cm)	22	89 6	6 2	77 0	103 0

Vertical Jump and Flexibility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Vertical Jump (cm)	21	54 8	8 1	42 0	74 0
Hamstring flexibility (cm)	22	24 5	7 0	13 0	38 0

County Level Midfielders - Percentiles

Anthropometrics

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	60	**70**	**80**	**90**	**100**
Age (yrs)	19 0	19 0	20 0	20 2	23 5	24 0	24 2	26 4	31 7	33 0
Height (cm)	179 1	182 2	183 5	185 1	187 1	187 9	188 4	189 2	193 6	194 9
Avr weight (kg)	79 0	82 1	83 0	84 0	85 3	86 2	90 7	95 6	101 1	105 0
BMI	22 4	23 5	24 0	24 3	25 1	25 7	26 3	27 3	28 7	30 0
RHR	51	55	57	60	62	64	67	69	75	77
SBP	113	118	118	120	124	130	130	138	140	144
DBP	68	70	71	72	74	76	80	83	88	90

Body Composition

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest skinfold	5 0	5 4	6 6	7 8	8 0	10 2	11 4	16 6	18 0	21 0
Thigh skinfold	6 2	8 0	9 6	10 0	13 0	14 0	15 4	18 6	23 2	24 0
Abdomen skinfold	7 8	12 0	14 0	19 0	22 0	24 2	26 4	32 6	35 8	43 0
Sum of skinfolds	19 4	27 4	29 6	33 8	44 0	50 8	55 2	62 8	73 0	87 0
% Body Fat	5 4	8 0	9 6	10 8	14 7	17 9	20 3	23 4	28 5	36 8
Fat mass (kg)	4 6	7 0	8 2	9 1	12 2	16 7	17 4	21 1	29 4	37 5
Lean body masss (kg)	64 8	67 8	69 2	72 9	74 0	75 0	76 0	79 0	84 1	92 0

Physical Characteristics

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest circumference (cm)	92 8	93 9	94 6	95 6	98 1	99 8	102 0	104 1	106 7	108 2
Biceps circumference (cm)	31 1	32 7	33 2	33 6	34 1	34 7	35 7	35 9	37 3	38 7
Quadriceps circumference (cm)	55 0	55 5	57 0	57 4	58 5	60 5	61 1	62 2	64 1	66 5
Waist Circumference (cm)	82 0	84 2	86 8	88 1	88 8	90 2	91 6	94 9	100 6	103 0

Vertical Jump and Flexibility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Vertical Jump (cm)	43 8	48 0	50 8	52 8	54 0	55 4	57 4	59 6	70 6	74 0
Hamstring flexibility (cm)	13 3	18 0	21 0	23 2	24 5	26 0	29 0	30 0	35 4	38 0

County Level Midfielders - Descriptive Data

Cardiorespiratory response at maximal exercise

Components	Valid	Mean	Std. Deviation	Minimum	Maximum
Max VT in one breath (l)	20	3.11	0.44	2.36	3.81
Max respiratory rate (l/min)	20	53	6	44	64
Max ventilation rate (l/min)	20	124	16	85	150
Respiratory exchange ratio	20	1.13	0.04	1.07	1.24
Vol of CO2 Expired (l/min)	20	4.88	0.57	4.20	5.86
Absolute vol. of O2 uptake (l/min)	20	4.40	0.55	3.11	5.21
Relative vol. O2 upake (ml/min/kg)	21	52.0	5.7	42.9	60.7
Ventilatory threshold (ml/kg/min)	14	44.9	3.9	37.3	50.0
Ventilatory threshold (% VO2 max)	14	86.0	8.0	72.5	99.1
Heart Rate Max	19	193	8	181	210

Anaerobic Power and Capacity

Components	Valid	Mean	Std. Deviation	Minimum	Maximum
Max absolute power (watts)	10	1061.7	158.1	832.7	1379.2
T1 - Peak power per kg bwt (watts)	10	12.3	2.1	10.0	17.6
T2 - Peak power per kg bwt (watts)	10	10.4	1.6	8.5	14.0
T3 - Peak power per kg bwt (watts)	10	9.7	2.4	7.2	15.6
T1 - Percentage Fatigue (%)	10	29.9	11.7	20.1	60.1
T2 - Percentage Fatigue (%)	10	33.1	8.6	22.1	46.9
T3 - Percentage Fatigue (%)	10	31.4	11.0	15.9	54.8
T1 - Avrg power per kg bwt (watts)	10	9.8	1.0	7.7	10.8
T2 - Avrg power per kg bwt (watts)	10	8.3	0.8	6.8	9.5
T3 - Avrg power per kg bwt (watts)	10	7.6	1.1	6.0	9.2

Speed and Agility

Components	Valid	Mean	Std. Deviation	Minimum	Maximum
5 metre time (sec)	9	1.06	0.05	0.99	1.13
5 metre speed (m/s)	9	4.72	0.23	4.44	5.07
5 metre acceleration (m/s/s)	9	4.47	0.45	3.95	5.13
20 metre time (sec)	9	3.00	0.29	2.26	3.26
20 metre speed (m/s)	9	6.74	0.82	6.14	8.85
20 metre acceleration (m/s/s)	9	2.30	0.62	1.88	3.92
50m Forward Backward time (sec)	9	14.46	0.74	13.41	15.64
5m backwards time (sec)	9	1.37	0.07	1.28	1.51
5m backward speed (m/s)	9	3.67	0.20	3.32	3.90
5m backward acceleration (m/s/s)	9	2.70	0.28	2.21	3.04

County Level Midfielders - Percentiles

Cardiorespiratory response at maximal exercise

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max VT in one breath (l)	2 47	2 64	2 79	3 02	3 10	3 28	3 36	3 62	3 74	3 81
Max respiratory rate (l/min)	46 1	47	48 6	51 4	53	54	54 7	57	62 8	64
Max ventilation rate (l/min)	102	111	114	120	126	131	134	140	147	150
Respiratory exchange ratio	1 08	1 09	1 10	1 11	1 12	1 13	1 14	1 16	1 22	1 24
Vol of CO2 Expired (l/mm)	4 22	4 27	4 39	4 51	4 79	5 15	5 32	5 48	5 80	5 86
Absolute vol of O2 uptake (l/mm)	3 81	4 02	4 06	4 11	4 22	4 49	4 96	5 03	5 05	5 21
Relative vol O2 upake (ml/min/kg)	43 7	46 2	48 2	49 7	51 6	54 8	56 2	57 4	60 6	60 7
Ventilatory threshold (ml/kg/min)	38 5	40 5	42 9	44 6	45 1	46 3	47 9	48 9	49 7	50 0
Ventilatory threshold (% VO2 max)	75 7	79 3	79 6	81 5	85 6	87 6	91 3	95 7	98 0	99 1
Heart Rate Max	184	185	188	191	194	195	198	202	203	210

Anaerobic Power and Capacity

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max absolute power (watts)	834 0	870 1	992 5	1055 1	1072 9	1103 0	1121 4	1149 3	1356 8	1379 2
T1 - Peak power per kg bwt (watts)	10 0	10 4	11 1	11 5	12 1	12 6	12 8	12 9	17 1	17 6
T2 - Peak power per kg bwt (watts)	8 5	8 8	9 5	9 6	10 0	10 7	11 1	11 6	13 8	14 0
T3 - Peak power per kg bwt (watts)	7 3	7 8	8 2	8 7	9 5	9 9	10 0	10 5	15 1	15 6
T1 - Percentage Fatigue (%)	20 4	23 0	23 4	24 2	24 4	29 4	33 4	33 7	57 5	60 1
T2 - Percentage Fatigue (%)	22 3	24 7	25 3	28 6	33 7	35 6	38 8	42 4	46 5	46 9
T3 - Percentage Fatigue (%)	16 7	23 7	24 9	25 9	28 6	32 3	35 9	40 7	53 5	54 8
T1 – Avrg power per kg bwt (watts)	7 8	8 8	9 3	9 6	10 0	10 3	10 6	10 7	10 8	10 8
T2 – Avrg power per kg bwt (watts)	6 9	7 5	7 7	8 0	8 4	8 6	8 8	9 1	9 5	9 5
T3 – Avrg power per kg bwt (watts)	6 0	6 4	6 9	7 0	7 6	8 2	8 2	8 8	9 2	9 2

Speed and Agility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
5 metre time (sec)	0 99	1 00	1 01	1 05	1 07	1 08	1 11	1 12	1 13	1 13
5 metre speed (m/s)	4 44	4 47	4 51	4 63	4 69	4 78	4 94	5 00	5 07	5 07
5 metre acceleration (m/s/s)	3 95	3 99	4 06	4 30	4 40	4 57	4 88	4 99	5 13	5 13
20 metre time (sec)	2 26	2 93	2 99	3 05	3 08	3 11	3 12	3 20	3 26	3 26
20 metre speed (m/s)	6 14	6 26	6 41	6 44	6 49	6 56	6 70	6 84	8 85	8 85
20 metre acceleration (m/s/s)	1 88	1 96	2 06	2 07	2 10	2 15	2 24	2 34	3 92	3 92
50m Forward Backward time (sec)	13 41	13 82	13 96	14 02	14 49	14 66	14 75	15 38	15 64	15 64
5m backwards time (sec)	1 28	1 30	1 31	1 33	1 36	1 38	1 40	1 45	1 51	1 51
5m backward speed (m/s)	3 32	3 45	3 58	3 63	3 67	3 77	3 83	3 86	3 90	3 90
5m backward acceleration (m/s/s)	2 21	2 38	2 57	2 63	2 69	2 85	2 93	2 98	3 04	3 04

Appendix 20

County Level Forwards – Descriptive Data

Anthropometrics

Components	Valid	Mean	Std. Deviation	Minimum	Maximum
Age (yrs)	43	22.9	3.5	17.0	30.0
Height (cm)	43	179.5	4.8	167.4	188.5
Avr weight (kg)	43	79.8	8.8	65.0	100.5
BMI	43	24.8	2.8	19.8	32.6
RHR	43	62	8	41	82
SBP	43	129	13	102	160
DBP	43	77	9	60	100

Body Composition

Components	Valid	Mean	Std. Deviation	Minimum	Maximum
Chest skinfold	43	10.3	4.4	4.0	28.0
Thigh skinfold	42	12.9	4.6	4.0	25.0
Abdomen skinfold	43	21.7	10.3	7.0	56.0
Sum of skinfolds	43	44.4	16.2	18.0	84.0
% Body Fat	43	15.6	7.3	5.0	34.6
Fat mass (kg)	43	13.0	7.4	3.4	34.2
Lean body masss (kg)	43	66.9	4.7	59.5	77.0

Physical Characteristics

Components	Valid	Mean	Std. Deviation	Minimum	Maximum
Chest circumference (cm)	43	95.1	5.3	86.8	109.2
Biceps circumference (cm)	43	32.6	2.2	28.8	38.0
Quadriceps circumference (cm)	43	57.1	5.1	37.8	67.2
Waist Circumference (cm)	43	85.0	6.5	75.3	101.2

Vertical Jump and Flexibility

Components	Valid	Mean	Std. Deviation	Minimum	Maximum
Vertical Jump (cm)	43	51.6	6.4	40.0	67.0
Hamstring flexibility (cm)	43	21.8	6.4	6.0	36.0

County Level Forwards – Percentiles

Anthropometrics

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Age (yrs)	18.0	19.0	21.0	21.6	23.0	24.0	24.8	26.0	28.0	30.0
Height (cm)	173.6	175.3	176.7	177.8	179.5	181.0	181.5	183.5	186.8	188.5
Avr weight (kg)	70.3	71.4	74.9	75.9	79.8	80.3	81.7	87.7	94.9	100.5
BMI	21.8	22.7	23.0	23.2	24.3	24.7	26.0	26.8	28.4	32.6
RHR	51	55	58	62	62	64	67	70	73	82
SBP	113	120	120	123	128	130	134	137	150	160
DBP	65	70	70	74	78	80	80	88	90	100

Body Composition

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest skinfold	6.0	6.8	7.0	8.0	10.0	11.0	12.0	13.2	14.6	28.0
Thigh skinfold	7.3	9.0	10.0	11.0	13.0	14.0	15.0	16.4	19.0	25.0
Abdomen skinfold	11.0	15.0	16.0	16.0	19.0	21.0	22.8	29.2	37.2	56.0
Sum of skinfolds	25.8	31.8	35.0	38.6	40.0	43.0	50.0	60.2	70.8	84.0
% Body Fat	7.6	10.1	11.0	12.7	13.4	14.6	17.6	22.6	27.9	34.6
Fat mass (kg)	5.3	7.6	8.3	9.5	10.6	11.5	14.1	19.3	25.6	34.2
Lean body masss (kg)	60.7	62.8	63.9	65.3	66.1	67.5	68.5	71.8	73.8	77.0

Physical Characteristics

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Chest circumference (cm)	89.2	90.5	91.8	92.7	94.4	95.5	96.4	99.6	104.1	109.2
Biceps circumference (cm)	30.0	30.5	31.3	32.0	32.4	32.6	33.0	34.0	36.6	38.0
Quadriceps circumference (cm)	51.9	54.3	55.0	56.0	57.1	57.9	59.0	61.6	63.5	67.2
Waist Circumference (cm)	77.6	78.7	81.0	82.9	83.0	84.9	87.3	90.0	96.1	101.2

Vertical Jump and Flexibility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Vertical Jump (cm)	42.4	46.8	49.0	49.0	51.0	52.8	54.0	56.0	61.8	67.0
Hamstring flexibility (cm)	13.0	16.0	20.0	21.6	22.0	23.0	24.0	28.0	30.6	36.0

County Level Forwards – Descriptive Data

Cardiorespiratory response at maximal exercise

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max VT in one breath (l)	41	2 78	0 39	1 93	3 92
Max respiratory rate (l/min)	41	54	7	41	67
Max ventilation rate (l/min)	41	115	15	78	146
Respiratory exchange ratio	41	1 12	0 06	1 01	1 23
Vol of CO2 Expired (l/min)	41	4 50	0 51	3 02	5 30
Absolute vol of O2 uptake (l/min)	41	4 09	0 45	2 85	4 86
Relative vol O2 upake (ml/min/kg)	41	51 5	6 3	37 5	67 5
Ventilatory threshold (ml/kg/min)	38	44 2	5 6	32 5	53 5
Ventilatory threshold (% VO2 max)	38	86 2	5 6	73 2	95 4
Heart Rate Max	39	195	11	168	210

Anaerobic Power and Capacity

Components	Valid	Mean	Std Deviation	Minimum	Maximum
Max absolute power (watts)	20	930 3	144 0	744 6	1263 7
T1 - Peak power per kg bwt (watts)	20	11 7	1 1	9 8	14 1
T2 - Peak power per kg bwt (watts)	20	9 5	1 1	7 1	12 6
T3 - Peak power per kg bwt (watts)	20	8 2	1 4	6 2	11 5
T1 - Percentage Fatigue (%)	20	21 5	5 3	12 8	30 1
T2 - Percentage Fatigue (%)	20	25 6	7 5	16 5	41 8
T3 - Percentage Fatigue (%)	20	24 4	6 9	10 0	38 0
T1 - Avrg power per kg bwt (watts)	20	9 9	0 8	8 5	11 5
T2 - Avrg power per kg bwt (watts)	20	8 0	0 9	6 0	10 3
T3 - Avrg power per kg bwt (watts)	20	6 8	1 1	4 5	8 7

Speed and Agility

Components	Valid	Mean	Std Deviation	Minimum	Maximum
5 metre time (sec)	23	1 08	0 05	0 99	1 20
5 metre speed (m/s)	23	4 62	0 20	4 16	5 04
5 metre acceleration (m/s/s)	23	4 28	0 36	3 46	5 08
20 metre time (sec)	23	3 11	0 07	2 95	3 27
20 metre speed (m/s)	23	6 44	0 16	6 12	6 79
20 metre acceleration (m/s/s)	23	2 07	0 10	1 87	2 31
50m Forward Backward time (sec)	23	14 86	0 89	12 46	16 73
5m backwards time (sec)	23	1 39	0 08	1 30	1 60
5m backward speed (m/s)	23	3 62	0 19	3 12	3 85
5m backward acceleration (m/s/s)	23	2 62	0 27	1 95	2 97

County Level Forwards – Percentiles

Cardiorespiratory response at maximal exercise

	Percentiles									
Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max VT in one breath (l)	2 45	2 53	2 58	2 68	2 71	2 80	2 89	2 99	3 33	3 92
Max respiratory rate (l/min)	45 2	47	51	54	55	56 2	58 4	60	63 6	67
Max ventilation rate (l/min)	96	102	107	113	117	119	122	128	136	146
Respiratory exchange ratio	1 05	1 08	1 09	1 10	1 12	1 13	1 15	1 18	1 21	1 23
Vol of CO2 Expired (l/min)	3 80	4 10	4 25	4 42	4 52	4 61	4 87	5 01	5 14	5 30
Absolute vol of O2 uptake (l/min)	3 47	3 67	3 91	4 00	4 08	4 25	4 30	4 59	4 68	4 86
Relative vol O2 upake (ml/min/kg)	43 5	45 2	48 0	50 2	52 6	53 4	55 0	56 6	58 4	67 5
Ventilatory threshold (ml/kg/min)	36 1	39 1	41 6	41 9	44 5	46 4	48 1	50 0	51 6	53 5
Ventilatory threshold (% VO2 max)	77 3	80 2	83 4	85 4	87 3	88 6	89 5	91 3	92 8	95 4
Heart Rate Max	177	188	191	194	194	198	202	205	209	210

Anaerobic Power and Capacity

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Max absolute power (watts)	768 6	801 8	835 7	842 0	895 7	967 9	986 1	1069 1	1178 4	1263 7
T1 - Peak power per kg bwt (watts)	10 6	10 8	11 0	11 1	11 5	11 8	12 1	12 6	13 8	14 1
T2 - Peak power per kg bwt (watts)	8 5	9 0	9 1	9 1	9 3	9 6	9 7	10 2	10 6	12 6
T3 - Peak power per kg bwt (watts)	6 2	7 1	7 4	7 7	8 1	8 4	8 7	9 5	10 1	11 5
T1 - Percentage Fatigue (%)	15 2	16 4	18 2	18 8	19 9	23 8	25 7	27 0	29 8	30 1
T2 - Percentage Fatigue (%)	16 9	17 5	19 8	22 3	25 3	27 3	28 0	32 9	38 1	41 8
T3 - Percentage Fatigue (%)	12 4	20 2	22 1	23 0	23 6	24 8	28 5	30 8	33 8	38 0
T1 - Avrg power per kg bwt (watts)	8 8	9 3	9 5	9 7	9 9	10 0	10 2	10 6	11 2	11 5
T2 - Avrg power per kg bwt (watts)	7 0	7 3	7 5	7 8	8 0	8 1	8 3	8 7	9 1	10 3
T3 - Avrg power per kg bwt (watts)	5 2	6 0	6 4	6 7	6 9	7 0	7 1	7 8	8 5	8 7

Speed and Agility

Components	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
5 metre time (sec)	1 02	1 04	1 06	1 07	1 09	1 10	1 10	1 11	1 15	1 20
5 metre speed (m/s)	4 37	4 50	4 54	4 56	4 60	4 68	4 72	4 80	4 90	5 04
5 metre acceleration (m/s/s)	3 81	4 04	4 13	4 16	4 22	4 39	4 46	4 60	4 79	5 08
20 metre time (sec)	3 00	3 05	3 07	3 09	3 12	3 13	3 13	3 17	3 21	3 27
20 metre speed (m/s)	6 24	6 31	6 39	6 40	6 42	6 47	6 52	6 56	6 68	6 79
20 metre acceleration (m/s/s)	1 95	1 99	2 04	2 05	2 06	2 09	2 12	2 15	2 23	2 31
50m Forward Backward time (sec)	14 03	14 17	14 34	14 60	14 95	15 05	15 25	15 42	16 20	16 73
5m backwards time (sec)	1 31	1 33	1 34	1 34	1 36	1 39	1 41	1 44	1 52	1 60
5m backward speed (m/s)	3 30	3 47	3 54	3 61	3 67	3 73	3 75	3 77	3 81	3 85
5m backward acceleration (m/s/s)	2 18	2 40	2 50	2 60	2 69	2 79	2 81	2 85	2 90	2 97

Appendix 21

Data collection sheet

Player Fitness Profiles

Anthropometrics

Name _____ Club _____ County _____

E-mail address _____ Contact Phone Number _____

Playing Position _____ Biceps Circum (cm) _____

Age (yrs)_____ Chest Circum. (cm) _____

Weight (kg) _____ Waist Circum. (cm) _____

Height (cm) _____ Thigh Circum. (cm) _____

Lower Back & Hamstring Flexibility (cm) _____ _____ _____

Body Composition

Triceps ____ ____ Mid Axillary ____ ____ Subscapular ____ ____

Pecs ____ ____ Suprailiac ____ ____ Abdominal ____ ____

Thigh ____ ____

% Body Fat _____ Lean Body Mass _____ Fat Mass _____

Power, Agility& Speed

Trial Number	#1	#2	#3
Vertical Jump – Two legged (cm)	_____	_____	_____
5m split time (secs)	_____	_____	_____
20m split time (secs)	_____	_____	_____

Aerobic Power

Level reached _____ Stage reached _____

Heart Rate (bpm) _____ Est VO_2 Max. (ml/kg/min) _____

Appendix 22

20 MST Recording Sheet

Name _____ **Playing Position** _____ **Date** _____

Level **Shuttle Number**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																
21																