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Research Article

Effects of 90-Minute Football Match on Red Blood Indices in Sedentary Young Males

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ABSTRACT

While exercise-induced haemorheological alterations are well-documented in various sports, the specific impact of a football match on red blood cell (RBC) parameters remains unknown. This study investigates the acute effects of a 90-minute football match on RBC indices in sedentary young males. After inclusion and exclusion criteria, twenty (20) moderately active, non-smoking male volunteers (mean age: 20.00 ± 0.4 years) participated in the study. Venous blood samples were collected pre- and post- football match to assess RBC count, haematocrit (HCT), and plasma volume (PV). Data generated were subjected to paired student's t-tests using SPSS, to compare values between pre- and post-match measurements. A p-value of less than 0.05 was considered indicative of statistical significance. The results showed a statistically significant decrease in haematocrit (HCT) and red blood cell count (RBC) after the match ($p < 0.05$) when compared to pre-match values. This was accompanied by a significant increase in plasma volume (PV) ($p < 0.05$), which was higher than pre-match values. These changes suggest that the physiological demands of the football match influenced blood parameters, likely due to fluid shifts and haemodilution during intense physical activity. These findings suggest potential implications for exercise physiology, diagnosis, and therapy in sports medicine.

Keywords: Soccer; Red Blood Cell; Exercise; Sedentary; Match

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INTRODUCTION

A post-exercise increase in blood viscosity is a well-documented phenomenon, influenced primarily by hematocrit and plasma viscosity, two key determinants of blood viscosity. Several mechanisms contribute to this rise in blood viscosity after exercise, including fluid shifts, an increase in circulating erythrocytes due to splenic contraction and their redistribution, elevated plasma protein concentrations, and water loss caused by thermoregulatory mechanisms and subsequent entrapment in muscle cells (Brun, 2002). While an increase in hematocrit can reduce blood flow, it enhances oxygen-carrying capacity, making changes in plasma viscosity potentially more significant for tissue oxygen supply (Lenz *et al*., 2008).

Exercise-induced alterations in red blood cell (RBC) parameters vary depending on the type of exercise performed. Football, classified as a high-intensity and intermittent team sport (Ekblom, 1986), is widely practiced globally across various age groups and levels of expertise (Stolen *et al*., 2005). The intense training and competitive nature of football can lead to significant physiological adaptations, including potential overloading effects (Varlet-Marie *et al*., 2004). Previous studies have indicated that early signs of overtraining in elite athletes are associated with changes in hemorheological patterns (Varlet-Marie *et al*., 2006). These hemorheological alterations during prolonged exercise are influenced by haematological parameters, particularly hematocrit and plasma protein levels (Neuhaus & Gaehtgens, 1994).

The impact of different types of exercise on blood rheology can vary. For instance, cycling has been shown to increase blood viscosity due to changes in plasma viscosity and hematocrit, while outdoor running does not significantly affect these parameters (Tripette *et al*., 2011). A previous study indicated that a standard 90-minute football match did not adversely affect blood rheology in regularly trained male footballers (Karakoc *et al*., 2005). However, it remains unclear whether a single 90-minute football match affects RBC indices in sedentary young males, particularly those who are not regularly engaged in physical exercise. Understanding these effects could provide valuable insights for diagnosis, therapy, and sports physiology. The aim of the present study is to investigate whether a single 90-minute football match acutely alters red blood cell indices in sedentary young males and to explore any associated changes in blood rheology.

MATERIALS AND METHODS

Participants

Employing purposeful sampling technique, twenty moderately active, non-smoking male volunteers (mean ± SEM: age = 20.00 ± 0.4 years; height = 1.70 ± 0.0 m; weight = 58.60 ± 1.0 kg; body mass index [BMI] = 20.19 ± 0.3 kg/m^2) were recruited for this study. All participants were free from acute or chronic diseases, were not on any medication, and goalkeepers were excluded from the study to maintain consistency in the type of physical exertion. Participants were fully briefed on the study details and provided written informed consent prior to participation. The study protocol was approved by the Ahmadu Bello University Ethical Committee, and all procedures complied with the Declaration of Helsinki.

Study Protocol

One week prior to the study, participants underwent health screenings and anthropometric measurements. They were instructed to refrain from vigorous exercise, caffeine, and alcohol consumption for 24 hours before the trials. On the morning of the experiment, participants arrived at the field between 09:00 and 11:00 AM after a 12-hour overnight fast. Following a 10-minute rest period, a venous blood sample (3 mL) was collected from each participant pre-match and immediately after the match.

Acute Exercise Study

The exercise consisted of a 90-minute football match, following the protocol described by Rahnama *et al*. (2009). The match was structured into two 45-minute halves with a 15-minute rest in between, and was played on a standard football field measuring 100 by 70 meters. The match was organized into two separate teams and played on the day of the test under normal conditions.

Red Blood Cell Indices Assays

Blood samples were collected in the morning, adhering to standard procedures with all aseptic precautions, and after an overnight fast. Venous blood samples were drawn from the antecubital vein before the match (pre-exercise) and 105 minutes after the match (post-exercise). These samples were collected in EDTA tubes and immediately transported to the laboratory in on ice. The RBC count (in millions per cubic millimeter), hematocrit (HCT or Packed Cell Volume [%]), and plasma volume (PV) were measured using a fully automated hematology analyzer (Automatic Cell Counter, Nihon Kohden, MEK 6420, Japan). PV was calculated as a percentage from the HCT values.

Data Analysis

Data are presented as mean ± standard error of the mean (SEM). Statistical analyses were conducted using SPSS software (version 20.0). Paired Student's t-tests were utilized to compare values between pre- and post-match measurements. A p-value of less than 0.05 was considered indicative of statistical significance.

RESULTS

The mean physical characteristics of the study participants are detailed in Table 1. The average age was 20.00 ± 0.4 years, height was 1.70 ± 0.0 meters, weight was 58.60 ± 1.0 kilograms, and the average body mass index (BMI) was 20.19 ± 0.3 kg/m^2. All participants were in good health, with no significant health issues or traumatic injuries reported during the study period.

Table 2 summarizes the red blood cell (RBC) indices measured before and after the 90-minute football match. The results show a significant decrease in both RBC count and hematocrit (HCT) following the match. Specifically, the RBC count decreased from 3.06 ± 0.05 × 10^6/mm^3 pre-match to 2.61 ± 0.08 × 10^6/mm^3 post-match ($p < 0.001$). Similarly, HCT decreased from 41.60 ± 0.54% to 39.05 ± 0.42% ($p < 0.001$). In contrast, plasma volume (PV) increased significantly after the match, rising from 58.40 ± 0.54% pre-match to 60.95 ± 0.42% post-match ($p < 0.001$).

DISCUSSION

This study examined the effects of a 90-minute football match on red blood cell (RBC) indices in sedentary young males. The key finding was a significant decrease in RBC count and hematocrit (HCT), accompanied by a significant increase in plasma volume (PV) post-match. These results align with previous findings by Cinar *et al*. (2013), who reported significant changes in complete blood counts, including RBC, platelet (PLT), and hemoglobin (HGB) levels, after a 10-day training program in footballers. The reduction in RBC count and HCT observed in our study, despite being an acute response, could reflect a protective cardiovascular adaptation, as suggested by prior research.

A decrease in HCT can be cardio-protective, particularly in the context of exercise-induced blood rheology changes. According to Poiseuille's law, increased blood viscosity can elevate vascular resistance and cardiac afterload, potentially burdening the cardiovascular system (Connes *et al*., 2009). Elevated HCT is known to increase blood viscosity, subsequently raising cardiac workload, as demonstrated by El Sayed *et al*. (2005) and Böning *et al*. (2011). In contrast, the observed decrease in RBC count and HCT following the football match could reduce blood viscosity, thereby lowering the cardiovascular strain.

Connes *et al*. (2012) provided insights into the mechanisms underlying these adaptations, suggesting that an increase in blood viscosity during exercise is positively correlated with nitric oxide (NO) production, which may lead to vasodilation and a reduction in vascular resistance. This could explain why the acute decrease in RBC indices observed in our study does not impair, but rather may enhance, cardiovascular function by optimizing blood flow and oxygen delivery.

The significant increase in PV observed in this study supports findings by Sawka *et al*. (2000) and Karakoc *et al*. (2005), who reported similar outcomes following acute exercise. The expansion of plasma volume is a well-documented compensatory response to counteract exercise-induced hemoconcentration (Schumacher *et al*., 2002). This response is mediated by several mechanisms, including increased aldosterone levels, elevated osmotically active plasma proteins, and reduced urodilation, all of which promote fluid retention and PV expansion (Wilkerson *et al*., 1977; Convertino *et al*., 1980). Training-induced hemodilution, characterized by plasma volume expansion, enhances cardiovascular efficiency by reducing blood viscosity, improving microcirculation, and optimizing oxygen delivery to active muscles (Schumacher *et al*., 2002).

CONCLUSION

The findings of this study indicate that a 90-minute football match leads to a decrease in red blood cell indices and an increase in plasma volume within the physiological range in sedentary young men. These changes, while significant, are unlikely to impair cardiovascular function in healthy individuals. Instead, they may enhance microcirculation and oxygen delivery to working muscles, supporting cardiovascular efficiency during physical activity. This suggests that the observed alterations in red blood cell indices represent adaptive mechanisms aimed at maintaining

cardiovascular stability and optimizing performance during acute exercise.

Conflict of interest

The authors do not have any conflict of interest

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Table 1: Physical Characteristics of Study Population

Characteristic	Mean ± SEM
Age (years)	20.00 ± 0.4
Height (m)	1.70 ± 0.0
Weight (kg)	58.60 ± 1.0
BMI (kg/m²)	20.19 ± 0.3

Table 2: Red Blood Cell Indices Before and After the Football Match

Red Blood Cell Indices	Before Match (Mean ± SEM)	After Match (Mean ± SEM)	Change	p-value
RBC (× 10^6/mm³)	3.06 ± 0.05	2.61 ± 0.08	-0.45	< 0.001
HCT (%)	41.60 ± 0.54	39.05 ± 0.42	-2.55	< 0.001
PV (%)	58.40 ± 0.54	60.95 ± 0.42	+2.55	< 0.001