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Original Article

Physical demands of soccer: lessons from team USA and Ghana matches in the 2010 FIFA WORLD CUP

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Abstract

Purpose: Distance covered and the intensity patterns of player movements using selected matches involving the national teams of United States of America and Ghana in the World Cup Soccer Tournament held in South Africa from June 11th to July 11th 2010.

Methodology: A total of eight matches played by nine teams were used in the study. Team USA played against England, Slovenia, Algeria and Ghana. The national team of Ghana played against Germany, Australia, Serbia, USA and Uruguay. The eight matches comprised 12.5% of all matches played while the nine countries comprised 32% of all the tournament participating countries.

Results: The results showed that soccer players on average covered 9.3 Kilometres to 13.476 per match. The United States of America players, on average, covered 10.76 km while those for Ghana covered 10.49km. Overall, the low activity movements dominated (84.1%), followed by high intensity (8.3%) and medium intensity (7.6%). However, the intensity patterns for United States of America's players were 83.5%, 8.75% and 7.75% compared to the players from Ghana, who, were characterized by 85% low, 7.8% high and 7.2% low intensity movements respectively.

Conclusions: It is apparent that soccer is an intermittent sport demanding high amounts of aerobic ability as well as anaerobic movements. Training must therefore target to develop both the aerobic as well as the anaerobic energy sources if players' performance is not to diminish towards the end of the matches.

Key words: Aerobic, anaerobic, conditioning, tactical, technical, skills

Introduction

In modern sports, the emphasis on winning and the competitive spirit of the participants demands a high level of physical and psychological conditioning as well as refined technical-tactical preparation of the individual player (Hughes et al., 2012; Jones & Drust, 2007; Njororai, 2000; 2007; Singh, 1982; Wade, 1972). The preparation of players for high level competition has therefore to be based on solid empirical evidence and scientific practices. Association football (soccer) is a demanding sport technically, tactically, psychologically and physically. In soccer, the physical aspect is expressed in the fight for possession of the ball, running off the ball, dribbling, tackling, counter attacking, overlapping, and jumping to head the ball and long tactical kicks. All these demand a high level of fitness in the players (Reilly, 1979, 1994, 1995; 2005; Reilly & Thomas, 1984; Stone and Kroll, 1986). The highest level of competition to which all young players aspire to reach and even win is the soccer world cup held after every four years. It is from such a level of competition that lessons are learnt to be incorporated in training and coaching for youth and elite players. The 2010 world cup soccer tournament was held in South Africa from June 11th to July 11th 2010. One of the attributes of the tournament that can be emulated by players in schools, colleges and even club level is the coping with physical demands of a game and a tournament.

The physical ability of a player, especially the aerobic component, provides the stability needed to execute the tactical and technical skills throughout a match and a tournament. Fitness level determines a player's capacity for concentration and crisp play in the late stages of a game. Besides all the physical benefits, being in great overall shape gives a player an important confidence boost and mental edge (Kagan, 2010). The physiological demands of competitive soccer at the elite level require that each player be in good physical condition if s/he is to give maximum effort throughout a particular match or tournament. Thus the optimization of physical fitness is now an integral facet of player and team preparation. One of the consequences of sustaining movement and physical activity for 90 minutes of soccer match-play is that capability of muscle to generate force declines. This impairment is reflected in the decline of work-rate towards the later part of the match (Reilly, 1994; Reilly, Drust, and Clarke, 2006). Association football is a sport where performance should be sustained for a prolonged period. In such prolonged performances, fatigue tends to set in as reflected by inability to sustain the required work-rate (Reilly et al., 2006).

Due to the importance of the physical aspects of soccer, a lot of studies have been done especially on male players. For a long time the best approach was using labor intensive time-motion analysis which demonstrated that elite male players typically cover a total distance of 9 – 14 km during a game (Ekblom, 1986;

Hoff, 2005; Mohr, Krstrup & Bangsbo, 2005; Muckle, 1981; Reilly, 1979, 1995; Wade, 1972; Winterbottom, 1964), while the females covered between 8 to 12 km (Carling, Bloomfield, Nelsen and Reilly, 2008). The advent of computerized motion analysis has made it easier to monitor the physical demands during a game including the distances covered by players.

According to Impellizzeri, Rampinini & Marcora (2005), aerobic training is an important component of physical training in soccer. The relevance of aerobic training to soccer has been confirmed by studies showing a relationship between aerobic power and competitive ranking, quality of play and distance covered during the match (Bangsbo & Lindquist, 1992; Hoff, 2005). Mohr et al. (2005) cites Helgerud, Engen, Wisloff and Hoff who established that aerobic training can improve some aspects of soccer performance, including distance covered, time spent at high intensity, number of sprints and touches of the ball during a match. Furthermore, the authors contend that high aerobic fitness appears to improve recovery during high-intensity intermittent exercise which characterizes soccer performance and training. The high-intensity movements interspersed with periods of lower-intensity activity in soccer demands that players be prepared physically to adapt to the intermittent match demands (Svensson & Drust, 2005).

National teams that rank among the top in the world of soccer are those that excel in competitive matches at international level. Some of the international competitions where teams aim to excel include the World Cup Soccer Tournament; the Continental Championships including Union of European Football Associations, Asian Cup of Nations; Africa Cup of Nations; Confederation of South American Championships, Confederation of North American and Caribbean Association Championships, among others (FIFA, 2010; Njororai, 2000). For a team to excel in any of these tournaments, it has to prepare adequately to outplay the opponents all the way to win the championships. Although winning teams display a mastery of the technical and tactical aspects that put them above the rest of the teams, the key basis for their success is the physical capacity that enables the players to maintain a high level of execution of skills and tactics throughout a match and cumulatively through a tournament. For example, for a team to win the World Cup Soccer tournament, it has to play seven matches including four that could go to over time during the round of 16, quarter, semi and final. Thus the physical preparedness of members of team plays a critical role in the performance on the field of play and therefore coaches need to monitor the level of fitness of their players regularly. Players who are aerobically well trained can maintain their work rates better especially towards the end of the game than those of poorer aerobic fitness. Additionally increasing maximal aerobic power may aid recovery following successive bouts of high intensity anaerobic efforts which produce transient fatigue (Carling et. al., 2008). Recovery from exertion is critical in a game as well as between matches in a tournament or a league.

One of the physical aspects that points to the physical preparedness of a team is the distance covered in a match by individual players and a team as a whole. Traditionally, time motion analysis was used to record distances covered by players. However, with advancing technology, computerized motion analysis can provide not only the distance covered by a player but also the distance covered when in possession of the ball, without possession and distance covered at top speed during a match. The world cup soccer tournament held in South Africa from June 11th to July 11th 2010 witnessed the use of technology to record match statistics to very great detail. This is very important not only to sports scientists but also to coaches, teachers, administrators, journalists among others. Monitoring of the distance covered, just like match analysis, helps the coach in the overall team preparation in training and for competition. The specific aims for monitoring the distance covered in a match include:

1. To identify strengths that require to be maintained and weaknesses to be corrected or improved.
2. To help match the physical capacity of a player and the actual tactical demands of his or her role during the game.
3. To carry out substitution if a player's work rate shows signs of declining during the later stages of the game.
4. To offer feedback to a player with regard to the tempo of the game.
5. To effectively vary the tempo of the match depending on the current status of a match.
6. To effectively prescribe the training load for players depending on their roles in the game.
7. To scout the potential opponents so that you can prepare your own team adequately.
8. To prepare the physical conditioning and training schedule throughout the year so as to maximize on peak efforts at the appropriate time.
9. To compare the overall distance run by individual players with that of team mates or opposition players to ascertain relative exertion rates.

Assessment of game demands can be done using indirect methods such as recording the distance covered and physiological responses in match situations or directly in simulated actions in a laboratory. The data used in this study is based on motion analysis to determine the work rate of players during actual games. Reilly (2005) asserts that aggregated data can be expressed as overall distance covered in a game and this index is sufficiently sensitive to differentiate between positional roles, environmental conditions, styles of play, and levels of play. He further asserted that the observations can be broken down into distinct categories including the distance covered, number of sprinting episodes, low to high intensity activities among others.

Performance records without interpretation and application are of no use to the improvement of the game. Thus there is need to analyze the distance covered and intensity patterns of players in selected matches during the 2010 world cup tournament with a view of helping coaches and sports teachers appreciate the importance of physical preparation of their players.

Methodology

The study was a retrospective one as the data was derived from the 2010 World cup held in South Africa between June 11th and July 11th 2010. During the tournament, a total of 32 teams played 64 matches which were all relayed live on Television and Internet. Additionally, all statistics pertaining to the matches were recorded. For this study, the teams of Team USA and Ghana were purposely selected to analyze their performances regarding distance covered; distance in first half compared to second half; distances at low, medium and top speed. Ghana played five matches against Germany, Australia, Serbia, USA and Uruguay, while Team USA played against England, Slovenia, Algeria and Ghana. The nine teams selected represented 28 percent of those that took part in the tournament while the eight matches selected formed 12.5% of all matches played. The statistics were accessed at <http://www.fifa.com/worldcup/statistics>. Castellano et al. (2012) established the reliability of the FIFA match statistics by randomly coding five matches and compared with the FIFA website data. The resulting values using Cohen’s Kappa (K) were between 0.93 and 0.97. This demonstrates a high reliability index for the FIFA website data. The derived data was organized and presented via tables and figures.

Results

Matches played and Total distance covered

Table 1 shows the matches played by Team USA and Ghana, results and distance covered in each game compared to their opponents.

Table 1: Matches played by Team USA and Ghana, Results and Distance covered

Match	Result	USA		Opponent	
		Total distance	Average	Total distance	Average
USA vs England	1:1	107.518 km	9.774 km	108.154 km	9.832km
USA vs Slovenia	2:2	107.109 km	9.737 km	106.815 km	9.710km
USA vs Algeria	1:0	110.619 km	10.056 km	104.540 km	9.504 km
USA vs Ghana*	1:2	148.231 km	13.476 km	140.317 km	12.756 km
Distance covered		473.48 km	10.76 km	459.83 km	10.451km
Match	Result	GHANA		Opponent	
		Total distance	Average	Total distance	Average
Ghana vs Germany	0:1	106.051 km	9.641 km	108.940 km	9.904 km
Ghana vs Australia	1:1	101.776 km	9.252 km	102.695 km	9.336 km
Ghana vs Serbia	1:0	97.692 km	8.881 km	94.150 km	8.559 km
Ghana vs USA*	2:1	140.317 km	12.756 km	148.231 km	13.476 km
Ghana vs Uruguay	1:1	131.173 km	11.925 km	135.740 km	12.34 km
Distance covered		577.009 km	10.491 km	589.756 km	10.723km

- **Match went into extra time and repeated in table**

Data Source: <http://www.fifa.com/worldcup/statistics>

Table one shows that Team USA outran all her opponents except England while Ghana was outrun by all opponents except Serbia. The USA team players ran an average distance of 10.76 km which was further than the average of 10.451 km for the opposing teams, whereas players from Ghana covered 10.491 km which was less than her opponents who on average ran 10.723 km.

Distance in the first and second halves

Table two shows the distances covered by key members of Team USA in the 1st and 2nd halves respectively. These players were selected as they were those that played the highest minutes and therefore were the core of the Team USA in the 2010 World Cup Tournament in South Africa. It is noteworthy to point out that whereas Michael Bradley covered 6,140 km in the first half of the game, his distance covered declined to 5965 in the second half.

Table 2: The distances covered in each half of the matches by selected members of Team USA

Player	England		Slovenia		Algeria		Ghana			Total	
	1 st (total)	2 nd	1 st total	2 nd	1 st total	2 nd	1 st	2 nd	Extra time	1 ST Difference	2 ND
Steve Cherundolo	5362 (10316)	4954	4802 (9552)	4750	5076 (10444)	5368	5126	5328	3636	20366	20444
Michael Bradley	5835 (11,719)	5884	5948 (12,091)	6143	6087 (11,753)	5666	6140	5965	4025	24010	23658 - 352
Landon Donovan	5732 (11076)	5344	5157 (10933)	5776	5731 (11276)	5545	5681	5762	3741	22301	22427 +126
Jozy Altidore	4835 (9963)	4128	4940 (9746)	4688	4741 (9186)	4445	4800	4773	----- ..(9573)	19316	18034 - 1282
Carlos Bocanegra	4846 (9789)	5141	4954 (10212)	5258	4815 (9851)	5036	4932	4837	3505	19547	20272 +725
Clint Dempsey	5097 (10732)	5635	5280 (10798)	5518	5614 (10925)	5311	5540	5407	3592	21531	21871 +340

Source of data: <http://www.fifa.com/worldcup/statistics>

Table 2 shows that the work rate of some of the players increased in the second half, while others slowed down.

Match play physical activity patterns

Figure 1 shows the physical activity patterns during various matches involving USA and Ghana in the 2010 world cup soccer tournament in South Africa.

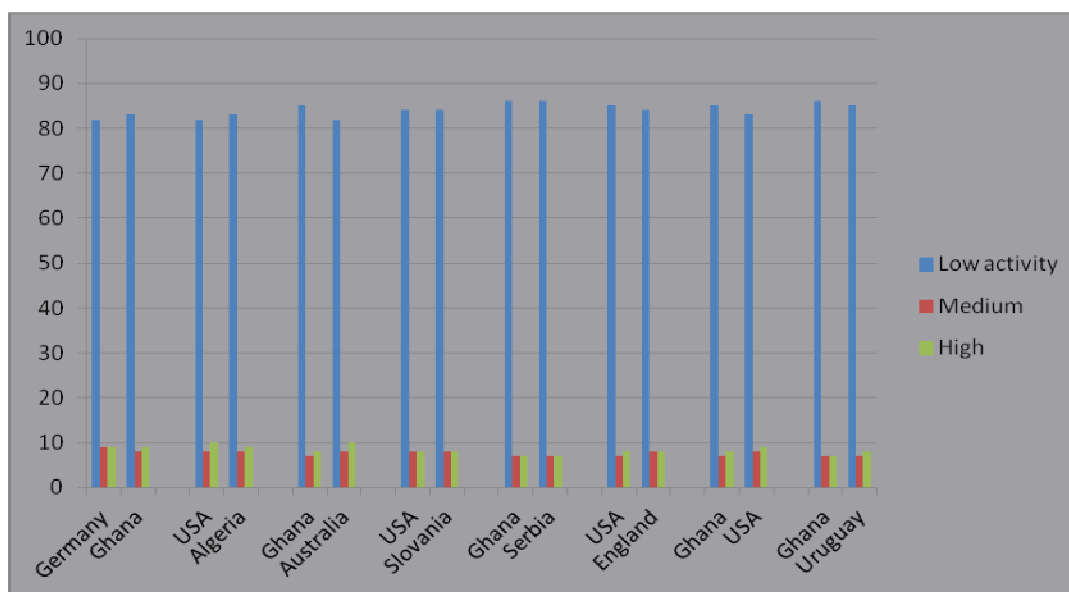


Figure 1: The percentage of low, medium and high activity patterns during matches

Figure 1 shows that the greatest percentage of the physical activities undertaken by soccer players were of low intensity. On average, 84.1 percent of the players' efforts were low in intensity and therefore aerobic in nature. The low intensity activities were followed by high intensity averaging 8.3 percent and medium intensity 7.6 percent. Players from Ghana averaged 85 percent of their movements on low, 7.2% on medium, and 7.8% high intensity activities. For team USA, 83.5%, 7.75% and 8.75% percent of their activities were low, medium and high intensity respectively. From the data, the team from Ghana had higher percentage of low activity compared to the USA but less in medium and high intensity activities. When all the eight selected matches are considered, the average for low intense movements was 84.1%, medium 7.6% and high 8.3%. Comparatively USA was on the higher end of medium and high intensity activities while Ghana was on the lower side.

Discussion

This level of distance covered compares favorably with data on players from Europe, Australia and South America (Carling et al., 2008). However, the overall figures obscure the individual accomplishments. One of the greatest highlights of the 2010 World Cup was the match between Ghana and USA. This match brought out the significance of physical fitness as Michael Bradley covered the longest distance in a single match. According to the 2010 FIFA World Cup South Africa Player Statistics, Michael covered 16,130 km (10,022 miles) over 128 minutes and 25 seconds of the match. It is therefore paramount that coaches incorporate serious training loads for players so as to develop their aerobic and anaerobic capacity to cover such distances without flagging in their technical and tactical performance.

The inconsistencies in the distances covered between the first and second halves and from one game to the next could be due to tactical changes by the coach, nature of the opposition, the status of the score, individual pacing, among others. Team USA conceded four of the five goals in the first half (and the other goal in the first half of extra time). This could have contributed to their high physical work rate even in the second half to equalize or to score so as to qualify for the next round especially in the match against Algeria where they needed to win to qualify for the second round. Research on Brazilian, Australian, Japanese, Italian, Danish, and English players all reveal a tendency to decline in distance covered between the first and second halves of the matches (Carling et al., 2008; Hoff, 2005; Mohr et al., 2005). The only exceptions are the Spanish players who showed a slight improvement in the second half (Carling et al., 2008).

A decline between the first and second half in the physical performance is associated with a decline in technical executions involving passing and receiving the ball (Hoff, 2005). Indeed more goals are scored and conceded in the second half when fatigue starts setting in, compromising tactical-technical executions and decision making (Njororai, 1996, 2004, 2007a). A coach should therefore monitor the distance as well as the work rate of players so as to change the tactics or even make a substitution to avoid the opposition exploiting this emerging physical weakness. Substitution of players before the onset of fatigue towards the end of the game may restore the imbalances in work rate. According to Carling et al. (2008), substitute players have been shown to

cover significantly more ground at high intensity during the final 15 minutes than the other players already on the pitch.

Despite the intermittent nature of the game of soccer, the contests for possession of the ball that entail anaerobic exercise are less compared to the low intensity activities that employ aerobic metabolism (Reilly 2005). According to Reilly, the modern game seems to be more demanding than the earlier times and therefore there is need for more systematic approach to training. According to him, changes to the rules that occurred in the 1990s such as prohibiting the goalkeeper from picking up a back-pass, penalizing time-wasting, and use of three substitutes have contributed to the increased tempo in matches. This has resulted in an increased reliance on optimum training programs to meet these elevated match demands (Reilly, 2005).

The high intensity activities in the selected soccer matches accounted for 8.3 percent of the movements whereas the medium intensity ones were 7.6 percent. Playing soccer constitutes intermittent exercise in which the timing of the high intensity efforts is acyclic and therefore unpredictable (Reilly 2005). A team that has been prepared to perform at a high tempo has a competitive edge over an equally skilled but less fit opposition. If recovery periods in between bouts of strenuous efforts are inadequate in duration, transient fatigue will ensue. According to Mohr, Krstrup and Bangsbo (2003), activity was reduced in the five minutes immediately after a five minute period of sustained exercise at high intensity. Players that are not well conditioned to pace themselves may therefore suffer undue fatigue if they engage in high intensity activities without having enough time to recover within a match.

It is apparent that players from Ghana were more likely to engage in low intense activities than the other teams while the converse was true for Team USA. The differences could be attributed to the different styles of play adapted by each national team as well as the prior physical and technical competence of the players.

Thus successful teams have players who can operate at high speed, under intense pressure and in smaller spaces given the higher work-rate of the players who close on the player with the ball faster than before (Tipping, 2009). For example, in Euro 2008, most matches were characterized by fast end-to-end action even though many of the players were coming off extremely competitive and long European seasons. It was regular for players to cover over 10 KM in one single match. This corresponds to the distances covered during the 2010 world cup. There is therefore a need for elite teams to hire fitness specialists so as to prepare the players adequately for the match play demands (Tipping 2009). However, at school and youth levels, coaches need to be prepared in physical conditioning routines that correlate with the match play patterns of physical exertion. Additionally, pacing of the players throughout the match is critical if performance is not to diminish towards the end of a match. It is also critical that a coach be on the lookout for players who have pushed themselves too hard in the first half so that substitution can be done to avoid falling work-rates in the second half.

Conclusion

Because of the intermittent nature of a soccer match, performance can be improved through repeated exposure of players to high intensity work in training. The repetition of anaerobic activities such as small sided games, shuttle sprints with and without the ball, among others should be tailored to match situations. These movements are crucial since the success of their deployment plays a critical role in the outcome of matches (Carling et al., 2005; 2008). In addition to high intensity anaerobic activities, it is important that low intensity activities with and without the ball be emphasized. This should mirror the actual game patterns where over 80% of the movements are of low intensity and the remaining 20% split between medium and high intensity.

Individualized and team preparations demand that time be spread out on perfecting the team and individual physical fitness and conditioning. All forms of sport involve achievement and goal oriented behavior. The practice situation is geared to preparing players to effectively play assigned roles within a team with a view of achieving certain goals. This is so because every sport situation offers various forms of contest and self-testing. This is evidenced by the concern of coaches, players, spectators and sports scientists with attributes of ability, competence, effort, mastery, performance, results and records. It is for this reason that detailed individual and team performance statistics are recorded and reported so that they can be used to enhance player development. Thus coaches should focus and develop the physical condition of the players. The condition factor includes strength, speed, endurance, flexibility and their combination as well as the dietary prescriptions for recuperation from physical exertion.

When two teams are matched in all other areas, the physical deterioration of one team can make a difference. In soccer, the majority of goals are scored in the last 15 minutes of matches (Njororai, 1996; 2004; 2007a) when fatigue sets in (Carling et al., 2005; Mohr et al., 2005) thus emphasizing the need for proper physical conditioning of a team. In major tournaments, a team not only plays several matches but also faces the likelihood of playing extra time in the knock-out phase. Tournament and League champions are teams that overwhelm their opposition throughout the period of competition via solid performances that reflect a high level of physical working capacity.

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