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Effect of strength and endurance training and combined strength endurance and mobility training on leg strength and vital capacity

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Abstract
The purpose of the present study was to find the effect of strength training and endurance training and combination of strength, endurance and mobility training on leg strength and vital capacity. For this purpose, sixty male hockey players from various colleges around Namakall Town, Tamilnadu, in the age group of 17 – 25 years were selected. They were divided into four equal groups (n = 15), in which group – I underwent strength training group – II underwent endurance training, group – III combination of strength, endurance and mobility training and group – IV acted as control group who did not participate in any special training. The training period for this study was three days in a week for twelve weeks. Prior to and after the training period the subjects were tested for leg strength and vital capacity. Leg strength was assessed by administering leg lift with dynamometer and vital capacity was assessed by using expirograph. The analysis of covariance (ANCOVA) was used to find out the significant difference if any, among the experimental groups and control group on selected criterion variables separately. Since there were four groups involved in this study the Scheffè *S* test was used as pos-hoc test. It was concluded from the result of the study that the strength training, endurance training and combination of strength, endurance and mobility training groups has positively altered the criterion variables, such as, leg strength and vital capacity. The result of the study also shown that there was no significant difference occurred between the experimental groups, such as, strength training, endurance training group and combination of strength, endurance and mobility training group.

Keywords: Strength training, endurance training, combined training, leg strength and vital capacity

Introduction
Children's motor skill development and physical fitness are aided by physical activity. Children and teens between the ages of 5 and 17 should exercise for at least 60 minutes each day at a moderate to vigorous level, according to the World Health Organization. The majority of the exercise should be aerobic, and should practise muscle-strengthening activities at least three times each week [WHO, (2010)] [17]. As a result, all young people should regularly engage in strength and endurance workouts. Strength and endurance exercises can help young athletes build their long-term athletic performance for a particular activity. High levels of physical strength and cardiovascular endurance are essential for performance in various sports [Baar, (2014); Bompa and Buzzichelli, (2015)] [2, 4]. According to the concept of training specificity, strength training increases muscular strength and endurance training increases cardiorespiratory endurance [Häkkinen *et al*., (1989) and Behm, (1995)] [8, 3].
According to Arnheim and Klafs (1963) [1], training is a methodical process of learning and acclimatisation that entails repeating incremental labour. Training takes time, and endurance athletes do not develop quickly. By taking quick cuts and rejecting rational and scientific methods, a coach cannot work miracles [Bompa, 1997] [5]. These essential training techniques will work better when combined with adaptations that are made specifically for the individual. According to Boucher and Malina (1993) [6], the ideal training programme is one that accelerates the improvement of the goal quality while minimising negative effects.
The primary goal of training is to encourage biological adaptation in order to enhance performance in a particular task. Certain training and loading must be done in order to hasten physiological progress and change.

When a person exercises at a level that is close to normal, the body experiences a variety of training modifications that increase efficiency. Different training techniques are used at various levels to enhance various aspects of physical and motor fitness.

According to Lesinski *et al*. (2016) [12] and Rhea *et al*. (2003) [14], strength training appears to be an adequate and successful method of enhancing muscular fitness and sport-specific performance in both trained and untrained athletes.

Strength training is the process of developing certain body parts by using resistance other than the body's own weight. It is frequently applied to improve physical power and strength. Additionally enhanced are muscle coordination, flexibility, and endurance. Strength training is the practise of carrying out structured exercises using weights for the express objective of boosting muscle contraction resistance.

When the total number of weekly training sessions is large, combining endurance and strength training frequently leads to reduced strength increase and muscle hypertrophy [Hickson, (1980) and Wilson *et al*., (2012)] [9, 18]. Men's maximal oxygen consumption (O2max) may be impacted by a protracted (20-week) period of concurrent endurance and strength training, according to only one training study—Nelson *et al*. (1990) [13]. As opposed to the majority of studies [Wilson *et al*., 2012] [18], which found no attenuation of concurrent training-induced VO2max increases.

On the other hand, mobility enables a person to regulate their whole range of motion with only their muscles. Mobility describes the muscle's strength within this range of motion. For instance, utilising only the muscles in the legs, one may control the whole movement of the leg. In contrast to flexibility, no assistance is required for the manoeuvre.

Leg strength is crucial for a man's daily tasks. It is a requirement for almost all games and sports. According to an old proverb, an athlete will only go as far as his legs would allow. Flexibility of the ankle, knee, and hip joints, as well as powerful muscles and tendons, are necessary for jumping. One of the best measures of human power is the broad jump.

Both the frequency of breaths and the tidal volume are accurately managed, as is the amount of air inhaled and expelled per unit of time. Breathing is controlled so that even in stressful conditions, such as during exercise, the lungs may maintain normal Pao2 and Paco2 levels.

Methods

This study under investigation involves the experimentation of strength training and endurance training and combination of strength, endurance and mobility trainings on leg strength and vital capacity. Only college male hockey players from various places around Namakkal Town, Tamilnadu, in the age group of 17 – 25 years were selected. They were divided into four equal groups (n = 15), in which group – I underwent strength training, group – II underwent endurance training, group – III underwent combination of strength, endurance and mobility training and group – IV acted as control group who did not participate in any special training. The training programme was carried out for three days (Monday, Wednesday and Friday) per week during morning session only (6 am to 8 am) for twelve weeks. Leg strength was assessed by using leg lift with dynamometer and vital capacity was assessed by using expirograph.

Analysis of data

The data collected prior to and after the experimental periods on leg strength and vital capacity of strength training, endurance training and combination of strength, endurance and mobility training and control groups were analysed and presented in the following table - I.

Table 1: Analysis of Covariance and 'F' ratio for Leg strength and Vital capacity for Strength training and Endurance training Group, Combination of Strength, endurance and mobility training Group and Control Group

Variable Name	Test ± S.D	Group Name				
		Strength Training Group	Endurance Training Group	Combined Training Group	Control Group	'F' Ratio
Leg strength (in Kg)	Pre-test Mean ± S.D	62.33 ± 5.54	63.20 ± 4.21	61.87 ± 4.24	63.80 ± 4.55	0.52
	Post-test Mean ± S.D.	65.13 ± 5.67	66.00 ± 4.09	65.20 ± 4.38	63.47 ± 4.30	0.78
	Adj. Post-test Mean	65.582	65.615	66.099	62.505	26.89*
Vital capacity (Liters)	Pre-test Mean ± S.D	4.47 ± 0.06	4.68 ± 0.78	4.49 ± 0.07	4.51 ± 0.12	0.89
	Post-test Mean ± S.D.	4.67 ± 0.07	4.68 ± 0.09	4.88 ± 0.07	4.50 ± 0.10	50.02*
	Adj. Post-test Mean	4.673	4.684	4.877	4.50	49.16*

* Significant at 0.05 level of confidence. (The table value required for significant at 0.05 level with df 3 and 56 and 3 and 57 are 2.78 and 2.77 correspondingly).

Table – I displays the 'f' - ratio values of pre- and post-test means of leg strength for strength training, endurance training, combination of strength, endurance and mobility training and control groups was 0.52 and 0.78, which was less significant. The 'f' - ratio of adjusted post-test means was 26.89 were superior to the requisite table value of 2.78 and 2.77 for significance with df 3 and 56 and 3 and 57 at 0.05 level of confidence. The result of this study showed that there was a significant dissimilarity among strength training and endurance training group and combination of strength, endurance and mobility training group and control group on muscular endurance.

The above table shows the 'f' - ratio values of pre-test mean of vital capacity for strength training, endurance training, combination of strength, endurance and mobility training and control groups was 0.89, which was not significant at 0.05 level of confidence. The 'f' ratio of post and adjusted post-test means was 50.02 and 49.16 was superior to the requisite table value of 2.78 and 2.77 for significance with df 3 and 56 and 3 and 57 at .05 level of confidence. The result of this study showed that there was a significant dissimilarity among strength training, endurance training, combination of strength, endurance and mobility training groups and control group on vital capacity.

Further to determine which of the paired means has a significant difference, Scheffĕ *S* test was applied as post-hoc test. The result of the follow-up test is presented in Table - II.

Table 2: Scheffe S Test for the Difference Between the Adjusted Post-Test Means of Leg strength and Vital capacity among Experimental Groups and control group

Adjusted Post-test Mean of Leg strength					
Experimental Group – I	**Experimental Group- II**	**Experimental Group – III**	**Control Group**	**Mean Difference**	**CI**
65.582	65.615			0.033	1.29
65.582		66.099		0.517	1.29
65.582			62.505	3.077*	1.29
	65.615	66.099		0.484	1.29
	65.615		62.505	3.11*	1.29
		66.099	62.505	3.594*	1.29
Adjusted Post-test Mean of Vital capacity					
4.673	4.684			0.011	0.088
4.673		4.677		0.004	0.088
4.673			4.50	0.173*	0.088
	4.684	4.677		0.007	0.088
	4.684		4.50	0.180*	0.088
		4.677	4.50	0.177*	0.088

* Significant at 0.05 level of confidence

Results

After applying the analysis of covariance, the result of this study showed that there was a significant difference among strength training, endurance training, combination of strength, endurance and mobility training and control groups on the changes in leg strength and vital capacity after twelve weeks of training. The criterion variables such as, leg strength and vital capacity was improved for the strength training group, endurance training group and combination of strength, endurance and mobility training group. Basically the strength training group, endurance training group and combination of strength, endurance and mobility training group has tremendously improves the physical fitness and physiological variables.

Conclusions

The strength training, endurance training, and combination of strength, endurance, and mobility training groups all shown significant increases in leg strength as compared to the control group. According to Saratha and Raja (2020) [15], an intense strength-and-endurance training plan significantly increased leg strength among female students. Leg strength was improved in the weight and endurance training group compared to the endurance training programme, as well as in the resistance training alone group.

The study's findings revealed that respiratory measures such as vital capacity all improved significantly. After the strength training and circuit strength training exercises, Dinesh and Raja (2020) [7] and Velmurugan (2019) [16] discovered a considerable improvement in vital capacity. Khosravi, Tayebi and Safan, (2013) [11] further stated that endurance training resulted in a considerable increase in vital capacity.

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