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POSITIONAL ASSESSMENT AND PHYSICAL FITNESS CHARACTERISTICS OF MALE PROFESSIONAL SOCCER PLAYERS IN SOUTH AFRICA

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ABSTRACT

The purpose of this study was to describe the physical fitness of professional soccer players in South Africa and assess the difference in fitness status between different playing positions. Professional soccer players (N = 140) from various clubs in the Premier Soccer League (PSL) in South Africa underwent a battery of tests assessing key physiological components during the first half of their competitive season. Players were separated into one of four primary playing positions (goalkeepers, GK, n = 16; defenders, DEF, n = 48; midfielders, MID, n = 46; forwards, FWD, n = 30) on the basis of their playing position and designated role within the team. Descriptive statistics (mean ± SD) were calculated for the entire group and each position, and a one-way ANOVA was used to compare the positions for each of the physical tests. No differences were found between positions in age, flexibility, absolute vertical jump height, strength-endurance, acceleration and speed, or agility. GK were significantly ($p < 0.05$) heavier, taller and carried more body fat than all other positions. GK also had better vertical jump relative power outputs, but lower aerobic power (VO_2max) and repeat sprint performances than all outfield positions. MID were significantly lighter than DEF and significantly shorter than DEF and FWD. No differences in power, speed, agility, VO_2max and repeat sprint performance were evident between outfield playing positions. Although the anthropometric differences in playing positions found here are similar to those reported elsewhere, outfield players were not different in fitness performance. The modern game may require above-average performance on a variety of physical components from all positions for successful soccer performance.

Key words: Professional soccer players, fitness profiles.

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INTRODUCTION

Soccer is the world's most popular sport, with the Soccer World Cup finals attracting record estimations of worldwide television audiences in the billions (Reilly, 1990; Reilly et al., 2000; Wilsey, 2006). It is therefore hardly surprising that scientific study of the so-called 'beautiful game' has also been popular. In particular, the physical characteristics of players have been a topic of interest (Reilly et al., 2000; Tumilty et al., 2000; Bloomfield et al., 2005). There are physical, psychological, and technical factors which contribute to soccer playing performance (Hoff, 2005; Stølen et al., 2005) and recently a large emphasis has been placed on player fitness characteristics (Hoff 2005; Stølen et al. 2005; Svensson & Drust, 2005; Siegler et al., 2006). The modern game places a wide range of physical demands on players during a game. Players need explosive quickness and speed in making decisive runs in defense or attack. Since players must accelerate their own body mass, excess body fat is a disadvantage, as it contributes to unproductive mass which must be moved, reducing performance times. Explosive power, agility and balance are often required in winning critical moments or contests within a game.

Maintaining work intensity throughout a soccer match is important in dominating possession and enforcing team tactics while maintaining technical competence (Bangsbo, 1994). The importance of player fitness is further highlighted when one considers that elite players perform 5% less work in the second half of matches (Reilly, 1990; Bangsbo, 1994; Ellis et al., 2000). The soccer player therefore requires good cardiorespiratory endurance. But a high degree of technical and tactical skill is required for success in a game in which only two of the 22 players on the field are permitted to handle the ball. The nature and level of fitness requirements for soccer players is therefore a popular point of discussion.

Players' physical capacities are said to contribute to the technical and tactical skills in soccer (Stølen et al. 2005). Improved physical capacity was proven to have a positive effect on distance covered, number of sprints, and ball contact in a soccer game (Hoff, 2005). Apparently, fitness test performance may vary depending on the individual player's profile, their position of play, and the team's style of play (Reilly, 1990; Stølen et al., 2005; Svensson & Drust, 2005). A number of studies have assessed the variation in fitness parameters between playing positions in European leagues (Bangsbo et al., 1991; Reilly et al., 2000). It is generally reported that midfield players are lighter than other playing positions, have lower muscular strength, cover greater distances during a game, and have higher maximal oxygen uptakes (VO_2max) (Bangsbo et al., 1991; Reilly et al., 2000). However, similar studies using players in African leagues are lacking.

Sport scientists or trainers need to have objective data to compare their players against when planning individual conditioning programs for their players. While soccer enjoys arguably the largest following of all sports in South Africa, no position-specific physical fitness results have been published on elite soccer players in the country. The purpose of this study was therefore to describe the physical fitness profile of top level professional soccer players in South Africa and assess the difference in fitness performance between playing positions.

The results may be useful in understanding physical fitness profiles of different positions and directing position-specific conditioning programs by coaching, technical and conditioning staff.

METHODS

Subjects

One-hundred-and-forty players from various professional teams in the Premier Soccer League (PSL) in South Africa volunteered as subjects for the study. No distinction was made between regular and reserve players, or between newly signed players and established players in the squads. After being briefed on the purpose, benefits and risks involved in the testing, written informed consent was provided. Subjects were separated by playing position into goalkeepers (GK, n = 16), defenders (DEF, n = 48), midfielders (MID = 46) and forwards (FWD = 30).

Procedures

Data collection took place at the Institute for Sport Research, University of Pretoria, during the first half of the domestic competitive soccer season in the 2005-2006 and 2006-2007 seasons. Teams reported that during this stage of the season 3 to 5 sessions a week involved time dedicated to fitness training. Testing sessions were conducted at the same time of day on each occasion. Subjects were instructed to arrive for the testing well rested, well hydrated and fed, avoid caffeine containing foods on the day of testing, and avoid physical exercise on the day prior to the testing. A standardized 15 minute warm-up was performed prior to the outdoor testing, and this consisted of easy running, stretching, dynamic drills, and harder but sub-maximal acceleration sprints. Specific warm-up and familiarization drills took place before each of the subsequent tests.

Anthropometry and body composition

Body mass was measured with a Tanita BF-350 electronic scale (Tanita Corporation, Tokyo, Japan) and stature was measured with a Seca 214 stadiometer (Seca Corporation, Hanover, USA). Skinfold thickness (triceps, subscapular, biceps, supra-iliac, calf, thigh, and abdominal) was measured with a Harpenden skinfold caliper (Baty International, British Indicators, West Sussex, England).

These were summed to obtain the sum of seven skinfolds (Norton et al., 2000). The equation of Durnin and Womersley (1974) was used to predict body density and then body fat was estimated using the Siri formula described by Lohman (1992).

Flexibility

Hip and trunk flexion was assessed with the modified sit-and-reach test (Hoeger, 1991; Ellis et al., 2000) using a sit-and-reach box. The total displacement of the fingertips between reach and stretch distance was recorded to the nearest 0.5 cm, and the best of three trials was accepted as the final score.

Strength-endurance

Maximum pull ups were assessed with players maintaining a pronated (overhand) grip on a fixed overhead, wall-mounted pull up bar. Hands were placed 5 cm wider than shoulder width. Pulling the body up from a hanging, straight-arm position to end with the chin above the bar was considered a legitimate pull up, and players performed the maximum number of repetitions possible without touching the wall or floor.

Players performed the maximum number of sit ups in two minutes. Sit ups were performed with knees bent at 90° and feet secured to the floor. Arms were crossed on the chest with hands grasping the shoulders, while players curled up from a supine position until the elbows touched the knees, and descended until the scapula touched the floor.

The maximum number of push ups that players could perform in one minute was measured. Players assumed a prone position with thumbs shoulder width apart. A legitimate push up involved pressing the body upward until the elbows were extended, with ascent of the hips and shoulders occurring simultaneously. Descent required lowering the body with the arms until the elbows were bent to 90° while only the hands and the toes touched the floor.

Power

The vertical jump test was used to assess explosive knee and hip extension (Ellis et al., 2000) using a Vertec device (Sports Imports, Columbus, USA).

The test was conducted using the procedures described by Ellis et al. (2000). The greatest distance between reach and jump height was recorded to the nearest 1 cm after three trials, and players rested between efforts. Instantaneous leg power was then calculated using the Lewis formula as described by Brooks et al. (2005).

Speed

A maximum effort sprint running test was used to assess players' speed and acceleration from a stationary position. Subjects sprinted on a level, even surface, in a straight line on a natural grass soccer pitch with the subjects wearing full soccer kit. The Swift Speedlight Timing System (Alstonville, Australia) was used in conjunction with the protocol described by Ellis et al. (2000). The faster of two trials was recorded to the nearest 0.01 s for 10 m and 40 m, and players rested for around 5 minutes between attempts.

Agility

The Illinois agility test, adapted and modified by Roozen (2004) and Tossavainen (2004) from Getchell (1985) was used as a measure of agility. The test requires maximal acceleration, deceleration and direction change while sprinting between a grid of cones. The Swift Speedlight Timing System (Alstonville, Australia) was used to measure test time with a timing gate set up at the finish line. Players started in the prone position behind the start line. Timing was initiated by an audio signal whereupon players got up and sprinted through the pre-determined grid of cones (Tossavainen, 2004). The fastest time of two attempts was recorded. Players had about 5 minutes of rest between attempts.

Aerobic endurance

The progressive maximal 20 m Multi-stage Shuttle run Test (MST) was used to assess aerobic power (Ellis et al., 2000). The test was conducted on a non-slip hard court surface (Lèger & Lambert, 1982). Players were instructed to pace their runs along the 20m shuttle distance according to the audio signal from the recorded compact disc. Failure to maintain the required pace for two consecutive shuttles was criteria for a verbal warning. If this continued, players were eliminated from the test. The level and shuttle immediately prior to elimination from the test was recorded as the player's score.

This score was used to estimate VO_2max (Lèger & Lambert, 1982).

Repeated sprint testing

A repeated sprint test was used to assess the ability to perform multiple bouts of high intensity running between brief periods of rest (Boddington et al., 2001). Six lines (labeled 0 to 5) were placed at 5m intervals. Players were required to sprint from the start line (line 0) to line 1, and back to the start line, then to line 2, back to the start line, and so on. Players were instructed to sprint as far as they could in this fashion for 30 s. A whistle blow signaled the start of each shuttle run, with six runs in total, each separated by 35 s of recovery time in which players returned to the start line. Strong verbal motivation was given and players were instructed to sprint as hard as possible. Total sprint distance for each 30 s sprint was recorded to the nearest 2.5 m and the distance of the six sprints summed to obtain the total repeat sprint distance in meters.

Data Analysis

Descriptive statistics [mean ± standard deviation (SD)] were used to characterize the players for the entire group and for each of the four major playing positions. A one-way ANOVA was used to compare the scores of each of the different positions, with t-tests on least square means as post hoc analysis. Results were considered significant if $P < 0.05$.

RESULTS

The test results for each of the playing positions and the complete group are shown in Table 1. The total group of players in this study (age 24.8 ± 4.2 years; mass 73.4 ± 9.1 kg; stature 176.7 ± 7.3 cm; body fat 13.3 ± 3.3 %) appear lighter and shorter than groups of elite Danish (Reilly et al., 2000) and Australian (Tumilty, 2000) players studied. Vertical jump height (53.8 ± 7.9 cm) is similar to that reported elsewhere (Tumilty, 2000), while VO_2max (52.6 ± 5.0 $ml·kg^{-1}·min^{-1}$) is somewhat lower than widely reported for other groups of elite players (Reilly 1990; Bangsbo et al. 1991; Reilly et al. 2000; Tumilty, 2000). No significant differences were found between playing positions in age, sit-and-reach distance, vertical jump height, sit up, push up, pull up, 10 m and 40 m sprint times, and Illinois agility test time.

Table 1: Anthropometric, flexibility, power, strength-endurance, speed, agility, aerobic power, and repeat sprint data (mean ± SD) of players in different positions in professional South African soccer teams

Variables	**GK (n = 16)**	**DEF (n = 48)**	**MID (n = 46)**	**FWD (n = 30)**	**TOTAL (N = 140)**
Age (years)	25.4 ± 3.8	25.5 ± 4.8	25.0 ± 3.7	23.2 ± 4.0	24.8 ± 4.2
Mass (kg)	81.7 ± 8.7 †‡	75.3 ± 8.7 †	69.3 ± 6.9 †	72.2 ± 9.5 ‡	73.4 ± 9.1
Stature (cm)	182.2 ± 3.4 †‡	179.8 ± 6.3 †	172.5 ± 5.9 †§	175.3 ± 8.2 ‡§	176.7 ± 7.3
Sum of seven skinfolds (mm) [a]	73.7 ± 23.5 †‡§	53.0 ± 16.6 †	55.3 ± 18.2 ‡	53.7 ± 14.7 §	56.3 ± 18.6
Body fat (%) [b]	16.2 ± 3.7 †‡§	12.7 ± 3.1 †	13.1 ± 3.3 ‡	12.9 ± 2.8 §	13.3 ± 3.3
Sit-and-reach (cm)	37.9 ± 8.6	39.9 ± 8.6	39.0 ± 8.3	38.1 ± 7.1	39.0 ± 8.1
Vertical jump (cm)	58.5 ± 7.2	53.8 ± 8.1	52.7 ± 7.9	52.8 ± 7.3	53.8 ± 7.9
Power ($W·kg^{-1}$) [c]	16.8 ± 1.2 †‡§	16.0 ± 1.0 †	15.8 ± 1.2 ‡	15.8 ± 1.1 §	16.0 ± 1.1
Maximum sit ups in 2min	78 ± 19	75 ± 14	75 ± 14	74 ± 11	75 ± 14
Maximum push ups in 1min	42 ± 10	48 ± 12	44 ± 9	43 ± 13	45 ± 11
Maximum pull ups	6 ± 3	7 ± 4	7 ± 3	7 ± 3	7 ± 4
10 m sprint time (s)	1.89 ± 0.08	1.88 ± 0.08	1.86 ± 0.07	1.86 ± 0.06	1.87 ± 0.07
40 m sprint time (s)	5.58 ± 0.18	5.52 ± 0.24	5.54 ± 0.20	5.50 ± 0.19	5.53 ± 0.21
Illinois agility test time (s)	16.4 ± 0.4	16.2 ± 0.5	16.4 ± 0.5	16.3 ± 0.4	16.3 ± 0.5
VO_2max ($ml·kg^{-1}·min^{-1}$) [d]	46.8 ± 4.6 †‡§	53.6 ± 4.1 †	53.2 ± 4.7 ‡	53.3 ± 5.0 §	52.6 ± 5.0
Total repeat sprint distance (m)	675 ± 43 †‡§	721 ± 36 †	716 ± 33 ‡	725 ± 34 §	715 ± 38

†‡§ Variables with the same superscript are significantly different from each other, $p < 0.05$

[a] Skinfolds: triceps, subscapular, biceps, supra-iliac, calf, thigh, and abdominal

[b] Based on the Siri formula as described by Lohman (1992).

[c] Based on vertical jump performance and using the formula described by Brooks (2005).

[d] Based on performance in the 20 m Multi-Stage Shuttle run test described by Lèger & Lambert (1982).

GK were significantly heavier and taller than all outfield playing positions. DEF were heavier and taller than MID, while FWD were significantly taller than MID. GK also carried more body fat than each of the outfield playing positions. When vertical jump performance was expressed in watts per kg body mass, the relative power output of GK was significantly higher than all outfield positions. Conversely, VO_2max and repeat sprint performance was significantly lower for GK than for DEF, MID or FWD.

DISCUSSION

During running, jumping and direction changes players must move their own body mass and a high body fat content would appear to be a disadvantage (Reilly, 1990). Although size could be theorized to be important in winning player contests during the game, it might negatively affect acceleration and nimbleness, arguably more valuable qualities in soccer. The finding that goalkeepers were significantly taller, heaver, and carried more body fat than outfield players are in line with other published data, as are the fact that midfielders are generally shorter than players in other positions (Reilly, 1990; Reilly et al., 2000). Larger individuals would be at an advantage in trying to cover the goal face, whereas lighter, leaner players may be more mobile in the outfield (Bangsbo, 1994). It is worth noting that the players in this study are lighter and shorter than those studied in Europe and Australia (Reilly et al., 2000; Tumilty, 2000) and this highlights the morphological differences in players of African and European descent.

Explosive power is required for accelerating the body mass during short distance movements and in leaping to win the ball in the air. Since this description characterizes major movement patterns of goalkeepers in play, it is not surprising that they showed higher relative power outputs than all other playing positions. More than any other position, goalkeepers need to be able to move their bodies quickly in order to guard the goal. Whether this is an innate characteristic influencing success at goalkeeping or a product of specialized power training for goalkeepers is not clear, but being able to produce higher relative power outputs seems to be important in goalkeeping.

It is reported that acceleration and running speed can differentiate between levels and positions of play (Tumilty, 2000; Svensson & Drust, 2005). During a soccer match, players generally sprint for average durations of less than 6 s (Reilly, 1990). Since no statistical differences were found between acceleration and speed scores between any of the playing positions, it is possible that all playing positions require speed of movement. Positional movements both in attack and defense, either with or without the ball are major determinants of the result of the passage of play (Bangsbo, 1994) and being able to perform these movements quickly seems necessary in all positions to play at the level of players studied here.

Agility is the ability to change the direction of body motion rapidly, and results from a combination of a variety of physical components (Svensson & Drust, 2005). Soccer players continuously change movement direction and body position during a match. Again, no significant differences were found between any positions in their agility scores. It is possible that this is a fundamental component required in soccer, no matter what the position, as described for speed and acceleration above.

Outfield players have been shown to cover around 10-13 km per game (Stølen et al., 2005), with variations based on playing position reported (Reilly 1990). The majority of the energy required during a soccer match is produced through oxidative metabolism (Hoff 2005). It is reasonable to expect that elevations in aerobic power and capacity would help to sustain high work rates during a game (Reilly, 1990), and that since midfield players are reportedly the most active (Reilly, 1990), they should have better aerobic endurance. However in the current study, no differences in estimated VO_2max between outfield players were found. Goalkeepers showed significantly lower VO_2max values than all other positions, and this is not unexpected given that the demands on goalkeepers during a match involve very sporadic, brief, intense movements rather than cyclic and regular intermittent work.

Soccer involves multiple sprints, and so players must be able to recover rapidly between intense bouts of work (Reilly, 1990). As with VO_2max, only goalkeepers covered significantly less distance in the repeat sprint test when compared to each of the other positions. Again, this may be a product of the reduced training time goalkeepers spend developing this ability, since, as mentioned above, the physical demand they face during a match is vastly different.

There are a number of possible explanations for the current findings. It may be that some of the fitness components, like agility and speed, are important requirements for all positions of play, from goalkeepers to forwards. Either only players with fair attributes in these components become successful, or all positions have engaged in training to target these aspects. Also, if the modern game requires a reasonably high level of performance in all fitness components, as Reilly et al. (2000) discuss, then it is reasonable to expect similar test performances amongst outfield players. Considering the outfield players only, no positional discrimination could be made on any measures of flexibility, body fat, power, acceleration and speed, strength-endurance, agility, aerobic power and repeat sprint performance. Alternatively, positional play may be more specialized in the European leagues previously studied in comparison with the professional soccer league in South Africa. If players perform less specialized roles in a game, one would expect more homogenous groups on all parameters, including physical fitness between different positions. Stated differently, the pattern of play in professional soccer leagues in Africa and Europe may differ enough that positional roles are less well distinguished on the basis of physical fitness in African soccer.

It is important to acknowledge the limitations of the current study. Firstly, there are inherent reliability concerns with outdoor testing as a result of variation in ambient conditions. While all squads were tested at the same time of the year and soccer season, daily variations are not controllable. Secondly, variations in the level of physical training amongst squads are potential confounders to this data. This is arguably insignificant, as previously we have found no significant differences in physical fitness of players in squads ranked either high or low on the league log (Clark, 2007), suggesting that training status may be rather similar between different clubs. A notable strength of the current study is that professional players from the top league in South Africa participated as subjects, providing data representative of elite players. Also, when controlled through strict adherence to procedure, field tests provide useful, valid and accurate means of assessing soccer fitness (Svensson & Drust, 2005).

CONCLUSIONS

The results of this study suggest that while there are some differences between goalkeepers and all other positions, outfield players perform remarkably similarly in various physical fitness tests, and the differences are largely anthropometrical. This is in disagreement with published data of some European players (Reilly, 1990; Bangsbo et al., 1991; Reilly et al., 2000), and suggests that professional South African players cannot be separated into playing position on the basis of fitness. This may be the result of similarities in requirements in a range of fitness components, and differences in positional specificity in different leagues. It highlights the fact that the physical demands of the game are multifactorial. These results should be considered by managers, coaches, and trainers when planning training and conditioning sessions for teams. Further research is needed to better describe the differences between African and European players to obtain data specific to regional leagues, and better understand the relationship these differences may have on the pattern of play.

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