Entomology and Applied Science Letters
Volume 7, Issue 3, Page No: 23-31

Available Online at: www.easletters.com

ISSN No: 2349-2864

Football Plyometric and sprint training on Hormones and Fitness elements among underweight College students

Syed Ibrahim[1]*, Syed Azhar Ahmed[2], Syed Muneer Ahmed[3], Syed Kaleem Ahmed[4]

[1] Physical Education Department, King Fahd University of Petroleum & Minerals, Dhahran, 31261, Saudi Arabia.
[2] Freelance Physiotherapist, Hyderabad, Telangana, India- 500004.
[3] Tennis Coach, GHMC, Hyderabad, Telangana, India.
[4] Tennis Coach, Hyderabad. Telangana, India.

ABSTRACT

The purpose was to examine mixed football plyometric with sprint training on hormone and fitness elements of college students. Twenty-six underweight males 18 to 19 years with BMI < 18.5 kg/m2 and FFM 40-55 kg were distributed to Training Group 1 (TG-1; FFM-40-45kg, n = 12) and Training Group 2 (TG 2; FFM-46-55 kg, n = 14). The tests were Physical Characteristics, triiodothyronine (T3), thyroxine (T4), thyroid-stimulating hormone (TSH), speed (20,40, 60 m run), standing long jump (SLJ), sit-ups, agility and sit and reach parameters at pre and post-test. TG 1 & 2 performed plyometric drills followed by sprinting short distances and football matches. The training was for 6 weeks, 2/W and 40 minutes per session. Independent and paired t-test were statistical tools with level of significance at $P \leq 0.05$. The results showed that TG-1 and TG-2 increased by 4.6, 4.4, 4.6, 3.8, 29.4, and 12%, and 4.6, 5.5, 3.4, 3.7, 21, and 13% in BM, BMI, FFM, SLJ, sit-ups, and sit & reach respectively ($P \leq 0.05$). TG-1 dropped by 7.2, 3.6, 3.5, and 23.1% in 20m, 40m, agility, and FT3. The TG-2 reduced in 20m, 40m, 60m, agility, and FT3 by 6.5, 4.8, 4.0, 4.1, and 11.4%, respectively ($P \leq 0.05$). It was concluded that mixed football plyometric with sprint training has an effect on power, muscular endurance, flexibility, speed, and FT3 of two groups of lean college male students. Both training groups had similar outcomes in most of the study variables with respect to the FFM.

Keywords: *Underweight Males, Hormones, Training, Power, Speed, Muscular Endurance, Flexibility, Illinois Agility*

HOW TO CITE THIS ARTICLE: Syed Ibrahim, Syed Azhar Ahmed, Syed Muneer Ahmed, Syed Kaleem Ahmed; Football Plyometric and sprint training on Hormones and Fitness elements among underweight College students, Entomol Appl Sci Lett, 2020, 7 (2): 23-31.

Corresponding author: Prof. Syed Ibrahim
E-mail ✉ sibrahim @ kfupm.edu.sa
Received: 12/02/2020
Accepted: 04/08/2020

INTRODUCTION

Football is a team sport containing different skills and activities such as jumping, tackling, and sprinting [1, 2]. It is the most popular game in the world and the most acceptable, enjoyable, and performed sports by elite and traditional people such as students, staff, children, males, females, and leans. In a football match, sprinting of 10- l5m (2-4 seconds) occurs every 90 seconds [3]. 3% of playing time and 1- 15% of the distance covered are taken by sprinting in a football match [4]. It was confirmed that most of the sprint bouts are shorter than 30m and about half of the sprints are less than 10m in the distance [4].

Plyometric is a brisk and dynamic action that stimulates the development of performance in the athletic arena through the physiological modifications that take place in the central nervous system [5]. Several studies have concentrated on the effect of mixed resistance and plyometric work out on speed [6-8], power [9], agility [10], and flexibility [10, 11] of male subjects. One of the studies has investigated the impact of mixed plyometric-sprint and strength working out with the Meridian elite sporty shoe for swiftness and strength in females [12]. Another exploration has observed the influence of unified sprint and jumps workout on the speed of young male football players for a period of 6 weeks [13]. The outcomes of a few more research probes have discovered that there is a remarkable metamorphosis amid groups at a sprint phase [14], power [14], robustness [12], dexterity and suppleness [10]. The outcomes of various other studies have established that these parameters had detected comparable consequences among groups [6-9]. Conversely, some of these investigations have been told confident training influence when the pre-test was compared with the post-test [4, 7, 8].

Sprinting is one of the main contributors in many sports comprises of three stages: an acceleration stage, a maximum stage, and a deceleration stage [15, 16] No training effects were confirmed between groups after 20m of sprint training among male subjects [17]. One research study showed a significant reduction in the 20m sprint by 3.1% [16]. Significant declines in 40m sprint times by 1.1% [8] and 5.6% [18] have been stated in the literature. In the 60m sprint, a significant drop by 8% was reported by a former research study [18]. The agility times declined meaningfully by 1.5% [19], 4.3% [16], 1.7% [20] and 3% [21] after working out. In contrast, no alterations were realized in agility times [22, 23]. In the SLJ, one of the previous studies pointed out remarkable modifications between groups [24], but an additional one reported similar results [11]. A number of earlier studies stated remarkable rises in SLJ by 10% [11], 2.8 to 3.2% [16], 10 to 14% [9], 5.5% [24] and 7 to 9% [19]. At sit and reach, there was no variation after 6 weeks of plyometric training among male swimmer athletes aged 11-14 years old [11]. The sit-ups went up remarkably by 66% after 8 weeks of circuit strength endurance training among underweight male college students [25].

The underweight subject is the person whose BMI is less than 18.5 kg / m^2 [26, 27]. Such a person is considered to be suffering from health issues, related to some therapeutic risk elements such as hyperthyroidism, food deficit, sickness, and genetic. These problems can be overcome by using sprint and strength training that develops boy mass [17], muscle tenor, and bone mineral concentration [17]. Plyometric training makes muscle hypertrophy and results in a weight increase for lean individuals. Increasing calorie consumption also can take place for the treatment of lean people. Investigators overlooked the lean persons and this can be observed noticeably in the literature.

The triiodothyronine (T3) and the thyroxine (T4) are the basic thyroid gland hormones that control the development and the rapidity of the work of several organisms in the human body. They increase body metabolism; cause the cardiac system to be more sensitive to the sympathetic nervous movement. The Thyroid-Stimulating Hormone (TSH) is a hypothalamus hormone; the excretion of TSH is stimulated when the T4 build-up is low. The movement of TSH is inhibited when the T4 is high. The main influence of TSH is to stimulate the excretion of T4. One of the previous investigators [28] observed a remarkable shrinkage in FT3 after training. In contrast, a meaningful elevation in FT3 was reported after one week of intense resistance training of young female weightlifters [29]. However, no modifications were noticed in the FT3 after resistance training [30, 31]. There were also no alterations in FT4 [30, 31]. A significant drop in FT4 was reported [32]. Remarkable reductions were stated in TSH after resistance exercise [29, 32]. However, no adaptation in TSH was indicated [30, 31].

In our understanding, no single research investigated the efficacy of mixed football plyometric plus sprint training on FT3, FT4, TSH of underweight college male students whose BMI is less than 18.5 kg / m ^{2} and his FFM ranged between 40-45 and 46-55 kg. Consequently, the objective of this investigation was to counterpart the influence of mixed football plyometric plus sprint work out on selected hormones, speed, power, muscular endurance, agility, and flexibility of lean college male students.

METHOD

Twenty-six inactive underweight college students from King Fahd University of Petroleum and Minerals (KFUPM) joined as participants. The subjects were chosen according to two factors. 1) The body mass index (BMI) is lower than 18.5 kg/m^2. 2) The fat-free mass (FFM) ranged between 40 to 45 and 46 to 55 kg. The subjects were separated into two training groups, named a training group-1 (TG-1, FFM (40-45 kg), n = 12) and a training group-2 (TG-2, FFM (46-55 kg), n = 14). The agreement of the participants was determined for their optional involvement throughout the working out period. The subjects were asked to eliminate their agreement in case they felt any distress in the course of the period of involvement in the study. All inquiries of the subjects were responded. The dependent variables that were examined in this study are physical characteristic (age, H, BM, BMI, %BF, FFM), hormones (FT3, FT4, TSH), sprint (20m, 40m, 60m), change of direction (Illinois Agility test), power (SLJ), muscular endurance (sit-ups for 30 seconds) and flexibility (sit & reach). The adaptation phase took place before one week of the pre-testing. The Training Program (TP) was administered for 6 weeks, twice a week and for 40 min per session. Both TGs performed plyometric drills and sprint for 20 min followed by 20 min of football matches. In each training session, the participants were administered to execute 3 sets per exercise drill. Each set consists of long jump, single-leg hop and double leg hop followed by sprinting for 20, 30, and 40m, respectively. All students were questioned to perform the plyometric drills with full height and distance. They also were asked to run at full speed. Moreover, they took part in the warm-up session before the start of each training session, which went on for 5 minutes. After each training session, they also took part in the cool down session lasting for 5 minutes duration. Mean and standard deviation was computed for all values via SPSS version 16.0 software. The Paired t-test was utilized to recognize any significant difference within the group independently. The independent t-test was utilized to differentiate between groups (Post- tests minus pre-tests). 0.05 was fixed as the significance level.

RESULTS

Table 1: Physical characteristics variables computed before and after training

Parameters	Tests	TG-1 FFM = 40-45 kg n = 12	TG-2 FFM = 4ti-55 kg n = 14	P-Values
Age (v)	Pre	18.58 ± 0.5 l	18.43 ± 0.51	0.452
Height (cm)	Pre	168.50 ± 5.50	174.36 ± 4.76	0.007*
Body Mass (kg)	Pre	46.91 ± 2.70	53.76 ± 3.39	0 000*
	Post	49.08 ± 2.76	56.25 ± 3.78	0 000*
	Change	2.16 ± 1.37	2.48 ± 2.41	0.689
Body Mass Index (kg/m^2)	Pre	16.48± 1.17	17.57 ± 0.80	0.010*
	Post	17.21± 1.20	18.54 ± 1.15	0.009*
	Change	0.73 ± 0.53	0.96 ± 1.09	0.513
BF (%)	Pre	9.75 ± 3.25	9.37 ± 1.81	0.717
	Post	9.62 ± 3.46	10. 12 ± 2.65	0.678
	Change	-0.12 ± 1.24	0.75 ± 1.50	0.124
FFM (kg)	Pre	42.30 ± 1.83	48.75 ± 2.82	0.000*
	Post	44.28 ± 1.67	50.44 ± 2.88	0.000*
	Change	1.98 ± 1.05	1.68 ± 1.36	0.546

BM: body mass, BMI: body mass index, Pre: earlier to exercise measure. Post: subsequently to exercise measure, Change: post-test minus pre-test, SD: standard deviation, P-values: Probability of significance, *: significant.

The independent t-test reported no changes between both training groups of all physical character variables (P > 0.05). Whereas, the paired t-tests showed that the TG-1 exhibited increases in BM, BMI, and FFM by 4.6%, 4.4%, and 4.6%, respectively (P ≤ 0.05). The TG-2 also showed increments in BM, BMI, and FFM by 4.6, 5.5, and 3.4%, respectively (P ≤ 0.05).

Table 2. Represents speed, power, muscular endurance, flexibility and agility parameters measured at pre and post-tests

Parameters	Tests	TG-1 FFM (40-45 kg)	n	TG-2FFM (46-55 kg)	n	P-Values
20M Run (sec)	Pre	3.46 ± 0.l9	12	3.36 ± 0.15	l4	0.188
	Post	3.21 ± 0.27	12	3.14 ± 0.23	14	0.497

	Change	-0.24 ± 0.28	12	-0.22 ± 0.18	l4	0.790
4 30M Run (sec)	Pre	6.28 ± 0.47	10	6.13 ± 0.44	14	0.452
	Post	6.05 ± 0.25	10	5.83 ± 0.39	14	0.125
	Change	-0.18 ± 0.26	12	-0.30 ± 0.22	14	0.227
40M Run (sec)	Pre	8.89 ± 0.60	12	8.42 ± 0.48	14	0.036*
	Post	8.70 ± 0.65	12	8.08 ± 0.52	14	0.013*
	Change	-0.18 ± 0.30	12	-0.33 ± 0.24	14	0. 199
SLJ (cm)	Pre	184.83 ± 26.99	12	185.43 ± 27.65	14	0.956
	Post	191.25 ± 24.01	12	192.57 ± 26.72	14	0.896
	Change	6.42 ± 5.43	12	7.14 ± 3.59	l4	0.687
Sit-Ups (reps /30 sec)	Pre	17.75 ± 3.54	12	19.79 ± 4.67	14	0.229
	Post	22.67 ± 3.82	12	23.29 ± 5.03	l4	0.731
	Change	4.92 ± 2.06	12	3.50 ± 1.87	14	0.079
Sit & Reach (cm)	Pre	25.42 ± 7.79	12	23.93 ± 9.31	14	0.666
	Post	28.58 ± 7.93	12	26.29 ± 9.65	14	0.518
	Change	3.l7 ± 2.32	12	2.36 ± 1.59	14	0.306
Agility (sec)	Pre	18.18 ± 0.76	12	17.95 ± 0.87	l4	0.489
	Post	17.54 ± 0.74	12	17.20 ± 0.71	14	0.243
	Change	-0.63 ± 0.44	12	-0.75 ± 0.36	14	0.470

n: number of subjects in each group, m: meter, sec: seconds

The TG-1 increased in SLJ, sit-ups, and sit & reach by 3.8, 29.4, and 12%, respectively, ($P \leq 0.05$) and decreased in 20m, 40m, and agility by 7.2, 3.6 and 3.5% respectively, $P \leq 0.05$. The TG-2 also raised by 3.7, 21 and 13% in SLJ, sit-ups and sit & reach, respectively, $P \leq 0.05$ and dropped by 6.5, 4.8, 4, and 4.1% in 20m, 40m, 60m, and agility, respectively, $P \leq 0.05$. Once, the post-tests were correlated with the pre-tests by the independent t-tests, there were no changes in SLJ, 20m, 40m, 60m run, agility, sit-ups, and sit & reach ($P > 0.05$). These results can be seen in Table 2.

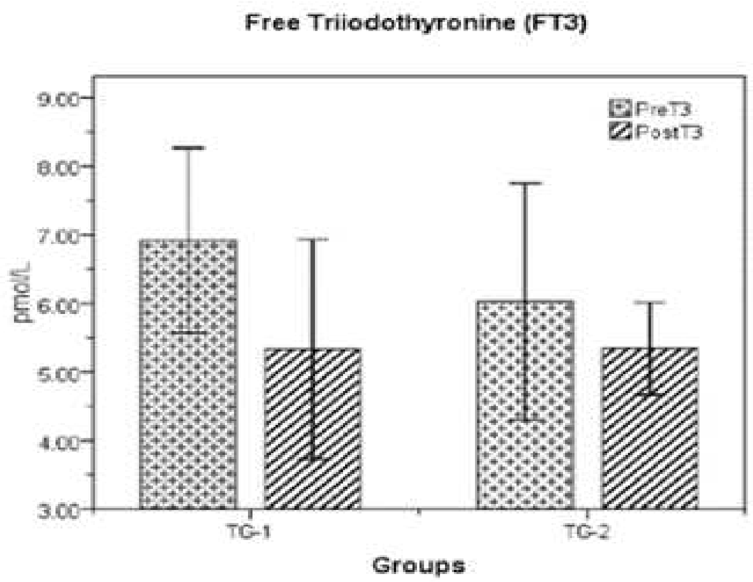

Figure 1: Free Triiodothyronine (FT3) of two training groups measured at pre and post-training.

It can be seen from Figure 1 that the TG-1 reduced by 23.1% (from 6.92 ± 0.67 to 5.32 ±0.80 pmol/1, P = 0.004) once the post-test was counterpart with the pre-test for each group independently. The TG-2 also fall by 11.4% (from 6.02 ± 0.86 to 5.33 ± 0.33 pmol/l, P = 0.026). The TG-1 showed greater reduction than the TG-2 (-1.59 ± 0.59 vs -0.68 ± 0.62 pmol/1, respectively, P = 0.30) as soon as the post-tests were subtracted from the pre-tests

Free Thyroxine (FT4)

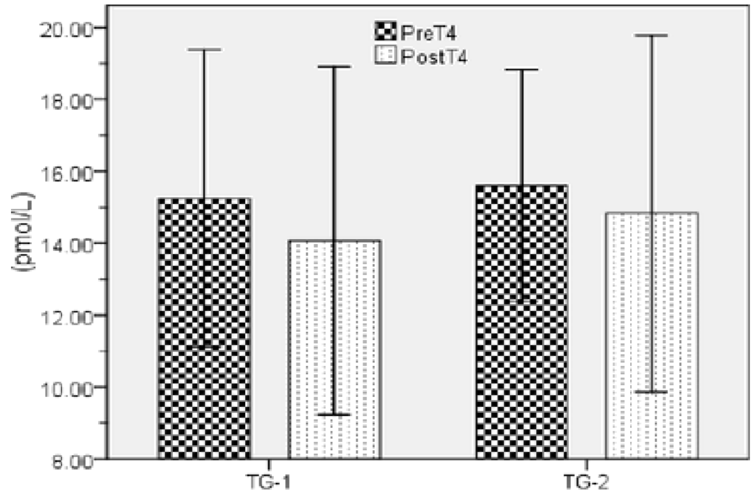

Figure 2: Free Thyroxine (FT4) measured at pre and post-training.

Changes were not observed between groups at pre-tests, post-tests, or post-tests minus pre-tests or within the group; the post-test was compared with the pre-tests independently (P > 0.05) as observed in **Figure 2.**

Thyrold•Stlmulat1ng Hormone {TSH)

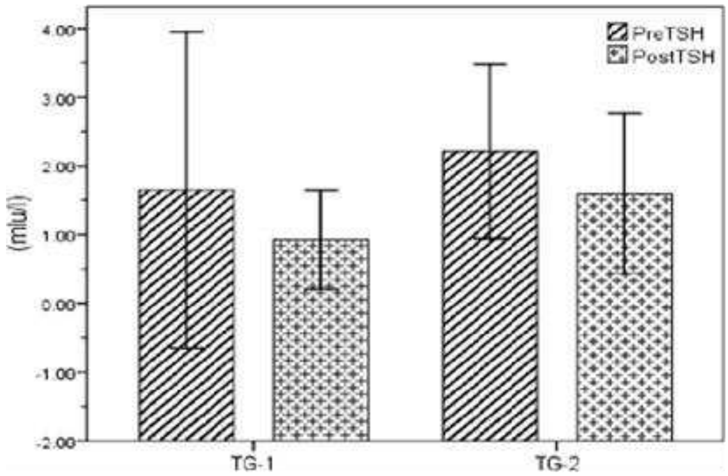

Figure 3. Thyroid-Stimulating Hormone (TSH) measured at pre- and post-training.

Similar outcomes were stated between groups (independent t-test) and within groups (paired t-tests) (P > 0.05). These consequences can be seen in **Figure 3.**

DISCUSSION

It was assumed that the TG-2 (FFM = 46-55 kg) will lead over the TG- 1 (FFM = 40-45 kg) in all the study variables. Nevertheless, this is not happening because both the training groups were untrained and improved by similar percentages after training despite the significant differences in the FFM before training.

The conclusions of this study pointed to positive working out effects in FT3 between and within each group. These consequences are alike to the previous findings of Simsch et al. (2002) who indicated a significant decrease in FT3 after resistance exercise [28]. In contrast, the outcomes of the present study are in disagreement with the previous study of Alen et al. (1993) who described a remarkable increase in FT3 within a week of intense resistance training of young women weightlifters [29]. However, Rahimi et al. (2013) and Pakarinen et al. (1988) stated no variations in FT3 after resistance training [10, 32]. The differences between the current findings and the previous results may be due to the use of different types of subjects, gender, training status, and blood sample testing time. No training effect in the FT4 was observed in the current study. Prospectively, our findings correspond with Rahimi et al. 2013, and Simsch et al (2002) [31, 28], while, Pakarinen et al. (1988) indicated a significant decrease in FT4 [32]. A non-significant drop was indicated in the current study in TSH. The outcome was not identical to the previous investigation of Simsch et al (2002). Pakarinen et al (1991), and Alen et al (1993) confirmed meaningful falls in TSH after resistance training [28, 29, 32]. Rahimi et al. (2013) investigated the effect of resistance working out on thyroid hormones among male college students and found out no alterations in TSH after training [31]. The impact of 6 weeks of mixed football plyometric with sprint training on the thyroid and the hypothalamus hormones is not clear up till now and this topic did not take enough attention by researchers and scientists. The lean individual is an example of the unawareness in this field of study [33].

In our study, training effects were observed in the 20m sprint by 7.2% (TG-1) and 6.5% (TG-2). These outcomes are in agreement with the finding of Markovic, (2007) of a 3.1% decrease [16]. However, one study was not in agreement with this outcome which found out that training groups have similar sprint time values after training [34]. They compared the influence of two-plyometric working out methods on power and agility in youth soccer players. The conflict between Thomas et al (2002) and our study may be due to the use of different types of subjects (trained soccer players) [34]. A 20m sprint represents the acceleration stage; in this stage, the hip and the knee extensors were the main body parts used mostly by the subjects to accelerate speed [35, 36]. The underweight students executed 12 sessions by plyometric workouts (single leg hop, double leg hops, and long jumps) and used short sprint bouts such as 20m and 30m. The above protocol reinforced the hip and knee extensors of the participants and resulted in the exercise outcomes amongst the lean students. It may also because of the drop in ground contact time from < 200 milliseconds at speeds up phase two < 1 00 milliseconds at maximum stage [37]. In a 40m sprint, 3.6% (TG-1) and 4.8% (TG-2) decreases were observed. These outcomes are corresponding with the finding of Ronnestad, 2008 (1.1%), and Ratamess, 2007 (5.6%) [8, 18]. These results may be because the hip and the knee extensors contract explosively to accelerate speed are the main body parts contributing to the acceleration phase. The acceleration stage is dependent on reaction time and the athlete's ability to create force and power of momentum [36]. The hip and the ankle extensor are the greatest participated portion of the body in the maximum speed level [36, 38] which may increase power by sprinting and plyometric exercises. The flexibility of the plantar flexor muscles has a great impact on the attainment of the maximum speed of 40m run [18]. The hip flexors [39] and knee extensors [35, 40] are the most contributors in the deceleration stage

At agility times, 3.5% (TG-1) and 4.1% (TG-2) drops were stated in the current study. These consequences are consistent with Kumar, 20l3 (1.5%), Markovic, 2007 (4.3%), Vaczi, 20l3 (1.7%), and Millar, 2006 (3%) [16, 19-21]. In contrast, no changes were observed in agility times [22, 23]. The agility is the ability of the physique to alter the course of movement and is based on acceleration and deceleration stages of speed [37]. The enhancement in agility can be credited to better motor enrollment or neural variation [21], muscle hypertrophy [41], and knee extensor strength [35, 36].

In our study, the increases of 3.8% and 3.7% in SLJ were observed in TG-1 and TG-2, respectively ($P \leq 0.05$). These outcomes agreed with the funding of Sadeghi, 2013 (10%), Markovic, 2007 (2.8-3.2%), Panakal, 2012 (10-14%), Faigenbaum, 2007 (5.5%), and Ratamess, 2007 (7-9%) [9, 11, 16, 18, 24]. Ratamess et al (2007) observed that superior influences of the plantar flexor muscles of the hip, knee, and ankle were 46, 4, and 50%, respectively in the course of the propulsive stage of the SLJ [18]. Power production [42] was enhanced by coordination [43] and neuromuscular adaptations [44] that were induced by the plyometric training.

Our finding of sit and reach increased by 12% (TG- l) and 13% (TG-2). The outcomes are against the study of Sadeghi et al. (2013) who reported no changes after 6 weeks of plyometric training among male swimmer athletes aged 11-

14 years old [11]. This conflict may be due to the types (trained athletes) and the age (11 -14 years) of the subjects. The improvement of sit and reach may be due to the participation in the combined training program in the current study. The hamstring and the back muscles are the main contributors to the flexibility test.

The current investigation indicated an increase of 29.4% and 21% in sit-ups. These consequences are in line with the result of Jafari et al. (2015) who insured an increase of 66.6% after 8 weeks of circuit strength endurance training among underweight male college students [25]. The greatest result of Jafari may be due to the rise of taller (177 cm) heavier (59 kg) subjects, and extended time (8 weeks) and greater frequency (3 days per week) of the training program.

CONCLUSION

It was concluded that 6 weeks of mixed football plyometric with sprint training has a training effect on power, muscular endurance, flexibility, speed, and FT3 of two groups of lean male college students. Both training groups had similar outcomes in most of the study variables with respect to the FFM.

REFERENCES

1. Ibrahim S, Ahmed SA. Performance-Related Fitness Variables, and Metabolic, and Physiological Components among Athletes. Int. J. Pharm. Res. Allied Sci. 2020;9(2):85-90.
2. Razavi MH, Chupankareh V, Smaeili M, Afshari M. A Study Of The Structural Challenges Of Football Club Privatization With A Factor Analysis Method. Journal of Organizational Behavior Research. 2018;3(2)1-8.
3. Bangsbo, J., Norregaard. I., Thorso, F. Activity profile of competition soccer Canadian Journal of Sport Sciences. 1991; 16(2): 110-116.
4. Stolen, T., Chamari, K., Castagna, C., Wisloff, U. Physiology of soccer, Sports. Med. 2005; 35(6): 501 -536.
5. Ibrahim S, Ahmed SA, Ahmed SM, Ahmed SK. Divergent Resistance Training Programs, Ramification on the Absolute and Relative Strength and Endurance among College Men. Int. J. Pharm. Res. Allied Sci. 2020;9(2):8-14.
6. de.Villarreal, E.S., Kellis, E., Kraemer, W.J. Izquierdo, M.. Determining variables of plyometric training for improving vertical jump height performance: A meta-analysis. J Strength Cont Res. 2009;23(2): 495-506.
7. Herrero, A.J., Martin, J., Martin, T., Abadla, O., Fernandez, B., Garcia-Lopez, R,V, D. The short-term effect of plyometrics and strength training with and without superimposed electrical stimulation on muscle strength and anaerobic performance: a randomized controlled trial. Journal of Strength and Conditioning Research. 2010; 24, (6); 1616-1622.
8. Ronnestad, B. R., Kvamme, N. H., Sunde, A., Raastad, T. Short-term effects of strength and plyometric training on sprint and jump performance in professional soccer players. Journal of Strength and Conditioning Research. 2008; 22(3): 773-780.
9. Panackal, M.B., Daniel, T., Abraham, G. Effects of different training methods on potwer output among school team players. International Journal of Advanced Scientific and Technical research. 2012; 5 (2): 56-63.
10. Vijayalakshmi., J. Effects of combination of own body resistance exercise and plyometric with and without yogic practices on selected physical and physiological variables among adolescent boys. IJALS. 2013; 6(3): 246-251.
11. Sadeghi, H., Nabavi Nik, H., Darchini, M.A., Mohammadi, R. The effect of six-week plyometric and core stability exercises on performance of male athlete. Advances in Environmental Biology. 2013;7 (6):1195-1201.
12. Rahimi, R., Arshadi, P., Behpur, N., Boroujerdi, S. S., Rahimi, M. Evaluation of plyometrics, weight training and their combination on angular velocity. Physical Education and Sport. 2006; 4(1): 1-8.
13. Marques, M.C., Pereira, A., Reis, I.G., Tillaar, R.V.D. Does an in-season 6-week combined sprint and jump training program improve strength-speed abilities and kicking performance in young soccer players. Journal of Human Kinetics. 2013; 39(1):157-166.
14. Rahimi, R.., Behpur, N. The effects of plyometric, weight and plyometric - weight training on anaerobic power and muscular

strength. Physical Education and Sport. 2005; 3 (l): 81 -91.

15. Ross, R. E., Ratamess, N. A., Hoffman, J. R., Faigenbaum, A. D., Kang, J., Chilakos, A. The effects of treadmill sprint training and resistance training on maximal running velocity and power. Journal of Strength & Conditioning Research. 2009; 23(2): 385-394.
16. Markovic, G., Jukic, I., Milanovic, D., Metikos, D. Effects of sprint and plyometric training on muscle function and athletic performance. Journal of Strength and Conditioning Research. 2007; 21(2): 543-549.
17. Robert, A., Murugavel, K. Effect of plyometric resistance and sprint training on acceleration speed flight time and jump height of male basketball players. International Journal of Life Sciences and Educational Research. 2013; 1 (3): 1 05-109.
18. Ratamess, N. A., Kraemer, W. J., Volek, J. S., Ffrench, D. N., Rubin, M. R., Gomez,A. L., Newton, R. U., Maresh, C. M. The effects of ten weeks of resistance and combined plyometric-sprint training with the meridian elite athletic shoe on muscular performance in women. Journal of Strength and Conditioning Research. 2007; 21(3): 882-886.
19. Kumar, R. The effect of 6 week plyometric training program on agility of collegiate soccer players. International Journal of Behavioral, Social and Movement Sciences. 2013; 102 (1):170-l76.
20. Vaczi, M., Tollar, J., Meszler, B., Juhasz, I., Karsai, I. Short-term high intensity plyometric training program improves strength, power and agility in male soccer players. Journal of Human Kinetics. 2013; 36(1): 17-26.
21. Miller, M. G., Herniman, J. J., Ricard, M. D., Cheatham, C. C., Michael, T. J. The effects of a 6-week plyometric training program on agility. Journal of Sports Science and Medicine. 2006; 5(3): 459-465.
22. Lehnert, M., Hulka, K., Maly, T., Fohler, J., Zahalka, F. The effects of a 6 week plyometric training program on explosive strength and agility in professional basketball players. Acta Univ. Palacki. Olomuc. Gymn. 2013; 43 (4): 7-15.
23. Zghal, F., Chortane, G., Gueldich, H., Mrabet, I., Messoud, S., Tabka, Z., Cheour, F. Effects of in-season combined training on running, jumping, agility and rate of force development in pubertal soccer players. IOSR-JPBS. 2014; 9 (4): 21 -29.
24. Faigenbaum, A. D.m McFarland, J. E., Keiper, F. B., Tevlin, W., Ratamess, N. A., Kang, J., Hoffman, J. R. Effects of a short-term plyometric and resistance training program on fitness performance in boys aged 12 to 15 years. Journal of Sports Science and Medicine.2007; 6(4): 5l9-525.
25. Jafari, S., Rahnani-nia, F., Arazi, H. The effect of a circuit strength-training program on the muscle strength, body image and anxiety of anxious undertweight male college students. Hrvat. Sportskomed. Vjesn. 2015; 30(1): 42-49.
26. National Heart, Lung, and Blood Institute. 2012.
27. Almaiman A, Al Wutayd O. Assessment of the Side Effects of Random Weight-loss Diet Programs (protein-based) on Health in a Saudi Community. Int. J. Pharm. Phytopharm. Res. 2019;9(6):39-46.
28. Simsch, C., Lormes, W., Peterson, K.G., Baur, S., Liu, Y., Hackney, A.C., Lehmann, M., Steinacker, J.M. Training intensity influences leptin and thyroid hormones in highly trained rowers. Int. J Sports Med. 2002; 23(06): 422-427.
29. Alen. M., Pakarinen. A., Hakkinen. K. Effects of prolonged training on serum thyrotropin and thyroid hormones in elite strength athletes. J. Sport. Sci. 1993; 11(6): 493-497.
30. Peeri, M., Boostani, M.H., Banaeifar, A., Kohanpour, M.A., Erfani, M., Abbariki, Z. Effect of eight weeks continuous resisting training on relaxation levels and responses of active young women' thyroid hormones to one turn sport. J. Basic. Appl. Sci. Res. 2013; 3,:648-653.
31. Rahimi, E., Zadeh, Y.M., Boostani, M.A. The effect of resistance training on thyroid hormones. European Journal of experimental Biology. 2013; 3(2): 443-447.
32. Pakarinen, A., Alen, M., Hafikinen, K., et al. Scrum thyroid hormones, thyrotropin and thyroxine binding globulin during prolonged strength training. Eur.J. Appl. Physiol. 1988; 57(4): 394-398.
33. Siri, W. E. Body composition from fluid spaces and density: Analysis of methods. A

technique for measuring body composition. J. Brozek and A. Henschel. eds. Washington. DC: National Academy of Science. 1961;61:223-44.

34. Thomas, K., French, D., Philip., R. The effect of two plyometric training techniques on muscular power and agility in youth soccer players. Journal of Strength & Conditioning Research. 2009; 23(1): 332-335.
35. Delecluse, C. Influence of strength training on sprint running performance. Current findings and implications for training. Sports Med. 1997; 24(3): 147-156.
36. Mero, A., Komi, P.V., Gregor, R.J, Biomechanics of sprint running: a review. Sports Med. 1992; 13(6): 376-392.
37. Plisk, S.S. Speed. Agility, and speed-endurance development, in: T.R. Baechle and R.W. Earle (Eds). Essentials of Strength Training and Conditioning. Champain: Human Kinetics Books. 2000; 471-492.
38. Wiemann, K., Tidow, G. Relative activity of hip and knee extensors in sprinting- implications for training. New Studies in Athletics. 1995; 10:29-49.
39. Mann, R.A., Moran. G.T., Dougherty, S.E. Comparative electromyography of the lower extremity in jogging, running, and sprinting. Am. J. Sports Med. 1986; 14(6): 301-5l0.
40. Dowson. M.N., Nevill, M.E., Lakomy, H.K.A., Nevill, A.M., and Hazeldine, R.J. Modelling the relationship between isokinetic muscle strength and sprint running performance. J. Sports Sci. 1998; 16(3): 257-265.
41. Malisoux, L., Francaux,. M., Nielens, H., Theisen, D. Stretch-shortening cycle exercises: an effective training paradigm to enhance power output of human single muscle fibers. J Appl Physiol. 2006; 100(3): 771-779.
42. Chelly, M. S., Ghenem, M. A., Abid. K., Hermassi, S., Tabka, Z., Shephard, R.J. Effects of in-season short-term plyometric training program on leg power, jump-and sprint performance of soccer players. Journal of strength and Conditioning Research. 2010; 24(10): 2670-2676.
43. de.Villarreal, E.S., Kellis, E., Kraemer, W.J. Izquierdo, M. Determining variables of plyometric training for improving vertical jump height performance: A meta-analysis. J Strength Cont Res. 2009; 23(2): 495-506.
44. Kraemer. W. J., Ratamess, N. A., Volek, J., Mazzetti, S. A., Gomez, A. L. The effect of the meridian shoe on vertical jump and sprint performances following short-term combined plyometric/sprint and resistance training. Journal of Strength & Conditioning Research. 2000; 14(2): 228-238.