Relationship Between Amateur Soccer Players Rated Ability to Complete a Full Session of Soccer Game and their Cardiovascular Aerobic Parameters and Indices

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Abstract

Background: *Soccer players always nurse the desire to play the game for the length of the football time, but this does not always happen.* ***Objectives:*** *This study aimed to identify the cardiovascular and aerobic parameters that may influence an amateur athlete's self-rated ability to complete a full session of a soccer game.* ***Methods:*** *Subjects (N-67) who were free from any cardiovascular ailment were qualified to participate in the study. These subjects' cardiovascular parameters and rating of perceived exertion (RPE) at baseline, immediately following a soccer game, as well as serially for 8 minutes into recovery, were monitored.* ***Data Analysis:*** *Descriptive statistics of mean and standard deviation were used to summarise the physical characteristics of the participant, and paired t-test and ANOVA were used to analyse the cardiovascular parameters at rest and after the soccer session.* ***Results:*** *The mean age and body mass index of the participants were 23±43 and 19.5±2.6, respectively. Participants who were always able to able to complete a soccer session (TAC) showed significantly higher ($p<0.05$) aerobic capacity (52.7 + 4.7 vs. 46.3 + 8.5) and also reported lower RPE (14.0 ± 2.0 vs. 16.0 ± 2.0) following a training session than their counterparts who were not at all able to complete a full soccer session (TNC). However, the aerobic capacity and RPE of the TAC group were not different from those of their TSC group counterparts (52.7 + 4.7 vs. 50.5 + 5.0). Conclusion: It can be argued that an amateur soccer player's self-rating of their ability to complete a full session of a soccer game is a function of the players' resting HR and their aerobic capacities.*

Keyword: Amateur Soccer Players, Exercise Preformance, Aerobic Capacity, Cardiovascular Parameters

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Introduction

Cardiovascular responses in exercise testing can be used to reproduce signs and symptoms, or to determine exercise tolerance (Lakhau *et al*.,2008) and are the basis for an individualised exercise prescription (Stuart *et al*., 2015). While resting and exercising, cardiovascular parameters provide individual reference values (Gambo *et al*., 2018). An individual's ability to sustain muscle performance during high-intensity exercise can be predicted by cardiovascular responses during exercise and in recovery following exercise and physical activity (Gambo *et al*., 2018). There is also the consensus that recovery parameters, more especially heart rate, also have prognosticative values, and previously it has been observed that a heart rate drop that is less than 8 beats within one minute into recovery following exercises is a good predictor of one-year mortality for cardiac patients (Keteyian *et al*., 2016).

Soccer is a physically demanding sport, and an individual player on a team can go from standing still momentarily to an explosive run. This sport is a recreational game that is competitive by its nature, and in order to achieve peak performance, soccer players may need to have good aerobic fitness, stamina or endurance, flexibility, and optimum quadriceps to hamstring muscles maximum torque or power ratio (Bondarev, 2008). It is generally believed that soccer players differ in their ability to endure a full session of a 90-minute soccer match: while some players can play through the full time in a match, others only struggle to continue a few more minutes after half-time. It is generally believed that soccer players differ in their ability to endure a full 90-minute match, while some players can sustain play throughout, others struggle to continue beyond halftime. This variation in endurance is plausibly influenced by an individual's aerobic fitness level and may also be reflected in cardiovascular parameters at rest, in response to activity, and during recovery following a practice session (Bangsbo, Mohr, & Krustrup, 2006; Stolen, Chamari, Castagna, & Wisloff, 2005; McArdle, Katch, & Katch, 2015). It is plausible that an individual's ability to play through a full soccer session may be influenced by aerobic fitness level and may also be reflected in the cardiovascular parameter at rest, in response to particular activity, and in recovery following a practice session (Bangsbo, Mohr, & Krustrup, 2006).

The pattern of hemodynamic response during recovery following an acute exercise bout or exercise testing is well established (Girandola *et al*., 2009). The bodily processes begin to return to the resting level immediately on cessation of exercise, but individual variation in recovery following a light, moderate or strenuous exercise or physical activity may be influenced by metabolic and physiological processes resulting from each level of effort (Girandola *et al*., 2009). During the first few minutes of recovery, even though the muscle is no longer actively working, oxygen demands do not immediately revert to the values at the resting baseline levels. Instead, oxygen consumption remains elevated for an extended period. This oxygen consumption, which exceeds the usually required consumption when at rest, has traditionally been referred to as the oxygen debt and recently as post-exercise oxygen consumption (Scott, 2015).

Overall, there is also consensus that the first phase of recovery following exercises and physical activity is marked by rapidly declining oxygen consumption and heart rate, and it is during this period that the tissues' stores of ATP and phosphocreatine depleted in the muscles are restored (Kelly, 2008). Restoration of ATP stored in the muscles can be completed within 30 seconds, although for most exercises of more than 10 minutes' duration, 100% restoration may not be achieved until after 3-5 minutes (Boyd *et al*., 2012). A high rate of post-creatine re-synthesis is an indication of greater ability to tolerate buffer and remove hydrogen ions. It is also an indication of greater ability to restore muscles to their desirable pH range and a greater oxidative enzyme, both of which are reflective of an accelerated recovery process (Boyd *et al*., 2012).

Individual differences exist in sportspeople's ability to metabolise lactate, and aerobic fitness or capacity play a great role in recovery. Some studies have reported an association between aerobic fitness and lactate removal, following high-intensity football training (Boyd *et al*., 2012), while others did not find an association (Kelly, 2008). At rest, the body consumes 3.5ml of oxygen per kilogram body weight per minute (One metabolic equivalent or MET), and physical activity between 3 and 6 METs is considered moderately intense and includes activities such as brisk walking. Vigorous activity of 6 METs or higher is more physically demanding and includes jogging, while hard or heavy activities may include running and playing football with a MET value of 8 MET or higher (Ainsworth, 2009). Performance in any sport or recreational activity is not only influenced by training or aerobic capacity, or fitness, but also by humoral factors, which are often determined by motivation and vertiginous stimulation.

Psychological disposition or make-up can be influenced by an individual's self-rating of ability or self-confidence in performing or completing a task and may, in turn, be a reflection of an individual's past performance and experience (Bandura,1997). In general, rating of perceived exertion (RPE) is a valid and reliable measure of subjective perception of effort (Borg 2014, Mellecker, 2008), and heart rate check during exercise testing is an objective method of detecting cardiovascular influence during resting and recovery or competition through limitation to activity tolerance. Based on the consensus from the literature, it is also expected that the cardiovascular response of players with higher aerobic fitness will recover faster than those with lower aerobic fitness (Facioli, T.P., Philbois, S.V., Gastaldi, A.C. *et al*, 2021). How the self-rated ability to complete a full session of soccer is related to aerobic fitness level and resting and recovery cardiovascular parameters is unclear.

A full-time soccer match consists of two 45-minute halves, separated by a 15-minute half-time break, totalling 90 minutes of regular play. In addition, matches may include stoppage time, typically 2 to 5 minutes per half, added by the referee to compensate for interruptions. In knockout competitions, if the score is level, the game may proceed to extra time (two 15-minute halves) and potentially a penalty shootout. Throughout a match, players engage in various physical and tactical demands, including Aerobic and anaerobic activity, Short sprints and high-intensity runs, Technical skills (passing, shooting, dribbling), Tactical decision-making, and Physical contact and recovery. A player's ability to perform consistently throughout these phases is heavily dependent on cardiovascular endurance, muscular strength, agility, and mental focus.

Amateur footballers are typically individuals who engage in the sport non-professionally, without receiving regular payment or contract-based employment. They may participate in local leagues or recreational settings and often balance football with other occupational or educational responsibilities. Professional players undergo structured training regimes, which enhance VO_2 max levels, heart rate recovery, and lactate threshold, enabling them to sustain high-intensity activity for longer durations (Krustrup *et al*., 2005). In contrast, amateurs usually have lower aerobic fitness due to irregular or less intensive training, which can result in quicker fatigue and slower recovery during matches. Professionals are conditioned to maintain performance across 90 minutes and beyond, while amateurs often struggle to maintain intensity, especially in the latter stages of a match. The difference is especially evident in sprint frequency, distance covered, and recovery between high-effort plays (Mohr, Krustrup, & Bangsbo, 2003)

Empirical data on how soccer players' ability to complete a full session of soccer games relates to their cardiovascular fitness is important and may be useful in making decisions on players selected for a match. This report is part of a larger study in which data on aerobic fitness, self-reported ability to complete a soccer game for its set duration, and cardiovascular parameters and responses before and after a soccer practice session were collected. Only the data on aerobic fitness and the scale of changes in cardiovascular responses from resting values are reported in this study. This study, therefore, aims to determine the cardiovascular and aerobic parameters that may influence amateur soccer players' perceived ability to complete a full session of a soccer game and their aerobic capacity.

Participants, Materials, and Methods

Participants

Healthy amateur male soccer players, in three football clubs in Maiduguri Metropolitan city in North-Eastern Nigeria, were identified from the Ministry of Youth and Sport, Borno state, Nigeria. The clubs were Qatar Football Club (QFC), Konduga United Football Club (KFC), and University Football Club (UFC). The study was conducted in the football fields of the clubs with 45 players from QFC, 35 from KFC, and 38 from the UFC. These three club sides were the existing amateur groups in the city.

Procedure

Ethical approval from the University of Maiduguri Research and Ethical Committee was sought and obtained before the commencement of this study. An introductory letter from the Department of Medical Rehabilitation (Physiotherapy), University of Maiduguri, explaining the purpose of the study, was presented to the coaches of all the soccer clubs. On the first day of the encounter, participants were interviewed for medical history of any cardiovascular ailment, and those who meet the following inclusion criteria (age range 18–40 years, free from diagnosed cardiovascular disease, Physically active or moderately active, as determined by a pre-screening physical activity questionnaire, Not on any cardiovascular or performance altering medication, and willingness to provide informed consent and comply with study procedures) were included in the study. The participants were advised not to take kolanut, cigarettes, and heavy food at least one hour before the next soccer training session in order to minimise physiological disruptions that could affect performance and safety. The participants were advised not to take kolanut, cigarettes, and heavy food at least one hour before the next soccer training session in order to minimise physiological disruptions that could affect performance and safety.

On the second encounter, which took place at least 24 hours following the first one, the protocol of the study was explained to the participants. Participants' weights were taken to the nearest 0.5kg, and height was also assessed to the nearest centimetre on a wooden calibrated height meter, using the standard method (World Health Organisation, 2008). The participants were asked to step on the scale, making sure they stood erect with their arms hanging loosely at their sides of the trunk, and their weight was recorded to the nearest 0.5kg. A wooden calibrated height meter was used to measure their height.

The participant stood barefoot with the feet together on the ground, the upper back, buttock s, and heel touching the goal post, the head was held erect, the eyes looking forward were used for measurement of participants' height to the nearest 0.1cm. After a warm-up period, which consisted of 5 minutes of stretching and brisk walking, participants underwent a 1.5-mile run test on a marked standard athletic field, and a stopwatch was used for timing the participants.

On the third encounter day, two days after the 1.5-mile test, participants were seated for at least 5 minutes, and their resting vitals, including HR, SBP, and DBP, were measured using an automated blood pressure and pulse rate monitor.

The participant was instructed to rest for 10 minutes before taking their resting vitals in the resting position. The cuff of the blood pressure monitor was wound around the left hand 2cm above the cubital fossa (Pickering *et al*., 2005). After taking the resting parameters, including rating of perceived exertion (RPE), the participants were released to start the soccer practice or training session. At the end of the session or when the subject is no longer able to continue the game, either voluntarily due to fatigue or discomfort, or involuntarily due to injury, medical concerns, or signs of physical distress, the activity is immediately discontinued to ensure participant safety. Cardiovascular parameters were again monitored within 10-30 seconds of terminating the practice session.

Derived values, including mean arterial pressure (MAP) = 1/3 (SBP − DBP), rate pressure product (RPP) = (HR × SBP), and pulse pressure (PP) = (SBP − DBP), were computed. MAP reflects the average pressure in a cardiac cycle, PP is a correlate of stroke volume, and RPP is an index of myocardial oxygen uptake (Alper & Mustapha, 2013). Body mass index (BMI), the ratio of body weight (kg) to the square of the subject's height (m^2), was also computed. In addition, aerobic capacity was estimated using performance on the 1.5-mile run test, applying the standard equation: VO_2 max = 483 / time (min) + 3.5, which provides a field-based estimate of cardiovascular fitness (McArdle, Katch, & Katch, 2015).

Data analysis

Descriptive statistics of mean and standard deviation were used to describe the participants' physical characteristics. One-way ANOVA was used to explore the difference in the cardiovascular parameters of the participants before training and the responses after training. A paired t-test was used to determine the difference between the rating of perceived exertion and the ability to complete the full session of the soccer game. For this study, the Statistical level of significance was set at $p < 0.05$.

Result

Physical Characteristics of the Participants

A total of 67 apparently healthy adult amateur soccer players participated in this study. The mean age, weight, height and body mass index of the participant were 23.2± 4.3 years (95% Confidence Interval =22.2-24.3 years) 65.6±10.0, 1.68 ± 0.10 and 19.5±2.6 (95% Confidence Interval = 18.8-20.1) Kg/respectively. The mean 1.5-mile run test time of the participant is 634.96 ± 59.66 sec, and their mean aerobic capacity is 50.2± 6.0. (Table 1)

Responses at baseline, following practice and during recoveries

The mean cardiovascular parameters and derived values at baseline, following practice session and in recovery have been reported elsewhere (Gambo *et al* 2019). Briefly, the mean resting HR, SBP and DBP of the participants before soccer practice were 71.6 ± 15.4, 130.1 ± 19.1 and 79.7 ± 15.9, respectively and also the mean rating of perceived exertion (RPE) at baseline was 6.0±0 respectively. Immediately after soccer practice, the mean HR, SBP and DBP were 138.7±16.6, 149.8±17.0. The mean values of the HR, SBP and DBP of the participants 2 Minutes after cessation of soccer exercise were 130.3±16.13, ±146.2±18.1 and 91.3±11.0, respectively.

For all the subjects combined, the change in HR, SBP and DBP from the baseline to the post soccer value is 67.4 ± 19.9, 19.6 ± 10.6 and 19.1 ± 14.9, respectively (Table 3). The change for the derived indices (i.e mean arterial pressure MAP, and rate pressure product RPP) for the subjects combined is as shown in Table 2. Data on the drop in parameter values during recovery were also computed as responses to exercise. The results show that two minutes into recovery, the drop in HR, SBP and DBP are 8.1 ± 6.5, 33.4 ± 13.4, and 7.4 ± 7.0, respectively. The drop in recovery parameters between successive measurements (2 minutes, 4 minutes and 8 minutes into recovery) as recovery progressed was also computed and is shown in Table 2.

Group Comparison of Responses

Comparisons of cardiovascular parameters were made between players by their reported ability to complete a full session of a soccer game. Participants who responded they were always able to complete a full soccer session (AAC) showed significantly higher ($p<0.05$) aerobic capacity (based on their 1.5-mile run time) than their counterparts who were not at all able to complete a full soccer session (NAC) (52.7 + 4.7 vs. 46.3 + 8.5). However, the aerobic capacity of the AAC group was not different ($p>0.05$) from that of their counterparts who reported they were sometimes able to complete a full session (ASC) of soccer practice (50.5 + 5.0). The AAC group shows significantly lower ($p<0.05$) RPE following a soccer practice session than their counterparts in the NAC group (14.0 ± 2.0 vs. 16.0 ± 2.0). The RPE score for the AAC group was, however, not significantly ($p>0.05$) different from that of the SAC group.

Group comparisons were also made on the baseline HR, and it was observed that the AAC subgroup shows a lower HR than those of the SAC and NAC groups. No differences in the baseline values in SBP, DBP, and the derived parameters were observed between the groups. Increases in post-exercise HR for the AAC group were significantly lower ($p<0.05$) than the increases for the NAC group (62.6 ± 18.9 vs. 80.4 ± 21.2), but not different from that of the SAC group (64.9 ± 18.6). No significant differences in the increases from baseline to immediate post-soccer changes were observed for SBP and DBP among the groups.

Comparison of Cardiovascular Drops During Recoveries

This study shows a drop in HR and SBP of the magnitude of 8.1±6.5 and 33.4±17.4, respectively, among the amateur soccer players by the second minute into recovery, and a further drop by a magnitude of 6.6±7.1, 4.8±9.9 and

5.4±5.3 four, six and eight minutes into recovery, respectively. However, while some meaning could be made of the drop in the first 2 minutes, the drops at the other time frames are too divergent (based on the standard deviation) to make any statistical meaning of the value of the drops. Nevertheless, overall, it appears that the drop observed for HR, SBP and DBP and the derived indices observed in the first two minutes into recovery was steeper than the drops in the other time frames during recovery. However**,** no change in PP (a correlate of stroke volume) was observed throughout the time points of measurements (that is, at rest, during practice session and in recovery).

Table 1: Physical Characteristics of the Participants

Group	Age	Aerobic Capacity X (SD)	BMI X (SD)	RPE X (SD)
AAC	22.5(4.1)[a]	51.7(4.7)[a]	19.4(3.1)[a]	14.0(2.0)[a]
SAC	23.8(3.5)[b]	41.3(4.1)[b]	20.7(4,0)[a]	16.3(2.2)[b]
NAC	23.4(2.8)[b]	40.5(7.2)[b]	20.9(4.8)[a]	17.1(3.4)[b]
Combined	23.3(4.3)	50.2(6.0)	19.5(2.6)	15.2(2.3)

BMI denotes Body Mass Index; AAC denotes participants' subgroups who are always able to play through a full session of soccer, SAC denotes those who are sometimes able to complete a full soccer session, and NAC denotes those who are never able to complete a soccer session

Means with different superscripts are significantly different from each other ($p<0.05$)

Table 2: Changes in Cardiovascular Responses Following Soccer Practice and Drops in Recoveries

Variable	Change	1st Drop	2nd Drop	3rd Drop	4th Drop
Heart Rate	67.4±19.9	8.1±6.5	6.6±7.1	5.5±7	7.4±7.7
Systolic Blood Pressure	19.6±10.6	33.4±17.4	4.8±9.9	8.5±29.0	7.0±5.4
Diastolic blood pressure	19.1±14.9	7.4±7.0	5.4±5.3	5.2±7.0	5.2±5.0
Mean arterial pressure	19.5±12.0	7.3±7.5	5.9±5.2	5.9±5.4	5.7±4.0
Rate pressure product	2.1±1.7	2.0±1.7	1.5±1.6	1.4±1.3	1.8±2.3

1st Drop denotes change from the preceding values 2 minute after the cessation of exercise; 2nd Drop denotes change from the preceding 2 minute values 4 minute after the cessation of exercise; 3rd Drop denotes change from the preceding 4 minute values 6 minute after the cessation of exercise; 4th Drop denotes change from the preceding 6 minute values 8 minute after the cessation of exercise Rate Pressure Product Values are in Thousands

Discussion

This study sought to determine any link between amateur soccer players' self-reported ability to complete a soccer game and cardiovascular and aerobic parameters. The study shows their aerobic capacity. The study shows HR, and SBP as well as the derived measures including MAP and RPP observed immediately after soccer practice were higher when compared to the baseline values is consistent with the consensus in the extant literature Karel *et al*., 2015; Sjokvist *et al*., 2011; Sercan Oncen and Levent Tanyeri, 2019. Higher DBP immediately after soccer practice, when compared to the baseline values is however inconsistent with that of Madanmohan *et al* 2004, Nieman, D.C., 1998, Aslan *et al*., 2012, Kelley, G. A., and Kelley K. S., 2000 and Kravitz, L. 2020, and others that reported exercise produce no change Aslan *et al*., 2012, Amri Hammani *et al*., 2017, or slightly lower DBP with exercise (Aslan *et al*., 2012, Kelley, G. A., and Kelley K. S., 2000. None of the parameters, including the derived indices, returned to the resting level throughout the recovery period of 8 minutes, except PP, which did not change from the baseline values for any of the time frames.

The present study shows that the perceived ability to complete a full session of a soccer game is influenced by resting HR, aerobic capacity and RPE following a soccer practice session. This study suggests that the lower the resting HR, the higher the probability that an athlete would be able to complete a full session of soccer. It also suggests that the higher the aerobic capacity of the athlete, the more the chance that the athlete would be able to complete a full session of a soccer game, always or sometimes. Change in HR between the baseline and exercise values is significantly ($p<0.05$) for the AAC subgroup, also affecting the probability that an athlete would complete a full session always or sometimes in a similar manner as the baseline HR and aerobic capacity (Krustrup *et al*., 2010). We observed a steepest drop (albeit in absolute but insignificant) in the values of the parameters (other than PP) at the second recovery time frame (4 minutes into recovery) compared to the other time frames during recovery. Smaller drops were observed (also in absolute but insignificant terms) after the 2-minute drop (Krustrup *et al*., 2010).

Why the scale of change in HR between baseline and immediate post-practice was lower for the AAC group compared to the NAC counterparts is unclear. It may be attributed to the stroke volume (an index of myocardial pump function or contractility), which is presumably larger for the more aerobically fit. Stroke volume may be sufficiently large such that, for a given workload, a large change in HR may not be needed compared to the less aerobically fit subjects. This study shows that the responses of the amateur soccer players did not return to the resting level 8 minutes into recovery. How long it would take for responses to return to equilibrium is unclear. However, based on the previous reports, 8 minutes is too short for the equilibrium state to be achieved. Bondarev *et al*., 2010, Steven *et al*., 2017, Mathieu *et al*., 20012.

Furthermore, why the correlates of SV did not change or remain the same can be explained by a ceiling effect due to high or near-maximal possible SV attributable to aerobically fit subjects, such as the soccer players in this study. Absence of change in PP may also be explained by the fact that this parameter is an index of cardiac contractility related to ejection fraction, and may not be expected to be influenced in a constant flow system such as the cardiovascular system. Those studies also show that with the lower rating of perceived exertion following the practice session, as observed for the more aerobically fit, RPE.

One limitation of this study is that the subjects' cardiovascular parameters following a soccer practice session were monitored within 20 seconds following cessation of play, because it is practically impossible to measure this response while still playing soccer. This is due to challenges of instrumentation usually found in a resource-limited environment, such as in many developing countries, including Nigeria. Although it can be safely presumed that values obtained within 20 seconds after cessation of activities can be expected to closely approximate the steady state exercise values, this may not be the same as the value if it were measured within 1 minute before the termination of the soccer session. One assumption is that a soccer player's reported ability to complete a full session of soccer reflects the true state of the player. Subjects in this study did not undergo practice for 90 minutes, as in a normal game, and therefore their self-reported ability to complete a full soccer game was not verified.

Conclusion

This study shows that an amateur soccer player's confidence or perceived ability to complete a full session of a soccer game is a reflection of their aerobic capacity of the amateur and how tired the amateur athlete will feel following a practice session. Just as the degree to which an amateur soccer player is exhausted or the rating of perceived exertion following a practice session may also be a reliable fool or indication of athletes' aerobic capacity or cardiovascular endurance. Just as RPE following a practice session may be a reflection of an amateur soccer player's ability to complete a full soccer match. The study shows that those who are able to complete a full session of a soccer game tend to consistently have higher aerobic capacity than their counterparts who are not able to or struggle to complete the soccer game.

Study Limitations

- Limited sample size and geographic scope
- Use of self-reported data for the ability to complete full sessions
- Absence of a control group for comparison
- Potential confounding variables (nutrition, hydration, sleep) were not controlled.
- Lack of detailed injury or adverse event reporting
- No assessment of psychological or motivational factors beyond RPE

Study Implication

One practical implication of the findings from this study lies in the strategic selection and grouping of players for both training sessions and competitive matches. If the goal is to ensure that footballers derive maximum physiological and tactical benefit from a session, it becomes essential that both teams are relatively well-matched based on relevant player characteristics. Key among these characteristics are aerobic capacity and rating of perceived exertion (RPE) following physical activity. Matching players by physical fitness between different teams during competitive matches is less feasible due to tactical priorities, role specialisation, and limited control over opposition characteristics. Likewise, monitoring RPE provides valuable insight into how players perceive workload, which is critical for balancing performance and recovery.

In both training and competitive settings, such matching promotes fairness, enhances engagement, minimises the risk of injury, and ensures that the physiological and psychological benefits of football participation are more evenly experienced across all participants. This approach may also support improved team cohesion and tactical execution, benefiting not only the players but also coaches and stakeholders in grassroots and professional football settings.

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