Changes in cardiovascular parameters of a-university football athletes associated with short duration pre-tournament training

Francis Osei, Monday Omoniyi Moses*, Prince Pambo1, Biggie Baffour-Awuah, Benjamin Asamoah, Daniel Afrifa, Eric Junior Appiah, Lady Gwendoline Akwa, Agnes Obour

Department of Sports and Exercise Science, Faculty of Allied Health Sciences, College of Health Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

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A B S T R A C T

Short-duration pre-tournament training (SDPT) is a common training technique used to prepare for major competitive football tournament. There is scarcity of report on the effects of SDPT on the cardiovascular parameters of university footballers in Ghana. This study examined the changes in cardiovascular parameters of a-university footballers due to SDPT. Thirteen male footballers (mean age 21.23 ± 1.73 years) who represented the Kwame Nkrumah University of Science and Technology in the Ghana University Sports Association’s competition in 2016 participated in the study. The players engaged in SDPT of moderate to high intensity training for 2 weeks. Blood pressure, heart rate, fasting plasma glucose, haemoglobin, red blood cells, haematocrit, mean cell volume, mean cell haemoglobin, mean cell haemoglobin concentration, white blood cells, neutrophils, lymphocytes, absolute content of leucocyte, erythrocyte and platelets were measured pre and post training. There were significance decreases in body mass index (P = 0.002), haemoglobin (P = 0.042), haematocrit (P = 0.003) and white blood cells (P = 0.017), while fasting plasma glucose (P = 0.017) and platelets (P = 0.004) increased significantly. SDPT predisposes a-university footballers to acute inflammatory responses. Appropriately designed training duration and intensity would prevent increase in fasting plasma glucose and improve cardiorespiratory performance in university footballers.

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* Corresponding author.Tel.: +233547336905.
E-mail addresses: oseifrancis7@gmail.com (F. Osei), momoses@knust.edu.gh, oseifrancis7@gmail.com (M.O. Moses), dr.pambo@yahoo.com (P. Pambo), bbonsu.chs@knust.edu.gh (B. Baffour-Awuah), benjasamoah@hotmail.com (B. Asamoah), sparrowdcrusader@yahoo.co.uk (D. Afrifa), lovericheric@gmail.com (E.J. Appiah), akwalady@gmail.com (L.G. Akwa), oaggie24@gmail.com (A. Obour).

1 Medical Directorate, National Sports Authority, Accra-Ghana.

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Introduction

Modern football progressive training load with predominantly increases in frequency, duration and intensity enhances players performance [1]. The performance of players is also judged by the level of competition, playing style, positional role, environmental conditions, years of experience and body composition [2]. Fitness components such as muscular strength, balance, aerobic power and anaerobic capacity are critical for optimal performance in the long term [3]. However, in both the short and long term, sports or exercise training has been reported to promote cardiovascular health in athletes [4]. Athletes with metabolic syndrome [5], hypertension [6], stable cardiovascular disease and even myocardial infarction [7] benefit from exercise training compared to those who do not partake in any training. Studies reveal that high-intensity endurance training elicits a significant increase in resting left-ventricular end-diastolic dimension and volume [8,9].

Long-duration sports training has proven to be more beneficial in non-professional athletes than short-duration training [10]. Short-duration/acute-conditioning training with high intensity, however, remains a convenient option for university athletes (non-professional), where academic demands/commitments take centre stage. All university athletes have to combine academic work with sports training, making them non-professional. Sports training are usually withdrawn until a month or a few weeks prior to competition for most university athletes including Ghana. The available short periods of training are often rigorous, without consideration for the effects of such training on the cardiovascular parameters of the athletes. Although many games are involved, footballers mostly complain of training side-effects. Side-effects of such acute-conditioning training reported, but, the case of university athletes in Ghana has received little or no attention. Hence, this study examined the effects of acute-conditioning non-competitive football training on cardiovascular parameters in university footballers.

Materials and methods

Participants

Registered footballers at the Kwame Nkrumah University of Science and Technology (KNUST) volunteered to participate in a high-intensity, acute-conditioning endurance football training programme on a standard FIFA football pitch. Thirteen university non-elite footballers from Ghana with a mean age of 21.23 ± 1.73 years, no known cardiovascular/pulmonary disease and no record of medication or tobacco consumption or any other medical contraindications to exercise training participated in the study. The players were monitored to ensure that they did not engage in any other specific training during the study period. The study procedure and any other possible risk factors were explained to all athletes, who gave their written informed consent prior to participation.

Training protocols

Two (2) weeks pre-tournament training programme was organised for the KNUST football team in preparation for the 2016 edition of the Ghana University Sports Association games. The short-duration pre-tournament training (SDPT) comprised twelve training sessions per week (sessions/wk−1) lasting 2 hrs, and the training volume was estimated as 16 h per week with the training model designed by the technical committee of the KNUST football team. The training model used in the present study was in line with the recommended international standard [11,12]. Training sessions were developed with moderate to high intensity (70–80% HRmax) of a continuous moderate aerobic type. The training programme included a warm-up, stretching, technique, tactics, drills (passing football, control and receiving football, crossing football, defending football, heading football, dribbling football, feints and moves football, goalkeeping football, football formations and systems, football attacking functional, football attacking phases of play, football defending phases of play, football attacking small sided games, football defending small sided games, football set pieces, finishing football) and a cool-down.

Assessment protocol

Weight and height were assessed using a stadiometer (model RGZ-160, China). The ratio of weight (kg) to height (m²) was calculated for body mass index (BMI). Blood pressure and resting heart rate were measured using an Omron blood-pressure monitor (M10-IT, China).

Haematological parameters

Red blood cells (RBC), white blood cells (WBC), platelets (PLT), mean cell volume (MCV), mean cell haemoglobin (MCH), mean cell haemoglobin concentration (MCHC), haematocrit (HCT), erythrocytes (ERT), neutrocytes (NEUT), lymphocytes (LYM), absolute content of leucocyte (MDX) and fasting plasma glucose (FBG) were assessed after 10-ml venous blood samples had been drawn from the antecubital vein between 07:00 and 09:00 am in accordance with the guidelines of the International Federation of Clinical Chemistry (IFCC) [13]. Blood samples were taken before the start of the training programme in an overnight fasted state at (6:00 am−8:00 am), and also 24 hrs at the end of the last training in an overnight fasted state at (6:00 am−8:00 am). The Mindray BC-300 Plus (Shenzhen Mindray Bio-Medical Electronics Co., Ltd, China) was
used to measure full blood count (FBC), while blood glucose was analysed with the CMP-168 Biochemical analyzer (Shenzhen Emperior Electronics Technology Co., Ltd., China). The technical error intra-rater measurement showed values lower than 1%.

**Statistical analysis**

All data were entered into Statistical Package for Social Science (SPSS 23.0, Chicago, IL, USA) computer software for analysis. Descriptive statistics of mean and standard deviation and an independent paired samples t-test set at 0.05 level of significance were employed for data analysis.

**Ethical issues**

The study was approved by the Committee on Human Research, Publications and Ethics (REF: CHRPE/AP/195/16) of the Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. All the participants signed consent forms after gaining a personal understanding of the rationale of the study.

**Results**

**Demographic information**

The participants had average age of 21.23 ± 1.73 years, height of 1.74 ± 0.05 m and weight of 77.69 ± 32.98 kg. On the average, the participants had football playing experience 5.32 ± 1.22 years. Mean differences in cardiovascular parameters between pre and post-training assessments were presented in Table 1.

**Biological parameters**

From Table 1, the outcome of the study showed that body mass index significantly decreased from 22.46±1.94 to 21.61 ± 1.26 kg/m². Blood pressure (systolic/diastolic) reduced from 123.38 ± 6.43 to 122.46 ± 7.25/ 73.38 ± 6.99 to 67.76 ± 9.85 mmHg. Heart rate of the participants in the study reduced from 75.46 ± 9.73 to 71.69 ± 10.09 bpm after two weeks of moderate to high intensity acute-conditioning pre-competition football training.

**Haematological parameters**

Red blood cells declined from 4.98 ± 0.29 to 4.92 ± 0.41 × 103/μL. Haemoglobin also reduced from 14.69 ± 0.96 to 14.11 ± 1.09 g/dL. Reduction occurred in the pre-posttest outcome of haematocrit from 43.87 ± 2.62 to 42.24 ± 3.09 as also seen in mean cell volume from 86.90 ± 3.33 to 86.06 ± 4.04fL. Insignificant reduction was also recorded in mean cell haemoglobin from 29.46 ± 1.54 to 28.66 ± 1.67pg and mean cell haemoglobin concentration from 33.43 ± 0.78 to 33.33 ± 0.83 g/dL. White blood cells shortened from 8.84 ± 2.03 to 7.66 ± 2.37 × 10³/μL significantly in the magnitude of 13.34% as compared to increment in neutrophils from 53.46 ± 10.58 to 55.69 ± 10.14 × 10³/μL. There was a negative change in lymphocytes from 43.00 ± 10.93 to 38.76 ± 9.54 × 10³/μL. Positive changes were however obtained in absolute count of leucocyte while the volume of erythrocyte increased from 1.61 ± 0.50 to 1.84 ± 0.89 × 10³/μL due to short duration of high intensity pre-competition soccer training. Platelets and fasting plasma glucose significantly increased as a result of the training model used for the sampled footballers in this study from 209.76 ± 33.83 to 249.76 ± 61.09 × 10³/μL and 4.88 ± 0.53 to 5.34 ± 0.68 mmol/L respectively.

**Discussion**

This study is the first of its kind in Ghana to examine changes in cardiovascular parameters of a-university footballers due to short-duration pre-tournament training (SDPT). Findings showed overall decline in the cardiovascular parameters of the footballers in the study. There was 3.82% decline in the overall BMI of the footballers because of the two weeks pre-competition which is regarded as vigorous fat combustion [14] and negative change in body size [15].

The outcomes of the present study would suggest possible decline in optimal performance during real competition with insufficient nutrients. Study has shown that body size plays important role when selecting players for different playing positions in football competition [16]. Players with lean body to fat ratio are best suited to playing as wingers and forwards, since they can sprint faster than those with high body fat [17–19]. However, the stress of academic commitment and the high intensity of the sports training could have resulted in the negative change in the body composition of the university athletes in this study. This condition could also portray negative performance during competition stage proper.

It has earlier been reiterated that significant cardiovascular changes are inevitable in the body system when acute bout of submaximal exercise is introduced [20]. A study on the effects of aerobic training intensity on resting, exercise and post-exercise blood pressure, heart rate and heart-rate variability in healthy sedentary non-smoking Belgian men or women who were at least 55 years old with systolic blood pressure (SBP) greater than or equal to 120 mmHg or diastolic blood pressure
Table 1
Mean differences in pre-posttest cardiovascular parameters.

| Variable       | Pre   | Mean ± deviation | Mean diff. | 95% CI        | r     | P-value |
|----------------|-------|------------------|------------|---------------|-------|---------|
| BMI (kg/m²)    | Pre   | 22.46 ± 1.94     | 0.85       | 0.15,1.53     | 2.66  | .020    |
|                | Post  | 21.61 ± 1.26     |            |               |       |         |
| SBP (mmHg)     | Pre   | 123.38 ± 6.43    | 0.92       | −3.21,5.06    | 0.40  | .636    |
|                | Post  | 122.46 ± 7.25    |            |               |       |         |
| DBP (mmHg)     | Pre   | 73.38 ± 6.99     | 5.62       | −1.02,12.25   | 1.84  | .090    |
|                | Post  | 67.76 ± 9.85     |            |               |       |         |
| RHR (bpm)      | Pre   | 75.46 ± 9.73     | 3.77       | −0.72,8.25    | 1.82  | .092    |
|                | Post  | 71.69 ± 10.09    |            |               |       |         |
| RBC (x10³/μL)  | Pre   | 4.98 ± 0.29      | 0.06       | −0.16,0.29    | 0.60  | .554    |
|                | Post  | 4.92 ± 0.41      |            |               |       |         |
| HBG (g/dL)     | Pre   | 14.69 ± 0.96     | 0.58       | 0.02,1.12     | 2.27  | .042    |
|                | Post  | 14.11 ± 1.09     |            |               |       |         |
| HCT (%)        | Pre   | 43.87 ± 2.62     | 1.63       | 0.13,3.12     | 2.37  | .035    |
|                | Post  | 42.24 ± 3.09     |            |               |       |         |
| MCV (FL)       | Pre   | 86.90 ± 3.33     | 0.84       | −0.87,2.55    | 1.06  | .308    |
|                | Post  | 86.06 ± 4.04     |            |               |       |         |
| MCH (pg)       | Pre   | 29.46 ± 1.54     | 0.80       | −0.18,1.77    | 1.76  | .104    |
|                | Post  | 28.66 ± 1.67     |            |               |       |         |
| MCHC (g/dL)    | Pre   | 33.43 ± 0.78     | 0.09       | −0.32,0.50    | 0.48  | .636    |
|                | Post  | 33.33 ± 0.83     |            |               |       |         |
| WBC (x10³/μL)  | Pre   | 8.84 ± 2.03      | 1.18       | 0.24,2.12     | 2.75  | .017    |
|                | Post  | 7.66 ± 2.37      |            |               |       |         |
| NEUT (x10³/μL)| Pre   | 53.46 ± 10.58    | −2.23      | −6.04,1.58    | −1.27 | .227    |
|                | Post  | 55.69 ± 10.14    |            |               |       |         |
| LYM (x10³/μL)  | Pre   | 43.00 ± 10.93    | 4.23       | −1.19,9.65    | 1.69  | .115    |
|                | Post  | 38.76 ± 9.54     |            |               |       |         |
| MLD (x10³/μL)  | Pre   | 3.46 ± 1.05      | −0.23      | −1.36,0.90    | −0.443|       | .666    |
|                | Post  | 3.69 ± 1.37      |            |               |       |         |
| ERT (x10³/μL)  | Pre   | 1.61 ± 0.50      | −0.23      | −0.97,0.51    | −0.67 | .513    |
|                | Post  | 1.84 ± 0.89      |            |               |       |         |
| PLT (x10³/μL)  | Pre   | 209.76 ± 33.83   | −40.00     | −64.51,−15.48 | −3.55 | .004*  |
|                | Post  | 249.76 ± 61.09   |            |               |       |         |
| FPG (mmol/L)   | Pre   | 4.88 ± 0.53      | −0.46      | −0.82,0.10    | −2.78 | .017*  |
|                | Post  | 5.34 ± 0.68      |            |               |       |         |

∗ Significant at P < 0.05.

Key: body mass index (BMI), systolic blood pressure (SBP), diastolic blood pressure (DBP), resting heart rate (RHR), red blood cells (RBC), haemoglobin (HBG), haematocrit (HCT), mean cell volume (MCV), mean cell haemoglobin (MCH), mean cell haemoglobin concentration (MCHC), white blood cells (WBC), neutrophils (NEUT), lymphocytes (LYM), absolute content of leucocyte (MLD), erythrocyte (ERT), platelets (PLT) and fasting plasma glucose (FPG).

(DBP) greater than or equal to 80 mmHg showed that both low- and high-intensity training reduced SBP at rest and during submaximal exercise by approximately 4–6 mmHg, whereas only high-intensity training significantly reduced DBP [21].

Equally important but negatively compromised profiles which have the capacity to enhance uptake, transport and delivery of oxygen during high-intensity sports competition are HBG, HCT and WBC, as confirmed in literature [22,23]. The outcomes of the present study run contrary to the findings of studies conducted outside the continent of Africa [24–27]. This implies that university footballers would need to gradually build up an adequate repository of cardiovascular traits if optimal performance is envisaged. Interestingly, the bad nutritional habits of university athletes in their learning environment should not be seen as good impetus for the high-intensity training as observed in football.

Studies show that an increase in blood HCT serves to enhance the oxygen-carrying capacity of such blood and aerobic performance [28,29]. However, the reduction in blood HCT levels can lead to increment of blood viscosity due to the shear stress of high intensity training [18]. A German-based study showed that brief exercise duration and low-intensity training programmes stabilised red blood cell mass with only a short-term shift in plasma volume, whereas endurance-trained athletes showed an increase in haemoglobin concentration and RBC count [30,31]. The increase in haemoglobin concentration in this study was to meet the demands of the body during exercise, which in turn stimulates erythropoiesis to improve sports performance [32]. White blood cells were increased in post training, but training is known to be an activity that boosts the content and level of white blood cells in players, exposing them to infections [33].

A literature review shows that changes in the haematological parameters used in this study might be due to intravascular haemolysis associated with high-intensity sports training [34–36]. Other studies showed a haemodilution-related increase in plasma volume in line with reductions in haematological indices as a result of response to exercise training [37–39], but it has been established that this issue can be remedied by nutritional intervention [40].

Although there are no significant differences in the pre-post MCV, MCH and MCHC values obtained in this study, the small changes in their units support the earlier argument in favour of the haemopoiesis response to exercise [41]. It has
also been stated that high-intensity exercise may cause tissue damage, production of stress hormones and alterations in haematological units and immune cells [42] such as WBC, LEU, ERT and PLT [43–45].

This study recorded an increase in neutrophils following 2 weeks of Short-duration pre-tournament training, which serves as an inflammatory response indicator [45]. Fasting plasma glucose significantly changed when compared to other reports on haematological and biochemical parameters in elite footballers during a competitive half-season that recorded no significant change [42]. The findings of this study show that platelets significantly increased after 2 weeks of SDPT, compared with the decrease reported in a study that determined the inflammatory modification in professional footballers associated with an intensive pre-season training programme [45].

Limitations

The small sample size of the study would prevent extrapolation of the results which should rather be recognised as undesired signals that could impede optimal sports performance of university athletes. This study did not also attempt to control diet, nutrient supplementation and degree of hydration in the footballers which have important roles that need to be studied in controlled groups in order to generalise the findings. In this regard, we suggest that in future studies the assessment of haematological parameters should be carried out from a longitudinal perspective that enables more specific and tighter control of the variables.

Conclusion

This study shows that 2 weeks of pre-tournament training reduces BMI, SBP, DBP, RHR, HBG, HCT, MCV, MCH, MCHC, WBC and LYM. However, it increases NEUT, MXD, ERT, PLT and FPG in university footballers. SDPT predisposes university football technical teams to severe inflammatory responses that could limit optimal performance in a highly competitive setting. University football technical teams should design training programmes of appropriate duration and intensity in favour of academic healthy living of university footballers. This would also prevent the possibility of an increase in fasting plasma glucose and improve cardiorespiratory performance.

Declaration of Competing Interest

The authors declare that they have no conflicts of interest.

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