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ISOLATED AND COMBINED EFFECT OF GAME SPECIFIC CIRCUIT AND TRX SUSPENSION BAND TRAINING ON SELECTED MOTOR FITNESS COMPONENTS OF HANDBALL PLAYERS

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ABSTRACT- **The reason for the investigation is to discover the isolated and combined effect of game specific circuit and TRX suspension band training on selected motor fitness components among Handball players. To accomplish the reason for the examination 60 handball players from St. Aloysius college Thrissur, Aquinas College Edakochi, Christ College, Thrissur were chosen as subjects and their age extends between 18 to 23 years. They were divided into four equal groups by random sampling method. Group-I acted as Experimental Group-I – isolated circuit Training, Group-II acted as Experimental Group II – isolated TRX suspension band training, Group-III acted as Experimental Group III – combined training and Group – IV acted as Control. The training duration for all three groups was restricted to 12 weeks (3days/week). The strength endurance and Cardio respiratory endurance were preferred as dependent variables. The data collected from the experimental and control groups on selected dependent variables was statistically analyzed by paired 't' test. Additionally, percentage of changes was also calculated. Further, the data were statistically analyzed to find out the significant difference if any, by applying the analysis of covariance (ANCOVA). Whenever the obtained 'F' ratio value was found to be significant for adjusted post test means, the Scheffe's test was applied as post hoc test. In all the cases the level of confidence was fixed at 0.05 level for significance. In response to game specific circuit, TRX suspension band and combined training men handball player's strength endurance and Cardio respiratory endurance were enhanced considerably.**

Key Words: Game specific circuit training, TRX suspension band training, Motor fitness components and Handball players

I. INTRODUCTION

Handball is a complex and highly demanding intermittent sport, involving multiple high-intensity runs (Schwesig et al., 2016), frequent body contacts, and other high-intensity strength and power actions. Creativity in combination with speed-jumping, turning, changing pace, ball throwing, and lateral movements makes this sport very attractive but tough to play. Povoas et al., (Povoas et al., 2012) reported that during an average 73 minutes of match time, 825 very short-duration (2–6 seconds) changes of activity were performed, with 6-second intervals. Their findings suggest that handball-specific conditioning should include exercises to develop high-intensity intermittent aerobic effort, speed, agility, strength, and power (Hermassi et al., 2011). However, the maintenance of technical skills is also a critical factor in the use of available training time, and coaches are increasingly relying on an integrated approach to conditioning and skill-based work, often programming handball-specific drills that include both technical and tactical assignments.

Circuit training is a method of physical conditioning in which one moves from one exercise to another, usually in a series of different stations or pieces of equipment Circuit training is a style of training that develops overall fitness. Performed regularly, circuit training will simultaneously improve muscular strength, endurance, cardiovascular fitness, and flexibility. "Circuit training is a method of fitness training that is designed to develop general, all-round physical and cardiovascular fitness" (Scholich, 1990). It is an excellent training program for improving different type of physical fitness abilities based on the program in different stations.

TRX suspension training helps the resistance of the body and body shaping, without swelling the muscles, but only shaping them; it develops the muscle resistance, the activity of profound muscles, the posture muscles and joints mobility; it can be a good means of recovery for those with joints and back problems. With TRX, we have the opportunity to be creative, to develop our own exercises depending on the level of training, increasing gradually the difficulty and complexity of exercises, observing the basic principles: from simple to complex, from easy to difficult and from known to unknown (Vom Hofe, 1995) Suspension training is an excellent way to improve any muscle imbalances we may have. This is primarily because of the amount of balance we must have to perform any of these exercise. Because of the constant instability, our body will perform as single unit to maintain the necessary balance.

To improve game performance, handball players must engage in specific conditioning, with additional resistance, sprint, and endurance training (Hermassi et al., 2010). Because of the ever-increasing demands of competition, in-season strength and conditioning have been proposed to maintain adequate strength and power over the playing season (Hermassi et al., 2011). Little is known, however, about the optimal way to improve performance, or whether there is interference between potential components of a training regimen. Handball playing can itself enhance many facets of performance, but there is increasing recognition that elite competitors should engage in additional conditioning. This should include exercises to develop high- intensity intermittent aerobic effort, speed, agility, strength and power (Hermassi et al., 2010; Schwesig et al., 2016), the combination of speed and explosive strength training needed to improve peak running speed and jump height (Gorostiaga et al., 2006), and bouts of high-intensity running to develop maximal anaerobic performance.

The evolving nature of the game necessitates greater ability and physical skills. Players should have better motor fitness elements, it is a well-known reality. However, there is a scarcity of previous research in India to determine the factors that dominate in handball players, as well as the factors that contribute to a unbeaten game result. The current research is a sincere attempt to investigate the above-mentioned, previously unexplored region. This attempt was to look into the significance of game specific circuit training and TRX suspension band training on selected motor fitness components among handball players.

II. METHODOLOGY

A. Subjects and Variables

To accomplish the reason for the examination 60 handball players from St. Aloysius college Thrissur, Aquinas College Edakochi, Christ college, Thrissur were chosen as subjects and their age extends between 18 to 23 years. They were divided into four equal groups by random sampling method. Group-I acted as Experimental Group-I – isolated circuit Training, Group-II acted as Experimental Group II – isolated TRX suspension band training, Group-III acted as Experimental Group III – combined training and Group – IV acted as Control. The strength endurance and cardio respiratory endurance was selected as dependent variable and it was assessed by conducting bent-knee sit-ups and Cooper 12 minutes R/W test.

B. Training Protocol

After the initial measurements the specially designed training programme was given to the subjects of the experimental group-I named as handball game specific circuit training. The training sessions were conducted three days a week i.e. (Monday, Wednesday, and Friday) over a period of twelve weeks. Each experimental session was of 30-45 minutes duration excluding warm-up and warm-down. They performed the following handball drills namely Two man passing, Zigzag passing, Chest pass, Wrist pass, Back pass, Long pass, High dribble, Low dribble, 6mts shooting, 9mts shooting, Defense skill respectively. In addition they performed 10 minutes Small Sided game practices. A week schedule was repeated to the proceeding week and the load was adjusted progressively. The training intensity was increased progressively from first week to proceeding week. The frequency of training was thrice in a week. The duration of warm-up and warm-down were fixed at ten minutes respectively. The work rest ratio of 1:1 between exercises and 1:3 between sets was given.

After the initial measurements the specially designed training programme was given to the subjects of the experimental group-II named as TRX suspension band training. The training sessions were conducted three days a week i.e. (Monday, Wednesday, and Friday) over a period of twelve weeks. Each experimental session was of 30-45 minutes duration excluding warm-up and warm-down. The training commenced with one week of general physical conditioning for the experimental groups, so that the subjects were ready physically and mentally to take on specific load administrated to them for the purpose of the study. After one week of conditioning the training was administrated to the experimental

group, which includes TRX suspension band training drills. The TRX suspension band training sessions were supervised by experienced coaches. The experimental group undertook three TRX suspension band training sessions in a week. They performed exercises such as TRX push-up, TRX chest press, TRX inverted row, Kneeling triceps press, Low row, Single-arm row, Triceps extension, Biceps curl, Squat and Hamstring curl respectively. Sessions were progressively structured to gradually increase intensity over each of the 12 weeks.

The experimental group-III performed combined training (game specific circuit training & TRX suspension band training) alternatively three days a week. The combined game specific circuit training and TRX suspension band training group performed game specific circuit training during every odd numbered week and TRX suspension band training every even numbered week

C. Collection of the Data

The data on strength endurance and cardio respiratory endurance was collected prior to the commencement of experiment (pre test) and after twelve weeks of training period (post test). Both the pre and post tests were administered under identical conditions, with same apparatus, testing personal and testing procedures.

D. Statistical Technique

The data collected from the experimental and control groups on strength endurance and cardio respiratory endurance was statistically analyzed by paired 't' test to find out the significant differences if any between the pre and post test. Further, percentage of changes was calculated. The data collected from the three groups prior to and post experimentation on strength endurance and cardio respiratory endurance was statistically analyzed, by applying the Analysis of Covariance (ANCOVA). Since, three groups were involved, whenever the obtained 'F' ratio value in the adjusted post test mean was found to be significant, the Scheffe's test was applied as post hoc test. The level of confidence is fixed at 0.05 for significance.

III. RESULT

The obtained results through the application of paired 't' test statistical technique, in order to estimate the effectiveness of game specific circuit, TRX suspension band and combined training (GSCT, TRXST, CT & CG) among men handball player's strength endurance is put on view in table-I.

Table – I: Obtained 't' Test Result on Strength Endurance of GSCT, TRXSBT, CT & CG Men Handball Players

Group	Test	N	Mean	SD	DM	't' - ratio	%
Game Specific Circuit Training (GSCT)	Pre	15	29.733	2.6313	3.20	12.22*	10.76%
	Post		32.933	2.8149			
TRX Suspension Band Training (TRXSBT)	Pre	15	28.400	3.6606	5.53	15.81*	19.47%
	Post		33.933	3.7123			
Game Specific Circuit & TRX Training (CT)	Pre	15	29.400	2.8983	7.53	15.80*	25.61%
	Post		36.933	2.4339			
Control(CG)	Pre	15	30.067	2.1202	0.67	1.58	2.23%
	Post		29.400	2.0284			

*Table value for df 14 is 2.14(*significant)*

The derived results through the application of paired 't' test statistical technique proved that the mean difference found between initial(pre) and final(post) data of game specific circuit, TRX suspension

band and combined training (GSCT, TRXSBT & CT) group's vary clearly, as the paired 't' values 12.22 (GSCT), 15.81 (TRXSBT) and 15.80(CT) are more than table(df14=2.14) value required. In response to game specific circuit (GSCT =10.76%), TRX suspension band (TRXSBT=19.47%) and combined training (CT= 25.61%) men handball player's strength endurance was enhanced considerably.

In the below given table, the derived ANCOVA statistic results on strength endurance of game specific circuit, TRX suspension band and combined training (GSCT, TRXSBT & CT) and control group's men handball players are displayed.

Table – II: Obtained ANCOVA Results on Strength Endurance of GSCT, TRXSBT, CT & CG Men Handball Players

	Game Specific Circuit Training (GSCT)	TRX Suspension Band Training (TRXSBT)	Game Specific Circuit & TRX Training (CT)	Control (CG)	SoV	SS	df	MS	'F' ratio
Adjusted Mean	32.65	34.78	36.93	28.84	B	525.63	3	175.21	84.71*
					W	113.76	55	2.068	

*(Table value for df 3 & 55 is 2.77)*Significant (.05 level)*

The resultant 'f' ratio of 84.71 derived through ANCOVA statistics proved that the adjusted(posttest) mean values on strength endurance of game specific circuit (GSCT =32.65), TRX suspension band (34.78), combined training (CT= 36.93) as well as control groups (CG=28.84) men handball players differ from one another. Because the obtained ANCOVA 'F' value (84.71) on strength endurance of TRX suspension band, GSCT, CT and CG is more than 2.77 (table value) degrees of freedom (df) 3 and 55.

In the below given table, the derived Scheffe's Test (post hoc) results on strength endurance of game specific circuit, TRX suspension band and combined training (GSCT, TRXSBT & CT) and control group's men handball players are displayed.

Table – III: Obtained Scheffe's Test Result on Strength Endurance of GSCT, TRXSBT, CT & CG Men Handball Players

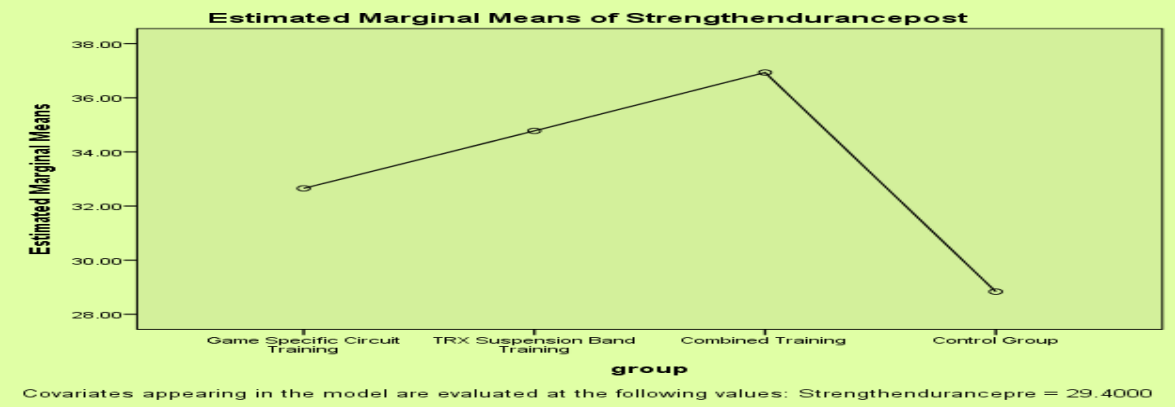
Game Specific Circuit Training (GSCT)	TRX Suspension Band Training (TRXSBT)	Game Specific Circuit & TRX Training (CT)	Control (CG)	MD	CI
32.65	34.78			2.12*	1.51
32.65		36.93		4.28*	1.51
32.65			28.84	3.81*	1.51
	34.78	36.93		2.16*	1.51
	34.78		28.84	5.94*	1.51
		36.93	28.84	8.10*	1.51

**Significant (.05)*

The applied post hoc test (Scheffe's**)** statistics make clear that as a result of game specific circuit, TRX suspension band and combined training (GSCT, TRXSBT & CT) the men handball players strength endurance was enhanced to a great extent, because these differences between means (3.81, 5.94 & 8.10) are more than 1.51 (CI value). Though, combined training (CT) is superior to performing TRX

suspension band training (TRXSBT) and game specific circuit training (GSCT) however, TRX suspension band training (TRXSBT) is better than game specific circuit training (GSCT). The below displayed diagram(Figure-I), showing the strength endurance mean scores of game specific circuit, TRX suspension band and combined training (GSCT, TRXSBT & CT) and control group's men handball players.

Figure-I: Figure Showing the Strength Endurance Mean Scores of Game Specific Circuit, TRX Suspension Band and Combined Training and Control Groups



A. Analysis of Cardio-Respiratory Endurance

The obtained results through the application of paired 't' test statistical technique, in order to estimate the effectiveness of game specific circuit, TRX suspension band and combined training (GSCT, TRXST, CT & CG) among men handball player's cardio-respiratory endurance is put on view in table-IV.

Table – IV: Obtained 't' Test Result on Cardio-Respiratory Endurance of GSCT, TRXSBT, CT & CG Men Handball Players

Group	Test	N	Mean	SD	DM	't' - ratio	%
Game Specific Circuit Training (GSCT)	Pre	15	2552.667	181.0472	115.33	7.00*	4.52%
	Post		2668.000	150.2949			
TRX Suspension Band Training (TRXSBT)	Pre	15	2528.667	132.0101	51.33	7.53*	2.03%
	Post		2580.000	142.5282			
Game Specific Circuit & TRX Training (CT)	Pre	15	2522.000	157.0805	110.00	6.13*	4.36%
	Post		2632.000	130.8325			
Control(CG)	Pre	15	2527.333	170.1876	21.33	2.69	0.84%
	Post		2506.000	185.1563			

*Table value for df 14 is 2.14(*significant)*

The derived results through the application of paired 't' test statistical technique proved that the mean difference found between initial(pre) and final(post) data of game specific circuit, TRX suspension band and combined training (GSCT, TRXSBT & CT) group's vary clearly, as the paired 't' values 7.00 (GSCT), 7.53 (TRXSBT) and 6.13 (CT) are more than table(df14=2.14) value required. In response to game specific circuit (GSCT =4.52%), TRX suspension band (TRXSBT =2.03%) and combined training (CT= 4.36%) men handball player's cardio-respiratory endurance was enhanced considerably.

Table –V;Obtained ANCOVA Results on Cardio-Respiratory Endurance of GSCT, TRXSBT, CT & CG Men Handball Players

	Game Specific Circuit Training (GSCT)	TRX Suspension Band Training (TRXSBT)	Combined Training (CT)	Control (CG)	S o V	SS	df	MS	'F' ratio
Adjusted Mean	2649.93	2583.61	2641.64	2510.82	B	185813.112	3	61937.704	25.44*
					W	133933.887	55	2435.162	

*(Table value for df 3 & 55 is 2.77)*Significant (.05 level)*

The resultant 'f' ratio of 25.44 derived through ANCOVA statistics proved that the adjusted(posttest) mean values on cardio-respiratory endurance of game specific circuit (GSCT =2649.93), TRX suspension band (TRXSBT =2583.61), combined training (CT= 2641.82) as well as control groups (CG=2510.82) men handball players differ from one another. Because the obtained ANCOVA 'F' value (25.44) on cardio-respiratory endurance of TRX suspension band, GSCT, CT and CG is more than 2.77 (table value) for df 3 and 55.

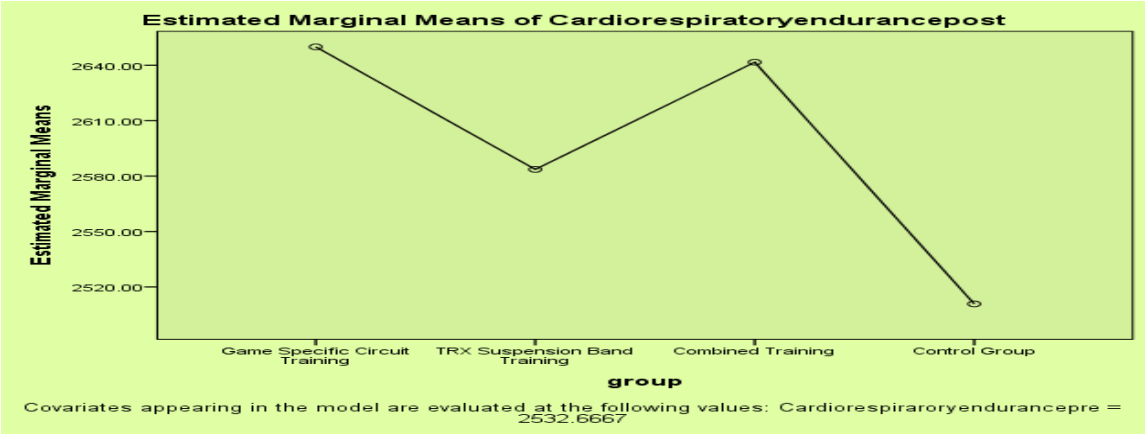
Table – VI:Obtained Scheffe's Test Result on Cardio-Respiratory Endurance of GSCT, TRXSBT, CT & CG Men Handball Players

Game Specific Circuit Training (GSCT)	TRX Suspension Band Training (TRXSBT)	Combined Training (CT)	Control (CG)	MD	CI
2649.93	2583.61			66.32*	51.94
2649.93		2641.64		8.30	51.94
2649.93			2510.82	139.12*	51.94
	2583.61	2641.64		58.02*	51.94
	2583.61		2510.82	72.80*	51.94
		2641.64	2510.82	130.82*	51.94

**Significant (.05)*

The applied post hoc test (Scheffe's**)** statistics make clear that as a result of game specific circuit, TRX suspension band and combined training (GSCT, TRXSBT & CT) the men handball players cardio-respiratory endurance was enhanced to a great extent, because these differences between means (139.12, 72.80 & 130.82) are more than 51.94 (CI value). Though, game specific circuit training (GSCT) and combined training (CT) are superior to TRX suspension band training (TRXSBT) however, between game specific circuit training (GSCT) and combined training (CT) insignificant differences were observed.

Figure-II;Figure Showing the Cardiorespiratory Endurance Mean Scores of Game Specific Circuit, TRX Suspension Band and Combined Trainingand Control Groups



IV. DISCUSSION

The results of the present study reveal that game specific circuit, TRX suspension band and combined training have significantly increased the strength endurance and cardio-respiratory endurance. These results are in conformity with the findings of the studies undertaken by Gettman and Pollock, (1981); Kelemen, *et al*., (1986); LeMura *et al*., (2000); Pipes (1977) and Kaikkonen *et al*., (2000).

Circuit training, which is designed to be performed 3 days a week during 12 weeks of training, improves sprint-agility and anaerobic endurance (Taskin and Halil (2009), cardio respiratory endurance and muscular endurance (Venkatachalapathi, 2006), muscular strength, muscular activation, and cardio respiratory fitness (Brentano *et al*., 2008), speed and power of adolescents (Adeniji, 2007). Circuit training alone induced strength and power improvements that were significantly greater than when resistance and endurance training were combined, irrespective of the intra session sequencing (Chtara *et al*., 2008). Shafeeq *et al.,* (2012) observed that interval circuit training significantly helped to improve the explosive power, cardio respiratory endurance and muscular strength.

The field of suspension training is a form of resistance training that includes bodyweight exercises in which a variety of multi-planar, compound exercise movements could performed. These done with the aim of developing strength, balance, flexibility, and joint stability simultaneously. (Amr, 2008) Suspension training develops physical strength while using functional movements and dynamic positions. TRX Suspension Training is a new sling training for an intense full-body workout in a short time. By the versatile exercises, not only power, but also coordination, stability and mobility can work effectively. For the improvement and maintenance of cardiorespiratory fitness, the ACSM has recommended a target energy expenditure of 150–400 kilocalories per day. Research has found that participation in a 60 minute TRX Suspension Training class yields a mean energy expenditure of ~400 kilocalories that satisfies the ACSM recommendations for daily energy expenditure. This volume of energy expenditure is comparable to other nontraditional alternative activities.

V. CONCLUSION

In response to game specific circuit (GSCT =10.76%), TRX suspension band (TRXSBT=19.47%) and combined training (CT= 25.61%) men handball player's strength endurance was enhanced considerably. Though, combined training (CT) is superior to performing TRX suspension band training (TRXSBT) and game specific circuit training (GSCT) however, TRX suspension band training (TRXSBT) is better than game specific circuit training (GSCT). In response to game specific circuit (GSCT =4.52%), TRX suspension band (TRXSBT =2.03%) and combined training (CT= 4.36%)

men handball player's cardio-respiratory endurance was enhanced considerably. Though, game specific circuit training (GSCT) and combined training (CT) are superior to TRX suspension band training (TRXSBT) however, between game specific circuit training (GSCT) and combined training (CT) insignificant differences were observed.

REFERENCES

[1] Adeniji, B.A. (2007). "Comparative effects of circuit training programme on speed and power of pre- and post-menarchial girls African". *Journal of Educational Studies in Mathematics and Sciences,* 5: 35-42.
[2] Amr. S, (2008). The effect of the compound on the training and some physical changes of gene expression and the level of performance of my skills challenged the plane and attack the emerging fencing, *PhD thesis*, Faculty of Physical Education for Boys, Zagazig University.
[3] Brentano, MA, Cadore, EL, Da Silva, EM, Ambrosini, AB, Coertjens, M, Petkowicz, R, Viero, I, Kruel, LFM(2008), Physiological adaptations to strength and circuit training in postmenopausal women with bone loss, *J Strength Cond Res.,* 22(6): 1816-1825.
[4] Chtara M, Chaouachi A, Levin GT, Chaouachi M, Chamari K, Amri M, Laursen PB (2008) Effect of concurrent endurance and circuit resistance training sequence on muscular strength and power development, *J Strength Cond Res*., 22(4): 1037-45.
[5] Gettman, L. R., & Pollock, M. L. (1981). Circuit weight training: a critical review of its physiological benefits, *The Physician and Sports Medicine,* 9.
[6] Gorostiaga, EM, Granados, C, Ibanez, J, Gonzalez-Badillo, JJ, and Izquierdo, M. (2006). Effects of an entire season on physical fitness changes in elite male handball players. *Med Sci Sports Exerc.,* 38: 357–366.
[7] Hermassi, S, Chelly, MS, Fathloun, M, and Shephard, RJ. (2010). The effectof heavy- vs. moderate-load training on the development ofstrength, power, and throwing ball velocity in male handball players. *J Strength Cond Res.,* 24: 2408–2418.
[8] Hermassi, S, Chelly, MS, Tabka, Z, Shephard, RJ, and Chamari, K. (2011). Effects of 8-week in-season upper and lower limb heavy resistance training on the peak power, throwing velocity, and sprint performance of elite male handball players. *J Strength Cond Res.,* 25: 2424–2433.
[9] Kaikkonen H, *et al.,* (2000). The effect of heart rate controlled low resistance circuit weight training and endurance training on maximal aerobic power in sedentary adults, *Sc and J Med Sci Sports*. 10(4): 211-5.
[10] Kelemen, M. H., *et al.,* (1986). Circuit weight training in cardiac patients, *American College of Cardiology,* 7.
[11] LeMura, L.M., *et al.,* (2000). Lipid and lipoprotein profiles, cardiovascular fitness, body composition, and diet during and after resistance, aerobic and combination training in young women, *Eur J Appl Physiol.,* 82(5-6): 451-8.
[12] Pipes, T.V. (1977). Physiological responses of fire fighting recruits to high intensity training, *J Occup Med*., 19(2): 29 - 32.
[13] Povoas, SC, Seabra, AF, Ascensao, AA, Magalhaes, J, Soares, JM, and Rebelo, AN. (2012). Physical and physiological demands of elite team handball. *J Strength Cond Res.,* 26: 3365–3375.
[14] Scholich M. (1990). *Circuit Training for All Sports: Methodology of Effective Fitness Training*. Sport Books Publisher: Toronto.
[15] Schwesig, R, Hermassi, S, Fieseler, G, Irlenbusch, L, Noack, F,Delank, KS, Shephard, RJ, and Chelly, MS. (2016). Anthropometric and physical performance characteristics of professional handball players: Influence of playing position and competitive level. *J Sports Med Phys Fitness,* 3: 3.
[16] Shafeeq, V.A., Kanniyan, AS., Hassan, M.A., and Singh, J.P.S (2012). Effect of interval circuit training on motor fitness and volleyball skill performance of male volleyball players. *Int. J Health Physical Edu. Computer Sci. Sports.,* 5 (1): 52-54.
[17] Taskin and Halil (2009). Effect of circuit training on the sprint agility and anaerobic endurance. *Journal of Strength and Conditioning Research,* 23 (6). 1803-1810.
[18] Venkatachalapathy, R. (2006) "Effects of circuit training and par course training on selected physical fitness physiological and biochemical variables, *Unpublished Doctoral thesis,* Annamalai University.
[19] Vom Hofe. A, (1995). The problem of skill specificity in complex athletic tasks: a revisitation. *International Journal of Sport Psychology*, 26, pp:249-261.