

EFFECTS OF HIGH-INTENSITY INTERVAL RESISTANCE TRAINING VERSUS CONVENTIONAL RESISTANCE TRAINING ON PHYSICAL PERFORMANCE AMONG COLLEGIATE FEMALE SPRINTERS - A PILOT STUDY

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ABSTRACT

Sprint performance is dependent on proper muscular strength, body composition, and agility. Although resistance training is frequently used to improve these elements, time-efficient training techniques like High-Intensity Interval Resistance Training (HIIRT) have drawn interest due to their ability to increase physical performance while shortening training sessions. In comparison to conventional resistance training, prior research has shown that HIIRT can improve lean body mass and improve muscle strength and increase sprint performance.

KEYWORDS: Sprint, HIIRT, Agility

INTRODUCTION

Sprinting is a high-intensity sport where appropriate body composition, muscular strength, power, agility, and speed must all be integrated for best performance. In order to produce force quickly and sustain acceleration during a competition, female sprinters mostly rely on lower limb muscle power and neuromuscular synchronization. Collegiate female sprinters represent a unique athletic subpopulation positioned at the peak of competitive development, where performance gains depend on highly precise training variables. A sprinter is an athlete who specializes in running short distances at maximum velocity, relying on explosive speed and power. These athletes compete in specific track and field events, typically remaining within assigned lanes for the entire race.

As a result, resistance training is now a crucial part of sprint conditioning regimens meant to enhance athletic performance and lower the risk of injury [1]. Sprinting is one of the highest-force activities the human body can perform. It demands an extreme blend of power, neural coordination, and metabolic efficiency.

Sprinting performance relies on a complex mix of physical attributes that allow an athlete to burst out of the starting blocks and maintain maximal velocity. If you are setting up a study on sprinters, introducing these core components lays a solid foundation for understanding what drives elite speed. Lower-Limb Muscular Strength Maximal force production, This involves the highest amount of force your leg muscles (like the quadriceps, hamstrings, and calves) can produce in a single effort. Foundation for speed, Strong lower limbs help apply greater force into the ground during each stride, directly influencing acceleration and top-end speed. Explosive Power Combining strength and speed, Power is the ability to release maximum force in the shortest possible time. The stretch-shortening cycle: Measured via jumps like the counter movement jump (CMJ), explosive power drives the powerful, bouncy leg action needed as feet strike and leave the track. Speed and Agility Linear velocity, Speed covers pure maximal running velocity over set distances (such as 10m, 30m, or 100m). Change of direction Agility involves quick footwork and rapid adjustments in body position or momentum, crucial even in straight-line sprinting for maintaining efficient mechanics under fatigue. Body Composition Lean mass vs. fat mass. This refers to the ratio of fat-free mass (muscle and bone) to body fat percentage. Power-to-weight ratio: Lower body fat and higher muscle mass improve relative strength, helping sprinters carry less dead weight and move more efficiently. Ability to Generate Force Rapidly Rate of Force Development (RFD) This is how fast your nervous system and muscles can turn on and produce force at the exact moment your foot hits the ground. Short ground contact times Elite sprinters touch the ground for only a fraction of a second, meaning high RFD is even more important than absolute raw strength Sprinters must apply massive amounts of force into the ground in fractions of a second. [1, 2, 3]

Sports conditioning frequently uses Conventional Resistance Training (CRT), which usually consists of several sets of exercises carried out with moderate to high loads and comparatively long rest intervals. Prior research has shown that CRT successfully enhances athletes' functional performance, muscular strength, and hypertrophy [2]. Traditional resistance training programs, on the other hand, can be time-consuming, limiting adherence and training efficiency among student athletes who must juggle academic and athletic responsibilities.

High-intensity interval resistance training (HIIRT), has become a popular and time-efficient substitute for conventional resistance training. While retaining the advantages of strength training, HIIRT increases metabolic stress and cardiovascular demand by combining resistance exercises with brief rest times [3]. Compared to traditional resistance

training, research has demonstrated that HIIRT can considerably raise resting energy expenditure and encourage higher fat oxidation, which can lead to positive changes in body composition [4].

One important factor influencing sprint performance is body composition. In sprinters, improved force output, acceleration, and running economy are linked to a higher percentage of lean muscle mass and a lower percentage of body fat [5]. Therefore, resistance training programs that increase lean body mass while reducing the formation of extra fat may offer a competitive advantage. According to earlier studies, HIIRT can maintain or increase maximal strength levels while increasing muscular endurance and lean body mass [6].

Another crucial component of athletic performance is agility, which is defined as the capacity to change direction quickly while being balanced and in control. Agility shows neuromuscular efficiency, coordination, and lower-extremity strength, all of which contribute to total athletic capability, even though sprinting largely involves linear movement [7]. Through changes in muscle strength, power production, and motor control, resistance exercise has been demonstrated to increase agility [8].

Sprint performance is still largely influenced by muscle strength. Increased strength enables athletes to produce higher ground reaction forces while sprinting, which improves speed and acceleration [9]. Studies contrasting HIIRT with conventional resistance training have shown that both training modalities develop muscle strength; however, because of its higher training density, HIIRT may offer better gains in muscular endurance and metabolic adaptations [6].

The effects of HIIRT on body composition, agility, muscle strength, and overall performance among collegiate female sprinters have not been thoroughly studied, despite mounting evidence of its efficacy. Additionally, rather than using professional athletes, the majority of earlier research has used people who are recreationally active. Consequently, it is necessary to assess whether HIIRT offers any advantages over traditional resistance training in this demographic.

The purpose of this randomized controlled experiment is to assess how High-Intensity Interval Resistance Training and Conventional Resistance Training affect the body composition, muscle strength, agility, and performance of female collegiate sprinters between the ages of 18 to 25. The results could help create evidence-based training plans that maximize athletic performance and increase training effectiveness.

Global positioning systems (GPS) with integrated accelerometers have been extensively applied in a variety of team sports during the last decade, for example, to measure running velocity in players during training sessions and games. The great advantage of GPS technology is that it allows assessment in the field of many players simultaneously. Numerous studies have aimed to investigate GPS validity and reliability for acceleration or speed assessment

AIM AND OBJECTIVE

This study aims to evaluate the effectiveness of High Intensity Interval Resistance Training (HIIRT) over Conventional Resistance Training on body composition, agility and muscle strength, and performance in collegiate female sprinters.

Primary objectives:

- To compare the effects of 8 weeks of HIIRT and CRT on body composition in collegiate female sprinters.
- To compare agility following 8 weeks of HIIRT and CRT.
- To compare improvements in muscle strength and endurance after 8 weeks of HIIRT and CRT.
- To compare the effects of 8 weeks of HIIRT and CRT on sprint performance.

MATERIALS AND METHODS

Materials Used

- Skinfold calliper.
- Weighing scale.
- Height scale
- Cones
- Stopwatch
- Measuring tape
- Velocity-based training device.
- Leg press machine (horizontal or 45° sledge-style)

METHODOLOGY

Study Design

- A randomised parallel trial will be conducted over 8 weeks, involving 24 collegiate female sprinters aged 18-22 years.
- Participants will be randomly assigned to either the HIIRT group A or the TRT group B.

METHOD

1. Three sets of six repetitions at 10 repetition maximum (10RM) will make up the HIIRT protocol. Rest 2 minutes between sets and 20 seconds between repetitions until exhaustion.
2. The three sets of 15 repetitions in the CRT procedure will be separated by 75 seconds of rest.
3. Outcome measures include skinfold assessments for body composition, the Agility T-Test for agility, 10RM testing for main muscle groups for muscle strength, and the Squat jump test using velocity based training device for performance evaluation.

Subjects

Twelve healthy participants were recruited for the study. Female sprinters aged 18-22 years. No current participation in structured resistance training programs, free from chronic diseases or injuries affecting exercise performance. Exclusion Criteria for the study included Use of medications affecting metabolism or muscle function; any orthopaedic limitations preventing participation in resistance training

Intervention Protocol

HIIRT Protocol:

1. Three sets of 6 repetitions at 6 repetition maximum (RM)
2. 20 seconds of rest between repetitions until exhaustion
3. 3 cycles with 2 minutes of rest between sets

TRT Protocol

1. Three sets of 15 repetitions
2. 75 seconds of rest between sets

Measurements

● **Body Composition:**

Skin fold measurement- SKIN FOLD CALIPER

● **Agility:**

Agility T-Test

● **Muscle Strength:** 10 RM Measurements (Leg Press)

Performance:

Explosive Power: Squat Jump Test (VBT velocity-based training device)

Study Design

Subjects are randomly designed to either high-intensity interval resistance training (HIIRT) or Traditional resistance training (TRT). Repetition maximum test (RM) was done for lower limbs, and a squat jump was used to test muscle power performance.

Statistics

The analysis was performed via Prism 8.0 GraphPad software (Abacus Concepts GraphPad Software, San Diego, USA). an alpha risk of 5% for the main variable (muscle strength measured as 1RM). An independent-samples t-test, an ordinary two-way ANOVA for repeated-measures was performed (using time as the within-subject factor and training as the between-subject factor) in order to assess differences between groups over the course of the study. Post-hoc analyses were performed using the Bonferroni test. Pearson correlation was used to assess the correlation between body composition techniques. Differences were considered significant at $p < 0.05$.

RESULT AND DISCUSSION

All subjects completed the study, indicating full retention with both protocols.

T DRILL Measurement

T -Drill measurement was done for Group 1 HIIRT (Pre and Post) and Group 2 CRT (Pre and Post). Performance was found to be decreased.

10 RM Measurement

It was done for Group 1 HIIRT and Group 2 CRT. Performance was found to increase in both the groups.

Skin Fold Measurement

It was done for Group 2 CRT and Group 1 HIIRT. There was a light decrease in both the groups.

Muscle Strength

The squat jump is done to measure muscle strength. Performance increased in both groups Group 2 CRT and Group 1 HIIRT.

Statistics

Alternate Hypotheses

- HIIRT will lead to greater improvements in lean body mass.
- HIIRT will enhance agility more effectively.
- HIIRT will increase muscle strength.
- HIIRT will improve the performance in sprinters.

Null Hypotheses

- HIIRT will not lead to greater improvements in lean body mass
- HIIRT will not enhance agility more effectively.
- HIIRT will not increase muscle strength.
- HIIRT will not improve the performance in sprinters.

All the groups showed significance in Two-way ANOVA, T test and Pearson Correlation.

This proves that null hypothesis is rejected and according to the alternate hypothesis, HIIRT improves lean body mass, enhance agility, improves muscle strength and improves performance in sprinters. The results are given in Annexure Tables 1 and 2.

One of the main goals of training programs is to improve muscle performance, and at the same time, try to implement cardiovascular fitness and optimize body composition. We have previously demonstrated that an acute bout of a modified rest-pause technique, which we have named HIIRT, increased resting energy expenditure and enhanced fat oxidation [9]. Based on these findings, we advanced the hypotheses that HIIRT may improve body composition and resting metabolism as well as enhancing muscle strength and aerobic capacity compared to a traditional training method (TRT). The main finding of this study was that long-term HIIRT protocol improved muscle mass and strength; however, its role on body weight control and blood lipid reduction was not confirmed in healthy young adults. During RT programs, muscle strength and performance can be enhanced by accurate management of their different components such as sets, repetitions or rest periods [5]. Manipulating inter-repetition rest time—in particular, reducing intervals between repetitions during a set—allows both to increase the chance of achieving muscular failure and reduce the total time necessary to complete the same volume of training. HIIRT technique is built upon this concept; indeed, our participants completed their training session

~20 min earlier compared to TRT group, which corresponded to approximately a 30% reduction in total training time. Some limitations of the present study should be taken into account. One is that dietary intake was uncontrolled. Subjects were asked to maintain their habitual caloric intake, as measured during the preliminary week of the study. However, it is possible that differences in energy or nutrient intake during the study and between groups could have existed and played a role in the slight increase in fat mass observed in HIIRT group. We already mentioned that participants assigned to HIIRT referred an increased hunger during the training period, and this may have translated into greater caloric intake. Secondly, although subjects were asked to fill a training report for each session, training was not regularly supervised. This may have affected the achievement of the proper intensity during each session. Moreover, the training volume between protocols was not perfectly equal, and that may have influenced the muscular response in terms of hypertrophy and strength. Thus, future research should normalize the training load in order to assess more precisely the effect of this particular cluster technique on muscle performance and body composition.

CONCLUSION:

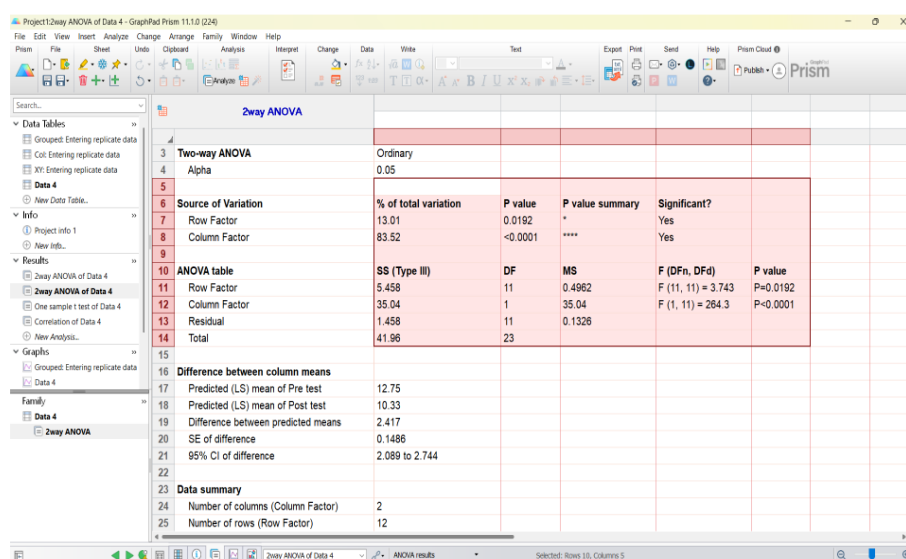
The results of the present study suggest that non-expert young adults can safely perform high intensity interval resistance training (HIIRT). HIIRT increases muscle mass and muscle strength in a shorter training session. However, HIIRT did not improve body fat percentage or resting energy expenditure as expected, suggesting that this training modality is not enough to promote alone fat metabolism. Lack of time is one of the principal obstacles to the regular practice of physical activity, thus a protocol that allows to obtain proper levels of muscle mass and performance and simultaneously guarantees a high adherence rate is essential to promote a healthy life style. HIIRT seems to be a good training alternative for those who do not have much time to exercise.

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Group 1 HIIRT TDRILL

Two way ANOVA



2way ANOVA					
3	Two-way ANOVA	Ordinary			
4	Alpha	0.05			
5	Source of Variation	% of total variation	P value	P value summary	Significant?
6	Row Factor	13.01	0.0192	****	Yes
7	Column Factor	83.52	<0.0001		Yes
8					
9	ANOVA table	SS (Type III)	DF	MS	F (DFn, DFd) P value
10	Row Factor	5.458	11	0.4962	F (11, 11) = 3.743 P=0.0192
11	Column Factor	35.04	1	35.04	F (1, 11) = 264.3 P<0.0001
12	Residual	1.458	11	0.1326	
13	Total	41.96	23		
14					
15	Difference between column means				
16	Predicted (LS) mean of Pre test	12.75			
17	Predicted (LS) mean of Post test	10.33			
18	Difference between predicted means	2.417			
19	SE of difference	0.1486			
20	95% CI of difference	2.089 to 2.744			
21					
22					
23	Data summary				
24	Number of columns (Column Factor)	2			
25	Number of rows (Row Factor)	12			

Interpretation (Degree of freedom is 0.05)

If $P < 0.05$, the treatments differ significantly. Here, the P-value is 0.0192 and < 0.0001 and both are significant. Since the P-Values are significant, the null hypothesis is rejected.

T- Test

One sample t test		A	B	C	D	E
		Pre test	Post test			
1	Theoretical mean	0.000	0.000			
2	Actual mean	12.75	10.33			
3	Number of values	12	12			
4						
5	One sample t test					
6	t, df	t=71.06, df=11	t=72.70, df=11			
7	P value (two tailed)	<0.0001	<0.0001			
8	P value summary	****	****			
9	Significant (alpha=0.05)?	Yes	Yes			
10						
11	How large is the effect?					
12	Discrepancy	12.75	10.33			
13	SD of discrepancy	0.6216	0.4924			
14	SEM of discrepancy	0.1794	0.1421			
15	95% confidence interval	12.36 to 13.14	10.02 to 10.65			
16	R squared (partial eta squared)	0.9978	0.9979			
17						
18						
19						

P- Value is < 0.0001 for both pre and post-test. They are highly significant and R square is 0.9978 and 0.9979. So null hypothesis is rejected.

Pearson Correlation

Correlation		A	B	C	D	E	F	G
Tabular results		Pre test	Pre test vs. Post test					
1	Pearson r							
2	r		0.5941					
3	95% confidence interval		0.03063 to 0.8710					
4	R squared		0.3529					
5								
6	P value							
7	P (two-tailed)		0.0417					
8	P value summary		*					
9	Significant? (alpha = 0.05)		Yes					
10								
11	Number of XY Pairs		12					
12								
13								
14								
15								

R square is 0.3529 and P- Value is 0.0471 and is significant.

GROUP 2 CRT TDRILL

2 Way ANOVA

2way ANOVA

1	Table Analyzed	Data 4			
2					
3	Two-way ANOVA	Ordinary			
4	Alpha	0.05			
5					
6	Source of Variation	% of total variation	P value	P value summary	Significant?
7	Row Factor	23.85	0.2120	ns	No
8	Column Factor	61.00	<0.0001	****	Yes
9					
10	ANOVA table	SS (Type III)	DF	MS	F (DFn, DFd)
11	Row Factor	10.18	13	0.7830	F (13, 13) = 1.575
12	Column Factor	26.04	1	26.04	F (1, 13) = 52.36
13	Residual	6.464	13	0.4973	
14	Total	42.68	27		
15					
16	Difference between column means				
17	Predicted (LS) mean of Pre test	13.36			
18	Predicted (LS) mean of Post test	11.43			
19	Difference between predicted means	1.929			

The two-way ANOVA showed that one factor did not have a statistically significant effect on the measured response ($p = 0.2120$, $p > 0.05$), indicating that the observed differences associated with this factor were not statistically significant. In contrast, the second factor showed a highly statistically significant effect on the response ($p < 0.0001$, $p < 0.05$). This indicates that the differences associated with the second factor are highly unlikely to have occurred due to random variation alone.

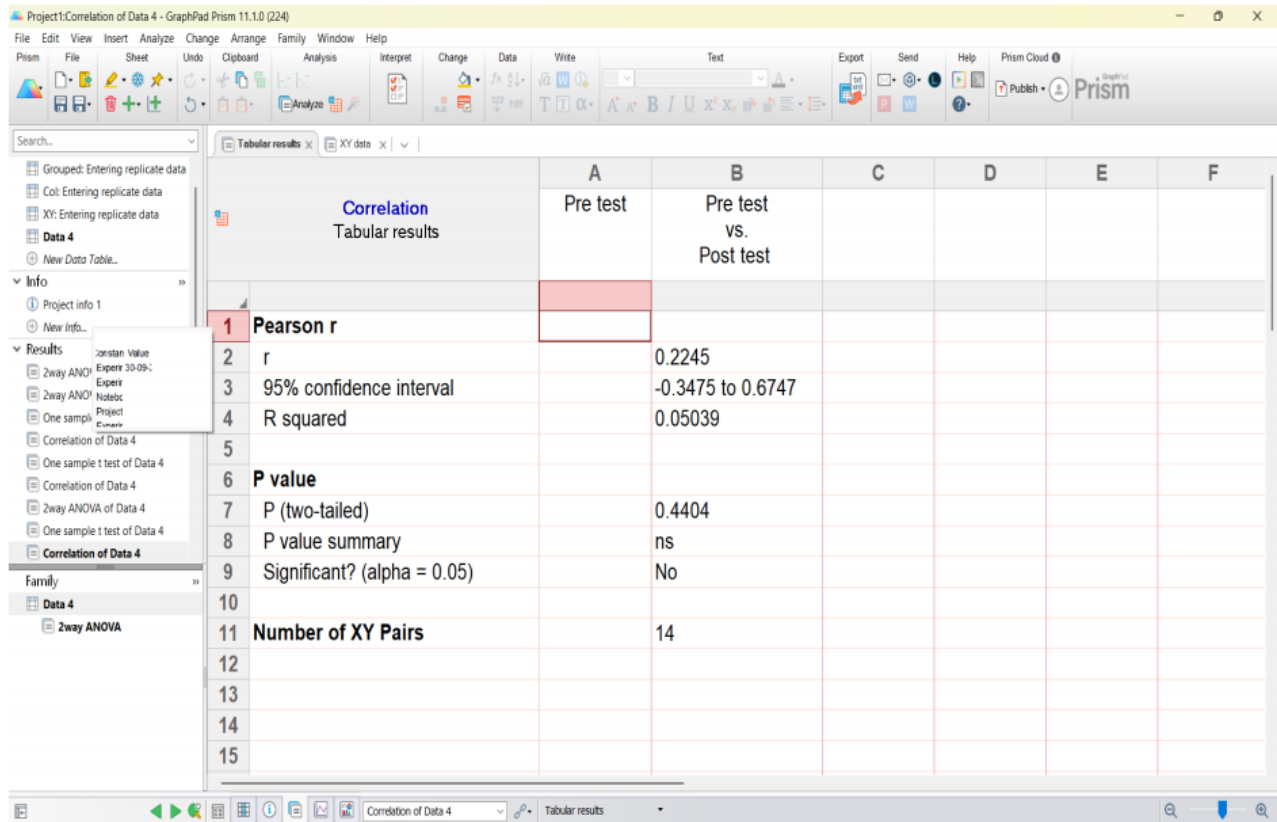
T Test

One sample t test

		A	B	C	D	E	F
		Pre test	Post test				
1	Theoretical mean	0.000	0.000				
2	Actual mean	13.36	11.43				
3	Number of values	14	14				
4							
5	One sample t test						
6	t, df	t=59.36, df=13	t=56.57, df=13				
7	P value (two tailed)	<0.0001	<0.0001				
8	P value summary	****	****				
9	Significant (alpha=0.05)?	Yes	Yes				
10							
11	How large is the effect?						
12	Discrepancy	13.36	11.43				
13	SD of discrepancy	0.8419	0.7559				
14	SEM of discrepancy	0.2250	0.2020				
15	95% confidence interval	12.87 to 13.84	10.99 to 11.87				
16	R squared (partial eta squared)	0.9963	0.9960				

Q- Value is < 0.0001 for both pre and post-test. They are highly significant and R square is 0.9963 and 0.9960. So null hypothesis is rejected.

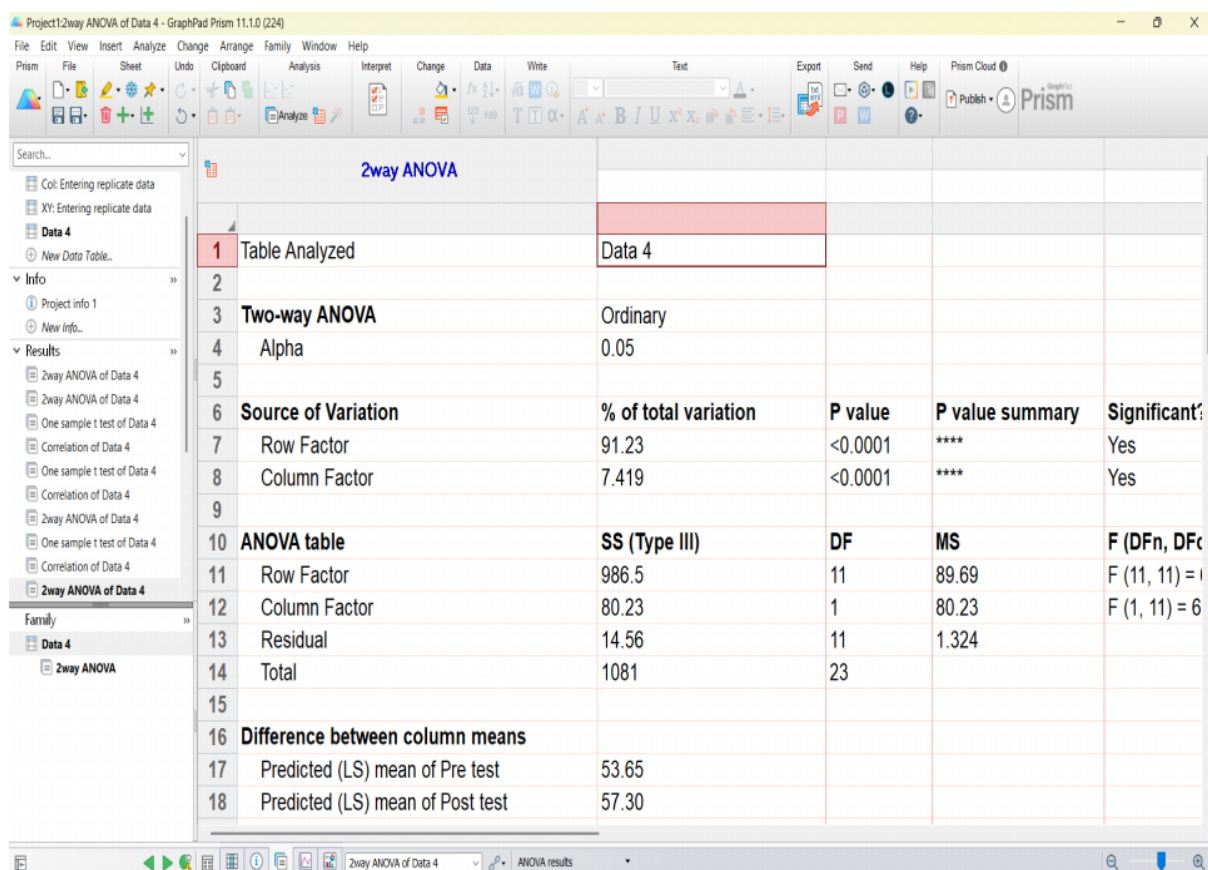
Pearson correlation



	A	B	C	D	E	F
Correlation	Pre test	Pre test vs. Post test				
Tabular results						
1 Pearson r						
2 r		0.2245				
3 95% confidence interval		-0.3475 to 0.6747				
4 R squared		0.05039				
5						
6 P value						
7 P (two-tailed)		0.4404				
8 P value summary		ns				
9 Significant? (alpha = 0.05)		No				
10						
11 Number of XY Pairs		14				
12						
13						
14						
15						

R square is 0.0.5039 and P- Value is 0.4404 and is not significant.

Group 2 CRT 10RM measurement 2 way ANOVA



2way ANOVA					
1 Table Analyzed	Data 4				
2					
3 Two-way ANOVA	Ordinary				
4 Alpha	0.05				
5					
6 Source of Variation	% of total variation	P value	P value summary	Significant?	
7 Row Factor	91.23	<0.0001	****	Yes	
8 Column Factor	7.419	<0.0001	****	Yes	
9					
10 ANOVA table	SS (Type III)	DF	MS	F (DFn, DFd)	
11 Row Factor	986.5	11	89.69	F (11, 11) = 1	
12 Column Factor	80.23	1	80.23	F (1, 11) = 6	
13 Residual	14.56	11	1.324		
14 Total	1081	23			
15					
16 Difference between column means					
17 Predicted (LS) mean of Pre test	53.65				
18 Predicted (LS) mean of Post test	57.30				

If $P < 0.05$, the treatments differ significantly. Here, the P-value is <0.0001 and both are highly significant. Since the P-Values are significant, the null hypothesis is rejected.

T- Test

One sample t test		A	B	C	D	E	F
		Pre test	Post test				
1	Theoretical mean	0.000	0.000				
2	Actual mean	53.65	57.30				
3	Number of values	12	12				
4							
5	One sample t test						
6	t, df	t=26.27, df=11	t=31.01, df=11				
7	P value (two tailed)	<0.0001	<0.0001				
8	P value summary	****	****				
9	Significant (alpha=0.05)?	Yes	Yes				
10							
11	How large is the effect?						
12	Discrepancy	53.65	57.30				
13	SD of discrepancy	7.073	6.402				
14	SEM of discrepancy	2.042	1.848				
15	95% confidence interval	49.15 to 58.14	53.24 to 61.37				
16	R squared (partial eta squared)	0.9843	0.9887				
17							
18							

P- Value is < 0.0001 for both pre and post-test. They are highly significant and R square is 0.9843 and 0.9887. So null hypothesis is rejected.

Pearson Correlation

R square is 0.9521 and P- Value is <0.0001 and is highly significant.

Group 1 H11RT 2 way ANOVA

2way ANOVA					
1	Table Analyzed	Data 4			
2					
3	Two-way ANOVA	Ordinary			
4	Alpha	0.05			
5					
6	Source of Variation	% of total variation	P value	P value summary	Sig
7	Row Factor	92.84	<0.0001	****	Yes
8	Column Factor	7.016	<0.0001	****	Yes
9					
10	ANOVA table	SS (Type III)	DF	MS	F (D
11	Row Factor	1869	11	169.9	F (1
12	Column Factor	141.2	1	141.2	F (1
13	Residual	2.816	11	0.2560	
14	Total	2013	23		
15					
16	Difference between column means				

Here, the P-value is <0.0001 and both are highly significant. Since the P-Values are significant, the null hypothesis is rejected.

T Test

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Results

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- 2way ANOVA of Data 4
- One sample t test of Data 4
- Correlation of Data 4
- 2way ANOVA of Data 4
- One sample t test of Data 4

Family

- Data 4
- 2way ANOVA

One sample t test		A	B	C	D	E
		Pre test	post test			
1	Theoretical mean	0.000	0.000			
2	Actual mean	56.21	61.06			
3	Number of values	12	12			
4						
5	One sample t test					
6	t, df	t=21.02, df=11	t=23.03, df=11			
7	P value (two tailed)	<0.0001	<0.0001			
8	P value summary	****	****			
9	Significant (alpha=0.05)?	Yes	Yes			
10						
11	How large is the effect?					
12	Discrepancy	56.21	61.06			
13	SD of discrepancy	9.264	9.184			
14	SEM of discrepancy	2.674	2.651			
15	95% confidence interval	50.32 to 62.09	55.22 to 66.89			
16	R squared (partial eta squared)	0.9757	0.9797			
17						
18						

One sample t test of Data 4 Tabular results

Highly significant and R square is 0.9757 and 0.9797.

Pearson Correlation

Project1:Correlation of Data 4 - GraphPad Prism 11.1.0 (224)

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- 2way ANOVA of Data 4
- One sample t test of Data 4
- Correlation of Data 4

Family

- Data 4
- 2way ANOVA

Correlation		A	B	C	D	E
Tabular results		Pre test	Pre test vs. post test			
1	Pearson r					
2	r		0.9970			
3	95% confidence interval		0.9891 to 0.9992			
4	R squared		0.9941			
5						
6	P value					
7	P (two-tailed)		<0.0001			
8	P value summary		****			
9	Significant? (alpha = 0.05)		Yes			
10						
11	Number of XY Pairs		12			
12						
13						
14						
15						

Correlation of Data 4 Tabular results

R-squared is 0.9941, and the P-value is < 0.0001 and is highly significant.

Group 2 CRT Skin fold measure

2 Way ANOVA

2way ANOVA				
1	Table Analyzed	Data 5		
2				
3	Two-way ANOVA	Ordinary		
4	Alpha	0.05		
5				
6	Source of Variation	% of total variation	P value	P value summary
7	Row Factor	97.41	<0.0001	****
8	Column Factor	2.350	<0.0001	****
9				
10	ANOVA table	SS (Type III)	DF	MS
11	Row Factor	19.97	11	1.815
12	Column Factor	0.4817	1	0.4817
13	Residual	0.04833	11	0.004394
14	Total	20.50	23	
15				
16	Difference between column means			
17	Predicted (LS) mean of Pre test body fat	14.05		
18	Predicted (LS) mean of post test body fat	13.77		

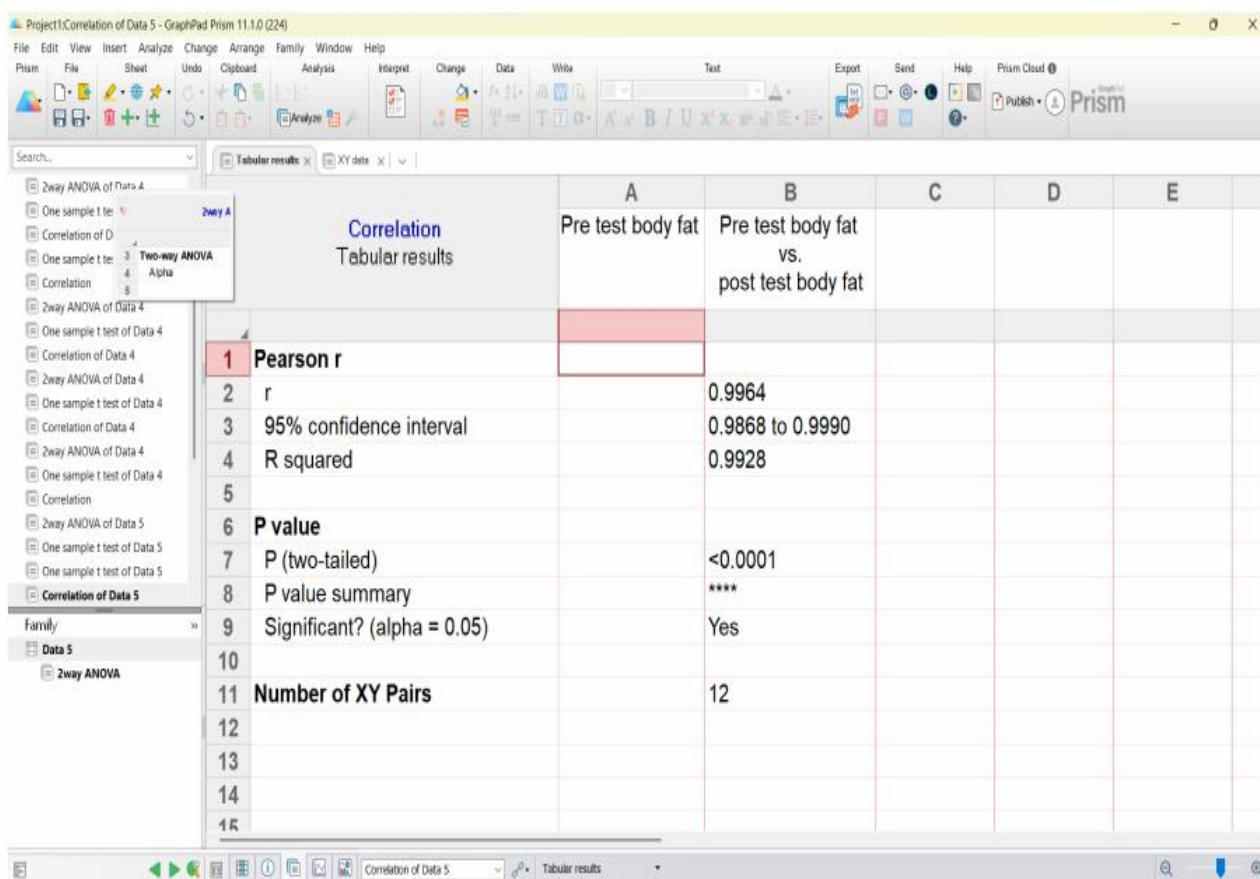
Here, the P-value is <0.0001 and both are highly significant. Since the P-Values are significant, the null hypothesis is rejected.

T Test

One sample t test		
	A	B
	Pre test body fat	post test body fat
1	Theoretical mean	0.000
2	Actual mean	14.05
3	Number of values	12
4		
5	One sample t test	
6	t, df	t=52.34, df=11
7	P value (two tailed)	<0.0001
8	P value summary	****
9	Significant (alpha=0.05)?	Yes
10		
11	How large is the effect?	
12	Discrepancy	14.05
13	SD of discrepancy	0.9298
14	SEM of discrepancy	0.2684
15	95% confidence interval	13.46 to 14.64
16	R squared (partial eta squared)	0.9960
17		
18		

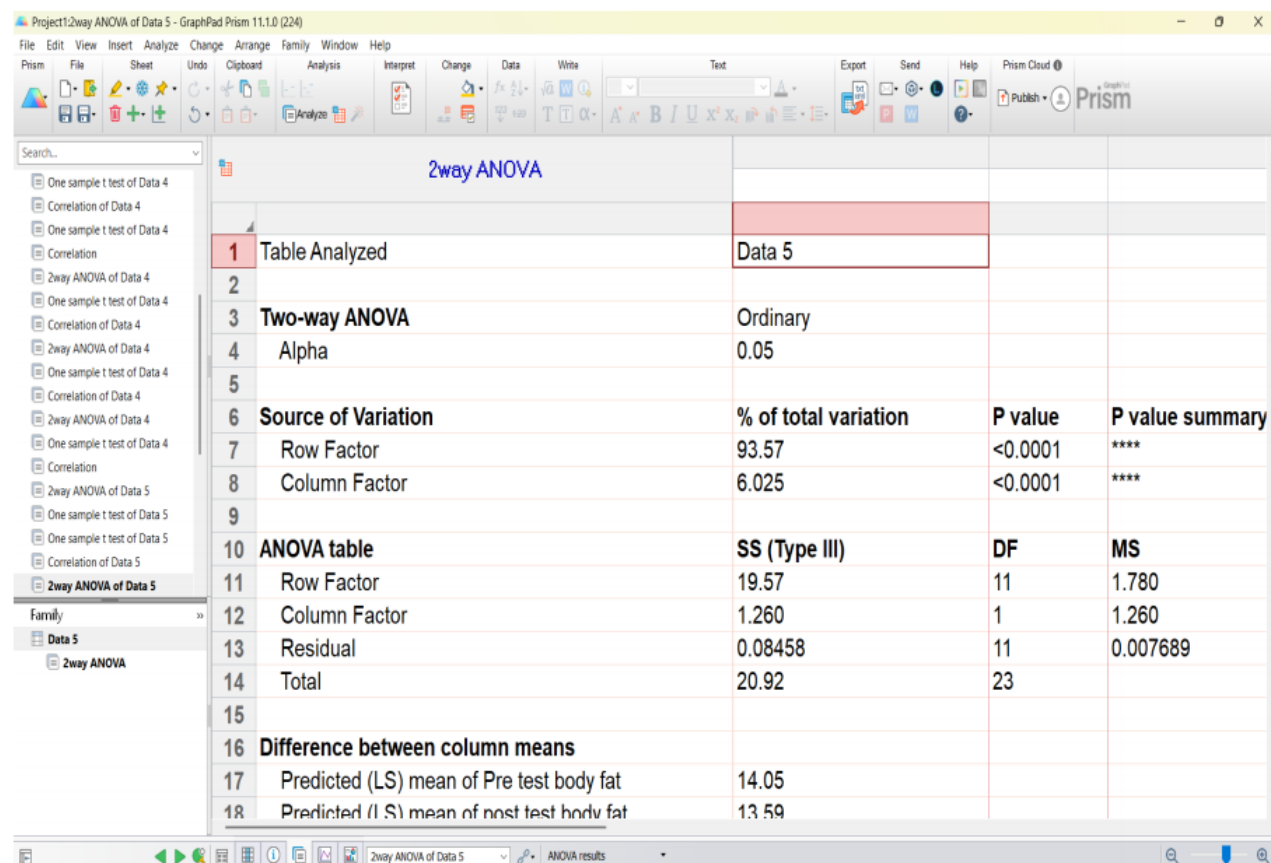
Highly significant and R square is 0.9960 and 0.9954.

Pearson Correlation



R-squared is 0.9928, and the P-value is < 0.0001 and is highly significant.

Group 1 H11RT Skin fold measurement 2 Way ANOVA



Here, the P-value is <0.0001 and both are highly significant. Since the P-Values are significant, the null hypothesis is rejected.

T Test

Project1:One sample t test of Data 5 - GraphPad Prism 11.1.0 (224)

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One sample t test

	A	B	C	D	E
	Pre test body fat	post test body fat			
1 Theoretical mean	0.000	0.000			
2 Actual mean	14.05	13.59			
3 Number of values	12	12			
4					
5 One sample t test					
6 t, df	t=52.34, df=11	t=49.02, df=11			
7 P value (two tailed)	<0.0001	<0.0001			
8 P value summary	****	****			
9 Significant (alpha=0.05)?	Yes	Yes			
10					
11 How large is the effect?					
12 Discrepancy	14.05	13.59			
13 SD of discrepancy	0.9298	0.9605			
14 SEM of discrepancy	0.2684	0.2773			
15 95% confidence interval	13.46 to 14.64	12.98 to 14.20			
16 R squared (partial eta squared)	0.9960	0.9954			
17					
18					

Family

Data 5

2way ANOVA

One sample t test of Data 5

Tabular results

Highly significant and R square is 0.9960 and 0.9954.

Pearson Correlation

Project1:Correlation of Data 5 - GraphPad Prism 11.1.0 (224)

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Correlation

Tabular results

	A	B	C	D	E
	Pre test body fat	Pre test body fat vs. post test body fat			
1 Pearson r					
2 r		0.9919			
3 95% confidence interval		0.9705 to 0.9978			
4 R squared		0.9839			
5					
6 P value					
7 P (two-tailed)		<0.0001			
8 P value summary		****			
9 Significant? (alpha = 0.05)		Yes			
10					
11 Number of XY Pairs		12			
12					

Family

Data 5

2way ANOVA

Correlation of Data 5

Tabular results

R square is 0.9839 and P- Value is <0.0001 and is highly significant.

GROUP 2 CRT SQUAT JUMP TEST

2 Way ANOVA

Project1:2way ANOVA of Data 5 - GraphPad Prism 11.1.0 (224)

2way ANOVA				
4	Alpha	0.05		
6	Source of Variation	% of total variation	P value	P value summary
7	Row Factor	98.08	<0.0001	****
8	Column Factor	1.543	<0.0001	****
10	ANOVA table	SS (Type III)	DF	MS
11	Row Factor	12248	11	1113
12	Column Factor	192.7	1	192.7
13	Residual	47.33	11	4.303
14	Total	12488	23	
16	Difference between column means			
17	Predicted (LS) mean of Pre test	304.8		
18	Predicted (LS) mean of Post test	310.4		
19	Difference between predicted means	-5.667		
20	SE of difference	0.8469		

Here, the P-value is <0.0001, and both are highly significant. Since the P-values are significant, we reject the null hypothesis.

T TEST

Project1:One sample t test of Data 5 - GraphPad Prism 11.1.0 (224)

One sample t test		A	B	C	D	E
		Pre test	Post test			
1	Theoretical mean	0.000	0.000			
2	Actual mean	304.8	310.4			
3	Number of values	12	12			
5	One sample t test					
6	t, df	t=45.86, df=11	t=44.35, df=11			
7	P value (two tailed)	<0.0001	<0.0001			
8	P value summary	****	****			
9	Significant (alpha=0.05)?	Yes	Yes			
11	How large is the effect?					
12	Discrepancy	304.8	310.4			
13	SD of discrepancy	23.02	24.25			
14	SEM of discrepancy	6.645	6.999			
15	95% confidence interval	290.1 to 319.4	295.0 to 325.8			
16	R squared (partial eta squared)	0.9948	0.9944			

R Square is 0.9948 and 0.9944 and P-Value is <0.0001 and is highly significant.

Pearson Correlation

	A	B	C	D	E
Correlation	Pre test	Pre test vs. Post test			
Tabular results					
1 Pearson r					
2 r		0.9936			
3 95% confidence interval		0.9767 to 0.9983			
4 R squared		0.9873			
5					
6 P value					
7 P (two-tailed)		<0.0001			
8 P value summary		****			
9 Significant? (alpha = 0.05)		Yes			
10					
11 Number of XY Pairs		12			
12					
13					
14					

R Square is 0.9873 and P-Value is <0.0001 and is highly significant

Group 1 H11RT Squat Jump Test 2 Way ANOVA

	A	B	C	D	E
2way ANOVA					
1 Table Analyzed		Data 5			
2					
3 Two-way ANOVA		Ordinary			
4 Alpha		0.05			
5					
6 Source of Variation		% of total variation	P value	P value summary	
7 Row Factor		97.85	<0.0001	****	
8 Column Factor		1.852	<0.0001	****	
9					
10 ANOVA table		SS (Type III)	DF	MS	
11 Row Factor		14803	11	1346	
12 Column Factor		280.2	1	280.2	
13 Residual		44.83	11	4.076	
14 Total		15128	23		
15					
16 Difference between column means					
17 Predicted (I.S.) mean of Pre test		309.0			

Here, the P-value is <0.0001, and both are highly significant. Since the P-values are significant, we reject the null hypothesis.

T Test

One sample t test		A	B	C	D	E
		Pre test	Post test			
1	Theoretical mean	0.000	0.000			
2	Actual mean	309.0	315.8			
3	Number of values	12	12			
4						
5	One sample t test					
6	t, df	t=40.97, df=11	t=42.36, df=11			
7	P value (two tailed)	<0.0001	<0.0001			
8	P value summary	****	****			
9	Significant (alpha=0.05)?	Yes	Yes			
10						
11	How large is the effect?					
12	Discrepancy	309.0	315.8			
13	SD of discrepancy	26.13	25.83			
14	SEM of discrepancy	7.542	7.457			
15	95% confidence interval	292.4 to 325.6	299.4 to 332.2			
16	R squared (partial eta squared)	0.9935	0.9939			
17						

R Square value is 0.9935 and 0.9939 and P-Value is <0.0001 and is highly significant.

Pearson Correlation

Correlation Tabular results		A	B	C	D	E
		Pre test	Pre test vs. Post test			
1	Pearson r					
2	r		0.9940			
3	95% confidence interval		0.9781 to 0.9984			
4	R squared		0.9881			
5						
6	P value					
7	P (two-tailed)		<0.0001			
8	P value summary		****			
9	Significant? (alpha = 0.05)		Yes			
10						
11	Number of XY Pairs		12			
12						
13						
14						

R Square is 0.9881, P-Value is <0.0001 and is highly significant.

Annexure

Table 1

	Statistics Test	Group for test									
		Group 1 HIIRT		Group 2 CRT		Group 2 CRT RM		Group 1 HIIRT		Group 2 CRT Skin fold	
		P-Value	Significance	P-Value	Significance	P-Value	Significance	P-Value	Significance	P-Value	Significance
1	Two-way ANOVA	<0.0001	Significant	<0.0001	Significant	<0.0001	Significant	<0.0001	Significant	<0.0001	Significant
2	T- Test	<0.0001	Significant	<0.0001	Significant	<0.0001	Significant	<0.0001	Significant	<0.0001	Significant
3	Pearson Correlation	0.0471	Significant	0.4404	Not Significant	<0.0001	Significant	<0.0001	Significant	<0.0001	Significant

Table 2

S.No	Statistics Test	Group for test					
		Group 1 HIIRT Skin Fold		Group 2 CRT Squat jump		Group 1 HIIRT Squat Jump	
		P-Value	Significance	P-Value	Significance	P-Value	Significance
1	Two-way ANOVA	<0.0001	Significant	<0.0001	Significant	<0.0001	Significant
2	T- Test	<0.0001	Significant	<0.0001	Significant	<0.0001	Significant
3	Pearson Correlation	0.0471	Significant	<0.0001	Significant	<0.0001	Significant