



## Physiology

## EFFECTS OF STRENGTH TRAINING ON THE IMPROVEMENT OF CARDIOVASCULAR ENDURANCE, FLEXIBILITY & MUSCULAR ENDURANCE IN 18 TO 29 YEARS YOUNG ADULTS.

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### ABSTRACT

**INTRODUCTION:** The present study was designed to examine the effects of 3 months to 1 year resistance training on cardiovascular endurance, flexibility and muscular endurance.

**METHODS & MATERIALS:** Subjects were required to do physical activity as prescribed by trained professional gym trainers. As the physical exercises were arranged as novice, beginner, and intermediate, expert & advanced. Subjects were allotted as per their status and ability of the physical fitness. All the subjects fitness were estimated at starting of the exercise and then periodically at every 1<sup>st</sup> week of each month thereafter.

**OBSERVATION & RESULTS:** rise in the percentage of muscular endurance after 6 months of exercise in nearly 70% subjects on push up grades and 75.5% subjects in curl up grades. ( $p < 0.05$ ). Considering flexibility in terms of sit and reach test 69.59% subjects improved flexibility after 3 months of training. While observing cardiovascular endurance 87% subjects improved after 3 months of the training.

**CONCLUSION:** Short-term resistance training can significantly improve flexibility and increase strength and power in Subjects. While development in cardio vascular endurance can be observed after training of 3 months only.

### KEYWORDS :

#### Introduction:

Sedentary life style is considered to be the reason for major health problem of the young adults in the developing world and an associated modifiable risk factor for various metabolic disorders. Also these life style modifications are one of the causes for increasing trend of obesity in young adults.<sup>1</sup>

Sedentary life style and its accompanying physical inoperativeness have an opposing effect on human metabolism processes, cardiac output and psychosocial behaviour<sup>2</sup>. It is clear that, along with nutrition and lifestyle, exercise plays a significant role in overcoming metabolic disorders<sup>3,4</sup>. Many research studies have also shown that exercise specially resistance training in young adults is significantly increasing the measures of healthy life<sup>5,6,11</sup>.

Because of the growing popularity of youth resistance training, further studies are needed to evaluate the effects of varying the combination of sets and repetitions on health and performance measures in Indian population. It is important to know the answer to this question because it can assist strength and conditioning professionals and exercise physiologists in designing the most effective programs in terms of both physical outcomes and compliance.

A major concern is developing and investigating effective and practical interventions for those who are at the risk of developing health problems because of reductions in quality and quantity of day to day physical activities lead by sedentary habits. Hence the present study was designed to examine the effects of 3 months to 1 year resistance training on cardiovascular endurance, flexibility and muscular endurance, which enables us to confirm changes in body composition and performances in the age group of 18 to 29 years young adults.

Moreover for the Indian setup we don't have the exact Indian Data which will show us how much change will be there in the Body

composition parameters with exercise.

#### Objective: -

effect of resistance training with healthy diet in improvement of fitness components (cardiovascular endurance, flexibility & muscular endurance) and Body composition.

#### Methods & Procedure:

In this population based study sample size of 384 subjects was calculated considering confidence limit of 5%, confidence interval of 95%. 453 subjects were selected randomly from the gymnasium in the age group of 18 to 29 years age whose body mass index was in the range of normal, overweight and obese of which 69 subjects were either drop outs or were opted not to take part in the study.

All subjects participated in a supervised resistance training program (4 - 6 d/week) for the duration of up to 1 year (6 months minimum). The subjects were measured at base line and periodically during the training program for body composition, cardiovascular endurance, muscular endurance and flexibility.

For all performance tests and training, the subjects were familiarized with the technique in a separate session. All the subjects fitness were estimated at starting of the exercise and then periodically at every 1<sup>st</sup> week of each month thereafter. In the fitness test, for the Muscular endurance, we have used "Push up and "Curl Up". For the Flexibility "Sit and Reach test" is used and for cardiovascular endurance Heart rate is used at resting and after treadmill.<sup>6,7</sup>

Following grades of exercise were considered as per K11 academy of fitness sciences standardized protocol<sup>8</sup> and for the Heart rate after treadmill exercise we considered guidelines as per the American college of sports medicine (2010; miller et al., 1993; Wallace, 2006)<sup>9</sup> and resting heart level as per the American Heart Association.

Exercise	Males				Females			
	Excellent(4)	Good(3)	Average(2)	Poor(1)	Excellent(4)	Good(3)	Average(2)	Poor(1)
HR at rest	≥61	62-73	--	74≤	≥65	66-78	--	79≤
HR treadmill (% HR max)	57-63	64-76	--	77-95	57-63	64-76	--	77-95
Push Ups	>48	34-38	17-33	06-16	>48	34-38	17-33	06-16
Curl Ups	>60	45	30	15	>50	40	25	10
Sit and reach	>40	28-40	22-28	15-22	>43	33-43	22-33	17-22

**Subjects:**

**Inclusion criteria followed were:**

- a) Healthy, obese & overweight volunteers in an age group of 18-29 years were included in the study. Volunteers having history of previous surgery, diabetes hypertension, asthma cardiovascular and neuromuscular diseases were excluded from the study.
- b) Absence of musculoskeletal limitations
- c) Absence of spinal pain.

The written and informed consent was obtained. The study was approved by the institutional ethics committee.

**Testing Protocols**

Activity Records: Subjects were required to do physical activity as prescribed by trained professional gym trainers. As the physical exercises were arranged as novice, beginner, and intermediate, expert & advanced. Subjects were allotted as per their status and ability of the physical fitness.

**Table.1 Level: Novice**

Day	Workout	exercises 1 2-3 sets x 12-15 repeats
1	strength	quadriceps : squats 1 static lunges / leg press calves : standing calf raise hamstrings: hamstrings curls alternate standing leg curls back : lateral pull down 1 low cable rows chest : bench press 1 15 incline db press shoulder : overhead press shoulder internal rotation abdominals: partial crunches superman / reverse back extension stretches : alternate hand / leg raisesfull body stretches

**Table 2 Level: Beginner**

Day	Workout	Exercises 1 1-2 sets x 12-15 repeats
1	Strength	quadriceps : squats 1 leg press calves : standing calf raise hamstrings : hamstring curls, alternate standing leg curls back : lateral pull down 1 seated rows chest : 15 incline db press shoulder : overhead press, shoulder external rotation stretches : alternate hand / leg raises30 leg raise, full body stretches

**Table. 3 level: intermediate**

Day	Workout	exercises 1 2-3 sets x 10-12 repeats
1	Lower Body	Quadriceps : squats 1 front squats, static lunges / leg press Calves : seated calf raise, standing calf raise Hamstrings : hamstrings curls, full body stretches
3	Upper Body	back : low cable rows lateral pull down 1 shrugs chest: bench press, decline bp shoulder : overhead press, lateral raises external rotation, Back extension 1 full body stretches

**Table.4 level: expert**

Day	Workout	Exercises 1 2-3 sets x 4-6 repeats
1	quadriceps	quadriceps : back squats 1 overhead / front squats 1 lunges 1 step ups
2	calves, hamstrings & abdominals	calves : seated calf raise, standing calf raise, tibia raises hamstrings : hamstring curls abdominals : crunches 1 twisting crunches
4	pull	back : dead lifts / bentover db rows shrugs 1 seated rows, prone pull up / prone lateral pull, down supine pull up / supine lateral pull down rear deltoid : prone high rows biceps : bicep curl 1 hammer curl

5	push	chest : bench press, decline bp, incline bp shoulder : overhead db / military press lateral raises, 1 external rotation triceps : parallel bar dips 1 close grip bp
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**Table 5 level : advanced**

Day	Workout	Exercises 1 2-3 sets x 8-10 repeats
1	Legs	Quadriceps : squats 1 lunges 1 step ups Calves : seated calf raise Standing calf raise 1 tibia raises Hamstrings : hamstrings curls
3	pull	back : deadlifts / bentover db rows shrugs, 1 seated rows prone pull ups / prone lateral pull down supine pull ups / supine lateral pull down rear deltoid : prone high rows biceps : bicep curl 1 hammer curl
5	push	chest : bench press 1 decline bp, incline bp shoulder : overhead press 1 lateral raises external rotation triceps : parallel bar dips close grip bp

For all the groups the instruction was to “Repeat day 1 & 2, Cardio every alternate day, Rest once a week”. This regimen is a training guideline designed to maximize performance by minimizing reciprocal inhibition.

As over the time subject's fitness improved due to the strict continuous exercise module application and they were allotted to next higher level of exercise module. Subjects were asked to include specific information regarding the type of exercise, duration, and intensity in their record. Activity records were checked for any significant changes in activity levels at weeks 0 and on each month (1<sup>st</sup> week of month).

Anthropometric Measurements & Body composition: Anthropometric measurements of height and weight were determined using standard procedures on each month (1<sup>st</sup> week of month). All anthropometric measures were carried out by the same investigator.

Cardiovascular endurance: To assess the cardiovascular endurance, the subjects resting level (sitting comfortably with no physical & mental exertion) heart rate was noted and then the subjects were asked to do the treadmill test as a 6 minutes run test and there heart rate noted just after the test.

Muscular Endurance: To assess muscular endurance, the subjects were asked to perform as many push-ups and curl ups as possible. These were performed using full push-ups with a shoulder width grip. They were also required to maintain a constant cadence (steady pace) as determined by the tester.

Training Procedure: The resistance training sessions consisted of total body workouts using a combination of different body weight and power exercises, as well as a variety of exercise equipment (Table 1 to 5). The primary aim was to incorporate exercises at the Novice level (table 1) and once the subject has well acquitted with Novice level then the transition is made to next Beginner level (Table 2), usually this transition requires 4 to 6 weeks, and there after transition is made to Intermediate level and so on.

**Result:**

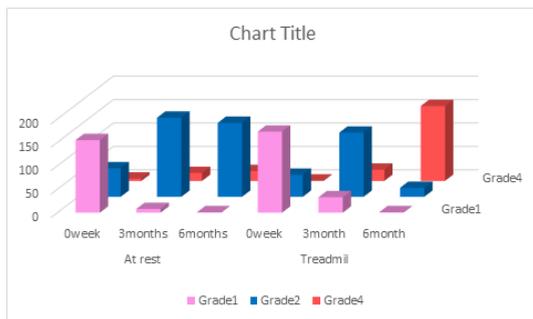
There were no reported training injuries or excessive muscle soreness at any stage of the training program. Training compliance was 84.76%. We originally had 453 subjects enroll in the study out of which 45 withdrew before the completion of study and 24 were dropouts based on study criteria. When reasons for withdrawal were given, they included lack of time, other commitments, and migrating jobs.

Physical fitness in the form of cardiovascular endurance, improved after 6months of training program (p<0.05) as depicted in table.6

**Table.6 CV Endurance at Rest:**

Grade	At rest			treadmill		
	0 Weeks	3 Months	6 Months	0 Weeks	3 Months	6 Months
1	155 (70.13%)	8 (4.12%)	01 (0.55%)	173 (78.28%)	33 (17.01%)	1 (0.5%)

3	61 (27.6%)	169 (87.11%)	158 (87.78%)	47 (21.27%)	137 (70.62%)	19 (10.55%)
4	05 (2.26%)	17 (8.76%)	21 (11.76%)	01 (0.5%)	24 (12.37%)	160 (88.89%)
Total	221	194	180	221	194	180



From the table 6 it has been observed that when compared with the startup group at first week of the study 87.78% of the subjects improved their cardiovascular endurance at rest by doing 6 months of resistant training and nearly 87% subjects improved cardiovascular endurance by doing minimum of 3 months of the successful training. While observing cardiovascular endurance after treadmill 88.89% subjects had shown betterment after 6 months of the training when compares with the beginners.

The fitness level in form of muscular endurance has been depicted in table 7 which clearly demarcates rise in the percentage of muscular endurance after 6 months of exercise in nearly 70% subjects on push up grades and 75.5% subjects in curl up grades.(p<0.05)

**Table. 7Muscular Endurance:**

Grade	Push up Grades			Curl up grades		
	0 Weeks	3 months	6 month	0 weeks	3 months	6months
1	147 (66.51%)	06 (3.09%)	01 (0.5%)	187 (84.61%)	10 (5.15%)	01 (0.5%)
2	61 (28.05)	117 (60.31%)	09 (5%)	31 (14.03%)	123 (63.4%)	37 (20.56%)
3	12 (5.4%)	69 (35.37%)	126 (70%)	02 (0.9%)	59 (30.41%)	136 (75.56%)
4	1 (0.45%)	02 (1%)	44 (24.44%)	01 (0.45%)	02 (1%)	06 (3.33%)
Total	221	194	180	221	194	180

Considering flexibility in terms of sit and reach test 69.59%subjects improved flexibility after 3 months of training from poor to good grades as depicted in table8.

**Table 8 Flexibility – Sit reach**

Grade	0 Weeks	3 Months	6 Months
1	80(36-19%)	1(0.5%)	1(0.5%)
2	103(46.6%)	37(19.07%)	30(16.67%)
3	34(15.38%)	135(69.59%)	126(70%)
4	04(1.81%)	21(10.82%)	23(12.78%)
Total	221	194	180

These results demonstrate that the resistance training program implemented produces significant changes in cardiovascular endurance, muscular endurance, flexibility as well as being well tolerated by the participants.

**Discussion: -**

In present study resistance training program which has been followed is associated with least or no injury to any age group people with application of proper age related training guidelines<sup>10,11</sup>.

Exercise under proper training is an essential part of life style modifications for all the age groups as it is related with increased working capacity, psychosocial well behavior in younger age group people. This clearly demarcates gain of present study with Faigenbaum. A; that improvement on the basis of resistance training is having beneficial effects on psychosocial well being of the individuals<sup>12</sup>.

Along with this reduction in cardiovascular accidents and increase in muscular endurance raise the chances of healthy survival in adult humans. Results of the present study are in accordance with Alter DA having increased percentage of cardiovascular endurance after doing minimum of 3 months of the resistance training<sup>13</sup>. In relation with Niebaure J continuing such training for long term basis will reduce chances of cardiovascular accidents in young adults which coincides the outcome of the present study<sup>14</sup>.

was able to produce significant changes in flexibility, strength and power measures.

Although numerous studies have investigated the effects of exercise, relatively few have used resistance training models. This study adds to the body of literature by showing that resistance training programs can effectively benefit body composition and physical performance in young adults<sup>4,5,15</sup>.

**Conclusion: -**

Resistance training young adults is going to improve flexibility as well as muscular endurance after a minimum duration of 6 months. While development in cardio vascular endurance can be observed after training of 3 months only. This opens newer ways to search for need for diet and resistance training programs in different age group population along with standardizing the resistance training program homogenously to population across the Nation which is far beyond the scope of present study.

Hence it can be concluded that Short-term resistance training can significantly improve flexibility and increase strength and power in Subjects. It seems that this mode of training can be well tolerated and enjoyed by participants. An undulating scheduled program provides variation and results in significant increases in increased strength, power and working abilities of body.

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**REFERENCES:-**

1. K. Umamaheshwari, Y. Dhanalakshmi, S. Karthik, Nitin Ashok John and Rehana Sultana .Effect of exercise intensity on body composition in overweight and obese individuals. IJJP2017; 6(1)58-64.
2. Owen, N. Healy, G.N. Mathew, C.E. & Dunstan, D.W. Too Much Sitting: The Population Health Science of Sedentary Behaviour.2010; 38(3):105-113.
3. Falk, B and Eliakim, A. Resistance training, skeletal muscle and growth. *Pediatr Endocrinol Rev* 1: 120–127, 2003.
4. Falk, B, Sadres, E, Constantini, N, Zigel, L, Lidor, R, and Eliakim, A. The association between adiposity and the response to resistance training among pre- and early-pubertal boys. *J Pediatr Endocrinol Metab* 15: 597–606, 2003.
5. Sothern, MS, Loftin, JM, Udall, JN, Suskind, RM, Ewing, TL, Tang, SC, and Blecker, U. Safety, feasibility, and efficacy of a resistance training program in preadolescent obese children. *Am J Med Sci* 319: 370–375, 2000.
6. Yu, C, Sung, R, So, R, Lui, K, Lau, W, Lam, P, and Lau, E. Effects of strength training on body composition and bone mineral content in children who are obese. *J Strength Cond Res* 19: 667–672, 2005.
7. Healthline.com. What Is Cardiorespiratory Endurance and How Can You Improve It?.c2005-2019 Available from <https://www.healthline.com/health/cardiorespiratory-endurance#exercises>. Accessed on December 26,2018.
8. Keleven.org. Mumbai:K11 academy of fitness sciences;c2016.Available from <https://www.keleven.com/consultancy>. accessed on December 30,2018.
9. Plowman S, Smith D. Exercise physiology for health, fitness, and performance. Edition 4Th Wolters Kluwer/Lippincott Williams & Wilkins 2014
10. Guy J, Micheli L. Strength training for children and adolescents. *J Am Acad Orthop Surg*. 2001;9:29-36.
11. Hamill B. Relative safety of weight liftingand weight training. *J Strength Cond Res*.1994;8:53-57
12. Faigenbaum A, Kraemer W, Cahill B, et al.Youth resistance training: position statementpaper and literature review. *StrengthCond J*. 1996;18:62-75.
13. Alter DA, Oh PI, Chong A. Relationship between cardiac rehabilitation and survival after acute cardiac hospitalization within a universal health caresystem. *Eur J Cardiovasc Prev Rehabil*. 2009;16:102–113.11.
14. Niebauer J, Clark AL, Webb-Peplow KM, Coats AJ. Exercise training in chronicheart failure: effects on pro-inflammatory markers. *Eur J Heart Fail*. 2005;7:189–193.
15. Wells, K.F. & Dillon, E.K. (1952). The sit and reach. A test of back and leg flexibility. *Research Quarterly*, 23. 115-118.