



EFFECTS OF CORE STRENGTHENING INTERVENTION ON MAXIMAL OXYGEN UPTAKE, FLEXIBILITY AND LOWER LIMB STRENGTH IN UNIVERSITY LEVEL CYCLISTS

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Abstract:

The aim of this study was to explore the effects of 6-week core strengthening intervention on Maximal Oxygen Uptake, Flexibility and Lower limb strength of University level Cyclists. Thirty, University level male Cyclists of Guru Nanak Dev University, Amritsar between the age group of 18-28 years (Mean \pm SD: age 21.766 \pm 2.2078 yrs, body height 167.533 \pm 5.593 cm, body mass 63.08 \pm 3.723 kg) volunteered to participate in the study. Queens College Step test was performed to calculate Maximal Oxygen Uptake (VO_{2max}), Sit and Reach test was performed to calculate Flexibility and Vertical Jump Test was performed to calculate Lower limb Strength. The subjects from Group-A: Experimental were subjected to a 6-week core strength exercise program, 3 days a week for six weeks. Statistical analyses were performed using the Statistical Package for the Social Sciences for Windows version 16.0 software (SPSS Inc., Chicago, IL). Data is expressed as the mean \pm SD. Paired sample t-test was utilized to compare the means of the Pre-Test and the Post-Test. The level of significance was set at 0.05. Significant differences were found in Maximal Oxygen Uptake, Flexibility and Lower limb Strength in the Experimental Group subjected to 6-week core strengthening intervention. However, no significant changes were noted in the Control Group at the end of 6-week duration.

Keywords: cyclist, maximal oxygen uptake, flexibility, lower limb strength, core

1. Introduction

Core stability and core strength have been subject to research since the early 1980s [1, 2]. The “core,” also referred to as the lumbopelvic-hip complex, is a 3-dimensional space with muscular boundaries: diaphragm (superior), abdominal and oblique muscles (anterior-lateral), paraspinal and gluteal muscles (posterior), and pelvic floor and hip

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girdle (inferior) [3]. The inherent nature of these muscular boundaries produces a corset-like stabilization effect on the trunk and spine [4]. Generally, core stability comprises the lumbopelvic-hip complex and is the capacity to maintain equilibrium of the vertebral column within its physiologic limits by reducing displacement from perturbations and maintaining structural integrity [5, 6, 7, 8]. Clinically and practically, this definition lacks a tangible, functional perspective that translates into principles for practical application of core stability assessment and training in active, athletic population.

Core stability plays an important role in cycling performance. It exerts effect on lower limb cycling biomechanics. The core stability has generated a lot of interest especially with regard to functional and sport specific training. Research has shown positive impact of core training on increasing performance as well as for injury prevention [8]. It has been found that Physical activity (PA) increases aerobic capacity and muscular strength, especially of the lumbar extensor muscles and is important for patients with chronic low back pain in assisting them to complete activities of daily living [9]. However, different exercises have been found to result in varying levels of effectiveness in reducing lower back pain [10]. In addition, too much or too little PA can be associated with low back pain [11], suggesting that PA as an intervention for low back pain is complex. The benefits of exercise are profound and include improved cardiovascular fitness, muscle strength, flexibility, and endurance [12].

Maximal oxygen consumption (VO_{2max}), an index of maximal cardiovascular (CV) function, decreases 5 to 15% per decade after the age of 25 yr [13]. Decrease in both maximal cardiac output and maximal arteriovenous O_2 difference contribute to the age-associated reduction in VO_{2max} [14, 15, 16, 17].

The lower limb strength and power has been examined quite frequently by isokinetic testing or vertical jump test [18]. The vertical jump test could be performed in the laboratory by using jump platforms or in the field using Sargent Jump Test (SJT). This test measures the explosive strength of lower limbs of athletes' in different sports [19, 20]. Strength conditioning is generally defined as training in which the resistance against which a muscle generates force is progressively increased over time. Muscle strength has been shown to increase in response to training between 60 and 100% of the 1 RM [21].

Flexibility is a general term which encompasses the range of motion of single or multiple joints and is the ability to perform specific tasks. It is evident that flexibility declines with age, with the maximum range of motion occurring in the mid- to late twenties for men and women, respectively [22, 23, 24].

Thus, the aim of the present study was to explore the effects of 6-week core strengthening intervention on Maximal Oxygen Uptake, Flexibility and Lower limb Strength of University level Cyclists.

2. Material and Methods

2.1 Subjects

Thirty, University level male Cyclists of Guru Nanak Dev University, Amritsar between the age group of 18-28 years (Mean ± SD: age 21.766 ± 2.2078 yrs, body height 167.533 ± 5.593 cm, body mass 63.08 ± 3.723 kg) volunteered to participate in the study. The subjects were purposively divided into two groups:

- Group-A: Experimental (N₁=15)
- Group-B: Control (N₂=15)

Distribution and demographics of subjects are brought forth in Table 1.

Table 1: Distribution and Demographics of Subjects (N=30) (i.e., Experimental Group (N₁=15) and Control Group (N₂=15))

Variable (s)	Sample Size (N=30)		
	Total N=30	Experimental Group (N ₁ =15)	Control Group (N ₂ =15)
Age (yrs)	21.766 ± 2.2078	22.266 ± 2.051	21.266 ± 2.313
Body Height (cm)	167.533 ± 5.593	168.466 ± 5.396	166.6 ± 5.816
Body Mass (kg)	63.08 ± 3.723	63.8 ± 3.4207	62.36 ± 3.989

*N; sample size, yrs; years, cm; centimeters, kg; kilograms.

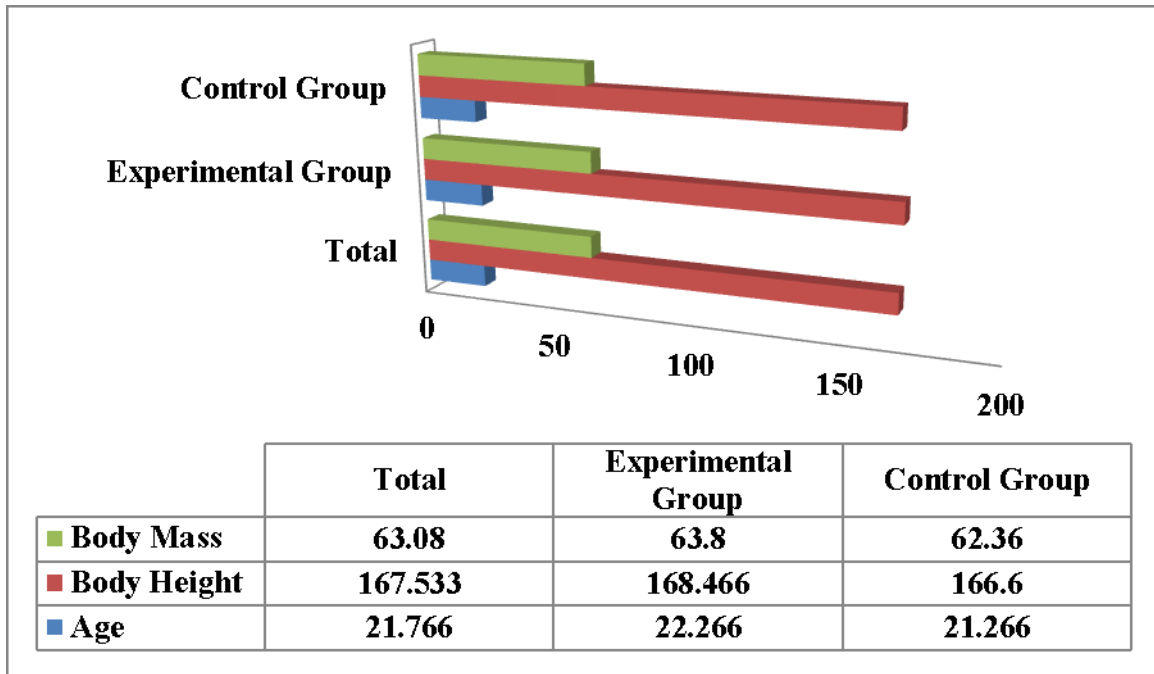


Figure 1: Distribution and Demographics of Subjects (N=30) (i.e., Experimental Group (N₁=15) and Control Group (N₂=15))

2.2 Methodology

This study is designed as a retrospective cross-sectional study. Queens College Step test was performed to calculate Maximal Oxygen Uptake (VO_{2max}) [25], Sit and Reach test

was performed to calculate Flexibility [26] and Vertical Jump Test was performed to calculate Lower limb Strength [27]. The subjects from Group-A: Experimental were subjected to a 6-week core strength exercise program, 3 days a week for six weeks [28].

2.3 Statistical Technique

Statistical analyses were performed using the Statistical Package for the Social Sciences for Windows version 16.0 software (SPSS Inc., Chicago, IL). Data is expressed as the mean \pm SD. Paired sample t-test was utilized to compare the means of the Pre-Test and the Post-Test. The level of significance was set at 0.05.

3. Results

Table 2: Descriptive statistics (Mean & Standard Deviation) and paired sample t-test of Experimental Group ($N_1=15$) and Control Group ($N_2=15$) for Maximal Oxygen Uptake, Flexibility and Lower Limb Strength

Maximal Oxygen Uptake						
Group	Number	Mean	Standard Deviation	Variance	t-value	p-value
Experimental (Pre-Test)	15	159.8	1.4736	2.1714	6.8074	0.000
Experimental (Post-Test)	15	158.2	1.8205	3.3143		
Control (Pre-Test)	15	146.3	5.1	26.6	1.1457	0.271
Control (Post-Test)	15	145.9	4.8	23.0		
Flexibility						
Experimental (Pre-Test)	15	13.46	4.17	17.4	16.7336	1.188
Experimental (Post-Test)	15	18.8	5.12	26.3		
Control (Pre-Test)	15	12.2	3.39	11.4	0.8987	0.384
Control (Post-Test)	15	12.4	3.29	10.8		
Lower Limb Strength						
Experimental (Pre-Test)	15	53	6.39	40.85	19.5784	1.434
Experimental (Post-Test)	15	60.2	6.98	48.74		
Control (Pre-Test)	15	54.13	4.37	19.12	0.3669	0.719
Control (Post-Test)	15	54.2	4.53	20.6		

3.1 Maximal Oxygen Uptake

The results of Maximal Oxygen Uptake in group (Experimental) and group (Control) are shown in Table 2. The Mean and Standard Deviation values of Maximal Oxygen Uptake of Pre-Test and Post-Test of Experimental Group were 159.8 ± 1.4736 and 158.2 ± 1.8205 respectively. However, the Mean and Standard Deviation values of Maximal Oxygen Uptake of Pre-Test and Post-Test of Control Group were 146.3 ± 5.1 and 145.9 ± 4.8 . The t-value in case of Experimental Group was 6.8074 and for Control Group it was 1.1457.

In group (Experimental) the calculated t exceeds the critical value ($6.8074 > 2.145$), so the means are significantly different, whereas in group (Control) the calculated t value is smaller than critical value ($1.1457 < 2.145$), so the means are not significantly different.

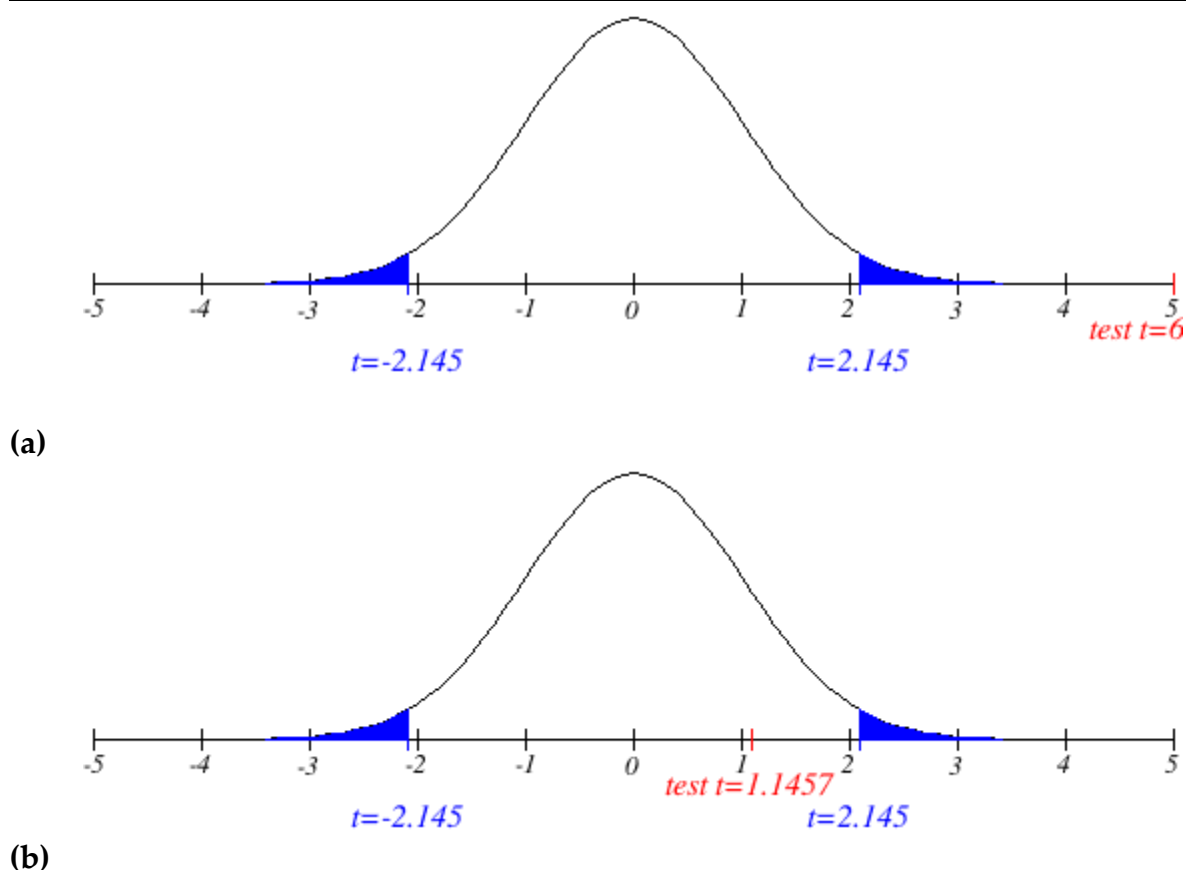


Figure 2: t-test and p-value for the Experimental (Pre-Test & Post-Test) and Control (Pre-Test & Post-Test) Groups on the variable Maximal Oxygen Uptake

3.2 Flexibility

The results of Flexibility in group (Experimental) and group (Control) are shown in Table 2. The Mean and Standard Deviation values of Flexibility of Pre-Test and Post-Test of Experimental Group were 13.46 ± 4.17 and 18.8 ± 5.12 respectively. However, the Mean and Standard Deviation values of Flexibility of Pre-Test and Post-Test of Control Group were 12.2 ± 3.39 and 12.4 ± 3.29 respectively. The t-value in case of Experimental Group was 16.7336 and for Control Group it was 0.8987.

In group (Experimental) the calculated t exceeds the critical value ($16.7336 > 2.145$), so the means are significantly different, whereas in group (Control) the calculated t is smaller than critical value ($0.8987 < 2.145$), so the means are not significantly different.

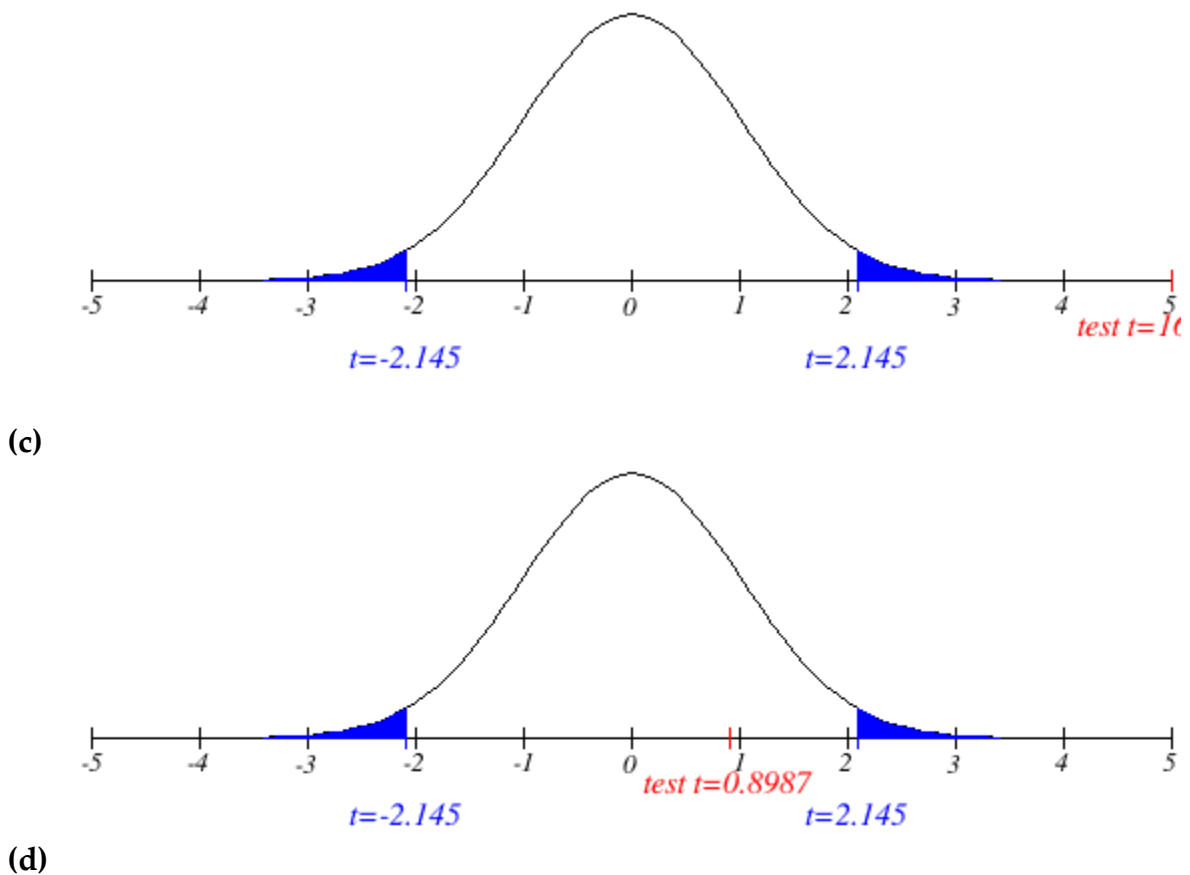


Figure 3: t-test and p-value for the Experimental (Pre-Test & Post-Test) and Control (Pre-Test & Post-Test) Groups on the variable Flexibility

3.3 Lower Limb Strength

The results of Lower limb Strength in group (Experimental) and group (Control) are shown in Table-2. The Mean and Standard Deviation values of Lower Limb Strength of Pre-Test and Post-Test of Experimental Group were 53 ± 6.39 and 60.2 ± 6.98 respectively. However, the Mean and Standard Deviation values of Lower Limb Strength of Pre-Test and Post-Test of Control Group were 54.13 ± 4.37 and 54.2 ± 4.53 respectively. The t-value in case of Experimental Group was 19.5784 and for Control Group it was 0.3669.

In group (Experimental) the calculated t exceeds the critical value ($19.5784 > 2.145$), so the means are significantly different, whereas in group (Control) the calculated t is smaller than critical value ($0.3669 < 2.145$), so the means are not significantly different.

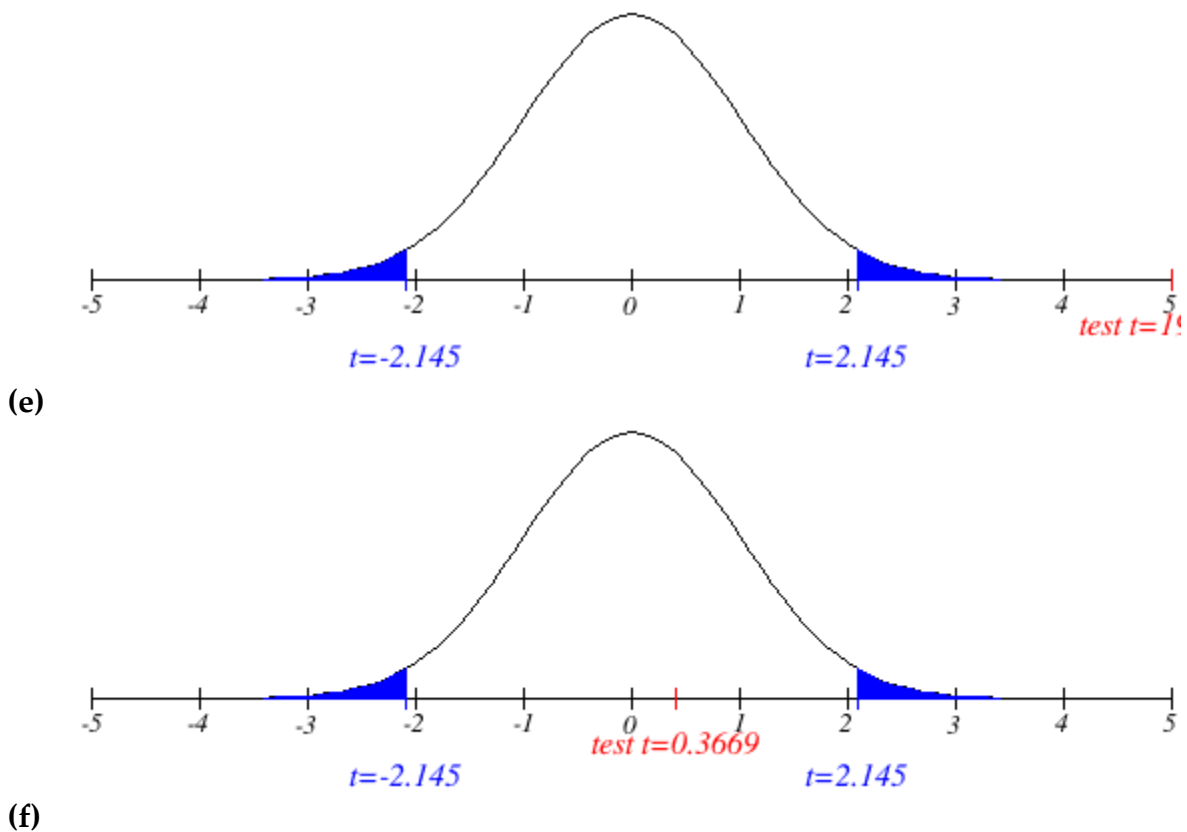


Figure 4: t-test and p-value for the Experimental (Pre-Test & Post-Test) and Control (Pre-Test & Post-Test) Groups on the variable Lower Limb Strength

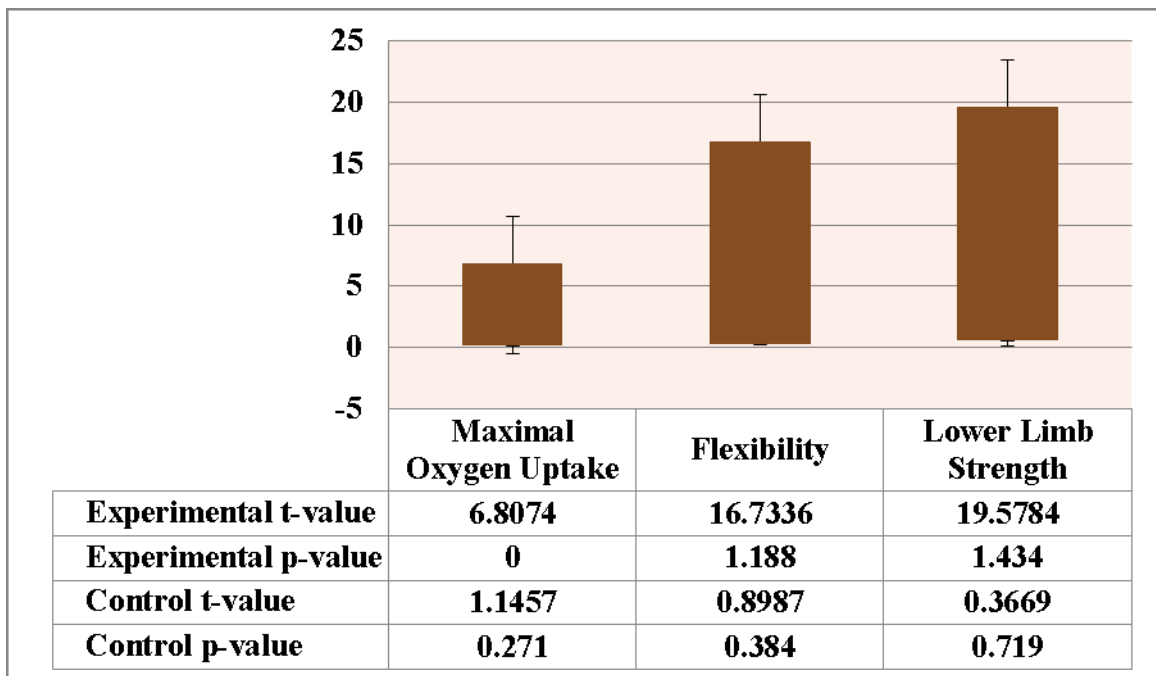


Figure 5: t-value and p-value for the Experimental (Pre-Test & Post-Test) and Control (Pre-Test & Post-Test) groups scores of Maximal Oxygen Uptake, Flexibility and Lower Limb Strength

4. Discussion

This study explored the effects of 6-week core strengthening intervention on Maximal Oxygen Uptake, Flexibility and Lower limb Strength of University level Cyclists. Significant differences were found in Maximal Oxygen Uptake, Flexibility and Lower limb Strength in the Experimental Group subjected to 6-week core strengthening intervention. However, no significant changes were noted in the Control Group at the end of 6-week duration. The significant differences observed in the Experimental Group could be attributed to the effects of core strength training intervention administered to this group. Research has shown that core strength training provides a stable foundation for force generation in cyclists [29]. The greater stability of the lower limb is vital component for optimal athletic performance as well as it serves as an important tool in prevention and rehabilitation of injuries [30].

Sports scientists have shown that development of explosive power in the lower limbs of athletes is extremely important. Even those activities that are not directly related with vertical jump e.g. block in soccer; there also vertical jump test serves as an effective method of power and strength measurement and acts as an indirect indicator of sports performance [31, 32].

For success in sports, it is essential that athlete should have skill to produce greater amount of force in a short span of time. This ability is termed as explosive power/force. The vertical jump is an economical method for evaluation of lower limb strength. This method provides an insight into the current status of lower limb strength as well as for talent identification [33].

5. Conclusion

Based upon the findings it could be concluded that core strength training is an important method to enhance the physical conditioning parameters in athletes as observed in Experimental Group. Higher levels of core stability offers a platform for more force production in both upper and lower limbs [34]. The lower limb muscles generate or resist forces on the platform provided by the core. The core exercises result in increased sensitivity of muscle spindles which lead to a higher state of promptness to react to disturbing forces applied to the body. During training when the joint is exposed to destabilizing forces, stimulus thus may be given for growth of compensatory mechanisms. On the other side, the lack of core muscle conditioning may lead to faulty biomechanics and finally to injuries [35].

5.1 Practical Application

The strength and conditioning coach, sport scientist, sport physiotherapist, fitness trainers etc. may tailor the respective training sessions making use of the training protocol to enhance the performance of athletes in general. The study provides a training method through which not only strength and conditioning, but injury

rehabilitation programs may be designed. Sports Physiotherapist, Sports physician, Coaches and Athletic Trainers may utilize the findings of the present study by preparing or modifying the existing training schedules for the Cyclists. The data regarding Maximal Oxygen Uptake, Flexibility and Lower limb Strength variables will help the coaches and trainers to regulate the training programme for the Cyclists.

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