CHAPTER IV

RESULTS AND DISCUSSION

4.1. OVERVIEW

The collected data is analysed and presented in this chapter. The purpose of the present study was to find out the effect of tabata interval methods of various durations on selected physiological and athletic performance variables of school students. To achieve this purpose, 45 male students who were selected from Navbharath Matric. Hr. Sec. School, Ponnaiyah Ramajayam Public Hr. Sec. School and St. Antony's Hr. Sec. School, Thanjavur, Tamil Nadu, India. The age of the subjects ranged between 15 and 17 years.

The study was formulated as a true random group design, consisting of pre test and post test. The selected subjects were divided into two experimental groups: Group I (**TTG1**) - Tabata Interval Training group (1: 1 (20 seconds active period : 20 seconds rest period)), Group II (**TTG2**) - Tabata Interval Training group (1: 0.5 (20 seconds active period : 10 seconds rest period)) and control group (**CG**) with fifteen subjects (n=15) each. The effect of the two independent variables namely TTG1 and TTG2 on body fat, VO_2max and resting heart rate as physiological variables and speed, speed endurance, agility, abdominal muscular endurance and muscular strength as athletic performance variables were investigated. The duration of the training period was six weeks and the number of sessions per week was confined to three. However, control group was not exposed to any specific training but they participated in the regular scheduled work.

All the subjects were tested on selected dependent variables prior to and after the treatment. The data pertaining to the variables in this study were examined by using

dependent t-test to find out significant changes and analysis of covariance (ANCOVA) for each variable separately in order to determine the differences if any among the adjusted post test means. Whenever 'F' ratio for the adjusted post-test was found to be significant, the Scheffe's test was used as post-hoc test to determine the three paired mean differences. The level of significance was fixed at 0.05 level of confidence in all the cases.

4.2. TEST OF SIGNIFICANCE

Statistical significance is used in hypothesis testing, whereby the null hypothesis (that there is no relationship between variables) is tested. A level of significance is selected (most commonly alpha = 0.05 or 0.01), which signifies the probability of incorrectly rejecting a true null hypothesis. (**Polit and Beck, 2012**) If there is a significant difference between two groups at alpha = 0.05, it means there is only a 5% probability that the difference between the groups is due to chance; it gives no indication of the magnitude or clinical importance of the difference. (**Haase, Ellis and Ladany, 1989**). When statistically significant results are achieved, they favour rejection of the null hypothesis, but they do not prove that the null hypothesis is false. Likewise, non-significant results do not prove that the null hypothesis is true; they also give no evidence of the truth or falsity of the hypothesis the researcher has generated. (**Polit and Beck, 2012**). Statistical significance relates only to the likelihood that results obtained were not due to chance.

This is the vital portion of the thesis for achieving the conclusion by examining the hypothesis. The procedure of testing the hypothesis was either by accepting the hypothesis or rejecting the same in accordance with the results obtained in relation to the level of confidence.

The test was usually called the test of significance since one can test whether the difference between the three groups or within many groups the scores were significant or not. In this study, however, the obtained F value was greater than the table value, the hypothesis was accepted to the effect that there existed significant difference among the means of the groups compared and if obtained F value was lesser than the table value, then the hypothesis was rejected to the effect that there existed no significant difference among the means of the groups under study.

4.2.1. LEVEL OF SIGNIFICANCE

The purpose of this study was to find out effect of tabata interval methods of various durations on selected physiological and athletic performance variables of school students. The collected data pertaining to the dependent variables in this study were examined by using dependent t-test to find out significant improvement between pre and post tests and the analysis of covariance (ANCOVA) to find out the significant differences if any among the groups on selected criterion variables separately. In all the cases, 0.05 level of confidence was fixed to test of significance which was considered as appropriate for this study.

4.3. COMPUTATION OF DEPENDENT 't' TEST, ANALYSIS OF COVARIANCE AND SCHEFFE'S POST HOC TEST ON BODY FAT

The analysis of dependent 't' test on the data obtained for **body fat** of the pre-test and post-test means of TTG1, TTG2 and CG has been analysed and presented in Table VI.

TABLE VI

SUMMARY OF MEAN STANDARD DEVIATION AND DEPENDENT 't' TEST FOR THE PRE AND POST TESTS ON BODY FAT OF EXPERIMENTAL AND CONTROL GROUPS

(**Body fat** scores are expressed in Percentage)

		TTG1	TTG2	CG
Pre test	Mean	20.342	20.612	20.503
	SD	1.055	1.375	1.814
Post test	Mean	19.015	18.049	20.470
	SD	1.594	1.653	1.821
't' test		3.986*	9.580*	1.083

*Significant at .05 level. The table value required for .05 level of significance with df 14 is 1.761.

4.3.1. Results of Dependent 't' Test on Body Fat

Table VI shows that the pre-test mean values of TTG1, TTG2 and CG on **body fat** are 20.342, 20.612 and 20.503 respectively and the post-test mean values on **body fat** are 19.015, 18.049 and 20.470 respectively. The obtained dependent t-ratio values between the pre and post test means of TTG1, TTG2 and CG on **body fat** are 3.986, 9.580 and 1.083 respectively. The table value required for significant difference with df 14 at .05 level is 1.761. Since, the obtained 't' ratio values of experimental groups are greater than the table value, it is understood that TTG1 and TTG2 had significantly reduced the **body fat**. However, the control group had not significantly

reduced the **body fact**. The obtained 't' value for the control group is less than the table value as they were not subjected to any specific training.

The analysis of covariance on **body fat** of TTG1, TTG2 and CG were analysed and presented in Table VII.

TABLE VII

ANALYSIS OF COVARIANCE FOR THE DATA ON BODY FAT AMONG EXPERIMENTAL AND CONTROL GROUPS

Adjusted Post Test Means			Sources of Variance	Sum of Squares	df	Mean Squares	F-Ratio
TTG1	TTG2	CG					
19.151	17.929	20.454	Between	47.789	2	23.894	23.894*
			Within	41.000	41	1.000	

* Significant at 0.05 level of confidence.
The table value for significance at 0.05 with df 2 and 41 is 3.23.

4.3.2. Results of Analysis of Covariance on Body Fat

Table VII shows that the adjusted post-test means of TTG1, TTG2 and CG on **body fat** are 19.151, 17.929 and 20.454 respectively. The obtained F-ratio value is 23.894, which is higher than the table value 3.23 with df 2 and 41 required for significance at .05 level. Since the value of F-ratio is higher than the table value, it indicates that there exist significant differences among the adjusted post-test means of TTG1, TTG2 and CG. To find out which of the paired means had a significant difference on **body fat**, the Scheffe's post-hoc test was applied and the results are presented in Table VIII.

TABLE VIII

SCHEFFE'S TEST FOR THE DIFFERENCES BETWEEN THE ADJUSTED POST TEST PAIRED MEANS OF BODY FAT

TTG1	TTG2	CG	Mean Difference	Confidential Interval
19.151	17.929		1.222*	0.927
19.151		20.454	1.303*	0.927
	17.929	20.454	2.525*	0.927

*Significant at .05 level.

4.3.3. Results of Scheffe's Test on Body Fat

The table VIII shows that the adjusted post test mean difference on **body fat** between TTG1 and TTG2, TTG1 and CG and between TTG2 and CG are 1.222, 1.303 and 2.525 respectively which are higher than the confidence interval value of 0.927 at .05 level of confidence.

The pre and post test mean values of TTG1, TTG2 and CG on **body fat** are graphically represented in figure 1.

The adjusted post test mean values of TTG1, TTG2 and CG on **body fat** are graphically represented in figure 2.

FIGURE 1

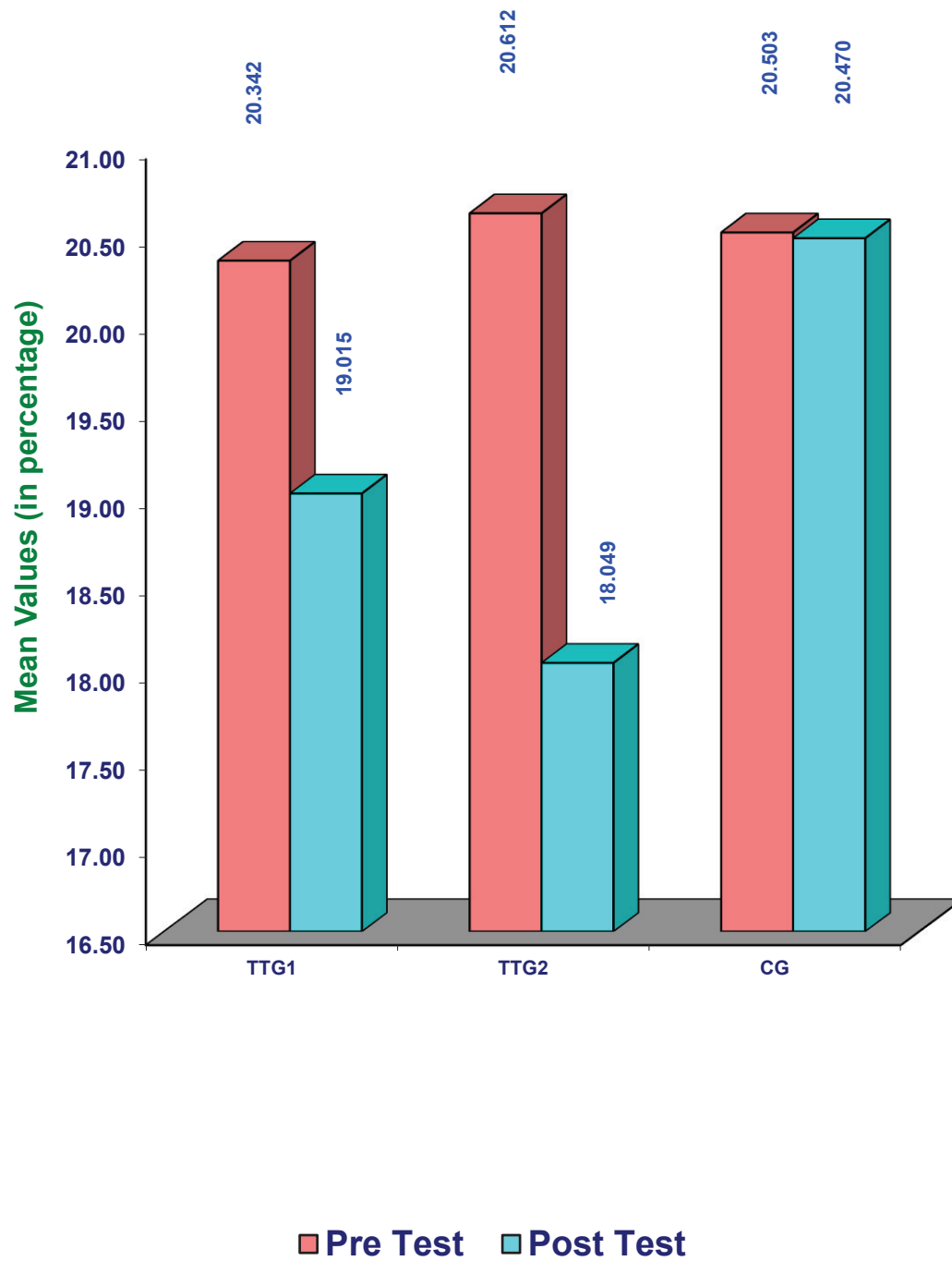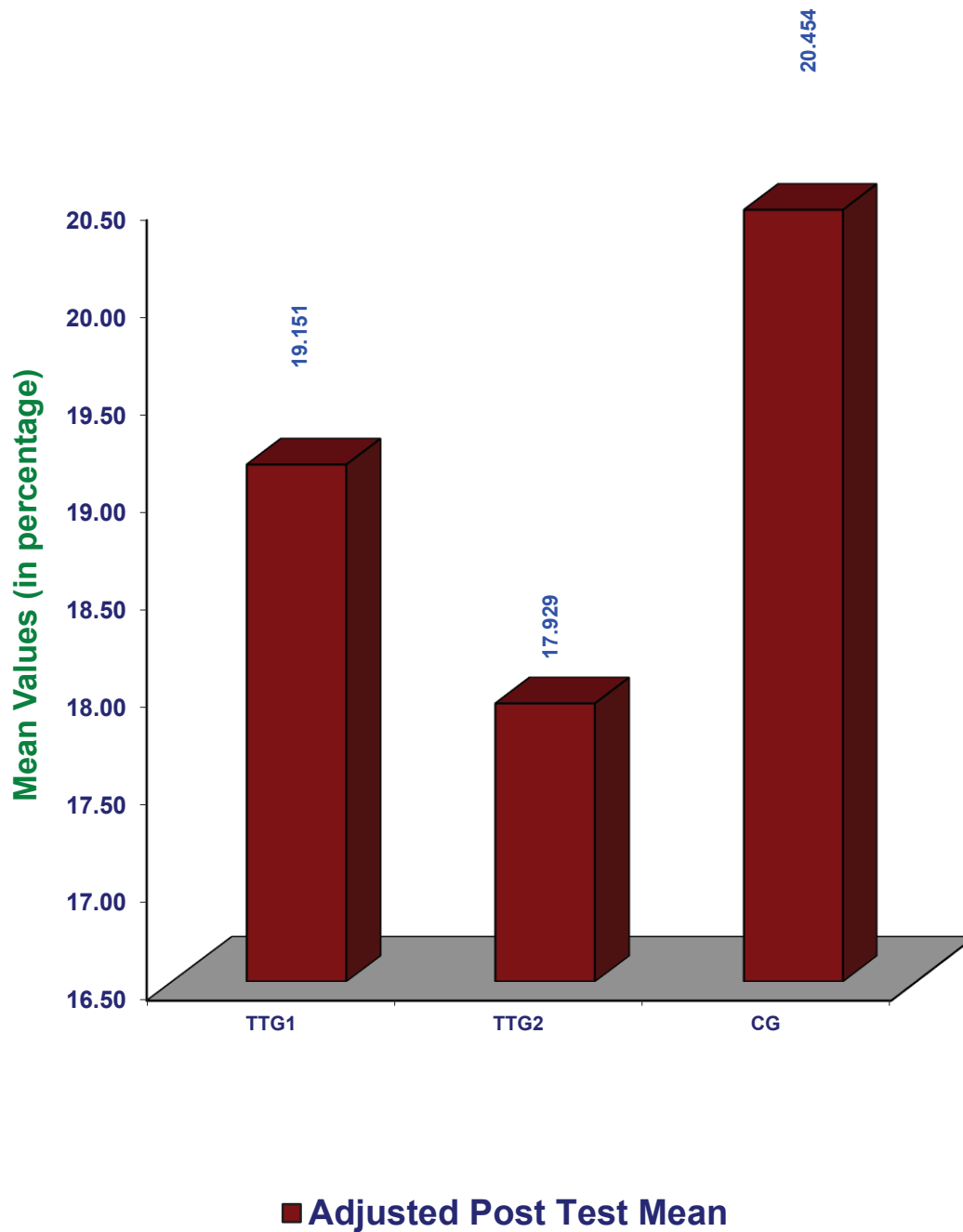**PRE TEST AND POST TEST MEAN VALUES OF TTG1, TTG2 AND CG ON BODY FAT**

FIGURE 2

ADJUSTED POST TEST MEAN VALUES OF TTG1, TTG2 AND CG ON BODY FAT

4.3.4. Discussion on Findings on Body Fat

The result of the study indicates that both the experimental groups significantly differed when compared to the control group on **body fat**. However, it is further revealed that the experimental group namely TTG1 and TTG2 had reduced **body fat** better than the control group (CG) but TTG2 had reduced **body fat** better than the other two groups.

Baquet, et al., (2002) suggested that after seven weeks of HIIT training the experimental group significantly improved absolute peak VO_2 and VO_2 peak relative to body mass. The result of the findings the present study also incorporated with the findings of **Buchheit and Laursen (2013); Helgerud**, **et al., (2007); Esfarjani and Laursen, (2007);** and **Burgomaster, et al., (2005)**. **Tabata, et al., (1997),** in their study, stated that Tabata interval protocol with 20:10 seconds exercise-to-rest ratio at 170% of VO_2max had the highest average power, average RPE, average sRPE, average %HRR, average HLa (blood lactate accumulation). The result of findings of the present study also supported with the results of **Salassi, et al., (2014); Gosselin, et al., (2012)** and **Harbin, (2014). Boutcher (2011)** concluded that high intensity intermittent exercise induced body fat loss. The present findings also very well sustained by the researchers **Tremblay, et al., (1994); Smith-Ryan, Melvin and Wingfield (2015); Hasan, et al., (2014); Perry, et al., (2008); Schoenfeld, et al., (2009); Hrazdíra, et al., (2014)**   and **Costigan, et al., (2015)**.

4.4. COMPUTATION OF DEPENDENT 't' TEST, ANALYSIS OF COVARIANCE AND SCHEFFE'S POST HOC TEST ON VO₂MAX

The analysis of dependent 't' test on the data obtained for **VO$_2$max** of the pre-test and post-test means of TTG1, TTG2 and CG has been analysed and presented in Table IX.

TABLE IX

SUMMARY OF MEAN STANDARD DEVIATION AND DEPENDENT 't' TEST FOR THE PRE AND POST TESTS ON VO$_2$MAX OF EXPERIMENTAL AND CONTROL GROUPS

(**VO$_2$max** scores are expressed in ml/Kg/min)

		TTG1	TTG2	CG
Pre test	Mean	32.826	32.960	32.693
	SD	1.585	1.601	1.458
Post test	Mean	33.817	34.494	32.921
	SD	1.556	1.471	1.636
't' test		5.520*	13.739*	0.808

*Significant at .05 level. The table value required for .05 level of significance with df 14 is 1.761.

4.4.1. Results of Dependent 't' Test on VO₂max

Table IX shows that the pre-test mean values of TTG1, TTG2 and CG on **VO$_2$max** are 32.826, 32.960 and 32.693 respectively and the post-test mean values on **VO$_2$max** are 33.817, 34.494 and 32.921 respectively. The obtained dependent t-ratio values between the pre and post test means of TTG1, TTG2 and CG on **VO$_2$max** are 5.520, 13.739 and 0.808 respectively. The table value required for significant difference with df 14 at .05 level is 1.761. Since, the obtained 't' ratio values of experimental groups are greater than the table value, it is understood that TTG1 and TTG2 had significantly improved the performance of **VO$_2$max**. However, the control group had not

significantly improved the **VO₂max**. The obtained 't' value for the control group is less than the table value as they were not subjected to any specific training.

The analysis of covariance on **VO₂max** of TTG1, TTG2 and CG were analysed and presented in Table X.

TABLE X

ANALYSIS OF COVARIANCE FOR THE DATA ON VO₂MAX AMONG EXPERIMENTAL AND CONTROL GROUPS

Adjusted Post Test Means			Sources of Variance	Sum of Squares	df	Mean Squares	F-Ratio
TTG1	TTG2	CG					
33.818	34.368	33.046	Between	13.161	2	6.581	22.252*
			Within	12.125	41	0.296	

* Significant at 0.05 level of confidence.
The table value for significance at 0.05 with df 2 and 41 is 3.23.

4.4.2. Results of Analysis of Covariance on VO₂max

Table X shows that the adjusted post-test means of TTG1, TTG2 and CG on **VO₂max** are 33.818, 34.368 and 33.046 respectively. The obtained F-ratio value is 22.252, which is higher than the table value 3.23 with df 2 and 41 required for significance at .05 level. Since the value of F-ratio is higher than the table value, it indicates that there exist significant differences among the adjusted post-test means of TTG1, TTG2 and CG. To find out which of the paired means had a significant difference on **VO₂max**, the Scheffe's post-hoc test was applied and the results are presented in Table XI.

TABLE XI

SCHEFFE'S TEST FOR THE DIFFERENCES BETWEEN THE ADJUSTED POST TEST PAIRED MEANS OF VO$_2$MAX

TTG1	TTG2	CG	Mean Difference	Confidential Interval
33.818	34.368		0.550*	0.504
33.818		33.046	0.772*	0.504
	34.368	33.046	1.322*	0.504

*Significant at .05 level.

4.4.3. Results of Scheffe's Test on VO$_2$max

The table XI shows that the adjusted post test mean difference on **VO$_2$max** between TTG1 and TTG2, TTG1 and CG and between TTG2 and CG are 0.550, 0.772 and 1.322 respectively which are higher than the confidence interval value of 0.504 at .05 level of confidence.

The pre and post test mean values of TTG1, TTG2 and CG on **VO$_2$max** are graphically represented in figure 3.

The adjusted post test mean values of TTG1, TTG2 and CG on **VO$_2$max** are graphically represented in figure 4.

FIGURE 3

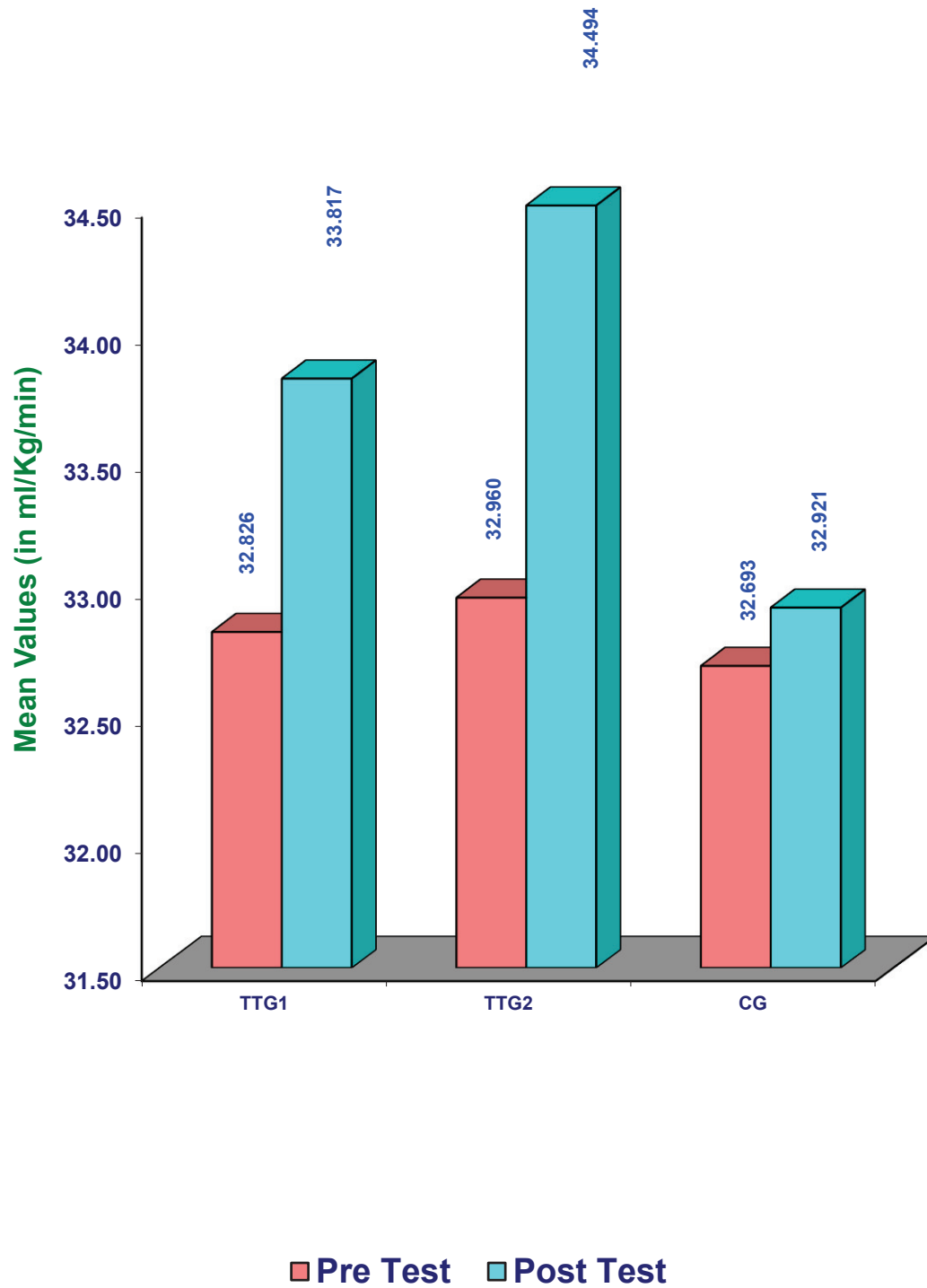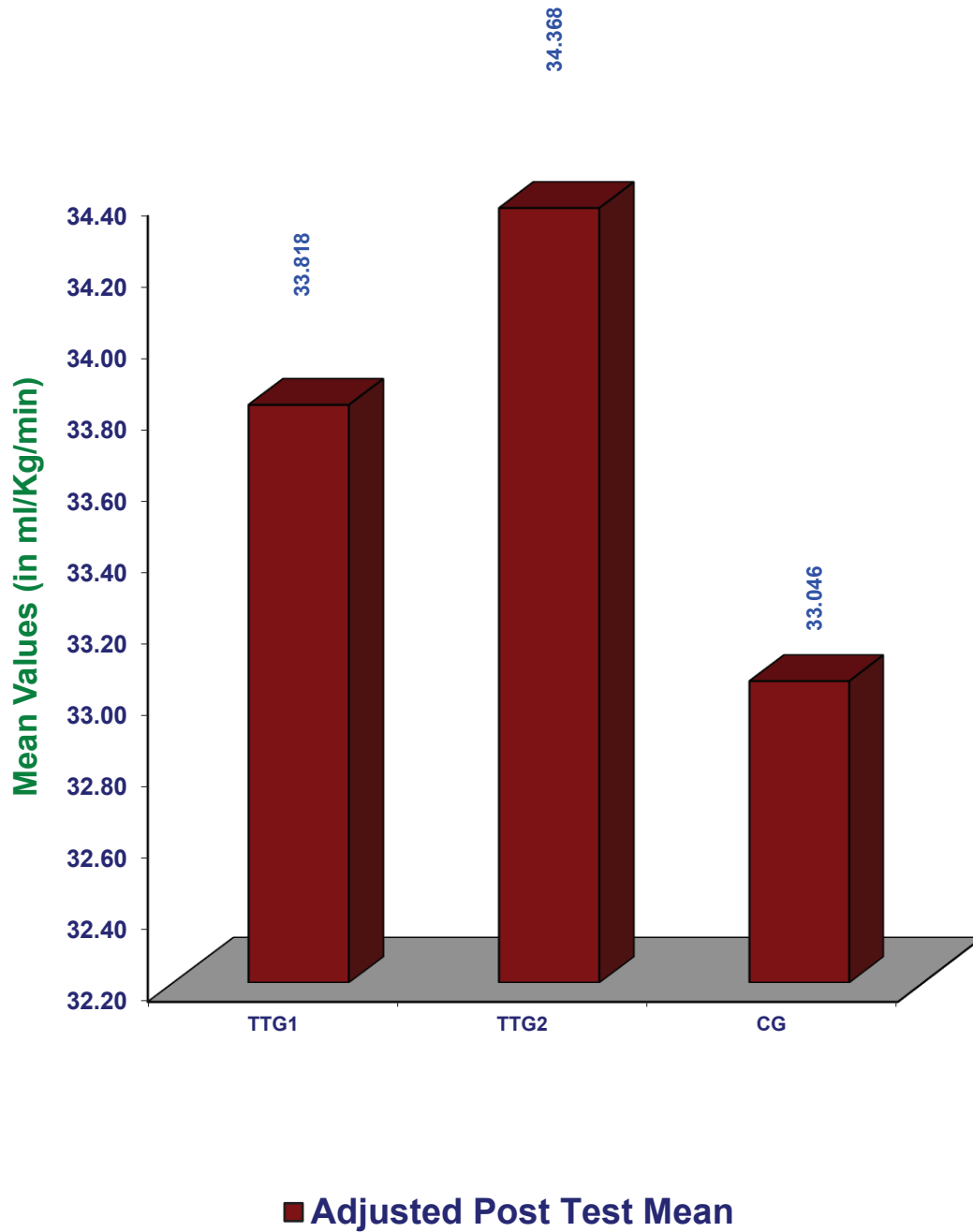## PRE TEST AND POST TEST MEAN VALUES OF TTG1, TTG2 AND CG ON VO$_2$MAX

Pre Test   **Post Test**

FIGURE 4

ADJUSTED POST TEST MEAN VALUES OF TTG1, TTG2 AND CG ON VO$_2$MAX

4.4.4. Discussion on Findings on VO$_2$max

The result of the study indicates that both the experimental groups significantly differed when compared to the control group on **VO$_2$max**. However, it is further revealed that the experimental group namely TTG1 and TTG2 had improved the performance of **VO$_2$max** better than the control group (CG) but TTG2 had improved the performance of **VO$_2$max** better than the other two groups.

Billat, et al., (2001) suggested that short interval-training of 15s-15s at 90-80 and 100-70% v VO$_2$ max proved to be the most efficient in stimulating the oxygen consumption to its highest level in healthy middle-aged long-distance runners used to doing only long slow distance-training. The findings of the present investigation is also supported with the findings of **Helgerud**, **et al., (2007); Rozenek, et al., (2007)**. The findings of the present investigation is also supported with the findings of **Tabata, et al., (1997)** who suggested that intermittent exercise defined by the Intermittent Exercise protocol (20s exercise with a rest 10s) may tax both the anaerobic and aerobic energy releasing systems almost maximally. **Tabata et al., (1996)** concluded that after HIIT training period, VO$_2$max increased by 7 ml/Kg/min. The present study also revealed that after 6 weeks of tabata interval methods of various durations increased VO$_2$max significantly. The result of present investigation also supported by the researchers **Natasha Carr (2011); Helgerud, et al., (2006); MacDougall, et al., (1998); Wakefield and Glaister (2009); Tabata, et al., (1995); Astorino, et al., (2012); Dunham and Harms (2012)** and **Fernandez-Fernandez, et al., (2012).**

4.5. COMPUTATION OF DEPENDENT 't' TEST, ANALYSIS OF COVARIANCE AND SCHEFFE'S POST HOC TEST ON RESTING HEART RATE

The analysis of dependent 't' test on the data obtained for **resting heart rate** of the pre-test and post-test means of TTG1, TTG2 and CG has been analysed and presented in Table XII.

TABLE XII

SUMMARY OF MEAN STANDARD DEVIATION AND DEPENDENT 't' TEST FOR THE PRE AND POST TESTS ON RESTING HEART RATE OF EXPERIMENTAL AND CONTROL GROUPS

(**Resting Heart Rate** scores are expressed in beats per minute)

		TTG1	TTG2	CG
Pre test	Mean	69.400	69.800	69.667
	SD	1.404	0.862	1.234
Post test	Mean	68.400	67.667	69.733
	SD	1.404	1.543	1.624
't' test		4.183*	8.631*	0.775

*Significant at .05 level. The table value required for .05 level of significance with df 14 is 1.761.

4.5.1. Results of Dependent 't' Test on resting heart rate

Table XII shows that the pre-test mean values of TTG1, TTG2 and CG on **resting heart rate** are 69.400, 69.800 and 69.667 respectively and the post-test mean values on **resting heart rate** are 68.400, 67.667 and 69.733 respectively. The obtained dependent t-ratio values between the pre and post test means of TTG1, TTG2 and CG on **resting heart rate** are 4.183, 8.631 and 0.775 respectively. The table value required for significant difference with df 14 at .05 level is 1.761. Since, the obtained 't' ratio values of experimental groups are greater than the table value, it is understood that TTG1 and TTG2 had significantly reduced the **resting heart rate**. However, the control group had

not significantly reduced the **resting heart rate**. The obtained 't' value for the control group is less than the table value as they were not subjected to any specific training.

The analysis of covariance on **resting heart rate** of TTG1, TTG2 and CG were analysed and presented in Table XIII.

TABLE XIII

ANALYSIS OF COVARIANCE FOR THE DATA ON RESTING HEART RATE AMONG EXPERIMENTAL AND CONTROL GROUPS

Adjusted Post Test Means			Sources of Variance	Sum of Squares	df	Mean Squares	F-Ratio
TTG1	**TTG2**	**CG**					
68.618	67.492	69.690	Between	36.142	2	18.071	18.228*
			Within	40.647	41	0.991	

* Significant at 0.05 level of confidence.
The table value for significance at 0.05 with df 2 and 41 is 3.23.

4.5.2. Results of Analysis of Covariance on resting heart rate

Table XIII shows that the adjusted post-test means of TTG1, TTG2 and CG on **resting heart rate** are 68.618, 67.492 and 69.690 respectively. The obtained F-ratio value is 18.228, which is higher than the table value 3.23 with df 2 and 41 required for significance at .05 level. Since the value of F-ratio is higher than the table value, it indicates that there exist significant differences among the adjusted post-test means of TTG1, TTG2 and CG. To find out which of the paired means had a significant difference on **resting heart rate**, the Scheffe's post-hoc test was applied and the results are presented in Table XIV.

TABLE XIV

SCHEFFE'S TEST FOR THE DIFFERENCES BETWEEN THE ADJUSTED POST TEST PAIRED MEANS OF RESTING HEART RATE

TTG1	TTG2	CG	Mean Difference	Confidential Interval
68.618	67.492		1.126*	0.923
68.618		69.690	1.071*	0.923
	67.492	69.690	2.198*	0.923

*Significant at .05 level.

4.5.3. Results of Scheffe's Test on resting heart rate

The table XIV shows that the adjusted post test mean difference on **resting heart rate** between TTG1 and TTG2, TTG1 and CG and between TTG2 and CG are 1.126, 1.071 and 2.198 respectively which are higher than the confidence interval value of 0.923 at .05 level of confidence.

The pre and post test mean values of TTG1, TTG2 and CG on **resting heart rate** are graphically represented in figure 5.

The adjusted post test mean values of TTG1, TTG2 and CG on **resting heart rate** are graphically represented in figure 6.

FIGURE 5

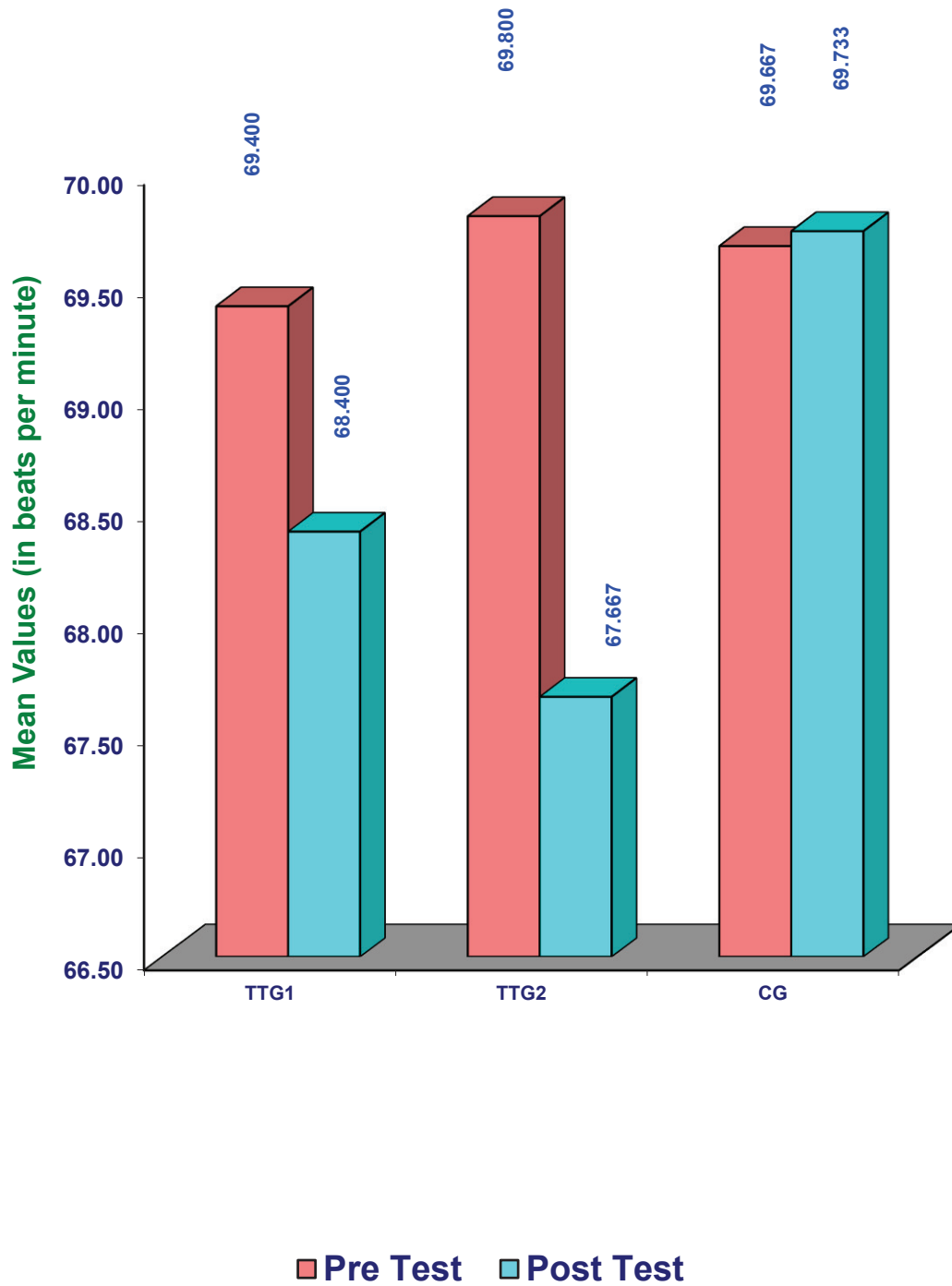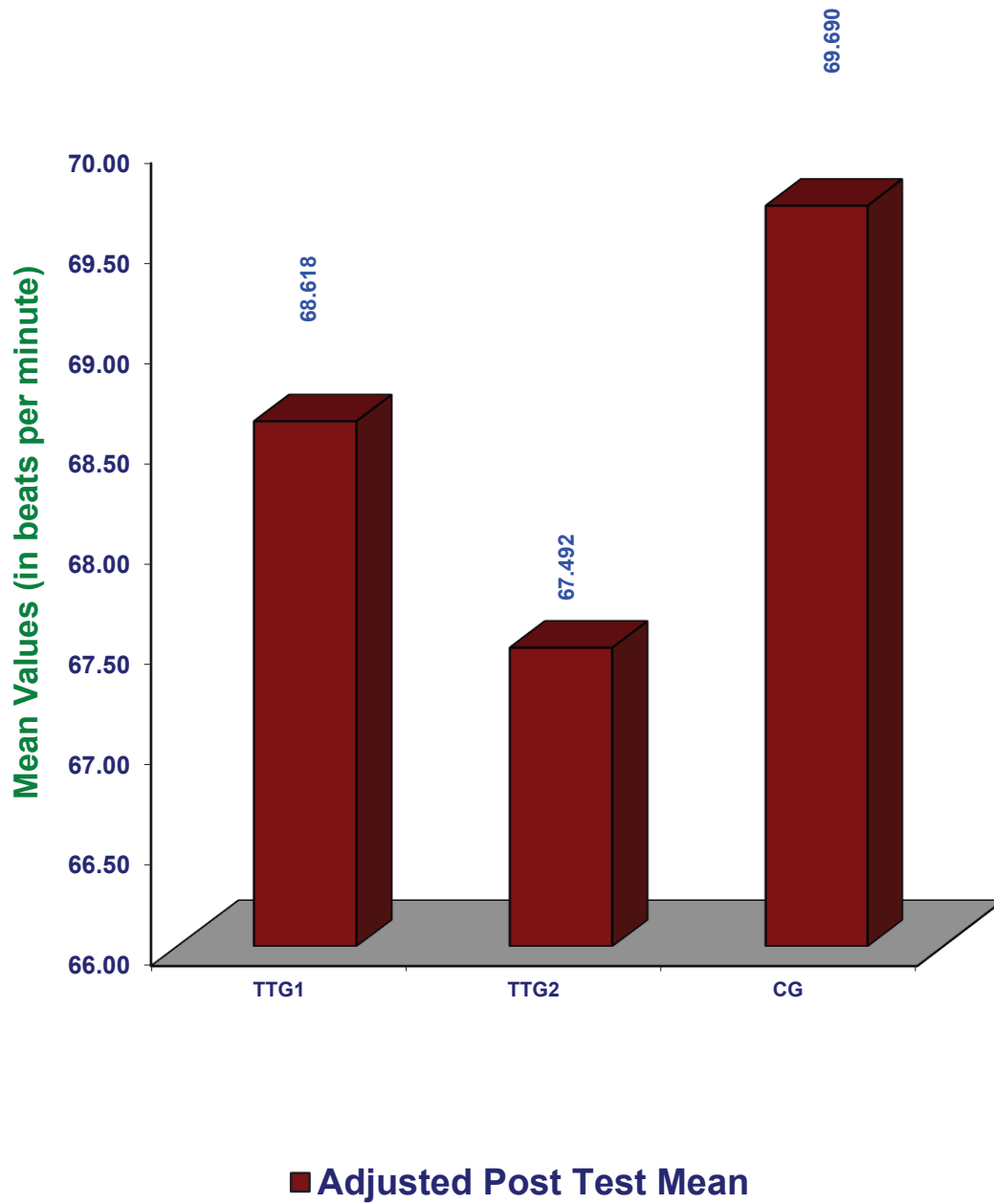## PRE TEST AND POST TEST MEAN VALUES OF TTG1, TTG2 AND CG ON RESTING HEART RATE

FIGURE 6

ADJUSTED POST TEST MEAN VALUES OF TTG1, TTG2 AND CG ON RESTING HEART RATE

4.5.4. Discussion on Findings on resting heart rate

The result of the study indicates that both the experimental groups significantly differed when compared to the control group on **resting heart rate.** However, it is further revealed that the experimental group namely TTG1 and TTG2 had improved the performance of **resting heart rate** better than the control group (CG) but TTG2 had improved the performance of **resting heart rate** better than the other two groups.

The findings of the present study also supported with the findings of **Burgomaster, et al., (2005)** who concluded that completing four sets of three, 20-second sprints with 20-second recoveries (1:1 W/R), separated by 4-minute intervals, three days per week, HRE was reduced by 3.7 ± 0.3 scale points ($p < 0.001$) and post training HR was 12.5 ± 1.0 bpm ($p < 0.001$) lower than pre training values. **Astorino, et al., (2012)** in their study concluded that HIIT improving resting heart rate. The present findings also very well incorporated by the researchers **Tsutsumi, et al., (1997)** and **Mandana Gholami, et al., (2013).**

4.6. COMPUTATION OF DEPENDENT 't' TEST, ANALYSIS OF COVARIANCE AND SCHEFFE'S POST HOC TEST ON SPEED

The analysis of dependent 't' test on the data obtained for **speed** of the pre-test and post-test means of TTG1, TTG2 and CG has been analysed and presented in Table XV.

TABLE XV

SUMMARY OF MEAN STANDARD DEVIATION AND DEPENDENT 't' TEST FOR THE PRE AND POST TESTS ON SPEED OF EXPERIMENTAL AND CONTROL GROUPS

(**Speed** scores are expressed in seconds)

		TTG1	TTG2	CG
Pre test	Mean	8.015	7.943	7.946
	SD	0.242	0.223	0.264
Post test	Mean	7.587	7.292	7.920
	SD	0.385	0.162	0.259
't' test		5.972*	11.007*	1.052

*Significant at .05 level. The table value required for .05 level of significance with df 14 is 1.761.

4.6.1. Results of Dependent 't' Test on speed

Table XV shows that the pre-test mean values of TTG1, TTG2 and CG on **speed** are 8.015, 7.943 and 7.946 respectively and the post-test mean values on **speed** are 7.587, 7.292 and 7.920 respectively. The obtained dependent t-ratio values between the pre and post test means of TTG1, TTG2 and CG on **speed** are 5.972, 11.007 and 1.052 respectively. The table value required for significant difference with df 14 at .05 level is 1.761. Since, the obtained 't' ratio values of experimental groups are greater than the table value, it is understood that TTG1 and TTG2 had significantly improved the performance of the **speed**. However, the control group had not significantly improved

the performance of **speed**. The obtained 't' value for the control group is less than the table value as they were not subjected to any specific training.

The analysis of covariance on **speed** of TTG1, TTG2 and CG were analysed and presented in Table XVI.

TABLE XVI

ANALYSIS OF COVARIANCE FOR THE DATA ON SPEED AMONG EXPERIMENTAL AND CONTROL GROUPS

Adjusted Post Test Means			Sources of Variance	Sum of Squares	df	Mean Squares	F-Ratio
TTG1	TTG2	CG					
7.555	7.309	7.935	Between	2.986	2	1.493	28.407
			Within	2.155	41	0.053	

* Significant at 0.05 level of confidence.
The table value for significance at 0.05 with df 2 and 41 is 3.23.

4.6.2. Results of Analysis of Covariance on speed

Table XVI shows that the adjusted post-test means of TTG1, TTG2 and CG on **speed** are 7.555, 7.309 and 7.935 respectively. The obtained F-ratio value is 28.407, which is higher than the table value 3.23 with df 2 and 41 required for significance at .05 level. Since the value of F-ratio is higher than the table value, it indicates that there exist significant differences among the adjusted post-test means of TTG1, TTG2 and CG. To find out which of the paired means had a significant difference on **speed**, the Scheffe's post-hoc test was applied and the results are presented in Table XVII.

TABLE XVII

SCHEFFE'S TEST FOR THE DIFFERENCES BETWEEN THE ADJUSTED POST TEST PAIRED MEANS OF SPEED

TTG1	TTG2	CG	Mean Difference	Confidential Interval
7.555	7.309		0.245*	0.213
7.555		7.935	0.381*	0.213
	7.309	7.935	0.626*	0.213

*Significant at .05 level.

4.6.3. Results of Scheffe's Test on speed

The table XVII shows that the adjusted post test mean difference on **speed** between TTG1 and TTG2, TTG1 and CG and between TTG2 and CG are 0.245, 0.381 and 0.626 respectively which are higher than the confidence interval value of 0.213 at .05 level of confidence.

The pre and post test mean values of TTG1, TTG2 and CG on **speed** are graphically represented in figure 7.

The adjusted post test mean values of TTG1, TTG2 and CG on **speed** are graphically represented in figure 8.

FIGURE 7

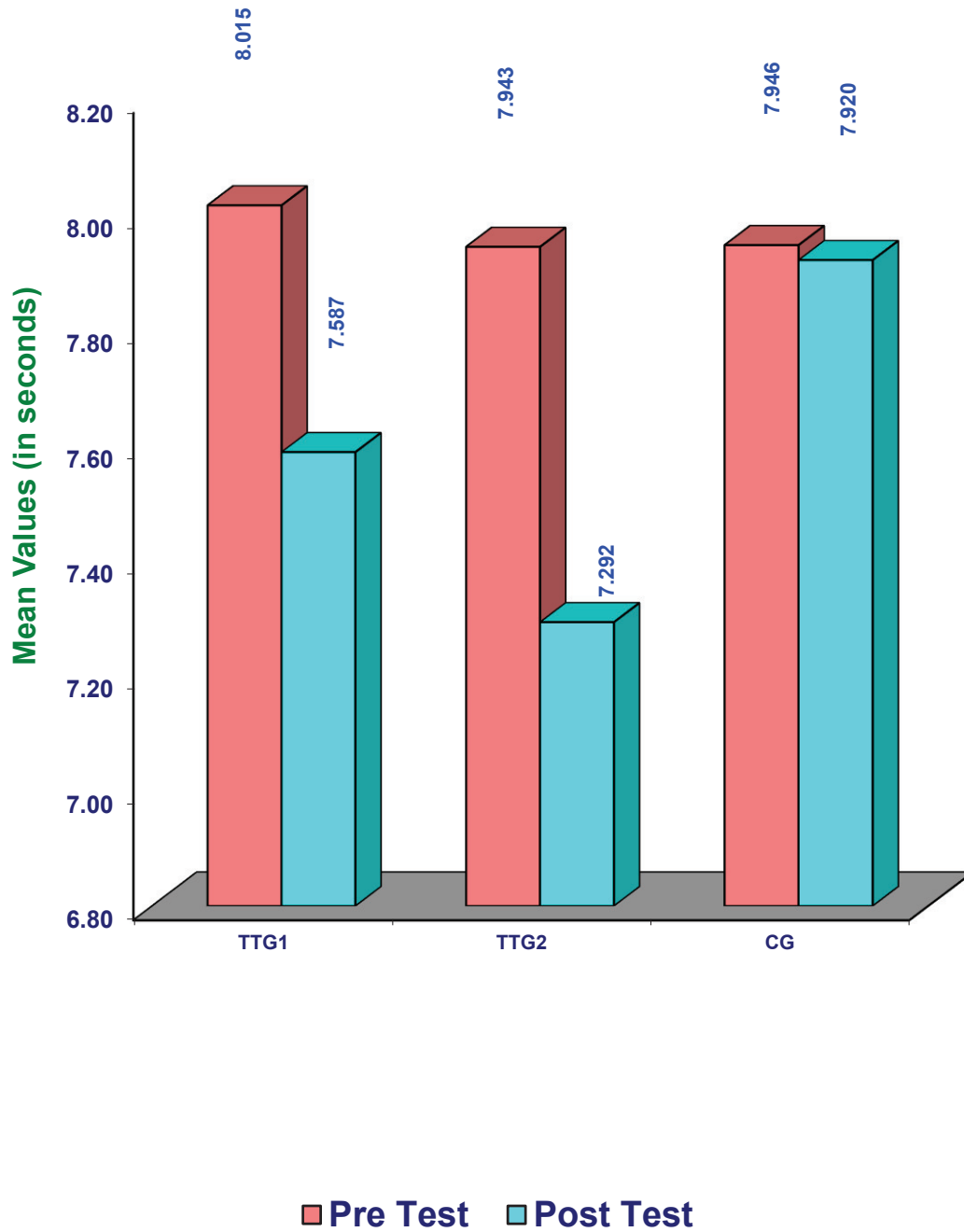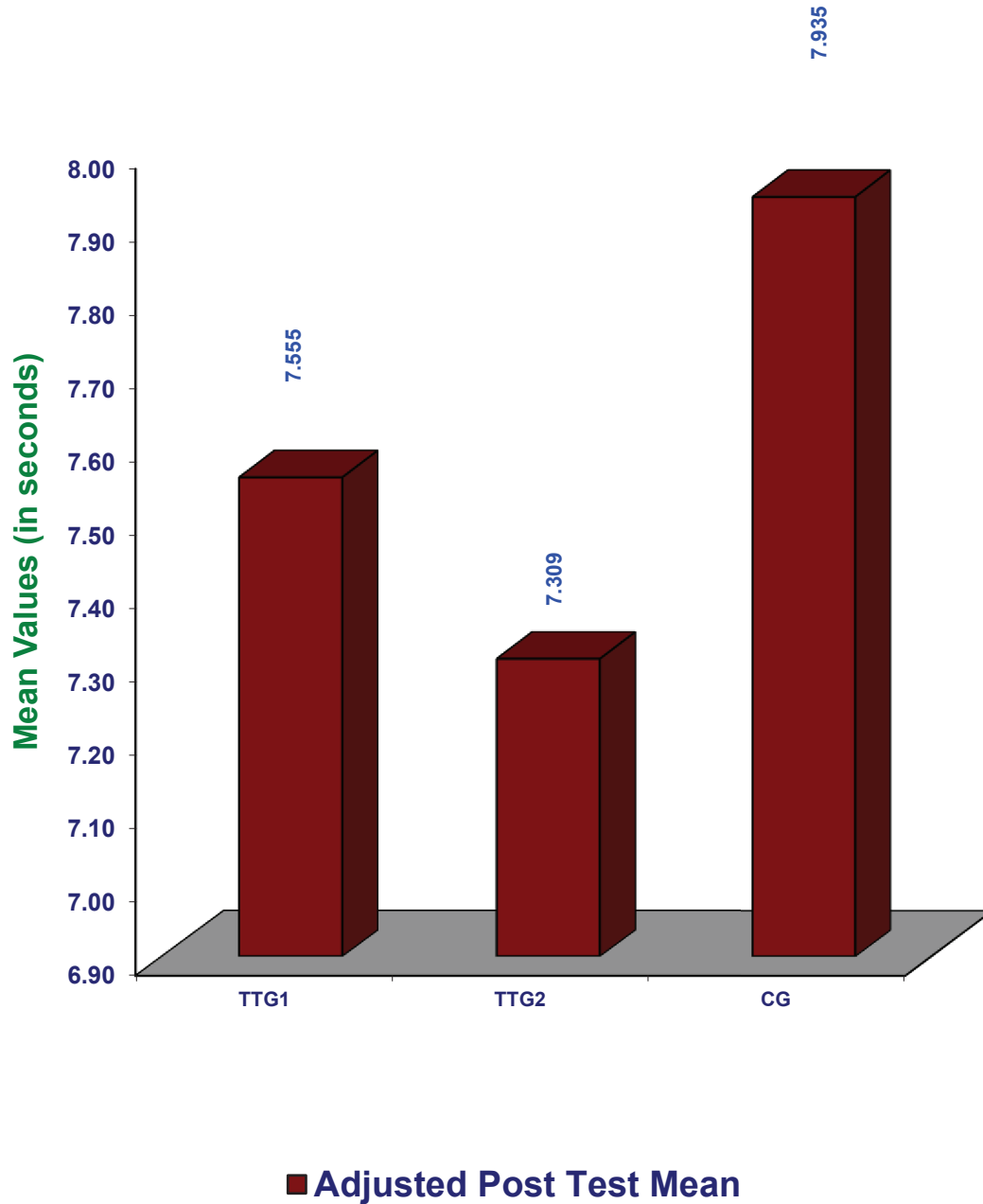**PRE TEST AND POST TEST MEAN VALUES OF TTG1, TTG2 AND CG ON SPEED**

FIGURE 8

ADJUSTED POST TEST MEAN VALUES OF TTG1, TTG2 AND CG ON SPEED

4.6.4. Discussion on Findings on speed

The result of the study indicates that both the experimental groups significantly differed when compared to the control group on **speed.** However, it is further revealed that the experimental group namely TTG1 and TTG2 had improved the performance of **speed** better than the control group (CG) but TTG2 had improved the performance of **speed** better than the other two groups.

According to **Giannaki et al., (2015)** eight weeks of combined group--based HIIT and conventional training improve various physical fitness parameters and reduce both total and visceral fat levels. The present findings also very well concurrence with the findings of **Buchheit and Laursen (2013)** who stated that from work/relief interval manipulation (1:1 W/R) to HIT periodization, using different examples of training cycles from different sports, with continued reference to anaerobic glycolytic contribution and neuromuscular/musculoskeletal load. The present findings also very well concurrence with the findings of **Harbin (2014)** who stated that tabata interval training, despite being associated with higher HLa, %HRR and RPE, elicits similar improvements in anaerobic and aerobic capacity. The present study also revealed that after 6 weeks of tabata interval methods of various durations significantly improved the performance of speed. The present findings also concurrence with the researchers **Kohn, et al., (2011); Soulas, et al., (2005); Zacharogiannis, et al., (2003)** and **Velmurugan and Kalimuthu (2011).**

4.7. COMPUTATION OF DEPENDENT 't' TEST, ANALYSIS OF COVARIANCE AND SCHEFFE'S POST HOC TEST ON SPEED ENDURANCE

The analysis of dependent 't' test on the data obtained for **speed endurance** of the pre-test and post-test means of TTG1, TTG2 and CG has been analysed and presented in Table XVIII.

TABLE XVIII

SUMMARY OF MEAN STANDARD DEVIATION AND DEPENDENT 't' TEST FOR THE PRE AND POST TESTS ON SPEED ENDURANCE OF EXPERIMENTAL AND CONTROL GROUPS

(**Speed endurance** scores are expressed in seconds)

		TTG1	TTG2	CG
Pre test	Mean	17.451	17.797	17.698
	SD	0.632	0.987	0.761
Post test	Mean	16.951	16.905	17.718
	SD	0.746	1.100	0.730
't' test		5.129*	6.312*	1.039

***Significant at .05 level. The table value required for .05 level of significance with df 14 is 1.761.

4.7.1. Results of Dependent 't' Test on speed endurance

Table XVIII shows that the pre-test mean values of TTG1, TTG2 and CG on **speed endurance** are 17.451, 17.797 and 17.698 respectively and the post-test mean values on **speed endurance** are 16.951, 16.905 and 17.718 respectively. The obtained dependent t-ratio values between the pre and post test means of TTG1, TTG2 and CG on **speed endurance** are 5.129, 6.312 and 1.039 respectively. The table value required for significant difference with df 14 at .05 level is 1.761. Since, the obtained 't' ratio values of experimental groups are greater than the table value, it is understood that TTG1 and TTG2 had significantly improved the performance of the **speed endurance**. However,

the control group had not significantly improved the performance of **speed endurance**. The obtained 't' value for the control group is less than the table value as they were not subjected to any specific training.

The analysis of covariance on **speed endurance** of TTG1, TTG2 and CG were analysed and presented in Table XIX.

TABLE XIX

ANALYSIS OF COVARIANCE FOR THE DATA ON SPEED ENDURANCE AMONG EXPERIMENTAL AND CONTROL GROUPS

Adjusted Post Test Means			Sources of Variance	Sum of Squares	df	Mean Squares	F-Ratio
TTG1	TTG2	CG					
17.147	16.758	17.669	Between	6.260	2	3.130	23.595*
			Within	5.438	41	0.133	

* Significant at 0.05 level of confidence.
The table value for significance at 0.05 with df 2 and 41 is 3.23.

4.7.2. Results of Analysis of Covariance on speed endurance

Table XIX shows that the adjusted post-test means of TTG1, TTG2 and CG on **speed endurance** are 17.147, 16.758 and 17.669 respectively. The obtained F-ratio value is 23.595, which is higher than the table value 3.23 with df 2 and 41 required for significance at .05 level. Since the value of F-ratio is higher than the table value, it indicates that there exist significant differences among the adjusted post-test means of TTG1, TTG2 and CG. To find out which of the paired means had a significant difference on **speed endurance**, the Scheffe's post-hoc test was applied and the results are presented in Table XX.

TABLE XX

SCHEFFE'S TEST FOR THE DIFFERENCES BETWEEN THE ADJUSTED POST TEST PAIRED MEANS OF SPEED ENDURANCE

TTG1	TTG2	CG	Mean Difference	Confidential Interval
17.147	16.758		0.389*	0.338
17.147		17.669	0.522*	0.338
	16.758	17.669	0.911*	0.338

*Significant at .05 level.

4.7.3. Results of Scheffe's Test on speed endurance

The table XX shows that the adjusted post test mean difference on **speed endurance** between TTG1 and TTG2, TTG1 and CG and between TTG2 and CG are 0.389, 0.522 and 0.911 respectively which are higher than the confidence interval value of 0.338 at .05 level of confidence.

The pre and post test mean values of TTG1, TTG2 and CG on **speed endurance** are graphically represented in figure 9.

The adjusted post test mean values of TTG1, TTG2 and CG on **speed endurance** are graphically represented in figure 10.

FIGURE 9

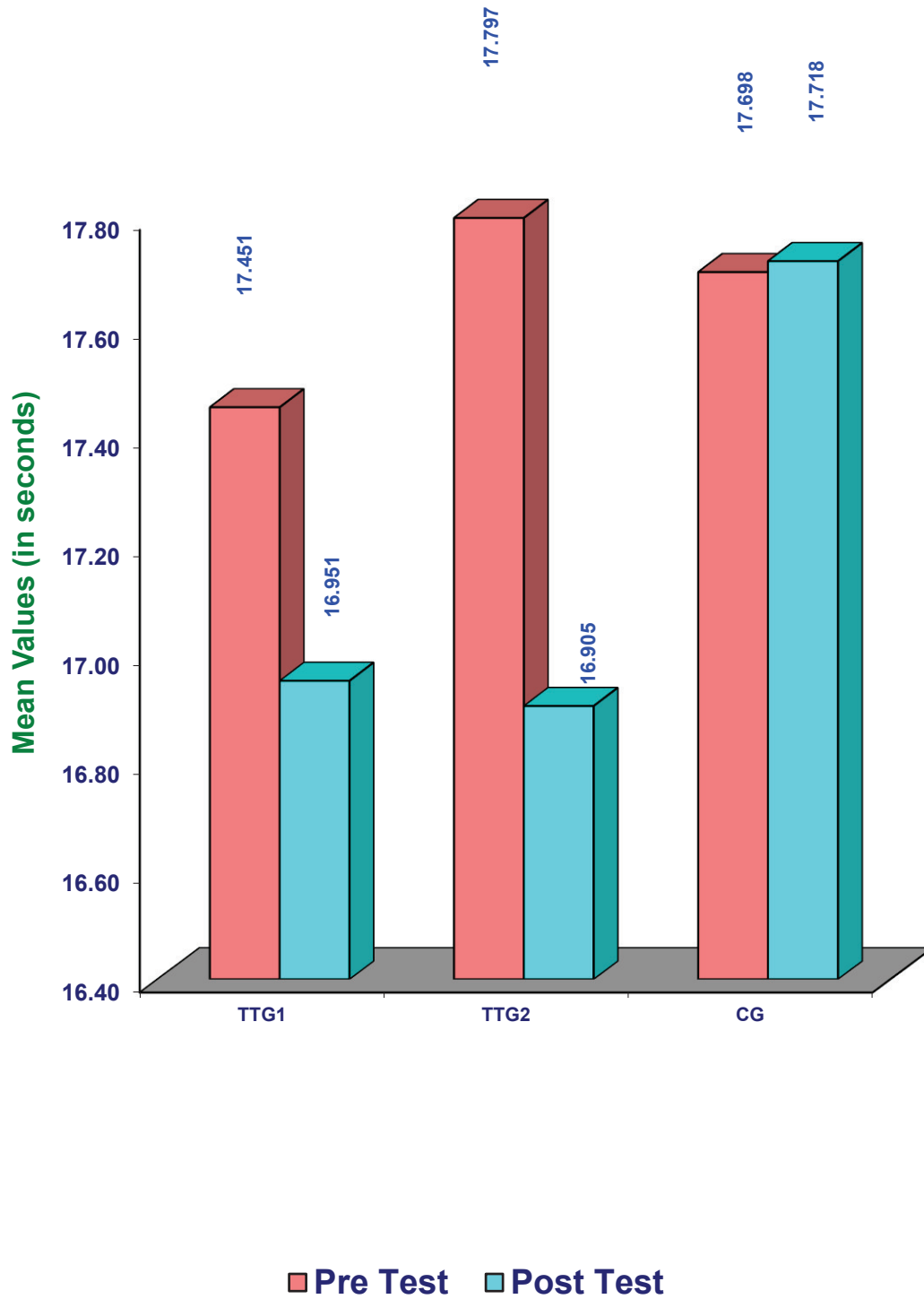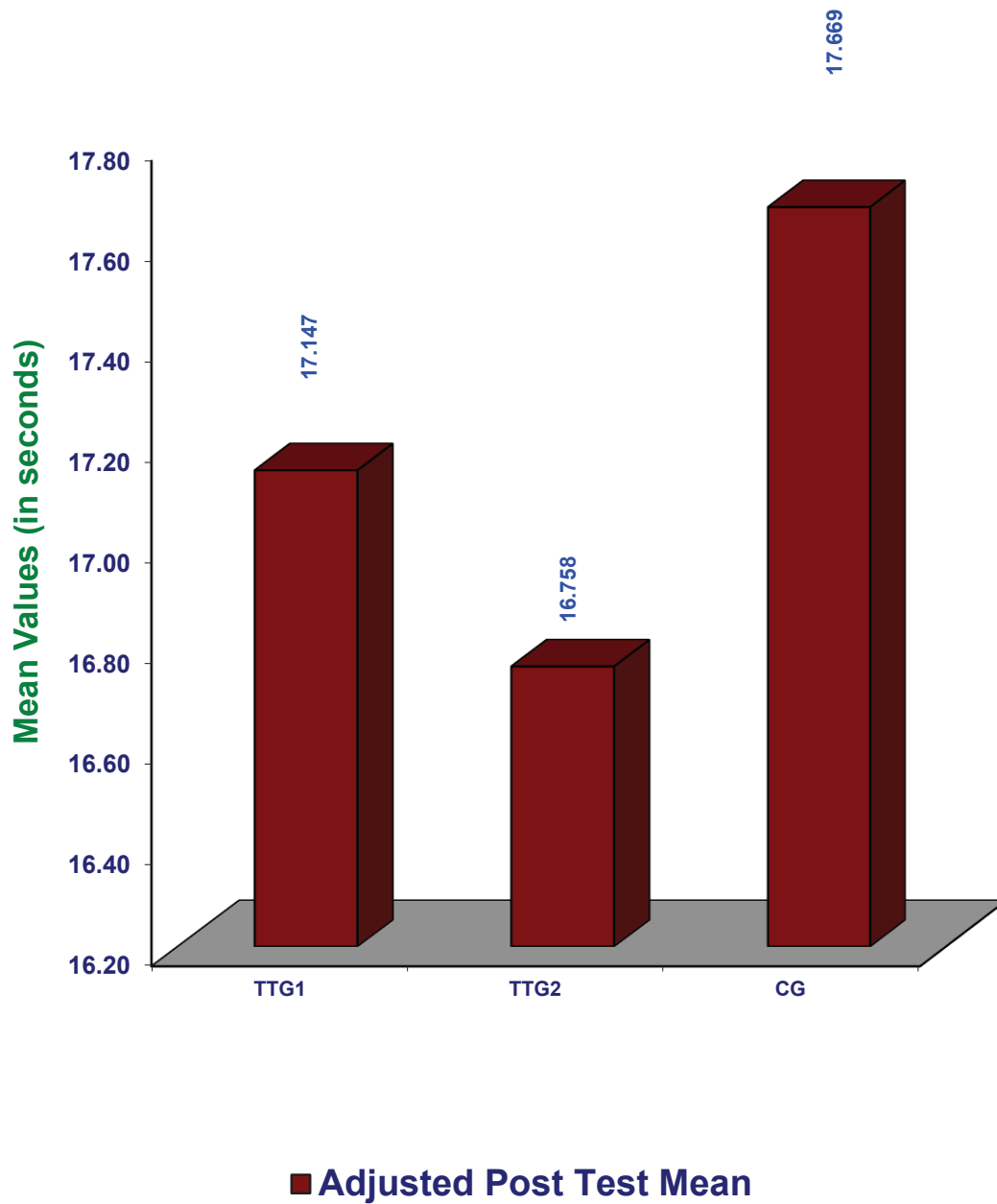## PRE TEST AND POST TEST MEAN VALUES OF TTG1, TTG2 AND CG ON SPEED ENDURANCE

Pre Test   Post Test

FIGURE 10

**ADJUSTED POST TEST MEAN VALUES OF TTG1, TTG2 AND
CG ON SPEED ENDURANCE**

4.7.4. Discussion on Findings on speed endurance

The result of the study indicates that both the experimental groups significantly differed when compared to the control group on **speed endurance.** However, it is further revealed that the experimental group namely TTG1 and TTG2 had improved the performance of **speed endurance** better than the control group (CG) but TTG2 had improved the performance of **speed endurance** better than the other two groups.

The present findings also approved with the researchers **Gibala and Jones (2013)** who concluded that a polarized approach to training, in which ~75% of total training volume be performed at low intensities, with 10-15% performed at very high intensities may be the optimal training intensity distribution for elite athletes who compete in intense endurance events. The present study also revealed that 6 weeks of tabata interval training with 1:0.5 ratio and 1:1 ratio significantly improved the performance of speed endurance. The present findings also very well approved with the researchers **Hughes, et al., (2003); Ratel, et al., (2004); Tomlin and Wenger (2001) and **Smith, et al., (2013).**

4.8. COMPUTATION OF DEPENDENT 't' TEST, ANALYSIS OF COVARIANCE AND SCHEFFE'S POST HOC TEST ON AGILITY

The analysis of dependent 't' test on the data obtained for **agility** of the pre-test and post-test means of TTG1, TTG2 and CG has been analysed and presented in Table XXI.

TABLE XXI

SUMMARY OF MEAN STANDARD DEVIATION AND DEPENDENT 't' TEST FOR THE PRE AND POST TESTS ON AGILITY OF EXPERIMENTAL AND CONTROL GROUPS

(**Agility** scores are expressed in seconds)

		TTG1	TTG2	CG
Pre test	Mean	10.521	10.579	10.627
	SD	0.645	0.531	0.779
Post test	Mean	10.219	9.953	10.617
	SD	0.705	0.556	0.785
't' test		4.937*	7.413*	1.713

*Significant at .05 level. The table value required for .05 level of significance with df 14 is 1.761.

4.8.1. Results of Dependent 't' Test on agility

Table XXI shows that the pre-test mean values of TTG1, TTG2 and CG on **agility** are 10.521, 10.579 and 10.627 respectively and the post-test mean values on **agility** are 10.219, 9.953 and 10.617 respectively. The obtained dependent t-ratio values between the pre and post test means of TTG1, TTG2 and CG on **agility** are 4.937, 7.413 and 1.713 respectively. The table value required for significant difference with df 14 at .05 level is 1.761. Since, the obtained 't' ratio values of experimental groups are greater than the table value, it is understood that TTG1 and TTG2 had significantly improved the performance of the **agility**. However, the control group had not significantly

improved the performance of **agility**. The obtained 't' value for the control group is less than the table value as they were not subjected to any specific training.

The analysis of covariance on **agility** of TTG1, TTG2 and CG were analysed and presented in Table XXII.

TABLE XXII

ANALYSIS OF COVARIANCE FOR THE DATA ON AGILITY AMONG EXPERIMENTAL AND CONTROL GROUPS

Adjusted Post Test Means			Sources of Variance	Sum of Squares	df	Mean Squares	F-Ratio
TTG1	**TTG2**	**CG**					
10.273	9.950	10.567	Between	2.855	2	1.427	24.664*
			Within	2.373	41	0.058	

* Significant at 0.05 level of confidence.
The table value for significance at 0.05 with df 2 and 41 is 3.23.

4.8.2. Results of Analysis of Covariance on agility

Table XXII shows that the adjusted post-test means of TTG1, TTG2 and CG on **agility** are 10.273, 9.950 and 10.567 respectively. The obtained F-ratio value is 24.664, which is higher than the table value 3.23 with df 2 and 41 required for significance at .05 level. Since the value of F-ratio is higher than the table value, it indicates that there exist significant differences among the adjusted post-test means of TTG1, TTG2 and CG. To find out which of the paired means had a significant difference on **agility**, the Scheffe's post-hoc test was applied and the results are presented in Table XXIII.

TABLE XXIII

SCHEFFE'S TEST FOR THE DIFFERENCES BETWEEN THE ADJUSTED POST TEST PAIRED MEANS OF AGILITY

TTG1	TTG2	CG	Mean Difference	Confidential Interval
10.273	9.950		0.323*	0.223
10.273		10.567	0.293*	0.223
	9.950	10.567	0.617*	0.223

*Significant at .05 level.

4.8.3. Results of Scheffe's Test on agility

The table XXIII shows that the adjusted post test mean difference on **agility** between TTG1 and TTG2, TTG1 and CG and between TTG2 and CG are 0.323, 0.293 and 0.617 respectively which are higher than the confidence interval value of 0.223 at .05 level of confidence.

The pre and post test mean values of TTG1, TTG2 and CG on **agility** are graphically represented in figure 11.

The adjusted post test mean values of TTG1, TTG2 and CG on **agility** are graphically represented in figure 12.

FIGURE 11

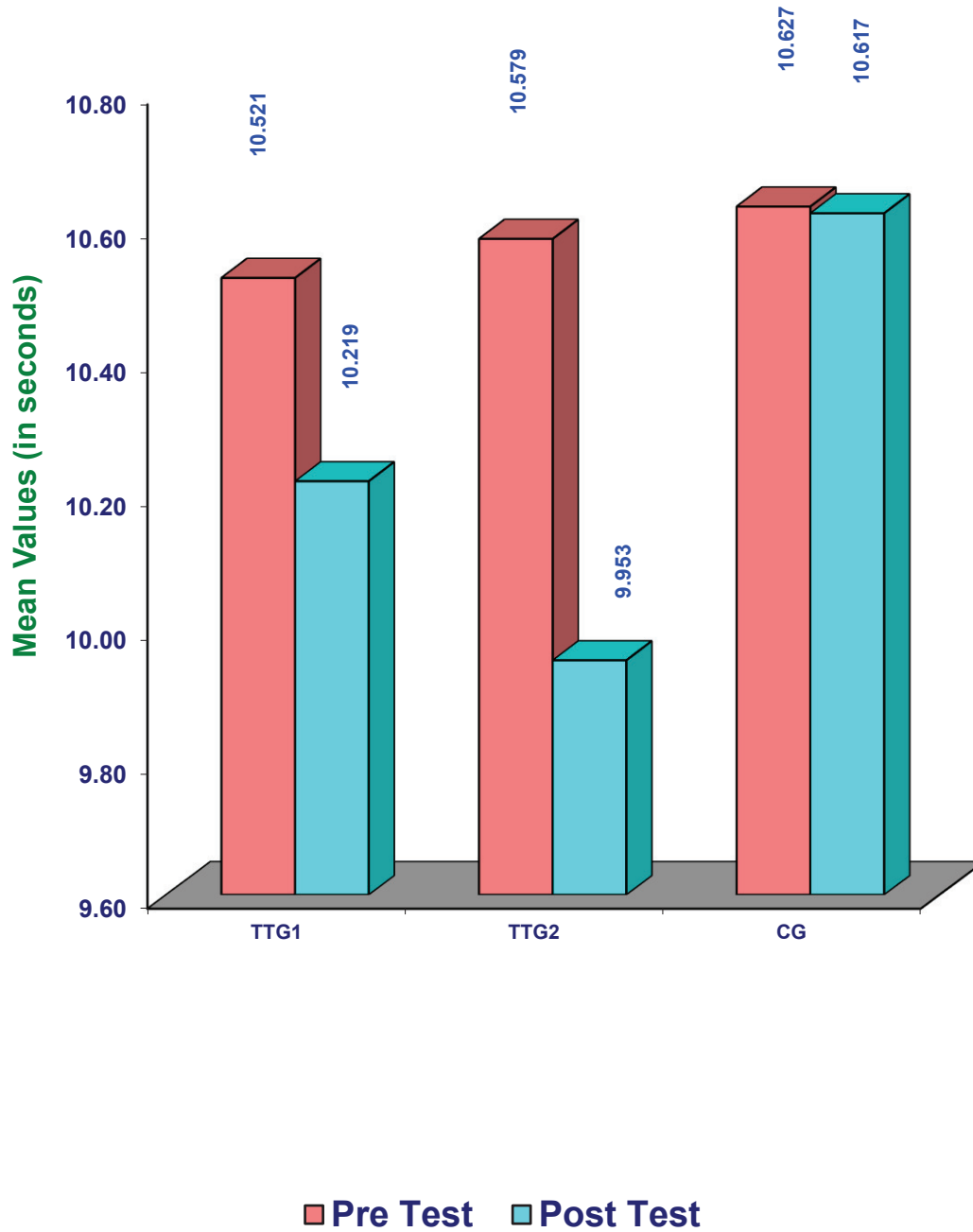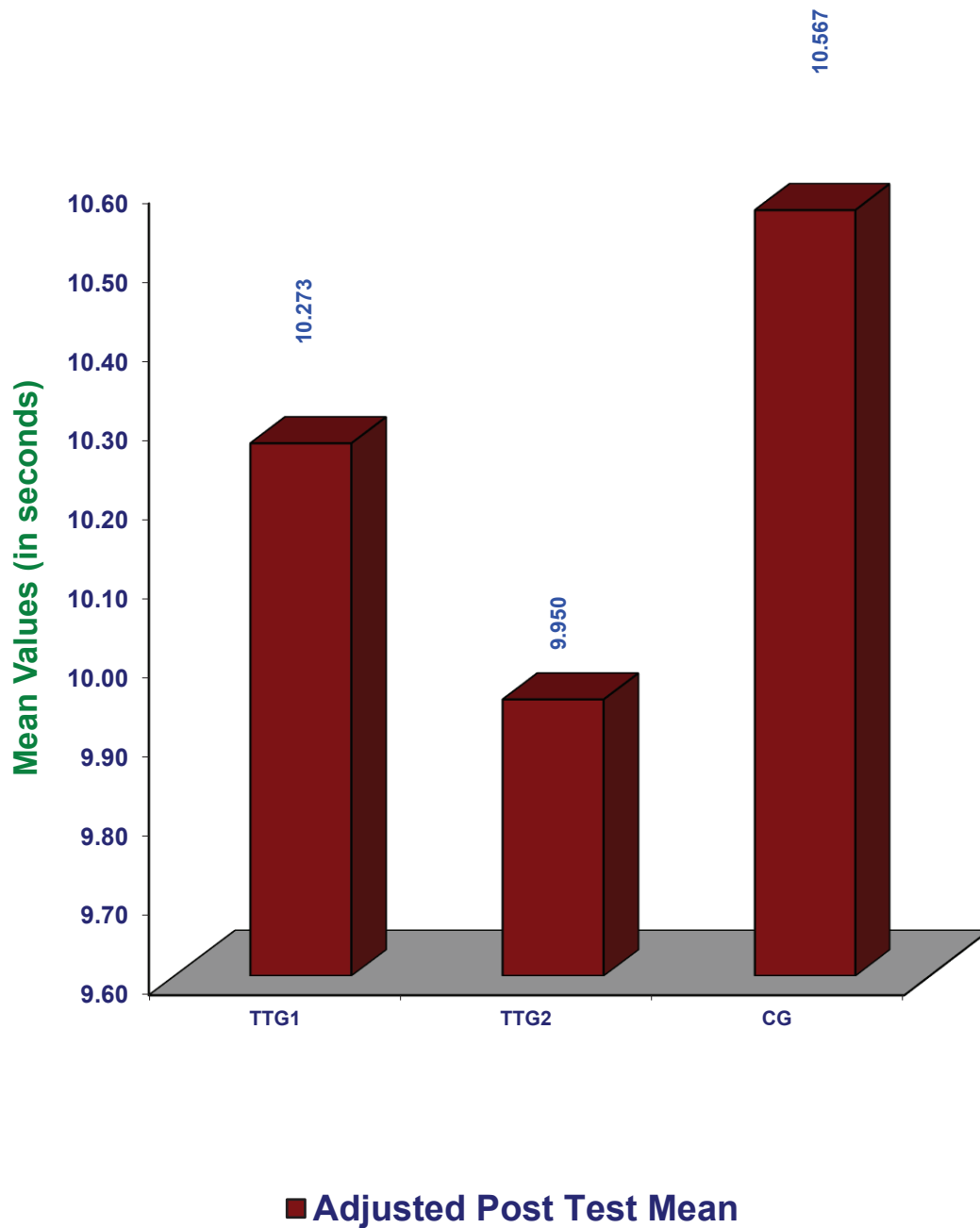## PRE TEST AND POST TEST MEAN VALUES OF TTG1, TTG2 AND CG ON AGILITY

FIGURE 12

ADJUSTED POST TEST MEAN VALUES OF TTG1, TTG2 AND CG ON AGILITY

4.8.4. Discussion on Findings on agility

The result of the study indicates that both the experimental groups significantly differed when compared to the control group on **agility.** However, it is further revealed that the experimental group namely TTG1 and TTG2 had improved the performance of **agility** better than the control group (CG) but TTG2 had improved the performance of **agility** better than the other two groups.

The present study also revealed that 6 weeks of tabata interval methods of various durations improved the performance of agility. The present findings also supported by the researchers **Chaouachi, et al., (2010) and Wong, et al., (2010).**

4.9. COMPUTATION OF DEPENDENT 't' TEST, ANALYSIS OF COVARIANCE AND SCHEFFE'S POST HOC TEST ON ABDOMINAL MUSCULAR ENDURANCE

The analysis of dependent 't' test on the data obtained for **abdominal muscular endurance** of the pre-test and post-test means of TTG1, TTG2 and CG has been analysed and presented in Table XXIV.

TABLE XXIV

SUMMARY OF MEAN STANDARD DEVIATION AND DEPENDENT 't' TEST FOR THE PRE AND POST TESTS ON ABDOMINAL MUSCULAR ENDURANCE OF EXPERIMENTAL AND CONTROL GROUPS

(**Abdominal muscular endurance** scores are expressed in numbers)

		TTG1	TTG2	CG
Pre test	Mean	27.467	27.333	27.200
	SD	1.187	1.234	1.207
Post test	Mean	28.867	29.533	27.600
	SD	1.356	1.457	1.404
't' test		6.984*	8.818*	1.268

*Significant at .05 level. The table value required for .05 level of significance with df 14 is 1.761.

4.9.1. Results of Dependent 't' Test on abdominal muscular endurance

Table XXIV shows that the pre-test mean values of TTG1, TTG2 and CG on **abdominal muscular endurance** are 27.467, 27.333 and 27.200 respectively and the post-test mean values on **abdominal muscular endurance** are 28.867, 29.533 and 27.600 respectively. The obtained dependent t-ratio values between the pre and post test means of TTG1, TTG2 and CG on **abdominal muscular endurance** are 6.984, 8.818 and 1.268 respectively. The table value required for significant difference with df 14 at .05 level is 1.761. Since, the obtained 't' ratio values of experimental groups are greater than the table value, it is understood that TTG1 and TTG2 had significantly improved

the performance of the **abdominal muscular endurance**. However, the control group had not significantly improved the performance of **abdominal muscular endurance**. The obtained 't' value for the control group is less than the table value as they were not subjected to any specific training.

The analysis of covariance on **abdominal muscular endurance** of TTG1, TTG2 and CG were analysed and presented in Table XXV.

TABLE XXV

ANALYSIS OF COVARIANCE FOR THE DATA ON ABDOMINAL MUSCULAR ENDURANCE AMONG EXPERIMENTAL AND CONTROL GROUPS

Adjusted Post Test Means			Sources of Variance	Sum of Squares	df	Mean Squares	F-Ratio
TTG1	TTG2	CG					
28.738	29.533	27.729	Between	24.465	2	12.233	19.641*
			Within	25.535	41	0.623	

* Significant at 0.05 level of confidence.
The table value for significance at 0.05 with df 2 and 41 is 3.23.

4.9.2. Results of Analysis of Covariance on abdominal muscular endurance

Table XXV shows that the adjusted post-test means of TTG1, TTG2 and CG on **abdominal muscular endurance** are 28.738, 29.533 and 27.729 respectively. The obtained F-ratio value is 19.641, which is higher than the table value 3.23 with df 2 and 41 required for significance at .05 level. Since the value of F-ratio is higher than the table value, it indicates that there exist significant differences among the adjusted post-test means of TTG1, TTG2 and CG. To find out which of the paired means had a significant difference on **abdominal muscular endurance**, the Scheffe's post-hoc test was applied and the results are presented in Table XXVI.

TABLE XXVI

SCHEFFE'S TEST FOR THE DIFFERENCES BETWEEN THE ADJUSTED POST TEST PAIRED MEANS OF ABDOMINAL MUSCULAR ENDURANCE

TTG1	TTG2	CG	Mean Difference	Confidential Interval
28.738	29.533		0.796*	0.732
28.738		27.729	1.009*	0.732
	29.533	27.729	1.804*	0.732

*Significant at .05 level.

4.9.3. Results of Scheffe's Test on abdominal muscular endurance

The table XXVI shows that the adjusted post test mean difference on **abdominal muscular endurance** between TTG1 and TTG2, TTG1 and CG and between TTG2 and CG are 0.796, 1.009 and 1.804 respectively which are higher than the confidence interval value of 0.732 at .05 level of confidence.

The pre and post test mean values of TTG1, TTG2 and CG on **abdominal muscular endurance** are graphically represented in figure 13.

The adjusted post test mean values of TTG1, TTG2 and CG on **abdominal muscular endurance** are graphically represented in figure 14.

FIGURE 13

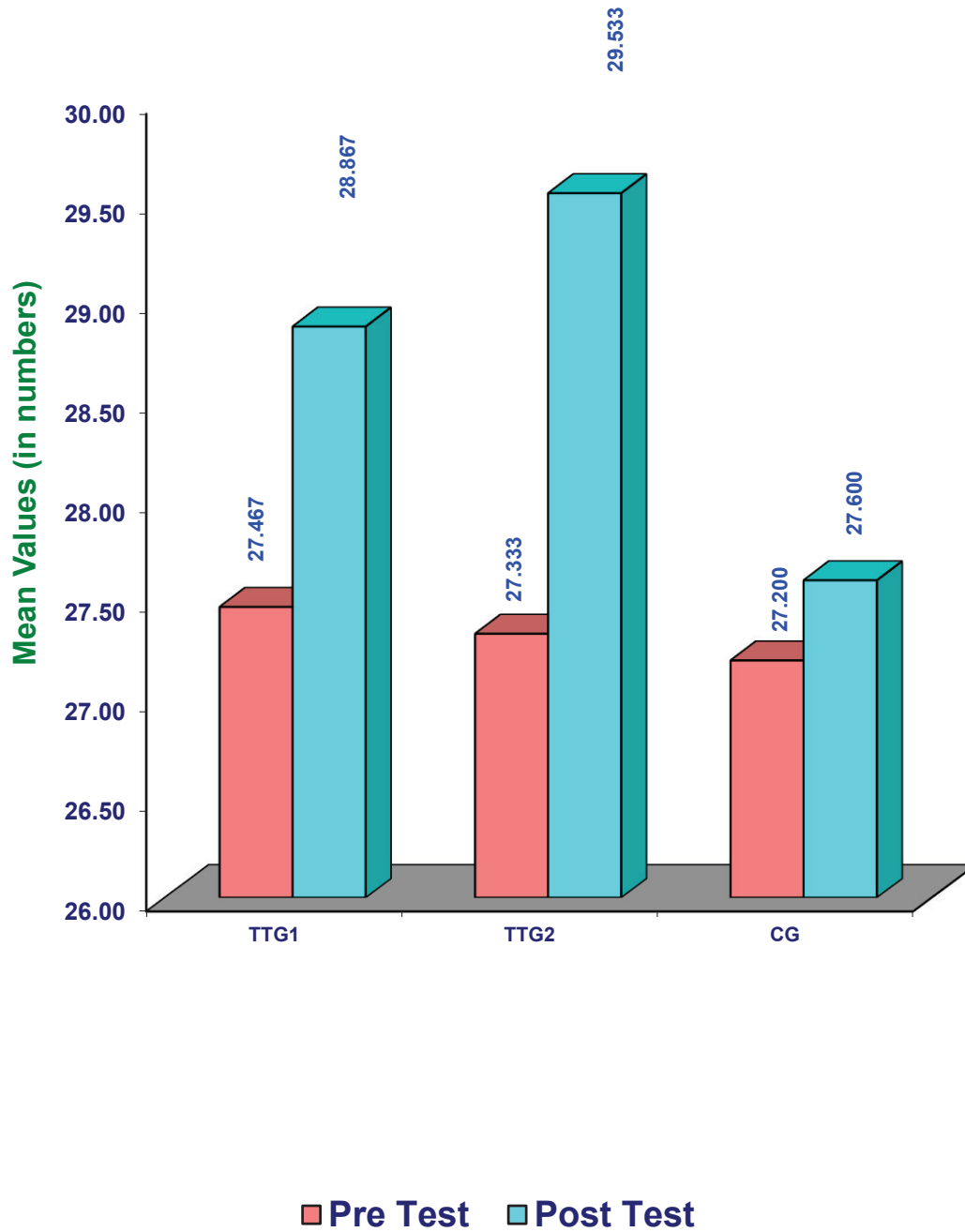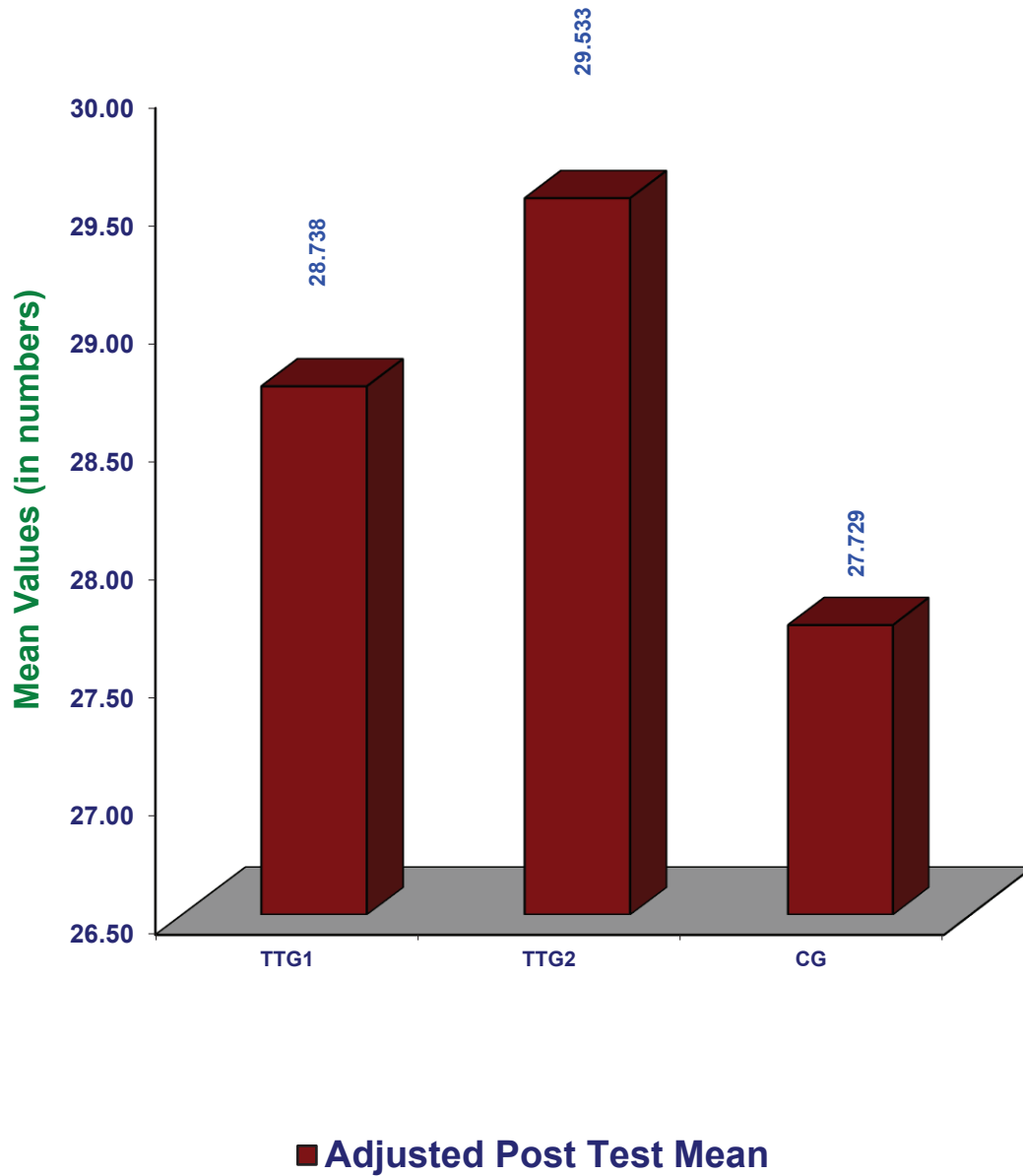## PRE TEST AND POST TEST MEAN VALUES OF TTG1, TTG2 AND CG ON ABDOMINAL MUSCULAR ENDURANCE

FIGURE 14

ADJUSTED POST TEST MEAN VALUES OF TTG1, TTG2 AND CG ON ABDOMINAL MUSCULAR ENDURANCE

4.9.4. Discussion on Findings on abdominal muscular endurance

The result of the study indicates that both the experimental groups significantly differed when compared to the control group on **abdominal muscular endurance.** However, it is further revealed that the experimental group namely TTG1 and TTG2 had improved the performance of **abdominal muscular endurance** better than the control group (CG) but TTG2 had improved the performance of **abdominal muscular endurance** better than the other two groups.

Schmidt, et al., (2015) suggested that slight improvements that are gender specific may also be observed in muscle strength as well as aerobic fitness. The present study also revealed that after 6 weeks of tabata interval methods of various durations improved significantly improved the performance of abdominal muscular endurance. The result of the present study also supported with the findings of **Tsutsumi, et al., (1997).**

4.10. COMPUTATION OF DEPENDENT 't' TEST, ANALYSIS OF COVARIANCE AND SCHEFFE'S POST HOC TEST ON ARM STRENGTH

The analysis of dependent 't' test on the data obtained for **arm strength** of the pre-test and post-test means of TTG1, TTG2 and CG has been analysed and presented in Table XXVII.

TABLE XXVII

SUMMARY OF MEAN STANDARD DEVIATION AND DEPENDENT 't' TEST FOR THE PRE AND POST TESTS ON ARM STRENGTH OF EXPERIMENTAL AND CONTROL GROUPS

(**arm strength** scores are expressed in numbers)

		TTG1	**TTG2**	**CG**
Pre test	Mean	20.467	20.533	20.267
	SD	1.407	1.060	1.668
Post test	Mean	21.600	23.267	20.400
	SD	1.404	1.710	1.639
't' test		6.648*	8.548*	0.391

***Significant at .05 level. The table value required for .05 level of significance with df 14 is 1.761.

4.10.1. Results of Dependent 't' Test on ARM strength

Table XXVII shows that the pre-test mean values of TTG1, TTG2 and CG on **arm strength** are 20.467, 20.533 and 20.267 respectively and the post-test mean values on **arm strength** are 21.600, 23.267 and 20.400 respectively. The obtained dependent t-ratio values between the pre and post test means of TTG1, TTG2 and CG on **arm strength** are 6.648, 8.548 and 0.391 respectively. The table value required for significant difference with df 14 at .05 level is 1.761. Since, the obtained 't' ratio values of experimental groups are greater than the table value, it is understood that TTG1 and TTG2 had significantly improved the performance of the **arm strength**. However, the

control group had not significantly improved the performance of **arm strength**. The obtained 't' value for the control group is less than the table value as they were not subjected to any specific training.

The analysis of covariance on **arm strength** of TTG1, TTG2 and CG were analysed and presented in Table XXVIII.

TABLE XXVIII

ANALYSIS OF COVARIANCE FOR THE DATA ON ARM STRENGTH AMONG EXPERIMENTAL AND CONTROL GROUPS

Adjusted Post Test Means			Sources of Variance	Sum of Squares	df	Mean Squares	F-Ratio
TTG1	TTG2	CG					
21.560	23.167	20.540	Between	52.309	2	26.154	27.108*
			Within	39.557	41	0.965	

* Significant at 0.05 level of confidence.
The table value for significance at 0.05 with df 2 and 41 is 3.23.

4.10.2. Results of Analysis of Covariance on arm strength

Table XXVIII shows that the adjusted post-test means of TTG1, TTG2 and CG on **arm strength** are 21.560, 23.167 and 20.540 respectively. The obtained F-ratio value is 27.108, which is higher than the table value 3.23 with df 2 and 41 required for significance at .05 level. Since the value of F-ratio is higher than the table value, it indicates that there exist significant differences among the adjusted post-test means of TTG1, TTG2 and CG. To find out which of the paired means had a significant difference on **arm strength**, the Scheffe's post-hoc test was applied and the results are presented in Table XXIX.

TABLE XXIX

SCHEFFE'S TEST FOR THE DIFFERENCES BETWEEN THE ADJUSTED POST TEST PAIRED MEANS OF ARM STRENGTH

TTG1	TTG2	CG	Mean Difference	Confidential Interval
21.560	23.167		1.607*	0.911
21.560		20.540	1.020*	0.911
	23.167	20.540	2.627*	0.911

*Significant at .05 level.

4.10.3. Results of Scheffe's Test on arm strength

The table XXVI shows that the adjusted post test mean difference on **arm strength** between TTG1 and TTG2, TTG1 and CG and between TTG2 and CG are 1.607, 1.020 and 2.627 respectively which are higher than the confidence interval value of 0.911 at .05 level of confidence.

The pre and post test mean values of TTG1, TTG2 and CG on **arm strength** are graphically represented in figure 15.

The adjusted post test mean values of TTG1, TTG2 and CG on **arm strength** are graphically represented in figure 16.

FIGURE 15

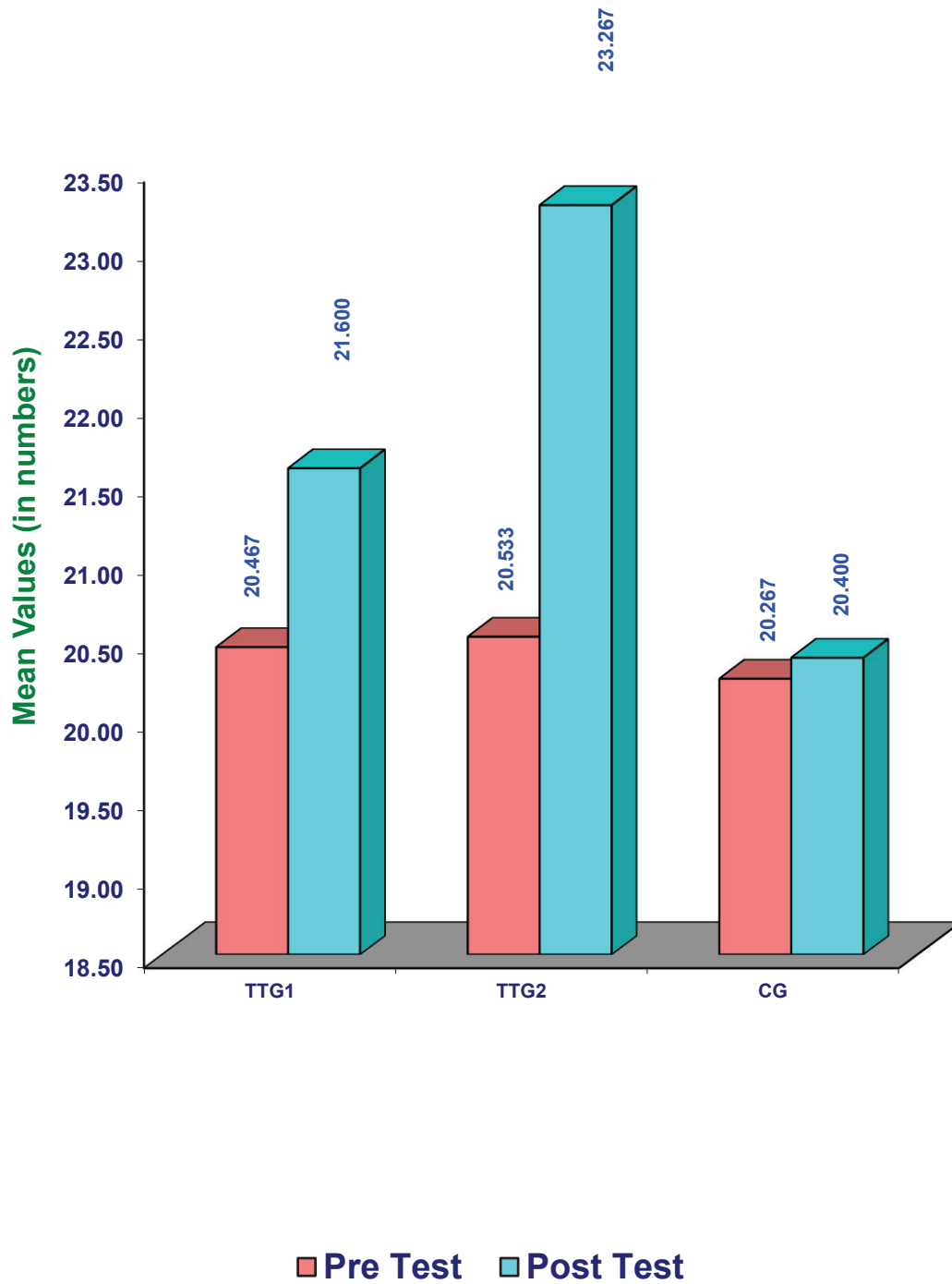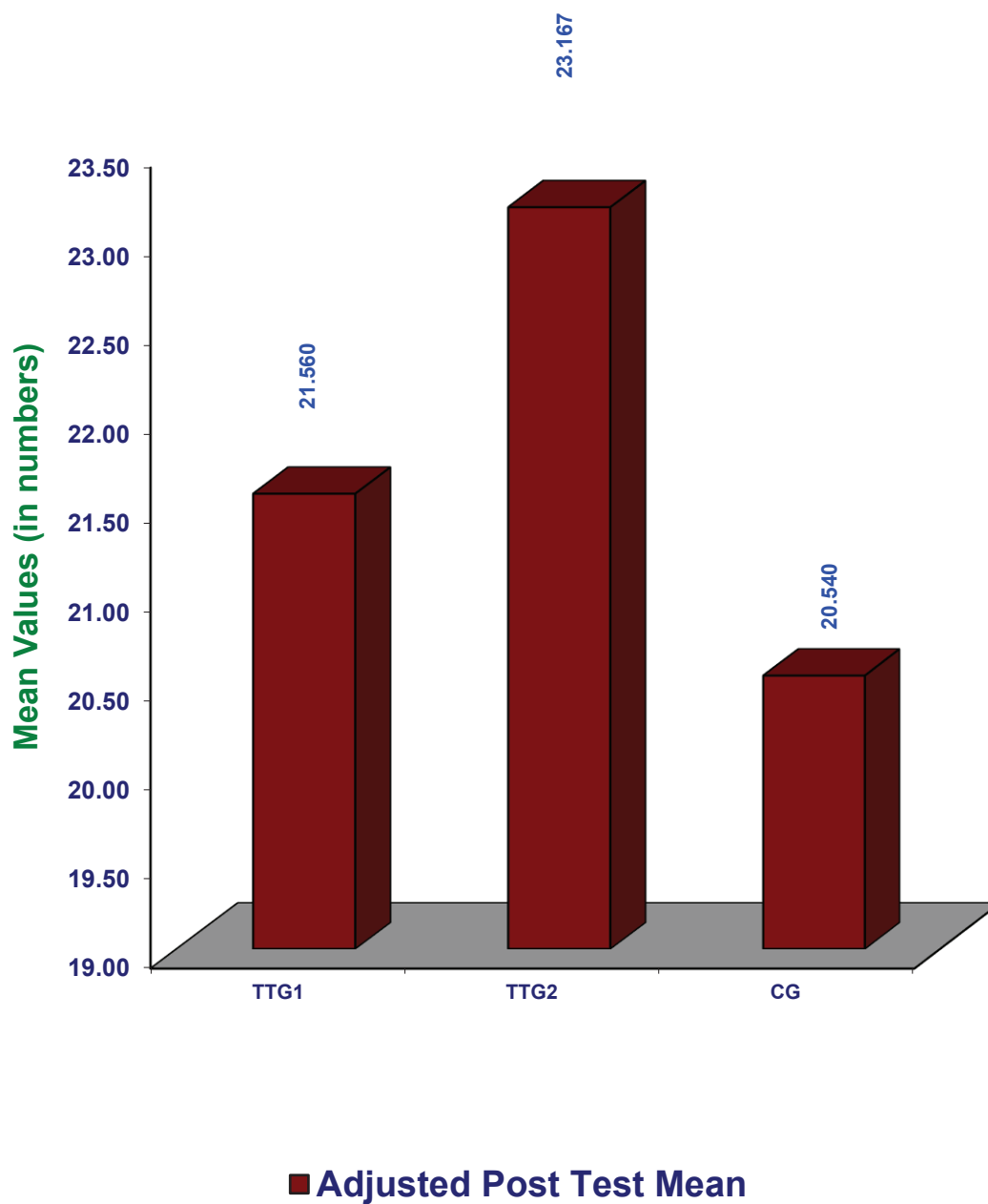**PRE TEST AND POST TEST MEAN VALUES OF TTG1, TTG2
AND CG ON ARM STRENGTH**

■ **Pre Test**   ■ **Post Test**

FIGURE 16

**ADJUSTED POST TEST MEAN VALUES OF TTG1, TTG2 AND
CG ON ARM STRENGTH**

4.10.4. Discussion on Findings on arm strength

The result of the study indicates that both the experimental groups significantly differed when compared to the control group on **arm strength.** However, it is further revealed that the experimental group namely TTG1 and TTG2 had improved the performance of **arm strength** better than the control group (CG) but TTG2 had improved the performance of **arm strength** better than the other two groups.

Tsutsumi, et al., (1997) concluded that participation in 12-weeks of high or low intensity strength training can improve overall physical fitness, mood, and physical self-efficacy in older adults while cognitive functioning remains constant. The present study also revealed that that after 6 weeks of tabata interval methods of various durations improved significantly improved the performance of muscular strength. The present findings also very well sustained by the researcher **Schmidt, et al., (2015); Iacono, Eliakim and Mecke (2015)** and **Wong, et al., (2010).**

4.11. DISCUSSION ON HYPOTHESES

1.   It was mentioned in the first hypothesis that there would be a significant improvement on selected physiological and athletic performance variables due to the influence of tabata interval training with 1 : 1 ratio (20 seconds active period : 20 seconds rest period). The result of the present study showed that significant improvement on selected criterion variables such as body fat, VO_2max, resting heart rate, speed, speed endurance, agility, abdominal muscular endurance and arm strength among school students due to the influence of 1 : 1 ratio ((20 seconds active period : 20 seconds rest period) tabata interval training methods. Hence, the first hypothesis was accepted at 0.05 level of confidence.

2. It was mentioned in the second hypothesis that there would be a significant improvement on selected physiological and athletic performance variables due to the influence of tabata interval training with 1 : 0.5 ratio (20 seconds active period: 10 seconds rest period). The result of the present study showed that significant improvement on body fat, VO_2max, resting heart rate, speed, speed endurance, agility, abdominal muscular endurance and arm strength due to the influence of tabata interval training with 1:0.5 ratio among school students. Hence, the second hypothesis was also accepted at 0.05 level of confidence.

3. In the third hypothesis, it was mentioned that there would be a significant improvement difference between tabata interval training with 1: 1 ratio and tabata interval training with 1 : 0.5 on selected criterion variables among school students. The result of the present investigation showed that the school students who underwent tabata interval training with 1 : 0.5 ratio (20 seconds active period : 10 seconds rest period) had improved significantly on selected criterion variables than that of who underwent tabata interval training with 1 : 1 ratio (20 seconds active period : 20 seconds rest period). Hence, the third hypothesis was also accepted at 0.05 level of confidence.