



Respiratory Responses to Short Term Sustained Isometric Muscle Contraction among Undergraduates

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Authors' contributions

This work was carried out in collaboration among all authors. Author SNS Literature search, survey, data collection, analysis, manuscript writing. Author GS Study design, data verification, manuscript drafting. All authors read and approved the final manuscript.

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ABSTRACT

Aim: This study sets out to investigate whether a short-term isometric abdominal exercise can benefit adults with improvement in ventilatory functions.

Materials And Methods: The present study was performed in 20 adults from the student population of I-BDS students with no history of smoking and respiratory illness. The participants did a daily 20-minute static abdominal exercise over a period of three days. The lung function test was assessed using spirometry and the values of FVC, FEV1, FEV1/FVC, PEFr, FEF 25-75. Paired dependent t test was done to evaluate the anthropometric variables and changes in lung functions pre-exercise on day 1 and post-isometric exercise on day 3.

Results: The study demonstrated a significant increase in the mean values of forced vital capacity and forced expiratory volume in one second. The FEV1/FVC ratio, PEFr, FEF 25-75% did not reveal significant changes.

Conclusion: The study concluded an innovative finding that ventilatory functions improved after short term isometric training.

Keywords: Isometric; abdominal exercise; training, pulmonary ventilation; oxygenation.

1. INTRODUCTION

An isometric muscle contraction is a form of exercise involving the static contraction of a muscle without any visible movement in the angle of the joint.[1] Isometric exercises help maintain strength of the muscle and increases the endurance of the muscle. For a particular muscle, or group of muscles, the respiratory changes are related to the force of contraction of the muscle after short term sustained isometric muscle contraction.[2][3] The mass of muscle involved has less effect on the blood pressure and heart rate responses. The respiratory responses to isometric muscle contraction have been less well investigated.

However, there is a scarcity of data evidence relating to isometric exercise and pulmonary function. The studies have mainly been on short term isometric abdominal muscle contraction.[3] It represent the responses to short term isometric muscle contractions of a small mass of muscle. Some subjects hyperventilate inappropriately which leads to marked falls in alveolar partial pressure of carbon di oxide. The present studies aim to compare the respiratory responses to contraction of a small mass of muscle and of a larger mass, the short-term isometric abdominal muscle contraction [4].

Another study determined the effectiveness of isometric handgrip exercise on pulmonary function capacity in prehypertensive adults using a quasi- experiment in two out-patients hospital settings. The exercise regimen was carried out for 24 consecutive days, an isometric handgrip exercise at 30% Maximum Voluntary Contraction. There was a significant difference between groups in FEV1 and PEF. (9) So the study planned to find the changes in ventilation during sustained isometric contractions is independent of the mass of the muscle involved, although oxygen consumption may rise with increasing active muscle mass. The reduction of alveolar PCO₂, resulting from hyperventilation, should be less with a larger muscle mass as carbon dioxide production will be increased. (10-16). Our team has extensive knowledge and research experience that has translate into high quality publications[5–9].

So, the aim of the present study planned to investigate effect of short-term isometric abdominal exercise on ventilatory functions.

2. MATERIALS AND METHODS

A pre-experimental design with a convenience sample was employed. The study group consisted of 20 adult males, ranging from 18 to 25 years old with similar anthropometric measurements like age, gender, height and body mass index (BMI). (Table-1).

2.1 Inclusion Criteria

Healthy adults from the student population of I-BDS students.

Exclusion criteria – Subjects with any respiratory illness, COPD or spinal deformities were excluded from the study.

The study was introduced and explained to the participants, and informed consent was obtained. They were taught short term static isometric exercise for 20 mins over a period of three days. Both the pre and post exercise routine spirometry tests were evaluated using HELIOS SPIROMETER and the values of Forced vital capacity (FVC), forced expiratory volume at the end of the first second (FEV1), FEV1/FVC ratio and peak expiratory flow rate (PEFR) and FEF 25-75 % using a spirometer both before and after 3 days of isometric exercise for 20 mins.

Statistical Analysis was done using SPSS Software and the Paired dependant t test was done to evaluate the anthropometric variables and changes in lung functions pre-exercise on day 1 and post isometric exercise on day 3.

3. RESULTS

The study showed the anthropometric measurements in Table -1 and there was a significant increase in FVC, FEV1 after short term isometric exercise and it was found to be statistically significant ($p < 0.05$). (Fig 1 & 2). PEFR and FEF25-75 (Fig 3,4 & 5). (Table -2) and FVC shows an increase after short term sustained isometric muscle contraction and the value was found to be statistically significant as in Paired dependent t test p value = 0.04 ($p < 0.05$ was statistically significant).

FEV1 shows an increase after short term sustained isometric muscle contraction and the value was found to be statistically significant as in Paired dependant t test $p = 0.00$ ($p < 0.05$ was statistically significant).

In the figure, FEV1/FVC ratio is equal before and after short term sustained isometric muscle contraction and the value was found was not statistically significant as in Paired dependant t test $p= 0.07$ ($p>0.05$ not significant).

contraction and the value was not statistically significant as in Paired dependant t test $p= 0.78$ ($p>0.05$ was statistically not significant).

In the figure, FEF 25-75% shows a decrease after short term sustained isometric muscle

PEFR shows a decrease after short term sustained isometric muscle contraction and the value was not statistically significant as in Paired dependant t test $p= 0.66$ ($p>0.05$ not significant).

Table 1. Demographic characteristics of studied subjects

Variable	Mean \pm SD Independent house residents	Mean \pm SD High rise apartment residents
Age in years	18.4 \pm 0.2	18.2 \pm 0.4
Height in cm	168.5 \pm 6.28	166.8 \pm 7.53
Weight in kg	64.8 \pm 6.14	60.8 \pm 7.35

Table 2. represents the lung functions in pre and post sustained isometric exercise training

Lung function parameters	Pre isometric training	Post isometric training
FVC (L/sec)	2.18 \pm 0.444	3.12 \pm 0.571
FEV1 (L/sec)	2.28 \pm 0.385	3.32 \pm 0.284
FEV1/FVC (L/sec)	100.01 \pm 0.000	100.01 \pm 0.000
PEFR (L/sec)	4.72 \pm 2.695	2.64 \pm 1.342
FEF 25-75% (L/sec)	3.39 \pm 2.007	3.39 \pm 1.393

Values are expressed as mean \pm standard deviation

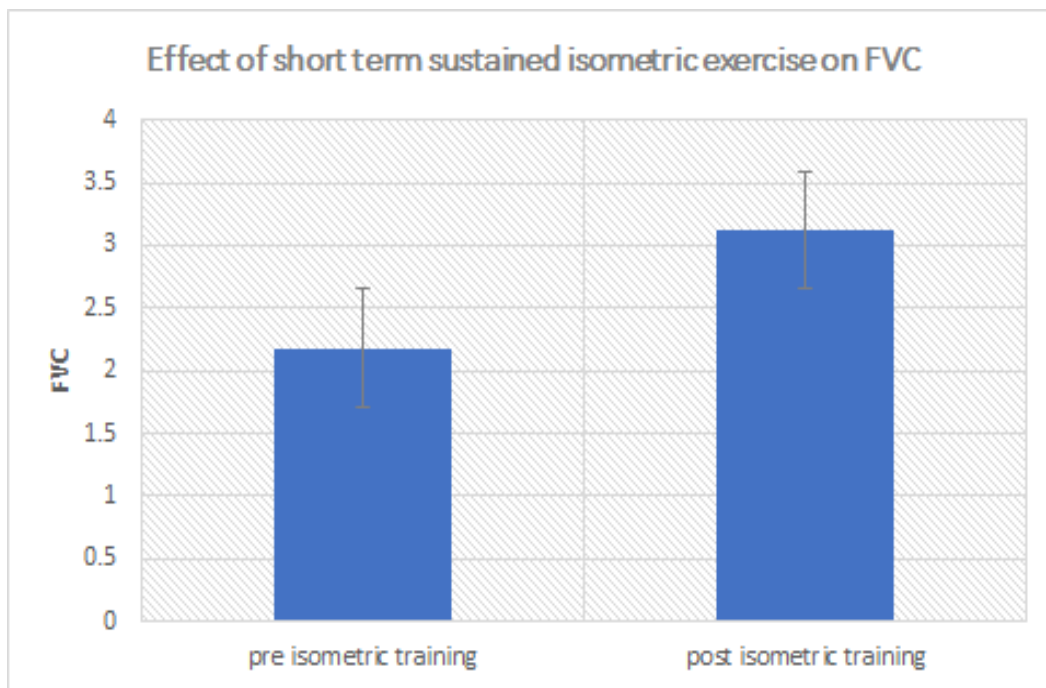


Fig. 1. Represents the changes in FVC pre and post short-term isometric exercise

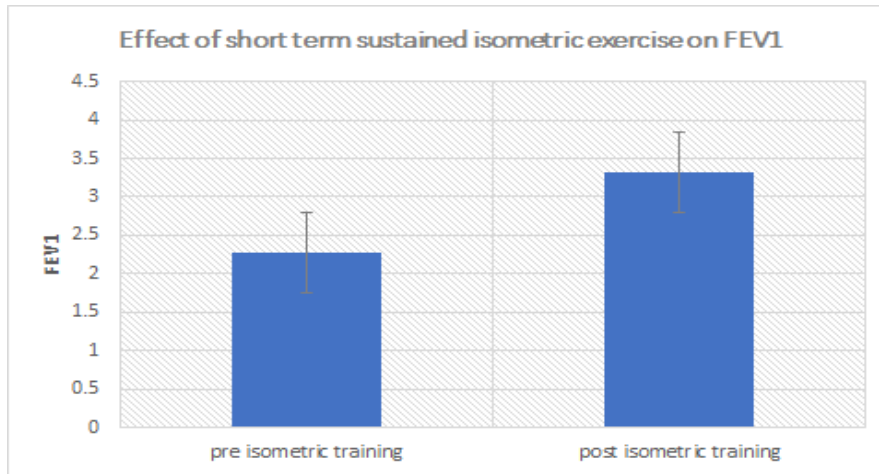


Fig. 2. Represents the changes in FEV1 pre and post short-term isometric exercise

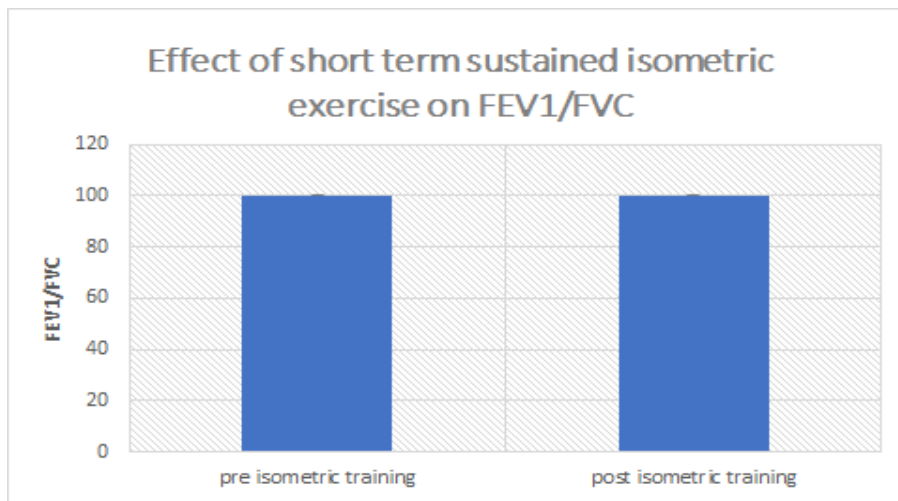


Fig. 3. Represents the changes in FEV1/FVC pre and post short-term isometric exercise

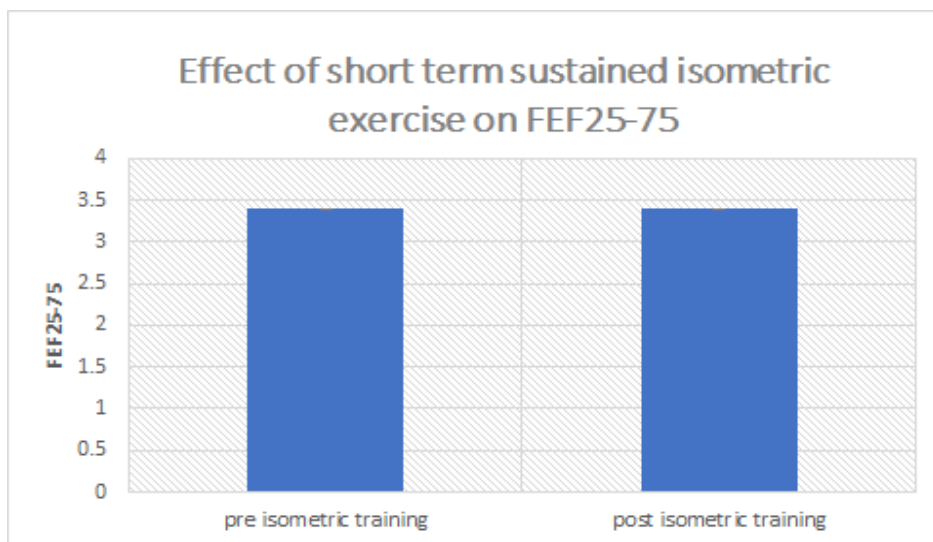


Fig. 4. Represents the changes in FEF 25-75 pre and post short-term isometric exercise

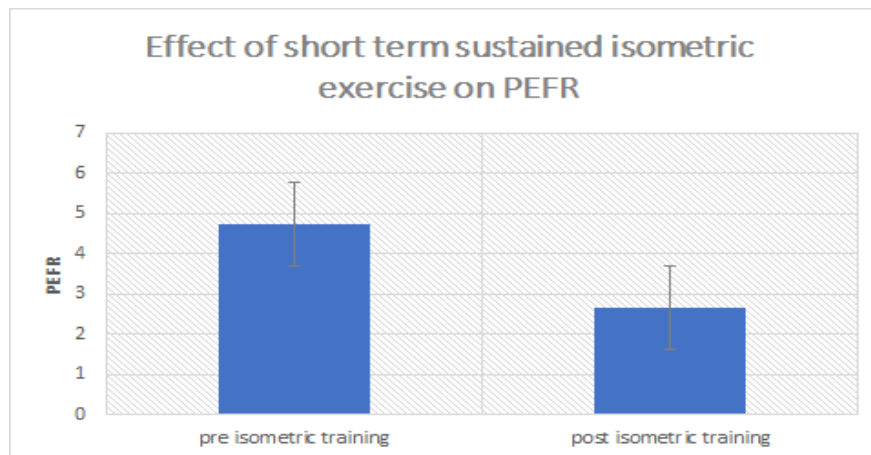


Fig. 5. Represents the changes in PEFR pre and post short-term isometric exercise

4. DISCUSSION

Short isometric strength training significantly improved pulmonary functions. Another study investigated the effect of isometric training intensity in normal and sporting type of people and pulmonary function parameters were evaluated in 35 soccer and 35 futsal athletes and the study found that the soccer athletes' group had a significantly higher value of FVC, FEV1, PEFR and FEV1/FVC ratio compared with the futsal athletes' group (30).

A number of research studies have been carried out to investigate the influence of physical activity and sport exercises on pulmonary function in patients who suffer from respiratory problems. The present study sets out to discover whether pulmonary function tests have different results in response to static abdominal exercise for 3 days. The present study revealed that there were significant improvements in FVC, FEV1. Previous reports suggested that short term isometric exercises can have a facilitatory effect on the lungs particularly FEV1 values. (17-21). It may be a three days exercise program, but this regimen enhanced the vital capacity and expiratory volumes. Also that the subjects' physical exertion during exercise could have helped to create reduced resistance to respiration and it has given the respiratory muscles an endurance training. This is likely to be an explanation for the significant difference in FVC values noted in our study. Also, that this effect is mediated to increase the ventilation. However, cardiovascular and respiratory changes following short term isometric exercise are partly stimulated by drive from higher centers

to the brain stem and role of chemoreceptors [10].

Previous reports also suggested that aerobic exercise improves respiratory functions and increases the body's ability to use oxygen. It tones up all the muscles, improving the circulation in the process. (22-29) It lowers blood pressure and reduces workload to the heart. It strengthens the respiratory muscles and, even reduces airflow resistance and facilitates the inflow and outflow of air in the lungs effectively[2].

5. CONCLUSION

The study concluded that short term isometric exercise significantly improves the lung functions and can reduce the predisposition of developing obstructive lung disease.

6. LIMITATIONS OF THE STUDY

The study population was confined only to a small group. If more sample size is added the results would have been statistically significant.

CONSENT

All the study participants signed consent forms before being enrolled.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Institute NC, National Cancer Institute. Isometric Exercise. Definitions 2020. Available: <https://doi.org/10.32388/7bxexn>.
2. Barnes M. chronic exertional compartment syndrome: muscle changes with isometric exercise. *Medicine & Science in Sports & Exercise* 2003;35:1794. Available: <https://doi.org/10.1249/01.mss.0000091501.73963.1d>.
3. Imms FJ, Mehta D. Respiratory responses to sustained isometric muscle contractions in man: the effect of muscle mass. *J Physiol* 1989;419:1–14.
4. Edwards RHT, Harris RC, Hultman E, Kaijser L, Koh D, Nordesjö L-O. Effect of temperature on muscle energy metabolism and endurance during successive isometric contractions, sustained to fatigue, of the quadriceps muscle in man. *The Journal of Physiology* 1972;220:335–52. Available: <https://doi.org/10.1113/jphysiol.1972.sp009710>.
5. Sathish T, Karthick S. Wear behaviour analysis on aluminium alloy 7050 with reinforced SiC through taguchi approach. *Journal of Materials Research and Technology* 2020;9:3481–7.
6. Campeau PM, Kasperaviciute D, Lu JT, Burrage LC, Kim C, Hori M, et al. The genetic basis of DOORS syndrome: an exome-sequencing study. *Lancet Neurol* 2014;13:44–58.
7. Dhinesh B, Niruban Bharathi R, Isaac JoshuaRameshLalvani J, Parthasarathy M, Annamalai K. An experimental analysis on the influence of fuel borne additives on the single cylinder diesel engine powered by *Cymbopogon flexuosus* biofuel. *J Energy Inst* 2017;90:634–45.
8. Parthasarathy M, Isaac JoshuaRameshLalvani J, Dhinesh B, Annamalai K. Effect of hydrogen on ethanol-biodiesel blend on performance and emission characteristics of a direct injection diesel engine. *Ecotoxicol Environ Saf* 2016;134:433–9.
9. Gopalakannan S, Senthilvelan T, Ranganathan S. Modeling and Optimization of EDM Process Parameters on Machining of Al 7075-B4C MMC Using RSM. *Procedia Engineering* 2012;38:685–90.
10. Williams CA. Effect of muscle mass on the pressor response in man during isometric contractions. *The Journal of Physiology* 1991;435:573–84. Available: <https://doi.org/10.1113/jphysiol.1991.sp018526>.
11. Godsday OU, Kingsley NE, Chukwuebuka NB, Ephraim C, Emmanuel E, Ejime AC, Chukwuka IJ. Isometric Handgrip Exercise Training Improves Spirometric Parameters and Pulmonary Capacity. *Pathophysiology* 2021, 28, 328–338. Available: <https://doi.org/10.3390/pathophysiology28030022>
12. Tareq Z, Razzaq A, Al-Madfai Z, Saeed GT. The Effect of Training and Sport Type on Pulmonary Function Parameters among Iraqi Soccer and Futsal Players. *IOSR-J. Sports Phys. Educ. (IOSR-JSPE)*. 2016;3:27–30.

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