International Journal of Community Medicine and Public Health
Multani GK et al. Int J Community Med Public Health. 2019 May;6(5):2235-2240
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: http://dx.doi.org/10.18203/2394-6040.ijcmph20191850

Original Research Article

Effect of core strengthening on cardiovascular fitness and flexibility in obese individuals: experimental study

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Received: 06 March 2019
Revised: 15 April 2019
Accepted: 16 April 2019

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ABSTRACT

Background: Obesity is associated with various physiological changes which decrease the cardiovascular fitness and flexibility and slows person activity. Core muscles strengthening improve respiratory efficiency and activity of the diaphragm. Hence this study aimed to examine effect of core strengthening on cardiovascular fitness and flexibility in obese individuals.
Methods: Experimental study of 6 weeks was carried out among 16 people who were selected by purposive sampling there was 1 drop out. Subjects between 18-25 years, male & female with BMI ≥25 kg/m2-35 kg/m^2 were selected. Pre reading were taken by measuring Queen's college step test, Modified sit and reach test, Shoulder and arm flexibility test which were recorded at week 1st, week 3rd and of the same at 6th week. Core strengthening exercise were given targeting 5 regions upper & middle abs, oblique, transverses, lower abs were progressed every 2 weeks by increasing repetition and difficulty level e.g., unstable surface (Swiss ball).
Results: A significant improvement was found in readings of VO_{2max} (Queen's College step test), modified sit and reach test, shoulder & wrist flexibility test ($p<0.0001$).
Conclusions: The study showed positive result with ($p<0.05$) which suggests that core strengthening improves cardiovascular fitness and flexibility in obese individuals.

Keywords: Core strengthening, Exercise, Flexibility, Cardiovascular fitness, Obesity

INTRODUCTION

Obesity is major health issue currently in overall population. Obesity is excess body fat in adipose tissue resulting in significant impairment in overall health of population.[1] Prevalence of obesity in Maharashtra for males is 16% and for females is 18.5%.[2] Risk factors for obesity are:-over eating, drinking alcohol, sedentary lifestyle, lack of self control, lack of sleep, stress.[3] It is associated with many co-morbidities as well as strongly associated with other metabolic diseases like DM, HTN, dyslipidemia, cardiovascular diseases, musculoskeletal disorders and many other forms of cancers.[4]

Cardiovascular fitness is the ability of the heart, blood cell and the lungs to supply oxygen.[2] This type of fitness is health-related component of physical fitness that is brought about by sustained physical activity and movement.[1,5] Studies have shown that cardiovascular fitness and flexibility decreases as the person becomes obese.[1,5] Flexibility is defined as ability to move single joint or series of joint through unrestricted and pain free ROM with ease. Carrying extra weight can slow person down during activity and prevent them from building optimal flexibility.[4] As people age they tend to lose flexibility, more seen in people with sedentary lifestyle.[6] Core muscles include multifidus, transverses abdominis,

external and internal oblique, rectus abdominis, paraspinalis, gluteus, hip muscles and diaphragm in rare part.[2] It is box with abdominals in front, paraspinals and gluteus muscles in back, diaphragm as the roof, pelvic floor and hip girdle muscles which are at bottom.[7,8] Core has been linked through a kinetic chain & biomechanically formed with the lower and upper extremities. Hence, the core is centre to all forms of functions and performance tasks thus help to maximize overall function. It maximizes force generation and minimize joint loads in all types of activities for normal as well as athletes. Apart from role as flow generator for ventilation diaphragm has role in circulation as well. Changes in intra-thoracic and intra-abdominal pressure variations, influence blood in and out of the trunk and extremities.[9] When diaphragm contracts pressure changes lead to increase circulatory as well as pulmonary function.[9] Abdominal muscle along with diaphragm also play role in "Auxillary heart".[10] It supplies blood to working muscles.

There is dirth evidence on direct relation of core muscles on cardiovascular fitness and flexibility. Hence purpose of study is to determine effect of core muscle strengthening on cardiovascular fitness and flexibility.

METHODS

Study was carried out at OPD, BSTR Hospital, Talegaon Dabhade.

Study duration

6 months; August 2018-January 2019 (6 weeks protocol on each individual)

Study design

Experimental study was carried out to determine effect of core strengthening on cardiovascular fitness & flexibility in obese individuals.

Ethical consideration

Signed informed consent was taken by the subjects and were explained about the study.

Subjects fulfilling the inclusion and exclusion criteria were selected and informed written consent were taken. Study of 6 weeks was carried out among 16 people, who were selected by purposive sampling there was 1 drop out. Subjects between 18-25 years, male & female with BMI ≥25 kg/m^2-35 kg/m^2 were selected. Demographic data such as age, sex, height, weight, BMI were recorded at beginning of intervention. Pre reading were taken by measuring Queen's college step test, Modified sit and reach test, Shoulder and arm flexibility test which are recorded at week 1st, week 3rd and of the same at 6th week. Exercise were given targeting 5 regions upper abs, lower abs, oblique {internal &external}, transverses, lower abs are progressed every 2 weeks by increasing repetition and difficulty level e.g. unstable surface (Swiss ball). Subjects with hypertension, diabetes, who workout daily, pregnancy etc were excluded.

Materials

Swiss ball, stepper of 17 inch long, scale, exercise mat, sit and reach box.

Outcome measures

Cardiovascular fitness:- It was been assessed by using Queen's college step test.[10] It is valid & reliable test to measure cardiovascular fitness. The Subjects steps up and down on the platform at a rate of 22 steps per minute for females and at 24 steps per minute for males. The subjects are to step using a four-step cadence, 'up-up-down-down' for 3 minutes. The subject stops immediately on completion of the test, and the heart beats are counted for 15 seconds from 5-20 seconds of recovery. Multiply this 15 second reading by 4 will give the beats per minute (b p m) value to be used in the calculation below.

Scoring: an estimation of VO_{2max} can be calculated from the test results, using this formula (Mc Ardle et al., 1972). A rating can be determined using the VO_{2max} norms.

Men: VO_{2max} (ml/kg/min) = 111.33 - (0.42 x heart rate (bpm))

Women: VO_{2max} (ml/kg/min) = 65.81 - (0.1847 x heart rate (b p m)).

Flexibility: it was been assessed by using modified sit & reach test & shoulder & arm flexibility test.

a) Shoulder and wrist flexibility test[4]

Starting position**:-**Lie prone on floor with arms fully extended overhead, grasp a yardstick with hands shoulder-width apart.

Movement:- Raise the stick as high as possible. Measure the vertical distance (nearest 0.5 inches) the yardstick rises from floor. Measure arm length from acromial process to tip of longest finger. Subtract the average vertical score from arm length.

b) Modified sit and reach test[4]

Starting position**:-**Sit on floor with back and head against wall, legs fully extended, with bottom of feet against sit and reach box. Place hand on top of each other, stretching the arms forward while keeping the head and back against the wall. Measure the distance from fingertips to the box edge with yardstick. This represents the zero or starting position.

Intervention

3 session per week at alternate days were given (6 weeks×3 days=18 session). Duration of each session was 30-45 minutes. Values of pre reading were recorded at week 1, week 3, week 6. 2 sets of each exercise were given. Warm up was given which included major stretches & active movements which were followed by exercise protocol (Table 1). Cool down was given for preventing domes & promoting relaxation.

Table 1: Exercise protocol.

Weeks	2 Sets of each	Exercises	Repetition
1-2	Upper abs	Traditional crunch	12-15 reps
	Lower abs	Leg raise	20 reps
	Oblique's	Oblique crunch	10reps
	Back extensors	Prone on elbows	12-15 reps
	Transverses	Negative crunch 90-45 degree	10 reps
	Plank	Plank on elbow hold Side plank each side	30 sec hold
3-4	Upper abs	90-90crunch Normal crunch Leg raise with toe touch	20 reps 20 reps 20 reps
	Lower abs	Flutter kicks 90-60-30 Knee to chest in supine	20 reps 10 sec holds each 3 reps
	Oblique's	Crunch side bend combo Heel touch	8 reps each side 15 eps
	Back extensors	Prone on hands Prone back extension	20-60 secs 1 15-20 reps
	Transverses	Negative crunch45-30 degree	10 reps
	Plank	Plank hold Side plank each side Shoulder taps	40 sec 20 reps
4-6	Upper abs	Bent leg crunch Toe touch Normal crunch	20 reps 12-15 reps 20
	Lower abs	Leg raise circling 30deg Leg raise with hip lift Flutter kick	15 reps each direction 20 reps
	Oblique's	Twisting crunch Heel touch Plank with obliques Plank with tuck	8 reps each side 20 each
	Back extensors	Twisting back extension back extension on inclined bench V plank with toe touch	15-20 reps
	Transverses	Negative crunch Plank with dips	20 reps 10 reps
	Plank	Plank jack Mountain climber Combo plank with oblique's & tuck	10-15 reps 20 reps 50 reps 50 reps

Holds were increased in every set for isometric exercises while repetitions were increased in every week.

Statistical method

Instat version 3.06, 32 bit is used. Repeated measure ANNOVA was applied to check values in each row matched. Parametric test:- Bonferroni multiple comparison test was used.

RESULTS

Using Bonferroni comparison test if 't' value >2.546, then p value is less than 0.05. Here 't' values for comparison

between week 1 & week 3, week 1 & week 6, week 3 & week 6 is >2.546. Suggesting that Core strengthening improves cardiovascular fitness (Figure 2).

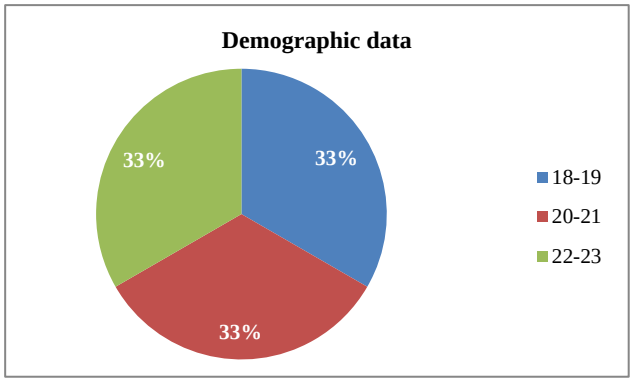

Figure 1: Age group included in study (18-25 were included in study both male and females).

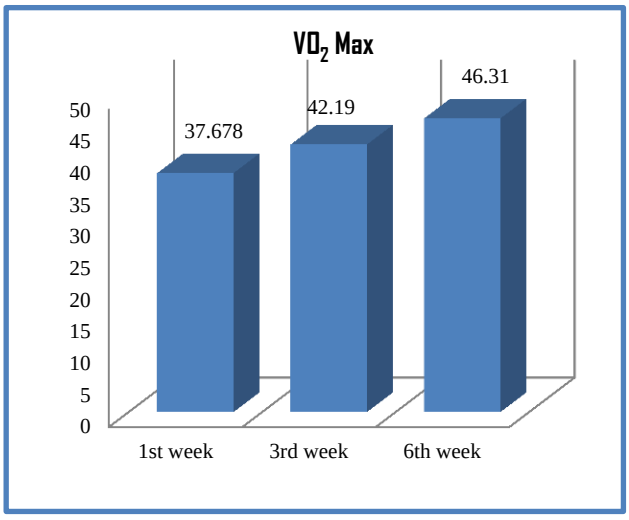

Figure 2: Mean of same group at specific intervals for Queen's college test.

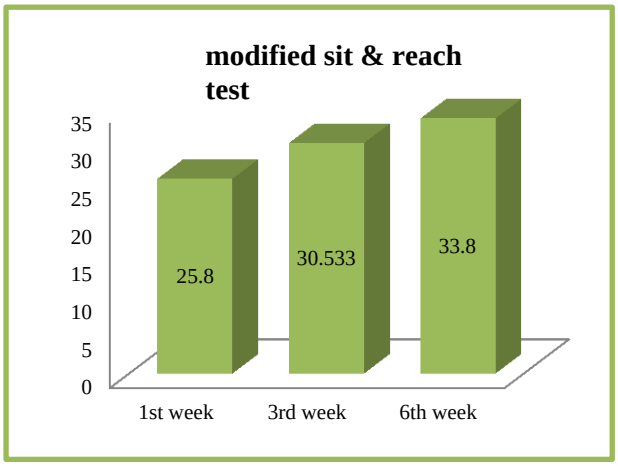

Figure 3: Means of reading taken at different week intervals of modified sit and reach test.

F = 60.618

P value <0.0001 variation among the column mean is significantly greater than the expected by chance. Using Bonferroni comparison test 't' value is greater than 2.546 thus p value is less than 0.05. This suggests that core strengthening improves trunk and hamstring flexibility.

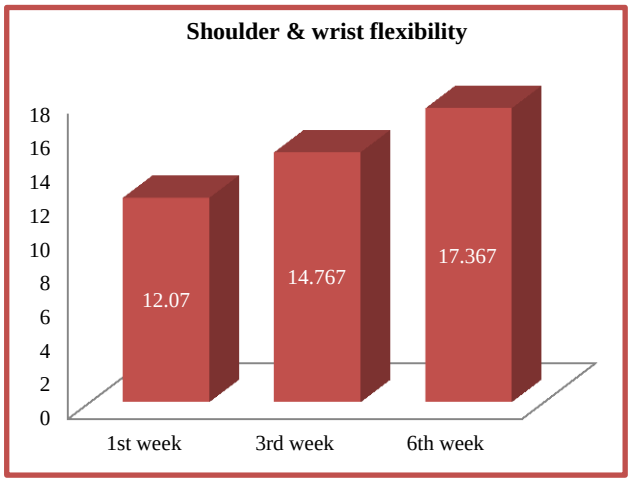

Figure 4: Mean of readings taken at different weekly intervals of shoulder & wrist flexibility test.

F =28.493

P<0.0001, variation among column means is significantly greater than expected by chance.

Using Bonferroni comparison test t value is greater than 2.546 thus suggesting that core strengthening improve shoulder and wrist flexibility test in obese individuals.

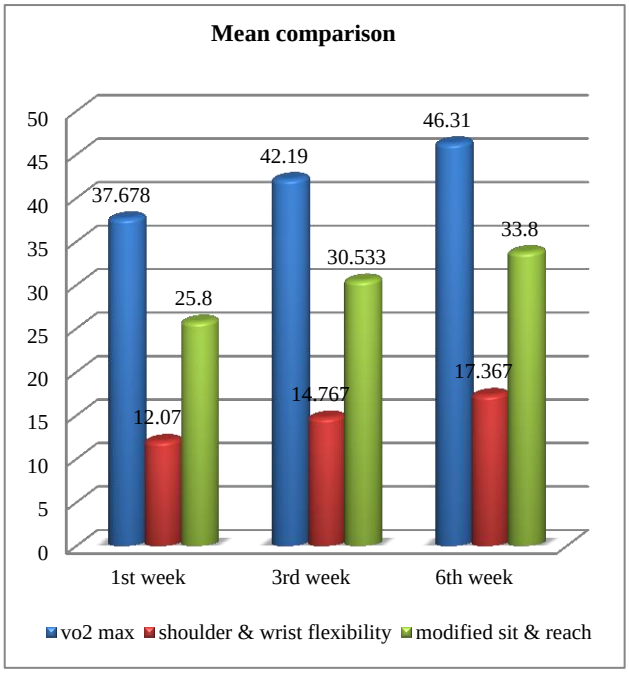

Figure 5: mean comparison of SD of all three outcome measure showed significant difference.

Table 2: F values of all three outcome measures.

	F value	P value
Vo_{2max}	16.67	<0.0001
Shoulder and wrist flexibility test	28.493	<0.0001
Modified sit and reach test	60.618	<0.0001

DISCUSSION

The purpose of this study was to determine the effect of core strengthening on cardiovascular fitness and flexibility in obese individuals after 6 week protocol. Core strengthening has good impact on spinal mobility, stability prevention of injury etc. In obese individuals usually strength of muscle is reduced, fitness and overall performance is also reduced.[7] Cardiovascular fitness is usually low in obese as ability of muscle to produce energy for movement is reduced.[18]As person gains weight overall activity is reduced thus leading to fat deposition in body thus resulting in decrease in optimal flexibility. [6] This study was designed to determine effect of core strengthening on cardiovascular fitness and flexibility in obese individuals. In this study 16 participants were selected from 18-25 years and there was 1 drop -out rate. Data analysis was done using Repeated Measure ANNOVA which showed significant improvement in cardiovascular fitness and flexibility in obese individuals after core strengthening for 6 weeks for 3 days/week ($p<0.05$).

In my study core strengthening exercises were performed and measured at 1st week, 3rd week and 6th week using Queen's college step test. Heart rate which was initially high after performing step test for three minutes reduced when measured at 3rd and 6th week after core strengthening protocol for 6 weeks. VO_{2max} was calculated at weekly intervals. The mean of 1st week was 37.678 which significantly improved in 3rd week with mean of 46.31 ($p<0.0001$) which showed that Cardiovascular fitness improved after core strengthening. Core muscle strengthening is associated with increasing blood flow to working muscles during any activity.[10] In With regular exercise cardiac output increases, thus VO2max increases. When we perform core strengthening exercises the co-contraction of various core muscles along with pressure changes by diaphragm help in supplying blood and meet O2 consumption required during that movement.[10] In the Study proposed by Sorosky's, he stated that Cardiovascular training enhances metabolism of free fatty acid which reduces body fat, increases the insulin sensitivity and improves blood flow to muscles, as well as the involuntary cardiac muscles present in the heart facilitate the pumping of blood through the body.[10]

Core strengthening enhances muscle function as well as leads to improve flexibility. Usually due to obesity overall activity reduces thus leading to shortening of muscles and increase fat deposition.[11] While performing exercises like reverse crunch, V plank, plank with oblique tuck, back extension etc. there is lengthening of one muscle group (hamstrings, rhomboids, abdominals, gluteus, etc) thus leading to improvement in flexibility. In my study there was significant difference in the means from 1st week to 6th week with shoulder and wrist flexibility at 12.07 in 1st week which increased upto 17.367 in 6th week ($p<0.0001$), where as it was 25.8 which significantly increased upto 33.8 ($p<0.0001$) for modified sit and reach test. During core strengthening exercises each muscle fiber extends to the full length of the muscle and performing certain core exercises also reduces regional fat in that area.[11] Apart from role in improving cardiovascular fitness it also reduce facet joint compressive forces and provide stretch to the lumbar muscles, ligaments, and myofascial structures. as stated by Gross and Worrell It also improves flexibility and enhanced flexibility has a greater effect on the range of motion and musculoskeletal injury prevention.[12,13] Due to eccentric muscle contraction there is an overall increase in muscle length thus improving flexibility of trunk, shoulder, wrist and lower limb musculature.[14]

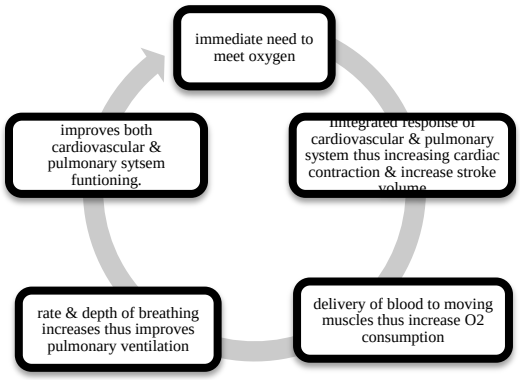

Figure 6: Exercise.[14]

Thus response from cardiovascular system, pulmonary system and eccentric muscle contraction could be the reason for improvement in cardiovascular fitness and flexibility in obese individuals.This response lead to significant change in mean readings of Queen's college step test, modified sit and reach test, shoulder and wrist flexibility test at interval reading of 1st week, 3 week and 6 weeks.

Limitations

Small sample size, participants require motivation for 6 week continuous protocol.

Scope of study

Study can be expanded further, Functional capacity of individual can be measured. Postural improvement can be assessed after core strengthening, Improvement in pulmonary function can be assessed after core strengthening, quality of life can be improved.

Clinical implication

Core strengthening can be added in daily protocol of weight loss and improving cardiovascular fitness in them. It will also improve posture and spinal stability in obese individuals as both are altered in obese.

CONCLUSION

The present study showed positive result with ($p<0.05$) which suggests that core strengthening improves cardiovascular fitness and flexibility in obese individuals. People who are obese should work on core as well to improve their cardiovascular fitness and flexibility.

ACKNOWLEDGEMENTS

I express my special thanks to all subjects who participated in this study and gave their full co-operation for this study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

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Cite this article as: Multani GK, Sutar A, Nikhade N, Ghodey S. Effect of core strengthening on cardiovascular fitness and flexibility in obese individuals: experimental study. Int J Community Med Public Health 2019;6:2235-40.