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Effect of Three Weeks Lower Limb Strength Training on Swimming Performance– A Randomized Controlled Trial

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Abstract
Background and Objectives: *In swimming, lower limb are said to contribute very less and the upper limbs are said to contribute than lower limbs. Hence, the objective of the present study is to foresee the effectiveness of three weeks lower limb strength training using Therabands exercises and/or conventional exercises and to compare the effects of the Theraband v/s Conventional exercise on swimming performance.*
Subjects: *The present study included 45 recreational swimmers, out of which 23 were allocated in Group A, which received Theraband Exercises and 22 were allocated in Group B, which received Conventional Exercises. Group A had 7 male participants and 16 female participants. In Group B, had 11 males and 11 females.*
Material and Methodology: *Purpose of the study was explained and a written informed consent was obtained from all the participants. Subjects were recruited after meeting the inclusion and exclusion criteria's. 45 subjects were randomly allocated into two groups A and B using the chit method. Group A having 23 subjects received Theraband exercises and group B having 22 subjects received Conventional exercises. All the outcome measures were measured pre and post intervention.*
Result: *The mean age on the participants in Group A was 19.83years, the mean age of the participants of Group B was 20.18years. Both the groups were compared based on the outcome measures which included H.H.D. and 100m sprint time. Group A and B both showed significant increase in the lower limb strength. Group A showed more significance than Group B in the swimming performance. The mean post intervention of Group A was 2.47 with (p=0.0321*).*
Conclusion: *The present study provided evidence, that the interventions used in the study showed significant results in both the groups with respect to lower limb strength, while Group A showed more significance in the swimming performance as compared to Group B.*
Keywords: *Recreational swimmers, swimming performance, lower limb, strength, Theraband exercises, Conventional exercises.*

INTRODUCTION

Swimming, is an activity that is continuing to gain popularity as a source of musculoskeletal, cardiovascular exercise and is also getting recognized as a highly recreational sport all around the world.[1] It has been proven to be a worthy all - round activity, as it helps to build up endurance, muscle strength, as well as keeps the muscles toned.[2] When it comes to swimmers and the physiology of swimming, in competitive swimmers the priority is mainly on the sprint performances i.e. The lap time of an individual. The main factor which can affect the sprint performance are said to be the strength and power generation of the locomotor muscles.[3] The locomotor muscles mainly comprise of the hip extensor (Hamstring), knee extensors (Quadriceps) and ankle plantar flexors (Soleus and Lateral and Medial Gastrocnemius muscles). [4] locomotor muscles should generate a high rate of powerful contraction to produce maximal mechanical power outputs (Kumagai et al., 2000; Stager and Tanner, 2005),[3] hence to achieve the strength of the lower limb muscles there is a need to strengthen the same and to improve the physiology, strength and speed for a better sprint performance.

As stated in two studies done by Costil ET. al., on muscle strength contribution in sprint swimming and the relationship between power and freestyle swimming, "the primary purpose of adding resistance to a swimming training programs is to improve muscle strength and power, which has shown, to have a direct correlation with swimming performances".(5,6) As well as according to the Anatomy Of Strength & Conditioning book written by Hollis Lance Liebman, "Strength training can be defined as the assistance of a group of muscles to complete a multi - jointed movement by increasing strength and muscle power". [7] Hence, the present study plans to use two different strengthening exercise regimens which include Theraband exercises and conventional exercises to provide the external resistance to the lower limbs in order to help develop the strength of the lower limbs of the swimmers. Therabands are defined as a latex resistance band or tube used for physical training and light strengthening exercises as a long term exercise approach. According to American Physical Therapy Association, the resistance provided by therabands have proved to increase strength, mobility and functions.[8] They are low-cost, convenient and versatile, made of natural rubber latex with varying levels of difficulty.(9,10, 11) Conventional strengthening exercises are based on resistance provided by gravity. These exercises can help increase the strength of the muscle groups being worked on these exercises also involve the use of various conventional equipment and can be performed in a manner that limits the direction of resistance to be overwhelmed.

Strength as one of the major components of this study will be assessed using the Hand Held Dynamometer and the swimming performance will be noted by recording the 100 meters sprint time of each swimmer pre and post strength training. A Hand Held Dynamometer can be described as a digital strain gauge dynamo-meter [12] used for measuring force strength and torque. It measures strength in terms of kilograms (Kg), pound's (lb.) and Newton's (N).[13] It displays force measurements to the nearest 0.2 lb. to a maximum of 115.0 lb. (512 N).[12] It has several advantages which includes low cost, easy to use, highly acceptable for use in clinical settings[15] and can be used for measuring the strength of both the upper limbs and of the lower limbs.[16]

A sprint can be described as the ability of performing repetitive actions at a faster rate which forms a characteristic technique. When coupled with force efficiently to produce the "sprint" which generally directs maximum sprinting ability in swimming.[17] Hence in the present study 100 mts sprint has been used to note the swimming performance. 100 meters sprint can be described as depending upon the length of the pool i.e. in a

50 meters, then it consists of two laps of the swimming pool.

The present study has been planned, to understand the effect of the lower limb strength training exercise on the swimmers performance. As well as to study the effectiveness of lower limb strength training for three weeks using Theraband Strengthening Exercise on swimming performance and/ or Conventional Strengthening Exercises on swimming performance and to compare effects of Theraband and/or Conventional Strengthening Exercises for lower limb strength training for three weeks on swimming performance.

MATERIALS AND METHOD

Institution Review Board Approval: The study was approved by the institutional review board and was conducted under the guidelines and rules and regulations of the ethical and human principles of research.

Participants: A total of 45 subjects were recruited on the basis of the inclusion criteria: 1.)Recreational swimmers between the age group of 18 years to 25 years. 2.) Both male and female recreational swimmers. 3.) Participants volunteering to participate in the study. Exclusion criteria: 1.) Any recent lower extremity injuries in the last 12 months. 2.) Metal implants. 3.) Neuro - musculoskeletal disorder: Muscular dystrophy, Polio, etc. 4.) Recently operated in the last 6 months. 5.)Arterial or venous diseases of the lower limb: Varicose Veins, Deep Vein Thrombosis, etc. The subjects agreed to sign the informed consent form and a brief demographic data was recorded that included their age, height, weight, BMI, age of onset of swimming and years of swimming.

Procedure: The participant were recruited. The study was carried out at K.L.E Suvarna J.N.M.C. Swimming Pool, Belagavi. A brief history was taken from the participants as per to the inclusion criteria.

The study protocol was explained and a written informed consent was obtained from all the subjects. All subjects were the screened on the basis of the inclusion and exclusion criteria prior to their enrolment into the study. Subjects were then selected and a brief demographic data was noted, which included the age height weight, BMI, years of swimming and age of onset of swimming. Height and weight were measure without shoes using a weighing machine and a metal tape respectively. The subjects were segregated into two different groups by using chit method.

Using the Hand Held Dynamometer (HHD) assessment of both lower limb strength in three different situations i.e. supine, prone and sitting from both the groups will be recorded. 1 value will be taken per subject for each lower limb for hip flexion and abduction, knee flexion and extension and ankle dorsiflexion pre and post intervention. 100 meters sprint time was also noted pre and post intervention to assess the sprint performance of both Group A and Group B

The strength training protocols was given to Group A and Group B participants. Group A received Theraband Exercises while Group B received Conventional Exercises. The exercise regimen was done on 3 times in a week, for 15 minutes. warm up session were given prior to their daily swimming sessions and after the exercises cool down session was also given. A total of 9 sessions were given to both groups.

RESULTS

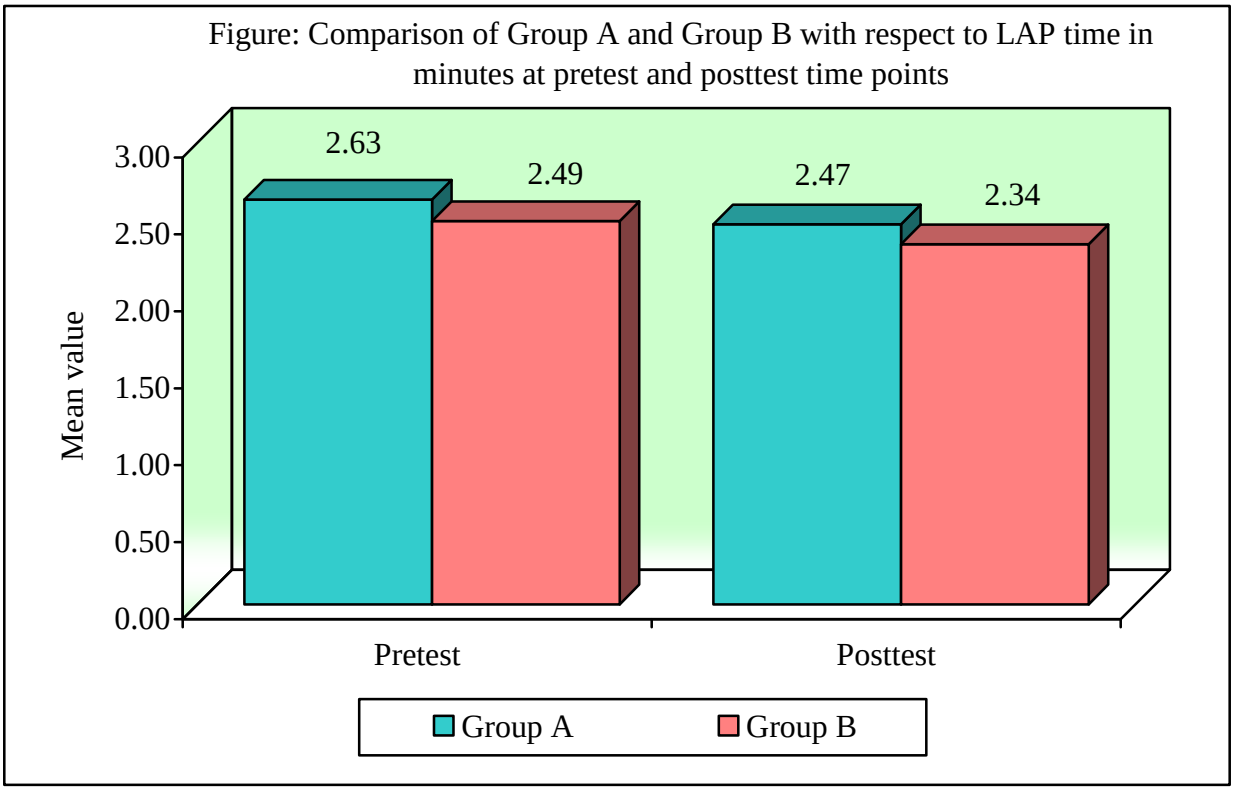
Group A and B both showed significant increase in the lower limb strength. Group A showed more significance than Group B in the swimming performance. The mean post intervention of Group A was 2.47 with (p=0.0321*)

Table: Comparison of Group A and Group B with respect to LAP time in minutes at pretest and posttest time points by independent t test

Groups	Pretest		Posttest		Changes	
	Mean	SD	Mean	SD	Mean	SD
Group A	2.63	0.53	2.47	0.51	0.16	0.32
Group B	2.49	0.78	2.34	0.83	0.15	0.13
% of change in group A					6.19%#, p=0.0321*	
% of change in group B					5.85%#, p=0.0001*	
t-value	0.6887		0.5882		0.2255	
P-value	0.4950		0.5597		0.8228	

*p<0.05, #applied dependent t test

Figure: Comparison of Group A and Group B with respect to LAP time in minutes at pretest and posttest time points



DISCUSSION

The aim of the present randomized controlled trial was to study the effectiveness of lower limb strength training on swimming performance for a duration of three weeks in terms of increased lower limb strength using Hand Held Dynamometer (H.H.D.) and evaluation of the swimming performance by noting down the 100m lap time / sprint time. 45 recreational swimmers were randomly allocated into 2 groups: Group A and Group B. Group A had a total of 23 participants that received Theraband Exercises and Group B with a total of 22 participants received Conventional Exercises. All participants were between the age group of 18 – 25 years.

In the present study, Group A showed statistical significance in right and left hip flexion, right hip abduction, right and left ankle dorsiflexion and Group B showed statistical significance in left hip abduction, right and left knee flexion and extension. While Group A also showed significant improvement of the 100m sprint time compared to Group B.

Group A and Group B, both showed significant improvement in the statistical variables of the H.H.D . Pre and post testing of strength of the

hip flexion, extension, abduction and adduction, knee flexion and extension and ankle dorsiflexion was done using Hand Held Dynamometer. In a study done by Ricahard W. Bohannon in a study done on test - retest reliability of the hand held dynamometer during a single session of strength assessment concluded that the hand held dynamometer is a reliable and valid tool for measuring the strength of the upper limb as well as of the lower limbs.[27]

In the present study theraband exercises lead to improvement in the strength of the lower limb muscles in Group A that received theraband exercises. This can be supported by a study done by Santosh Metgud et. al. on the effect of soccer trainer and elastic bands on quadricep femoris muscle strength in young healthy individuals, which was conducted for a period of three weeks between soccer trainer, theraband and isometric exercises for quadriceps femoris muscle strength training. The result of the study showed that there was an increase of the quadriceps muscle strength of the subjects, where the theraband group showed more significant increase.[6]

A study done by Kevin D. Tipton, et. al. based on muscle protein metabolism in female swimmers after a combination of resistance and endurance training that comprised of three groups which included 4,600m intense swimming workout, whole body resistance – training workout and a combination of swimming and resistance training. Result of the above study showed that these exercises alone did not prove to be very effective in causing any stimulatory effects of the protein metabolism of the muscles, but the combination of swimming along with the above mentioned exercise regimen proved, showed stimulatory result in the protein synthesis by 80% in the subjects. This is in disagreement with the present study as in the present study the exercises and the exercise regimen followed differed from the above mentioned exercises and were solely targeted to increase only the lower limb strength as the present study showed that only the exercises without the combination of swimming resulted in an increase of the lower limb strength.[7]

In the present study the improvement of the swim performance was noted down by evaluating the 100m sprint time of each swimmer from Group A and Group B, where in Group A showed to be more significant. In a study done by Alireza, et. al. between the relationship of sprint performance of front crawl swimming and muscle fascicle length, 25m sprint time was noted of the participants of the study. Result concluded that the young swimmers with faster front crawl swimming sprint performance had significant great absolute fascicle length as well as significant relationship between the muscle fascicle length and swimming performance time in the vastus lateralis and gastrocnemius lateralis muscles of the lower limb.[4] This helps to support the present study and could be a probable reason to explain the role of the lower limbs and its contribution in swimming performanceThe above results have proved to show an increase in the strength of the lower limb by using theraband as well as conventional exercises individually. But Group A showed more significant improvement in the swimming performance as compared to Group B probable reason for which could be that the resistance provided by the theraband was an additional external force other than that of only gravity compared with Group B that only had conventional exercises with no other external forces to provide resistance other than that of gravity. Group A & B showed significant increase in the lower limb strength , But Group B showed more significance than Group A probable reason of which could be, the theraband resistance used for training Group A was the same for all the individuals and no variation of resistance was provided for each participant.

LIMITATION

Limitations of the present study are as follows: The duration of the study was short. Long term follow ups were not done. There were more females than males in the study. Only recreational swimmers were used in the study. No much literature could be found to support the effects of conventional exercises on the lower limb strength.

FUTURE SCOPE

A prospective of this study could be taken up to evaluate the long term effects of the specified study. This study can also be repeated by using a different target population such as competitive swimmers, with a different age group which could be added to the literature on lower limb strength training effects on swimming performance. This study can also be repeated by using singular gender as the inclusion criteria of the study. As well as since no much literature is present on lower limb strength training programs for swimmers and its effects on swimming performance, hence further studies could be carried out in this direction.

CONCLUSION

The present study provided evidence to prove that the interventions used in the study showed significant results in both the groups, while Group A showed more significance in the swimming performance as compared to Group B. As well as Group A & B showed significance in lower limb strength.

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