Original Article

A study on the effects of 6 weeks of training on body composition, physical fitness and physiological variables of female football players

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ABSTRACT

Background: Female football becomes popular in last decades. The body fat, strength, power, endurance etc are playing an important role in female football. The present study has been designed to investigate the effects of 6 weeks of training on body composition, physical fitness and physiological variables of female football players. Materials and Methods: A total of eighty two female football players (age 16-18 yrs.) participated were included and twenty two were excluded from the study, the remaining were divided into control group (CG, n = 30) and experimental group (EG, n = 30). The volunteers of the experimental group followed a training programme (2 hrs/day, 5day/week, for 6 weeks), whereas no training was given volunteers of the control group. Selected body composition, physical fitness and physiological variables were performed at the beginning (0 week) and at the end of the study (6 weeks). Results: A significant reduction ($p < .05$) in body mass, body fat, resting heart rate, recovery heart rate, and systolic blood pressure; and an increase ($p < .05$) in strength, anaerobic power, VO_{2max}, FEV1, FVC and PEFR was noted after 6 weeks of training. Body fat showed negative correlation with back strength ($r = -0.26$, $p < .05$), grip strength ($r = -0.46$, $p < .01$), anaerobic capacity ($r = -0.30$, $p < .05$) and flexibility ($r = -0.32$, $p < .05$) of the volunteers. LBM showed positive correlation with grip strength right ($r = 0.59$, $p < .05$), grip strength left ($r = 0.53$, $p < .05$), back strength ($r = 0.73$, $p < .05$), flexibility ($r = 0.41$, $p < .05$). The anaerobic power showed a significant positive correlation with VO_{2max} ($r = 0.51$, $p < .01$). Conclusions: Regular monitoring of the indicators is essential to obtain optimal performance of the players.
Keywords: Sport medicine, Health, Body fat, Strength, Power, VO_{2max}, Lung functions, Training, Female football.

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INTRODUCTION

Female football becomes popular in recent era and is playing in different international events such as World Cup, Olympics etc. A numbers of young female players are coming up in last decades (Datson et al., 2014; Davis & Brewer, 1993). The female football players exert variety of skills during matches such as endurance, strength, power, flexibility etc. which demands for high level of physical fitness (Davis & Brewer, 1993; Hoff, 2005). As the players cover the big area in the ground during game for execution of various skills with and without the ball, the game demands for aerobic and anaerobic fitness (Hoff, 2005; Krustrup et al., 2005). Those who meet the high physical and physiological demands for top level of game became elite players. It has been reported that training helps to develop the physical and physiological demands of the players (Can et al., 2019; Hoff, 2005; Krustrup et al., 2005). During the games players are exposed to variety of physical stress; and the responses to the physical stress differs among the players. Training improves the physical fitness of the players which helps to overcome the physical stress during the game (Datson et al., 2014; Davis & Brewer, 1993). Training is become effective when given according to the principles of periodization (Bompa & Buzzichelli, 2021). Training is usually started from early stage of life, when the players show interest on the game (Hoff, 2005). The training induced changes observed in various body compositions, physical fitness and physiological variables can be attributed to appropriate load dynamic (Can et al., 2019; Hoff, 2005; Krustrup et al., 2005).

Body Composition has a great impact on football, taller players are recruited as defender, goalkeeper and forward (Emmonds et al., 2018; Gil et al., 2007). However, an optimum level of body mass is required for all playing positions (Emmonds et al., 2018; Gil et al., 2007). A lean body is desirable for playing football, as excess body fat increase the body mass and may interrupt the ability of the players to perform the difficult tasks during the game (Emmonds et al., 2020; Gil et al., 2007). Studies showed greater amount of fat free mass had a significant influence on endurance performance during the game by the football players (Emmonds et al., 2020; Vasconcellos et al., 2021). Playing football involves a number of physical contacts while performing various skills such as passing, kicking, dribbling, receiving the ball, head, etc. which required a high level of physical fitness (Hoff, 2005; Krustrup et al., 2005). Execution of different skills during match play required high level of strength, speed, power, flexibility and agility etc. (Hoff, 2005; Krustrup et al., 2005). The football players cover a big area during the game for attacks and defences, therefore the players required high levels of aerobic as well as anaerobic fitness (Milanović et al., 2017; Vescovi et al., 2021).

The present study has been focused on female football players as this sport become very popular. In India very few studies has been conducted on body composition, physical fitness and physiological variables female football players. The effects of training of body composition, physical fitness and physiological variables female football players are also lacking. In view of the above, the present study has been designed to investigate the effects of training of body composition, physical fitness and physiological variables female football players.

METERIALS AND METHODS

Subjects

Eighty two healthy female volunteers (age: 16–18 years) were included randomly from the training camp at Midnapore, W.B., India. Subjects regularly playing football for last 2 years and participating at the district level competitions were considered eligible for this study. All the volunteers were undergoing a medical checkup performed by physicians. Based on their decision volunteers without any history of disease, illness, injury and surgical conditions preceding the study were considered eligible for this study. Twenty two (not meeting the inclusion criteria = four; decline to participate = three; inability to perform training = seven; and unable to follow the schedule = eight) participants were excluded from the study. The remaining sixty volunteers were divided into two groups: (a) Control Group (CG, n = 30) and (b) Experimental Group (EG, n = 30).

Experimental design

Training programme related football was given 2 hours per day, 5 days per week for 6 weeks in the experimental group, whereas the control group volunteers did not receive any training. Measurement of body composition, physical fitness and physiological variables of female football players were performed at the beginning (0 week) and at the end of the study (after 6 weeks). Statistical analysis was performed to find out the significant differences among the variables (Figure 1).

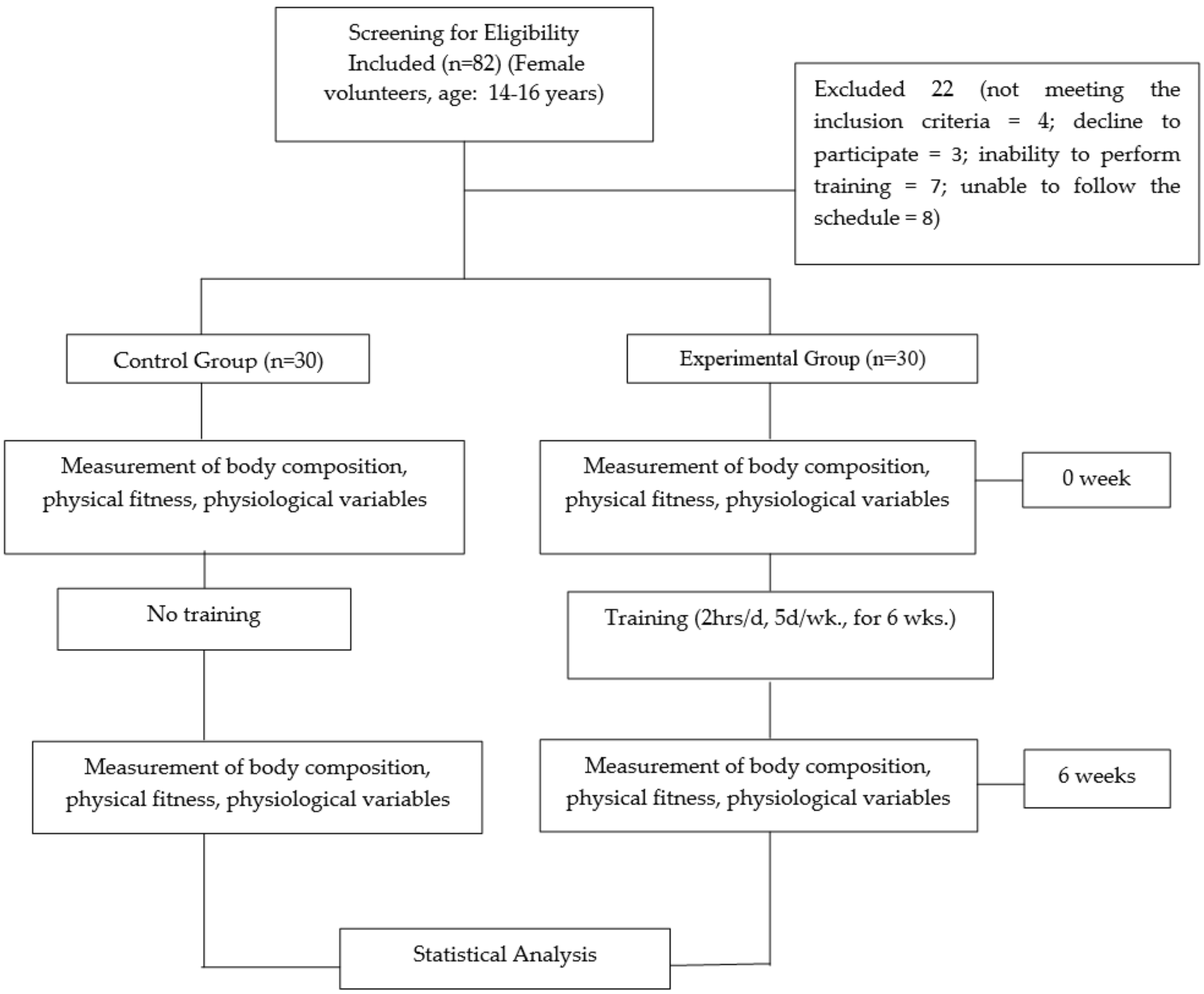


Figure 1. Schematic diagram used to show experimental design.

Ethical considerations

The purpose and possible complication of the investigation was explained to all the participants and their parents/legal guardians and a written informed consent was obtained. Institutional Ethical Committee (Human Studies) approved this study.

Training
General and specific training related football was given by the qualified coaches to the volunteers of experimental group, whereas the control group volunteers did not receive any training. Training includes speed training, strength and power training, flexibility training, interval training, endurance training, techniques and tactics. The training programme was followed for 2 hours per day, 5 days per week for 6 weeks.

Assessment of body composition variables
Assessment of stature and body mass
The stature (height) was assessed using stadiometer (Seca 220, UK) and body mass (weight) was assessed using the electronic scale (Seca Alpha 770, UK) following the standard methods (Jonson & Nelson, 1996). Body mass index (BMI) (Jonson & Nelson, 1996) and body surface area (BSA) (Du Bois, 1989) were derived from the height and body mass.

Determination of body fat
A skin fold calliper (Cescorf, Brazil) was used to measure skin fold thickness from biceps, triceps, subscapular and suprailiac skin fold site for subsequent determination of body density (Durnin & Womersley, 1974). The percentage of body fat was calculated using the standard equation (Siri, 1956). The fat mass and lean body mass (LBM) were determined using standard equation (Jonson & Nelson, 1996).

Measurement of mid upper arm circumference
The mid upper arm circumference was measured to the nearest 0.1 cm by using a flexible non stretch tape (Cescorf, Brazil) (Jonson & Nelson, 1996).

Determination of waist-hip ratio (WHR)
The hip and waist circumference were measured to the nearest 0.1 cm by using a flexible non stretch tape (Cescorf, Brazil). The waist-hip ratio (WHR) was determined by standard equation (Jonson & Nelson, 1996).

Assessment of physical fitness variables
Measurement of anaerobic power
Running based anaerobic sprint test (RAST) was performed to assess anaerobic power of the volunteer. The volunteer had to undertake six 35 metre sprints with 10 seconds recovery between each sprint, in a non-slip ground surface marked with cones. The volunteer was asked to warm up for 15 minutes. Then the volunteer was asked to stand at the starting point and was asked to run to the second cone when whistle is heard. The time taken by the volunteer to cover 35 meter was recorded. Then the volunteer was asked to come back 35 meters to reach the first cone after 10 seconds rest. The test was repeated for 3 times and time taken for six sprints was recorded. The anaerobic power, maximum power, minimum power, average power, anaerobic capacity, fatigue index of the athlete was determined using standard equation (Burgess et al., 2016).

Measurement of grip and back strength
The hand grip strength of the subject was measured following standard procedure (Jonson & Nelson, 1996). The subject was asked to stand erect and hold the grip dynamometer (Baseline, USA) in right hand at 90° with the body. Then the subject was asked to squeeze continuously for 3-5 seconds for three trials with a 30 seconds rest period between trials and the maximum value of three trials was recorded in kg. The back strength of the subject was measured following standard procedure (Jonson & Nelson, 1996). The subject was asked to stand erect on the base of the back dynamometer (Baseline, USA) keeping both feet apart and hold the centre of the bar mounted at the end of the chain with the palm facing upwards to the head and then

the length of the chain was adjusted to the participants height to the elongated knees. Then without bending and jerking the subject pull the bar with maximum force for 5 seconds, and the back strength was recorded in kg.

Measurement of flexibility
The modified sit and reach test was used to assess the heap and trunk flexibility of the subject. The subject was asked to remove shoes and sit on the floor placing head and back against a wall and stretch the leg ahead and keeping the knees flat against the floor. The modified sit and reach box (Baseline, USA) was placed touching the of the feet subject. The fingertips of both hands of the subject were placed on the ruler of the box after adjusting the zero mark on the ruler. The subject was asked to place the hands side by side and lean forward slowly as far as possible maintaining fingertips at the same level and keeping the legs flat, without jerk or bounce. The subject was asked to keep the stretching for 2 seconds and the measurement was taken from the ruler of the box in cm (Cuberek et al., 2013).

Assessment of physiological variables
Measurement of maximal aerobic capacity (VO_{2max})
The maximal aerobic capacity (VO_{2max}) of the subject was assessed using *Yo-Yo Intermittent Recovery Test 1 (YYIR1).* The subject was asked to performed specific running test for 20 m distance. A track was created for 20 m and 5 m for recovery. The subject ran in a specific rhythm and with the advancement of duration the speed of the subject was increased. The test was terminated when the subject was exhausted, the specific lap and shuttle was noted and from that specific lap and shuttle and VO_{2max} was determined (Grgic et al., 2019).

Measurement of heart rate and blood pressure
The subject was asked to seat quietly for 15 min. The resting heart rate and blood pressure was measured by using sphygmomanometer (Omron, Japan) following standard procedure (Asci, 2016). The pulse pressure and mean pressure were calculated. The maximal heart rate and 1st minute recovery heart rate was also recorded following the *Yo-Yo Intermittent Recovery Test 1 (YYIR1)* (Asci, 2016).

Measurement of lung functions
The pulmonary functions of the subject including force vital capacity (FVC), force expiratory volume in 1st sec (FEV1) and pear expiratory flow rate (PEFR) were assessed by using a digital spirometer (Micro I Spiromete, CareFusion, Japan) (Singh et al., 2015).

Statistical analysis
All the values of body composition, physical fitness and physiological variables were expressed as mean and standard deviation (SD). To find out the within group and between group difference in selected variables Paired sample t-test was performed. In each case the significant level was chosen at .05 levels (Banerjee, 2018).

RESULTS

Effect of training on body composition of female football players
In the present study a significant ($p < .05$) reduction in body mass, percent body fat, total fat mass and lean body mass was noted among the volunteers of experimental group after 6 weeks of training when compared to base line data (0 week). However, no significant difference was observed in height, body mass index, body surface area, waist circumference, hip circumference and waist hip ratio among the volunteers of

experimental group after 6 weeks of training when compared to base line data (0 week). In addition, the volunteers of experimental group had possessed lower ($p < .05$) body mass, percent body fat, total fat mass and lean body mass than the volunteers of control group after 6 weeks of study (Table 1).

Table 1. Effects of 6 weeks of training on body composition of female football players.

Parameter	Control Group (n = 30)		Experimental Group (n = 30)	
	0 week	6 weeks	0 week	6 weeks
Height (cm)	$152.9^{NS} \pm 6.0$	$153.6^{NS} \pm 6.2$	$153.5^{NS} \pm 6.4$	$153.6^{NS} \pm 6.6$
Weight (kg)	$40.3^{NS} \pm 2.1$	$40.8^{NS} \pm 2.3$	$40.9^{NS} \pm 2.2$	$39.1^{*\#} \pm 2.1$
BMI (kg/m^2)	$17.2^{NS} \pm 2.2$	$17.3^{NS} \pm 2.5$	$17.3^{NS} \pm 2.2$	$16.6^{NS} \pm 1.6$
BSA (m^2)	$1.3^{NS} \pm 0.05$	$1.3^{NS} \pm 0.07$	$1.3^{NS} \pm 0.05$	$1.3^{NS} \pm 0.06$
Body fat (%)	$18.2^{NS} \pm 2.2$	$18.7^{NS} \pm 2.2$	$18.2^{NS} \pm 1.7$	$14.1^{*\#} \pm 2.1$
Total fat mass (kg)	$7.3^{NS} \pm 1.8$	$7.6^{NS} \pm 1.8$	$7.4^{NS} \pm 1.3$	$5.5^{*\#} \pm 1.0$
LBM (kg)	$33.0^{NS} \pm 2.3$	$33.2^{NS} \pm 2.4$	$33.3^{NS} \pm 2.7$	$35.9^{*\#} \pm 2.5$
WC(cm)	$66.9^{NS} \pm 3.9$	$67.2^{NS} \pm 4.1$	$67.2^{NS} \pm 3.6$	$65.7^{NS} \pm 3.5$
HC (cm)	$80.3^{NS} \pm 5.5$	$80.4^{NS} \pm 5.6$	$81.5^{NS} \pm 5.2$	$81.4^{NS} \pm 5.5$
WHR	$0.83^{NS} \pm 0.03$	$0.8^{NS} \pm 0.02$	$0.8^{NS} \pm 0.04$	$0.8^{NS} \pm 0.04$

*Note. Data presented as mean ± SD, n = 30,paired sample t-test was performed; when compared to '0 week' and '6 week- *p < .05; when compared to CG and EG- #p < .05; SD = standard deviation, NS = non-significant, BMI- Body mass index, BSA- Body surface area, LBM = lean body mass, WC = waist circumference , HC = hip circumference, WHR - Waist Hip ratio.*

Effect of training on physical fitness variables of female football players

A significant ($p < .05$) increase in grip and back strength, flexibility, highest power output, lowest power output, average power output, anaerobic capacity and fatigue index was noted among the volunteers of experimental group after 6 weeks of training when compared to base line data (0 week). In addition, the volunteers of experimental group had possessed greater ($p < .05$) back strength, flexibility, highest power output, lowest power output, average power output, anaerobic capacity and fatigue index than the volunteers of control group (Figure 2, Table 2).

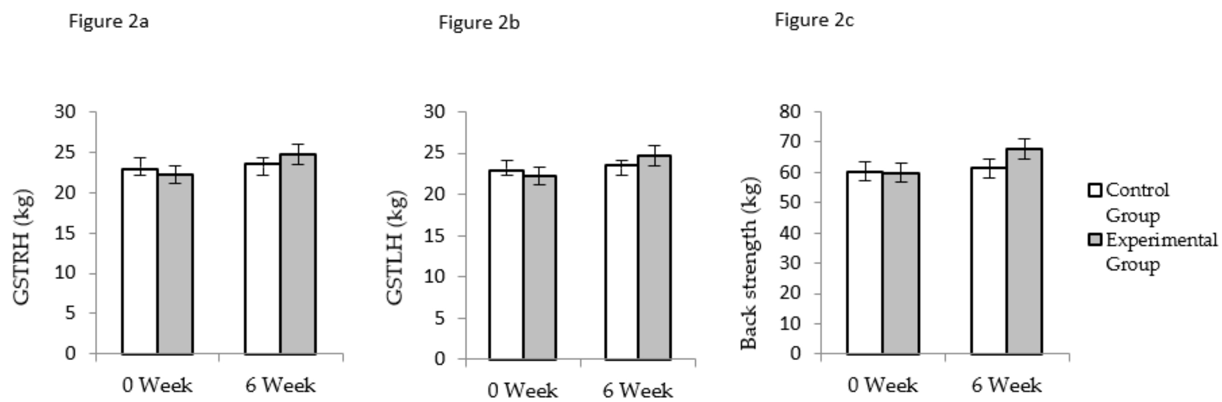
Table 2. Effects of 6 weeks of training on Physical Fitness variables of female football players.

Parameter	Control Group (n = 30)		Experimental Group (n = 30)	
	0 week	6 weeks	0 week	6 weeks
Flexibility (cm)	$31.3^{NS} \pm 3.2$	$31.7^{NS} \pm 3.2$	$32.5^{NS} \pm 3.2$	$36.5^{*\#} \pm 3.5$
HPO (watt)	$210.5^{NS} \pm 20.9$	$214.5^{NS} \pm 25.5$	$217.3^{NS} \pm 27.5$	$271.1^{*\#} \pm 34.4$
LPO (watt)	$122.9^{NS} \pm 11.9$	$127.5^{NS} \pm 13.8$	$129.7^{\#} \pm 14.1$	$154.5^{*\#} \pm 13.3$
APO (watt)	$162.9^{NS} \pm 45.5$	$164.9^{NS} \pm 43.2$	$169.4^{NS} \pm 46.4$	$209.4^{*\#} \pm 37.8$
AC (watt)	$977.7^{NS} \pm 72.6$	$989.5^{NS} \pm 67.5$	$1016.9^{\#} \pm 74.8$	$1256.8^{*\#} \pm 83.6$
FI (watt/sec)	$2.19^{NS} \pm 0.4$	$2.1^{NS} \pm 0.5$	$2.2^{NS} \pm 0.6$	$3.2^{*\#} \pm 0.4$

*Note. Data presented as mean ± SD, n = 30,paired sample t-test was performed; when compared to '0 week' and '6 week - *p < .05; when compared to CG and EG - #p < .05; SD = standard deviation, NS = non-significant. HPO = highest power output, LPO = lowest power output, APO = average power output, AC = anaerobic capacity. FI = fatigue index.*

Effect of training on physiological variables of female football players

A significant ($p < .05$) increase in VO_{2max}, FEV1, FVC, PEFR; and significant ($p < .05$) reduction in resting heart rate, recovery heart rate, systolic blood pressure and pulse pressure was noted among the volunteers of experimental group after 6 weeks of training when compared to base line data (0 week). However, no significant difference was observed in maximum heart rate, diastolic blood pressure, mean pressure and FEV1/FVC among the volunteers of experimental group after 6 weeks of training when compared to base line data (0 week). Moreover, the volunteers of experimental group had possessed greater ($p < .05$) VO_{2max}, FEV1, FVC, PEFR; and lower ($p < .05$) resting heart rate than the volunteers of control group after 6 weeks of study (Table 3, Figure 3 and 4).



*Note. Data presented as mean ± SD, n = 30, paired sample t-test was performed; when compared to '0 week' and '6 week - *p < .05; when compared to CG and EG - #p < .05; SD = standard deviation, NS = non-significant. GSTRH = grip strength of right hand, GSTLH = grip strength of left hand.*

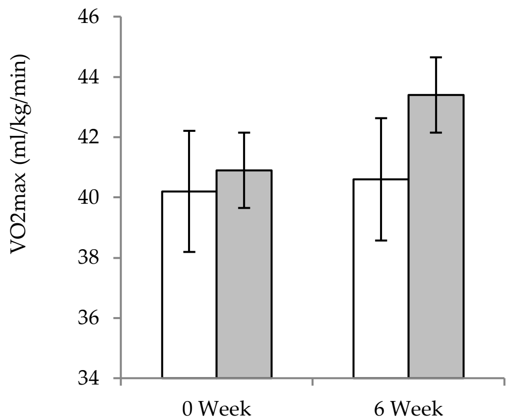
Figure 2. Effects of 6 weeks of training on (a) grip strength of right hand, (b) grip strength of left hand and (c) back strength of female football players.

Table 3. Effects of 6 weeks of training on physiological variables of female football players.

Parameter	**Control Group (n = 30)**		**Experimental Group (n = 30)**	
	0 week	6 weeks	0 week	6 weeks
SBP (mm Hg)	$114.8^{NS} \pm 6.0$	$110.8^{NS} \pm 5.4$	$113.7^{NS} \pm 6.3$	$108.8^{*} \pm 5.7$
DBP (mm Hg)	$66.8^{NS} \pm 4.3$	$65.2^{NS} \pm 4.4$	$65.3^{NS} \pm 4.5$	$63.5^{NS} \pm 4.7$
PP (mm Hg)	$48.0^{NS} \pm 3.0$	$45.7^{NS} \pm 3.9$	$48.4^{NS} \pm 3.0$	$45.3^{*} \pm .3.6$
MP (mm Hg)	$82.8^{NS} \pm 6.0$	$80.4^{NS} \pm 5.2$	$81.4^{NS} \pm 5.5$	$78.6^{NS} \pm 5.8$
RHR (bpm)	$76.9^{NS} \pm 5.4$	$75.9^{NS} \pm 5.7$	$77.8^{NS} \pm 5.3$	$71.6^{*\#} \pm 5.2$
HRmax (bpm)	$191.6^{NS} \pm 7.9$	$192.4^{NS} \pm 8.1$	$191.1^{NS} \pm 7.3$	$188.6^{NS} \pm 8.7$
RecHR1 (bpm)	$164.2^{NS} \pm 8.3$	$162.4^{NS} \pm 9.4$	$162.4^{NS} \pm 7.6$	$154.3^{*\#} \pm 7.5$
FEV1/FVC	$98.1^{NS} \pm 4.9$	$98.2^{NS} \pm 5.9$	$98.7^{NS} \pm 4.3$	$99.0^{NS} \pm 5.5$
PEFR (l)	$247.6^{NS} \pm 31.5$	$252.5^{NS} \pm 25.5$	$250.6^{NS} \pm 27.4$	$327.1^{*\#} \pm 29.3$

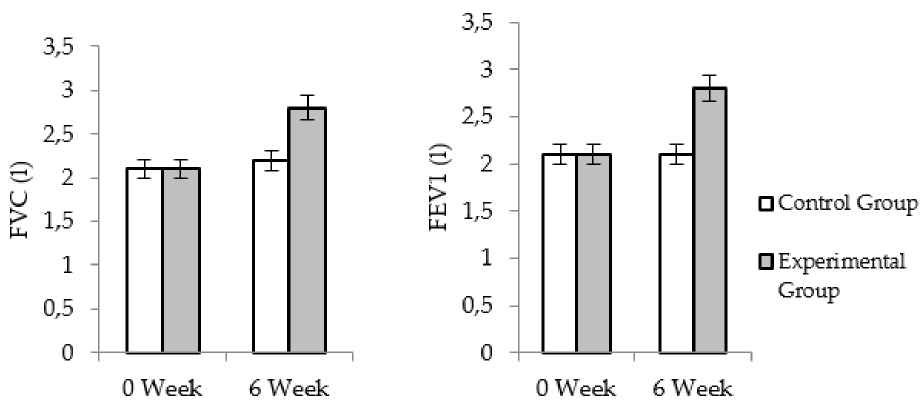
*Note. Data presented as mean ± SD, n = 30,paired sample t-test was performed; when compare to '0 week' and '6 week - *p < .05; when compare to CG and EG - #p < .05; SD = standard deviation, NS = non-significant, SBP = systolic blood pressure, DBP = diastolic blood pressure, PP = pulse pressure, MP = mean pressure, RHR = resting heart rate, Hrmax = maximum heart rate, RecHR1 = recovery heart rate in 1st min, FEV1 = force expiratory volume in 1st sec, FVC = force vital capacity, PEFR = peak expiratory flow rate.*

In the present study percent body fat showed significant negative correlation with back strength (r = - 0.26, $p < .05$), grip strength (r = -0.46, $p < .01$), anaerobic capacity (r = -0.30, $p < .05$) and flexibility (r = -0.32, $p < .05$) of the volunteers of the experimental group. Further, lean body mass showed significant positive correlation with grip strength right (r = 0.59, $p < .05$), grip strength left (r = 0.53, $p < .05$), back strength (r = 0.73, $p < .05$), flexibility (r = 0.41, $p < .05$). The anaerobic power showed a significant positive correlation with VO_{2max} (r = 0.51, $p < .01$) (Figure 5).



*Note. Data presented as mean ± SD, n = 30, paired sample t-test was performed; when compared to '0 week' and '6 week - *p < .05; when compared to CG and EG - #p < .05; SD = standard deviation, NS = non-significant. VO_{2max} = maximum aerobic capacity.*

Figure 3: Effects of 6 weeks of training on VO_{2max} of female football players of 16-18 years of age.



*Note. Data presented as mean ± SD, n = 30,paired sample t-test was performed; when compared to '0 week' and '6 week - *p < .05; when compared to CG and EG - #p < .05; SD = standard deviation, NS = non-significant, FEV1 = force expiratory volume in 1st sec, FVC = force vital capacity.*

Figure 4. Effects of 6 weeks of training on FVC and FEV1 of female football players of 16-18 years of age.

DISCUSSION

Female football become popular and is being played in different countries. Body composition plays a significant role in playing female football. The height is an important factor for football players. The tall players are recruited as goal keepers, defenders and forward positions; however, midfield players also pose an optimum height (Manson et al., 2014; Zanini et al., 2020). Body mass has an impact in playing football as body contact is essential in this game (Emmonds et al., 2018). The Percentage of body fat has an important role for the assessment of physical fitness of female football players (Hoff, 2005; Manson et al., 2014; Zanini et al., 2020). In the present study a significant reduction in body mass, percent body fat, total fat mass and lean body mass was noted among the volunteers of experimental group after 6 weeks of training when compared to base line data (0 week). It can be stated that the reduction in body mass, percent body fat, total fat mass and lean body mass among the volunteers of the experimental group might be due to training. Further, the volunteers of experimental group had lower body mass; percent body fat, total fat mass and lean body mass than the volunteers of control group after 6 weeks of study. It might be due to the fact that the control group volunteers did not follow the training schedule. However, no significant difference was observed in height, body mass index, body surface area, waist circumference, hip circumference and waist hip ratio among the volunteers of experimental group after 6 weeks of training when compared to base line data (0 week). It might be because of short duration of the training programme or improper optimization of the training load. It has been reported that the sports training, specifically aerobic training leads to greater utilization of fat as fuel and thus help the reduce body fat (Datson et al., 2014; Emmonds et al., 2020). Excess body fat create load without contributing the body's force-producing capacity (Datson et al., 2014; Emmonds et al., 2020).The previous studies indicated that body fat play a crucial role in female football, as excess body fat increases the body mass of the players and causes difficulty to perform skilful activities during the game (Datson et al., 2014; Emmonds et al., 2020).

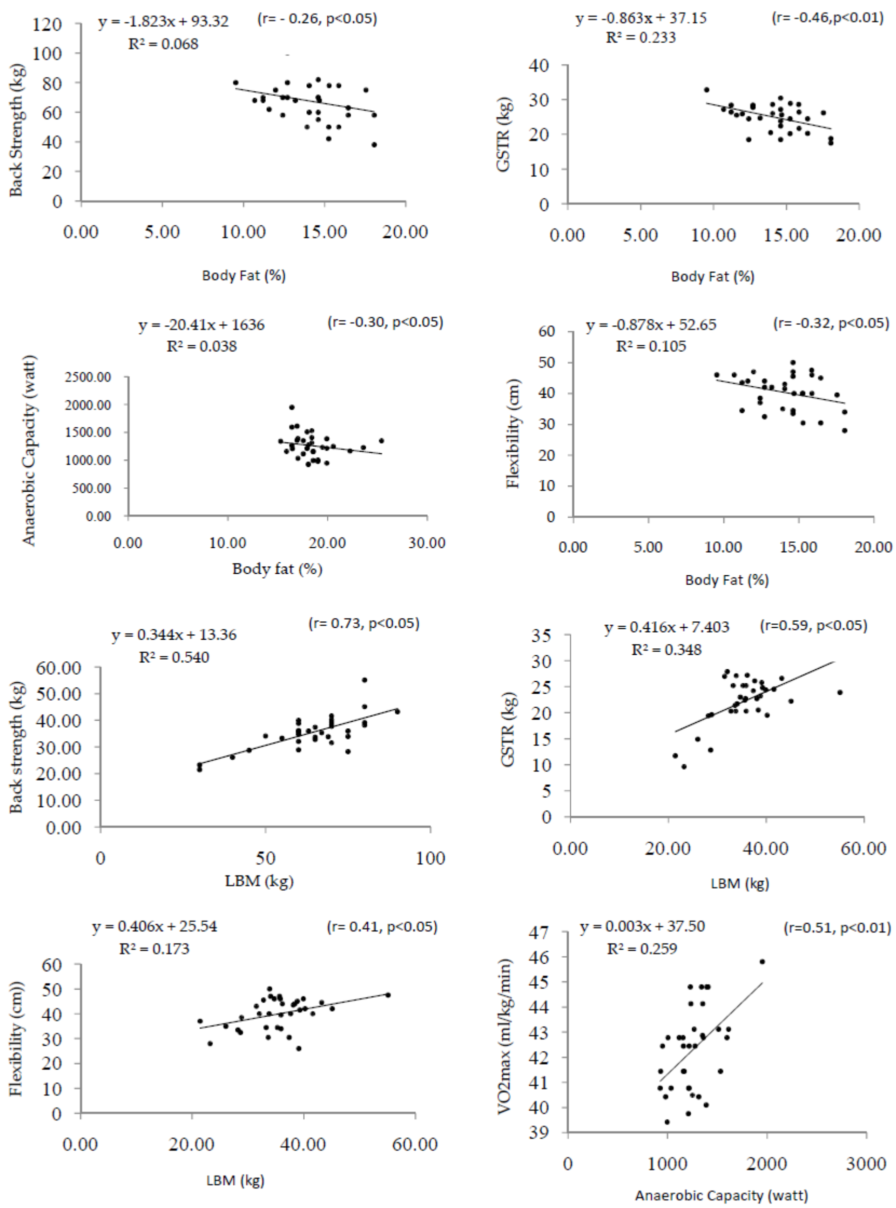


Figure 5. Correlation of body fat with back strength, grip strength, anaerobic capacity and flexibility; lean body mass with body fat with back strength, grip strength and flexibility; anaerobic capacity with VO_{2max}.

Playing football involve high intensity activities which required high levels of physical fitness. The players' execute different skills throughout the game which require high levels of strength, power and flexibility (Hoff, 2005; Mara et al., 2015). Football players' require high anaerobic power as quick acceleration and deacceleration are part of the game (Hoff, 2005; Krustrup et al., 2005). Anaerobic power represents the release of highest anaerobic energy, and thus a high anaerobic power improves the sprint quality of players (Hoff, 2005; Krustrup et al., 2005). Strength is the central component of a football player, as kicking, passing, head, changing pace, throw-in, catching and fisting the ball are the essential component of the game (Datson et al., 2014; Hoff, 2005). Flexibility is required particularly for goalkeeper and forward positions; however an optimum level of flexibility is needed for midfield and defender positions (Hoff, 2005; Mara et al., 2015). In the present study, a significant increase in grip and back strength, flexibility, highest power output, lowest power output, average power output, anaerobic capacity and fatigue index was noted among the volunteers of experimental group after 6 weeks of training when compared to base line data (0 week). It can be stated that the improvement in strength, power and flexibility among the volunteers of experimental group might be because of high intensity of the training programme. Earlier studies reported that, the strength, anaerobic power and flexibility of the female football players increased following a training programme (Mara et al., 2015; Paul & Nassis, 2015; Yousefian et al., 2023). This study also showed that the volunteers of experimental group had greater back strength, flexibility, highest power output, lowest power output, average power output, anaerobic capacity and fatigue index than the volunteers of control group. This might be due to the fact that the control group volunteers did not follow the training schedule (Mara et al., 2015; Paul & Nassis, 2015; Yousefian et al., 2023). In the present study, body fat showed significant negative correlation with back strength, grip strength, anaerobic capacity and flexibility of the volunteers of the experimental group. On the other hand, lean body mass showed significant positive correlation with grip strength, back strength and flexibility of the volunteers of the experimental group. This indicated that increase in body fat might reduce the strength, power and flexibility of the football players, whereas increase in lean body mass might improve these fitness indicators.

The physiological variables including maximum aerobic capacity (VO_{2max}), heart rate, blood pressure, pulmonary functions are important factors for female football players (Gil et al., 2007; Milanović et al., 2017; Hostrup & Bangsbo, 2023). The VO_{2max} is an indicator of cardiovascular fitness which is an essential component of the female football players (Hostrup & Bangsbo, 2023; Randell et al., 2021). A well-developed aerobic capacity helps football players to maintain the high-intensity activities during the game and also accelerate the recovery process (Hostrup & Bangsbo, 2023; Randell et al., 2021). A high level of maximum aerobic capacity improves the physical fitness at an optimal level which helps the players to perform the skilful activities throughout the game (Datson et al., 2014; Hoff, (2005; Krustrup et al., 2005). The heart rate, blood pressure and pulmonary functions are indicators of health and fitness. With an increase in work intensity heart rate increases due to sympathetic stimulation, and with the decrease in work intensity it decline because of parasympathetic responses (Gil et al, 2007; Hostrup & Bangsbo, 2023; Milanović et al., 2017). An optimum level of pulmonary functions helps to improve the oxygen delivery to the exercising muscle (Hostrup & Bangsbo, 2023; Randell et al., 2021). In the present investigation a significant increase in VO_{2max}, FEV1, FVC, PEFR; and significant reduction resting heart rate, recovery heart rate, systolic blood pressure and pulse pressure was noted among the volunteers of experimental group after 6 weeks of training when compared to base line data (0 week). It can be stated that the increase in VO_{2max}, FEV1, FVC, PEFR; and significant reduction resting heart rate, recovery heart rate, systolic blood pressure and pulse pressure might be because of training. Earlier studies reported that aerobic training has significant role in improvement in maximum aerobic capacity and pulmonary functions of the football players (Hostrup & Bangsbo, 2023; Randell et al., 2021). The increase in VO_{2max} might be due to increase in cardiac output, increase oxygen delivery to the exercising muscle and increase utilization of oxygen for aerobic metabolism (Datson et al., 2014; Eken & Kafkas, 2022; Krustrup et al., 2005). In addition, *regular exercise might increase the strength of the respiratory muscles, thus making them more efficient to uptake more air in the lung (*Mackała et al., 2020; Ozmen et al., 2017*). This might be the reason that the* FEV1, FVC and PEFR increased after training the programme *(*Mackała et al., 2020; Ozmen et al., 2017*). Aerobic t*raining also improves the circulation and strengthens the heart (Datson et al., 2014; Hoff, (2005; Krustrup et al., 2005). Therefore, the muscles require less oxygen to deliver and also produce less carbon dioxide. This reduces the amount of air need to breathe in and out for a given exercise *(*Eken & Kafkas, 2022; Ozmen et al., 2017*).* As quick acceleration and deacceleration are part of playing football, it is the quick deacceleration which is related to recovery process (Datson et al., 2014; Hoff, (2005; Krustrup et al., 2005). The faster recovery helps the players to perform repeated activities during the game (Datson et al., 2014; Hoff, (2005; Krustrup et al., 2005). It has been noted that the resting heart rate and the recovery heart rate of the players reduced after the training. Similar observations have been noted by other research groups (Castagna et al., 2022; Póvoas et al., 2023). However, no significant difference was observed in maximum heart rate, diastolic blood pressure, mean pressure and FEV1/FVC among the volunteers of experimental group after 6 weeks of training when compared to base line data (0 week). It might be because of short duration of the training programme or improper optimization of the training load. In addition, the volunteers of experimental group had greater VO_{2max}, FEV1, FVC and PEFR; and significant lower resting heart rate and recovery heart rate than the volunteers of control group after 6 weeks of study. This might be due to the fact that the control group volunteers did not follow the training schedule. Playing female football required high level of aerobic and anaerobic capacity. In the present study the anaerobic power showed a significant positive correlation with VO_{2max}. This indicated that both aerobic and anaerobic capacity of the female football players were developed after the training.

CONCLUSION

Playing female football required a high level of physical fitness. Training may improve the health and fitness indicators, which can be monitored by body composition, physical fitness and physiological variables. The present study showed a significant increase in strength, power, flexibility, aerobic capacity, lung functions; and decrease in body fat and recovery heart rate following a 6 weeks of training programme. These changes have significant positive impact on the performance of the female football players. Regular monitoring of the performance indicators is essential for improvement of performance of the female football players. Long term training may be more effective to improve the performance of the female football players.

AUTHOR CONTRIBUTIONS

Study Design, IM, GKC; Data Collection, PS, BP; Statistical Analysis, KG, SJB; Data Interpretation, IM, GKC; Manuscript Preparation, PS, KG, SJB; Literature Search, SG, AJ. All authors have read and agreed to the published version of the manuscript.

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