EFFECT OF SIT UP EXERCISE FOR 6 WEEKS ON PULMONARY FUNCTIONS IN FEMALES: AN EXPERIMENTAL STUDY

Subtitle:- Sit-up exercise effects on pulmonary functions

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Abstract

Background: Abdominal muscles are the major expiratory muscle and play an important role in ventilation. The purpose of this study is to examine the effects of respiratory muscles training with non-respiratory maneuver such as abdominal muscle training exercise on pulmonary functions in females.

Objective: 1) To determine the effects of sit up exercise for 6 weeks on pulmonary functions in females. 2) To determine appropriate training intensity by comparing effects of sit up exercise for 6 weeks on pulmonary functions in females at different intensities.

Methods: In this Experimental study 60 Subjects were randomly assigned to low (n=20), moderate (n=20), and high intensity (n=20) groups and they performed sit-up exercises 4 days a week for 6 weeks. The intensity for each group was set at 40% (low), 60% (moderate) and 80% (high) respectively as per the numbers of sit-ups they performed during 1-min sit-up test. Baseline and post-training measurements included pulmonary functions (Maximal Voluntary Ventilation, Forced Vital Capacity), Peak Expiratory Flow Rate and 1-minute sit-up test.

Results: Significant differences were found in post-training pulmonary functions among the 3 groups. Maximal Voluntary Ventilation after training was found significantly high ($p<0.05$) in all 3 groups. Forced Vital Capacity & Peak Expiratory Flow Rate was significantly increased ($p<0.05$) in High group as compared to Low group but not significantly high as compared to moderate group.

Conclusion: The non respiratory maneuver such as abdominal muscle training at moderate to high intensity not only improves abdominal muscle strength & endurance but also enhance the pulmonary functions through respiratory muscle training.

Keywords: Respiratory Muscle Training, Abdominal Muscle training, Pulmonary Functions, Sit-Up, Non-respiratory Maneuvers.

Introduction

The diaphragm is man's main respiratory muscle. The role of the abdominal muscles is in both quiet and forceful breathing. It is believed that the abdominal muscles could be strengthened in order to assist the ventilatory process. The strength of the abdominal muscles can assist prolonged and forced expiration.[1]
Few studies have been conducted to evaluate non-respiratory exercises and how these affect respiratory muscle strength and endurance.[2] Non-respiratory maneuvers have been found to activate the diaphragm to varying degrees depending on the type of exercise. With sit-up exercise trans-diaphragmatic pressure was at a maximum while inhaling during the sit-up exercise.[3]

Abdominal muscles are key muscles in ventilation, but how much effect ventilation has on expiratory muscle activity has not been examined to the extent as have inspiratory muscles.[4] Respiratory muscle training has effects on pulmonary function and physical performance in both healthy and cardiopulmonary disease populations.[5,6,7] It is rescannable to suggest that expiratory muscles are prone to fatigue that subsequently impairs pulmonary function. Expiratory muscle training, especially the abdominal muscles may improve pulmonary function exercise performance.[8]

According to the training theory, muscle performance may not improve if the training intensities are not sufficiently high. However, when the subject training exceeds their capability, subjects may suffer muscle fatigue, or even injury. The sit-up exercise, in addition to its effects on the diaphragm, is also a common method of training abdominal muscles in healthy subjects.[9]

Enhanced abdominal muscles activity during exercise helps expiration of air out of the lungs which result in decrease in the end-expiratory lung volume. This can help inspiratory muscles to produce a larger force by improving their length-tension relationship and assist with lung expansion at the beginning of inspiration through passive recoil of the chest wall[10]. Expiratory muscles have higher proportional of fast-twitch fibers and less oxidative stress than inspiratory muscles but are involved in similar proportion as inspiratory muscles during exercise.[11,12,13]

Abdominal muscles are also a major contributor to the trunk muscles. Consequently, the abdominal muscle plays an important role in maintaining postural stability during whole-body activities.[9]During strenuous physical activities, the abdominal muscles are facilitated, thereby increasing abdominal pressure. With such activities, the diaphragm is repeatedly involved; thus, the diaphragm strength can also be developed.[14]

It has been observed that abdominal muscle training protocols, both passive and active, may be effective to improve respiratory muscle strength.[15] Several exercise modalities focused on abdominal muscles and upper and lower limbs stimulate the diaphragm, increase transdiaphragmatic pressure, and induce different levels of abdominal muscle fatigue.[16,17]

Certain studies suggested that non-respiratory maneuvers such as abdominal exercises may have an effect on pulmonary function and respiratory muscle performance. However, few studies have explored the mechanisms of these effects. In addition to this which intensity and whether the benefits from abdominal muscle exercise parallel the traditional respiratory muscle training effects on respiratory muscle strength and pulmonary function remains unclear.

Aim of the study were1) To determine the effects of sit up exercise for 6 weeks on pulmonary functions in females. 2) To determine appropriate training intensity by comparing effects of sit up exercise for 6 weeks on pulmonary functions in females at different intensities.

Methodology

This study was an Experimental study. Sample Size was calculated using G Power. Total 60 participants were enrolled from the Uka Tarsadia University Campus. The inclusion criteria were all willing female participants of 18-25 years age group and with normal body mass index of 18.5-24.9 kg/m^2. Participants were excluded if they had a history of smoking, heart and lung diseases, musculoskeletal diseases, had undergone abdominal or thoracic surgery within the past 6 months, or had regular exercise habits. The study protocol was approved by Institutional Review Board. All procedures performed were in accordance with the ethical standards of the institutional research committee and with the ethical standards. All subjects gave their signed informed consent before enrolling the study. Introduction about the study was given to all participants.

The outcome measures selected in this study were MVV (Maximal Voluntary Volume) & FVC (Forced Vital Capacity) using Computerized PFT machine, PEFR (Peak Expiratory Flow Rate) using Peak Flow Meter & 1 Min Sit-Up test.All Participants performed the test in sitting position and a single, experienced investigator recorded the data. The procedures required the performance at least 3 trials, with the largest data within 5% variation accepted for analysis.

At the initial screening visit, baseline data such as age, health history, and physical status were obtained from the participants. The 1-min sit-up test and pulmonary function were measured for all participants. Participants were then randomly assigned to low intensity (LOW), moderate intensity (MOD), and high intensity (HIGH) group, 20 participants in each group. The intensity of sit-up exercise was determined by the number of sit-ups in each training sessions. Participants in LOW group performed 40% of the total numbers of sit-ups that participants completed during their baseline 1-min sit-up test. The MOD and

HIGH groups performed 60% and 80% of the total numbers of sit-ups during their baseline tests, respectively. Every participant performed the sit-up exercise 3 sessions per day, 4 days a week for 6 weeks under investigator's observation. Participants were asked to maintain normal diet and avoid any type of regular physical exercise during the study period. After completing the 6-week training program, these measurements were repeated by the same investigator.

The 1-min sit-up test was used to evaluate the dynamic endurance of the abdominal muscles. Subjects reclined their backs with knee flexed to 90°, hips flexed to 45°, and their feet flat. The subjects elevated their back approximately 75-90° off the floor. Each subjects received verbal instructions followed by a demonstration of the 1-min sit-up test. The subjects then practiced the sit-up 2 to 3 times to ensure proper techniques and were then given a 10 to 20-min rest period before the test. Before initiating the test, subjects were told to perform as many sit-ups as they could within 60s. The total number of sit-ups performed correctly was recorded.

Statistical Analysis

Data were analyzed using the statistical software package SPSS16.0[71] version for Windows. Results were expressed as means±standard deviation for baseline characteristics. Differences between groups pre- and post- measurements were compared with ANOVA Test & within group with Pair t-test.ANOVA was used for comparing means between all the three groups. Difference was considered to be significant if p value <0.05 & confidence interval was set at 95 %.

Descriptive statistics of age & BMI distribution among 60 participants was done.

Result

60 subjects were recruited into the study and were randomly allocated into 3 groups (20 subjects in each group). The demographic data were shown in Table 1. There were no differences between the groups with regards to age and BMI at the beginning of the study.

table 1 Baseline demographic data for subjects in 3 groups (mean ± sd)

GROUP	LOW	MODERATE	HIGH
NO. OF PARTICIPANTS	20	20	20
AGE(YEAR)	20.55±1.32	20.85±1.63	20.55±1.88
BMI(KG/M^2)	21.90±1.68	21.66±1.66	21.38±1.78

Interpretation-Significant differences were found between groups for FVC, PEFR & SIT-UPS/MIN at end of 6 weeks of training.

Table 2 Post Hoc analysis of MVV, FVC, PEFR & SIT-UPS/MIN after 6 weeks of training between 3 group

Dependent Variable	(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.
MVVPOST	L	M	-6.50000*	2.38945	.023
		H	-17.50000*	2.38945	.000
	M	L	6.50000*	2.38945	.023
		H	-11.00000*	2.38945	.000
	H	L	17.50000*	2.38945	.000
		M	11.00000*	2.38945	.000
FVCPOST	L	M	-.09550	.13258	.753
		H	-.34200*	.13258	.033
	M	L	.09550	.13258	.753
		H	-.24650	.13258	.160
	H	L	.34200*	.13258	.033
		M	.24650	.13258	.160
PEFRPOST	L	M	-79.50000*	14.65540	.000
		H	-100.50000*	14.65540	.000
	M	L	79.50000*	14.65540	.000
		H	-21.00000	14.65540	.331
	H	L	100.50000*	14.65540	.000
		M	21.00000	14.65540	.331
SIT-UPS / 1 MIN POST	L	M	-10.40000*	.79488	.000
		H	-18.45000*	.79488	.000
	M	L	10.40000*	.79488	.000
		H	-8.05000*	.79488	.000
	H	L	18.45000*	.79488	.000
		M	8.05000*	.79488	.000

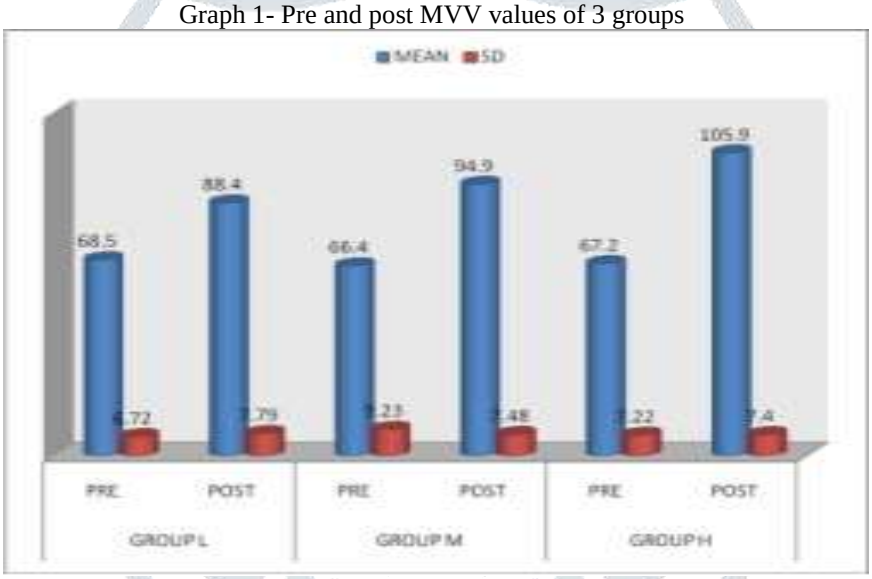
Interpretation-All three groups showed significant difference in MVV as compared to each other ($p<0.05$). Group-H showed significant improvement in FVC as compared to Group-L ($p<0.05$) but not significant to Group-M ($p=0.160$). Improvement in FVC was not significant in Group-M as compared to Group-L ($p=0.753$). At the end of 6th week Group-M & Group-H showed significant difference in PEFR as compared to Group-L ($p<0.05$) but the difference between Group M & Group-H was not significant for the same ($p=0.331$). There was significant difference in SIT-UPS/1 MIN in all the groups as compared to each other after 6 weeks of training.

Table 3 Within Group mean comparison of pulmonary function measurements and 1-min sit-up test for all Groups using paired t-test (Mean ± SD)

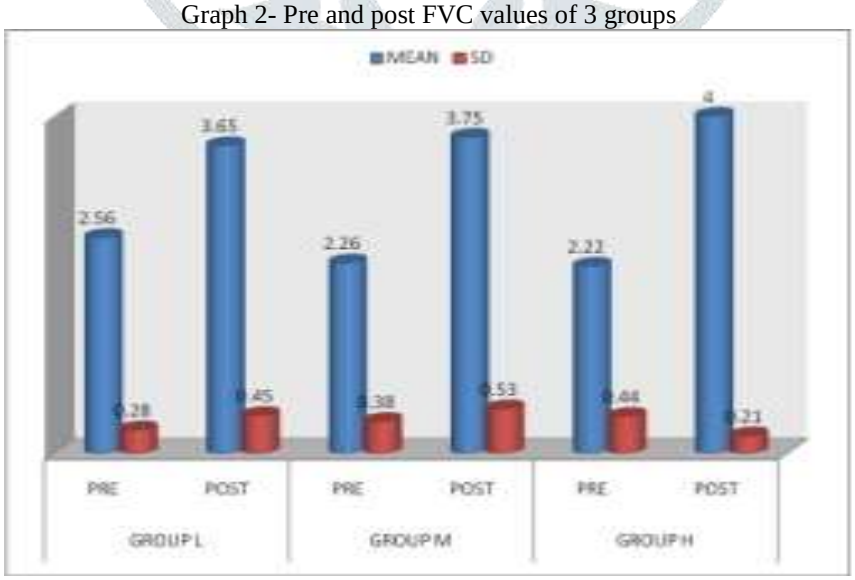
	VARIABLE	PRE	POST	Df	T value	P value
Group-L	MVV	68.50±6.72	88.40±7.79	19	-27.87	<0.05
	FVC	2.56±0.28	3.65±0.45	19	-9.80	
	PEFR	3.11±0.34	3.66±0.30	19	-22.60	
	SIT-UPS/1 MIN	18.2±2.60	24.3±2.80	19	-32.01	
Group-M	MVV	66.40±9.23	94.90±7.48	19	-36.24	<0.05
	FVC	2.26±0.38	3.75±0.53	19	-9.99	
	PEFR	3.75±0.53	4.45±0.52	19	-52.13	
	SIT-UPS/1 MIN	25.20±2.80	34.70±2.27	19	-18.07	
Group-H	MVV	67.20±7.22	105.90±7.40	19	-48.88	<0.05
	FVC	2.22±0.44	4.00±0.21	19	-16.18	
	PEFR	3.62±0.75	4.66±0.53	19	-12.33	
	SIT-UPS/ MIN	35.65±2.80	42.75±2.43	19	-37.26	

Interpretation-Figure 1,2 & 3 Graphical presentation of Mean Comparisons of MVV,FVC & PEFR after 6 weeks of training within & between 3 groups respectively

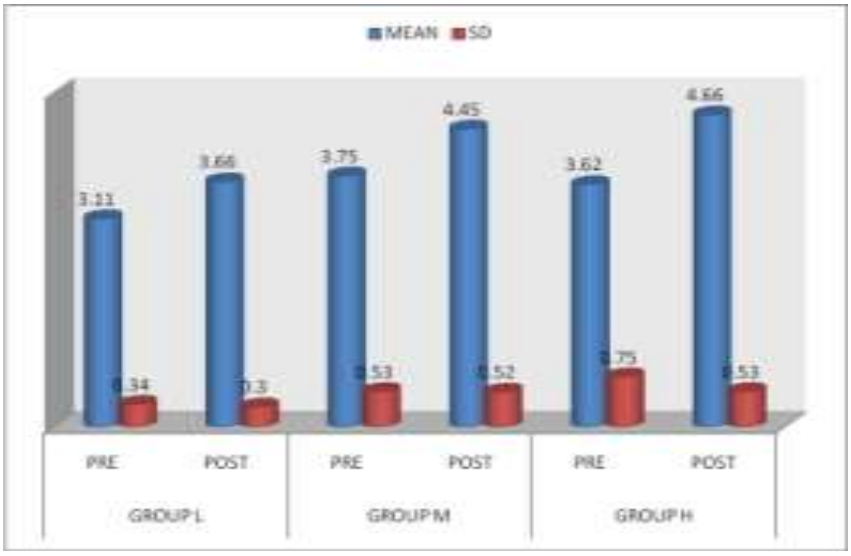
Graph 1- Pre and post MVV values of 3 groups



Graph 2- Pre and post FVC values of 3 groups



Graph 3- Pre and post PEFR values of 3 groups



Group-H showed significantly higher increase in MVV as compared to Group-L & Group-M after 6 weeks of training. Group-H showed significant improvement in FVC as compared to Group-L but not significant as compared to Group-M after 6 weeks of training. Group-H & Group-M showed significant improvement in PEFR as compared to Group-L after 6 weeks of training but not significant difference between Group-H & Group-M after 6 weeks of training.There is increase in SIT-UPS/1 MIN following 1 min sit-up test in all three of the group's participants (n=60) from their pre-training status to post-training status of 6 weeks when pooling data of the 3 groups.(26.35±7.71 to 33.92±8.01)

Discussion

The results of the present study showed that 6-weeks sit-up exercise training significantly improved abdominal muscle function, pulmonary functions & respiratory muscle function in female participants.The improvement in the 1-min sit-up test was associated with an increase in abdominal muscle strength & endurance plus improvement in participant's over all pulmonary functions after the 6-week sit-up exercise training. Sit-up, an exercise that requires forceful contraction of abdominal muscles, has been reported to significantly increase both abdominal muscle strength and endurance[9].Several authors supports the present study results that non-respiratory maneuvers such as sit-up exercise increases pulmonary functions.[8,18,19] Yii-Jiun Shao Et.ol[8] abdominal muscle training significantly increased in MVV in low, moderate and high-intensity groups.Previous studies have suggested that abdominal exercises may not only improve abdominal muscle strength, but also affect the diaphragm and inspiratory muscles[9,18,19]. Therefore FVC was improved in this study.Patil Poona & Sagar Javid stated that abdominal exercises improve peak expiratory flow rate in post-menopausal women[20]. So the present study succeeded to demonstrate a significant increase in MVV may indicate that sit-ups improve the efficiency of ventilation by increasing respiratory muscle strength. Prior studies have reported that respiratory muscle training improves pulmonary function[21,22]. However, these improvements were produced by a traditional respiratory muscle-training device. To our knowledge very few studies demonstrated significant improvement in MVV through abdominal muscle exercise training. But in this study the method which is used that requires no need of specific respiratory-training device, and had significant increase in MVV with low, moderate & high intensity training which is higher than that in previous study[23].High intensity (80%) group showed over all greater increased in all pulmonary functions[24] as compared to Low (40%) & Moderate (60%) intensity group. Moderate intensity group had significant improvement in PFR after 6 weeks of training as compared to Low intensity group.[25.26,27]

Conclusion

The present study concludes that Abdominal muscles training through sit-up exercise increase abdominal muscle strength & endurance, and pulmonary functions in females.Abdominal muscle training significantly increase MVV in low, moderate and high-intensity groups through increase ventilation. Stimulation of inspiratory & expiratory muscles increases FVC & PEFR & Training intensity should be kept moderate to high to achieve maximum training benefits.

Limitations of the study

The sample size was small. Less number of outcome measures were taken due to unavailability of other devices.The duration of the intervention was too short to identify differences between groups. Other limitation of the study was not adding control group which would have better determine the effectiveness of abdominal muscle training on pulmonary function. Results lack wider generability as only female participants were included.

Future scope

Future study can be done taking large sample size,different age groups & more outcome measures with longer training duration.Both gender should be included into the study to assess & compare the gender specific effect of training.

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