

RESPIRATORY RESPONSES TO EXERCISE IN PREGNANCYAnitha O. R¹, Smilee Johncy², Suresh Y. Bondade³, Christofer Thomas⁴**HOW TO CITE THIS ARTICLE:**

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ABSTRACT: BACKGROUND: Pregnancy is a naturally occurring physiological process, where in most control systems of the body are transitorily modified in an attempt to maintain the homeostasis. Exercise is another physiological state in which the bodily systems undergo adaptations, more so in pregnant women. There are many advantages of exercise in pregnant women as in any other individual; from the sense of well-being to prevention of hypertension and diabetes. There are not many studies done on Indian women to know the effect of exercise on the pulmonary function tests. **OBJECTIVES:** To study the effect of moderate exercise on the respiratory functions in pregnant women. **MATERIALS AND METHODS:** 50 healthy pregnant women in their 2nd trimester of pregnancy were taken as subjects. Minute Ventilation (MV), Forced Vital Capacity (FVC) & Forced Expiratory Volume in 1st second were measured in pregnant women who were then compared with age- matched controls. Respiratory parameters were recorded using a computerized spirometry (Medspiror). It was done at two instances once at rest and other after subjecting them to moderate exercise on a motorized treadmill. **RESULTS:** At rest, Minute ventilation was more in the pregnant group when compared to controls. Increase in MV after exercise was more in the pregnant women. FVC was not statistically different from those of controls at rest, though exercise increased FVC to greater value in pregnant women as compared to controls. Resting FEV₁ was less in pregnant women. It decreased after exercise in both the groups; the percentage decrease was not much different between the two groups. **CONCLUSION:** In our study, changes in respiratory functions to exercise in pregnant women were towards positive side giving the advantage of hyperventilation to the woman and the fetus. Keeping in mind the tremendous advantages of exercise, all healthy pregnant women should be encouraged to make exercise an integral part of their ante-natal care.

KEYWORDS: Pregnancy, Exercise, Minute ventilation, FVC, FEV₁.

INTRODUCTION: The energy demand of a living organism increases whenever its metabolism is stimulated, as in pregnancy and exercise. This increased demand results in variations in the respiratory functions. Although the increased demand of pregnancy, compete with those of exercise, under most circumstances, the maternal organism can meet the combined demands of both, through a remarkable reserve of physiological adjustments.¹

Traditionally, pregnant women were advised to rest throughout gestation. With the advent of industrialization in the recent years, more women are going out of their houses to work; many such jobs involve physical activities. There has been increase in the number of women participating in outdoor sports and fitness activities, as well as employment of women in nontraditional occupations that involve strenuous physical activities. When such women become pregnant, it is important to know the effects of pregnancy on maternal exercise.

Research now shows physical activity improves the health of the mother in normal pregnancy in terms of improved weight control, reduced risk of gestational diabetes and also provides potential

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long term benefits for the child.² But, there is not much data available on to the changes in respiratory functions due to exercise in Indian pregnant women at present.

So, this study was undertaken to observe the effects of exercise on the respiratory functions in healthy pregnant women. This was then compared with the effects of exercise in the controls. Inclusion criteria for controls were non-pregnant women with no history of medical or surgical illness and who were in age group of 20 yrs.– 30 yrs. All the participants were subjected to moderate exercise, i.e., walking on a treadmill at 2% slope for 6 minutes at a speed of 3.2 km.ph.³

MATERIALS & METHODS: The present study was conducted in the department of physiology. The ethical approval was taken from the institutional human research ethics committee of J.J.M. Medical College. Pregnant women who were in their 2nd trimester of pregnancy were taken as subjects. The mean age group of the subjects was 25.1± 2.4 (20yrs- 30 yrs.). Pregnant women with no history of medical or surgical illness of any systems were selected as subjects. 50 age-matched, non- pregnant women were taken as controls.

The lung function tests were done at 2 instances-at rest and immediately after moderate exercise. The tests were done after the subjects gave an informed consent to the procedure. The technique was explained to them in their own language. A detailed history was taken and clinical examination of all the systems was done.

Lung function tests were done using a computerized RMS Medspiror, which gives the predicted values for age, sex & height. Tidal volume (TV), Minute Ventilation (MV), Forced Vital capacity (FVC) and Forced Expiratory Volume at the end of 1st second(FEV₁) values were noted down. Both control and cases were subjected to exercise, that is walking on a motorized treadmill.

The subjects were made to walk on it for 6 minutes at a speed of 3.2 km.ph, at 12% grade slope, which accounted for moderate exercise.³ They were instructed to report if they felt dizzy, palpitations or any other problem, in which case the treadmill was stopped. Most of the subjects completed the task.

Statistical Analysis: The results were given as Mean ± Standard Deviation and range values. Comparisons between the 2 groups were performed using unpaired 't' test and within the group was done by paired 't' test. The results for each parameter were first compared within the group and then between the groups.

The p value of 0.05 or less was considered as statistically significant.

RESULTS: The mean resting respiratory rate in pregnant women and controls was not statistically significant at rest. With the moderate exercise, respiratory rate was increased in pregnant women as well as in controls. The difference in the increase between the two groups was statistically significant ($p < 0.01$). When the resting values of respiratory rate was compared with those after exercise, in pregnant women there was 5.4 cycles per minute rise(cpm) and in controls 9.1 cpm rise in values as an effect of exercise ($p < 0.001$). (Table 1).

Tidal Volume at rest was more in pregnant women as compared to controls. The difference was statistically significant. After moderate exercise, TV increased to a significantly higher level in both the groups (Table 1). Minute ventilation was more in pregnant women (17.0L/min) than in

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controls (11.7L/min) at rest. After moderate exercise, it increased to greater extent in pregnant women (30.7L/min) than those of controls (25.8L/min). (Graph 1)

The FVC in pregnant women (2.13L) was more than in controls (2.07L), but not statistically significant. After exercise also there was more increase in pregnant women (9.8% rise) as compared to 7.7% rise in controls. (Table 2, Graph 2)

Forced Expiratory Volume in 1st second (FEV₁): Both the resting FEV₁ (96.1% pred) & post exercise FEV₁ (94.2% pred) were less in pregnant women as compared to controls, where, resting was 98.7% pred & post exercise was 97% pred. But the difference between the 2 groups was not statistically significant. All the values were within normal range (Table 2).

DISCUSSION: This novel study was taken up to see the changes in the respiratory functions during pregnancy, more so its responses to exercise. Time tested & simple procedure of spirometry was used to record the data.

The mean resting Tidal Volume in pregnant women was significantly higher than those of controls at rest. The increase in tidal volume in pregnancy can be attributed to the hormone relaxin, which relaxes the ligament attachment of ribs thus increasing the antero-posterior & transverse diameter.⁴ The increase in tidal volume or the depth of respiration throughout the pregnancy is also due to progesterone. The site of action of progesterone appears to be central, through a direct stimulatory effect on the respiratory center, increasing its sensitivity to PCO₂. Similar increase in Tidal volume and minute ventilation were found by Emilia & others in a study on 52 pregnant women.⁵

In the present study after exercise, the tidal volume was increased to significantly higher levels both in pregnant women & controls. This increase during exercise may be attributed to be due to the action via the carotid & aortic chemo receptors. These produce increase in the oscillations of blood PO₂ which causes increased respiratory drive and increased tidal volume.⁶ Post exercise tidal volume in pregnant women was more than in controls. In a study by Lottgering and others, where hemodynamic and ventilatory responses during multilevel symptom limited treadmill exercise were studied in pregnant women, there was an increase in ventilation from 10.8 L/min to 22.2 L/min.⁷

In a study by Artal and others, the pulmonary responses of 88 pregnant women were compared to those of 39 non-pregnant control subjects during different exercise intensities. At rest, the pregnant women had higher tidal volume; oxygen consumption etc. and also pregnant subjects demonstrated a more efficient ventilatory response to moderate exercise when compared to non-pregnant control subjects.⁸

As resting tidal volume was more in pregnant women, Minute Ventilation was also more. This increase is due to the smooth muscle relaxation caused by progesterone¹. A cross sectional study in Thai pregnant women done by Charintip Sompras & others showed increase in minute ventilation to 30% more than the controls in 2nd trimester of pregnancy.⁹ Hyperventilation of pregnancy persisted during exercise. Similar increase in ventilation were found by Lottgering et al.⁷

Vital capacity in pregnancy has been a topic of debate since ages. There have been contradictory findings in this regard in the past, where few studies like the one by Mokkapatti et al,¹⁰ found a reduction in the vital capacity during pregnancy, more significantly in the third trimester which they attributed for the mechanical pressure of the enlarged uterus.

The vital capacity did not change during pregnancy in a longitudinal study done by Phatak & others, where they concluded that preservation of FVC is due to diminished abdominal compliance

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and augmentation of rib cage volume & unimpaired diaphragmatic movement despite progressive enlargement of gravid uterus.¹¹ whereas few other studies showed increased FVC during pregnancy, like the one done by Pradhan & others.¹²

In the present study, the mean FVC at rest in pregnant women was higher than those of controls, but the difference was not statistically significant. During pregnancy the growing uterus, ascends in the abdominal cavity, pushing the diaphragm up, thus decreasing the vertical length. But, along with this, the lower ribs flare outwards & increase the transverse diameter. The sub costal angle increases from 68° to 103°.¹

After exercise, FVC increased to a higher value in both the groups. A study done by Howard G. Knuttgen et al in Harvard Medical school – Boston, to know the physiological response in pregnancy at rest and during exercise, found that the resting vital capacity, respiratory reserve volume, oxygen consumption were all significantly higher in pregnant women as compared to postpartum.¹³

In the present study, resting FEV₁ in pregnant women was less than those of controls, but the difference was not statistically significant. The mechanical disadvantage to the respiratory apparatus induced by advancing pregnancy is well compensated by decrease in airway resistance and improved airway conductance due to smooth muscle relaxation caused by progesterone.¹⁴ After exercise, the FEV₁ was found to decrease in both the groups, but the difference in decrease was not statistically significant. Similar non-significant decrease in FEV₁ was found by Kenneth.¹⁵

A longitudinal study was conducted in hospital in Hyderabad in 115 pregnant women and compared with 20 controls. They observed that FEV₁ was reduced in pregnant women in all trimesters. This reduction was not significant in first 2 trimesters, whereas, it was significant in third trimester as compared to controls.¹⁰

CONCLUSION: In our study, at rest, Tidal Volume & Minute Ventilation was more; Vital Capacity remained same in pregnant women when compared to controls. FEV₁ was not significantly different. After exercise, the changes in these parameters among pregnant women were more towards the positive side. This hyperventilation in the mother is beneficial to the fetus, as better oxygenation of maternal blood is possible and it also facilitates fetomaternal gas exchange.

Therefore, exercise brings about beneficial respiratory responses in pregnant women. Thus, pregnant women can be encouraged to do moderate exercise during her pregnancy in view of its tremendous benefits. Thus this study, new of its kind throws light on to the effects of exercise on the respiratory system in pregnant women.

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Measurement	Groups	Rest	Exercise	Difference
RR (cycles/ min)	Pregnant women	19.6 ± 3.5	25.0 ± 5.4	5.4 ± 3.8
	Controls	19.0 ± 3.0	28.2 ± 3.2	9.1 ± 2.5
	P	> 0.05, NS	< 0.01, S	< 0.001, HS
TV (L)	Pregnant women	0.85 ± 0.29	1.20 ± 0.26	0.35 ± 0.15
	Controls	0.61 ± 0.08	0.91 ± 0.17	0.30 ± 0.13
	P	< 0.001, HS	< 0.001, HS	> 0.05, NS
MV (L/min)	Pregnant women	17.0 ± 6.3	30.7 ± 9.1	13.7 ± 6.5
	Controls	11.7 ± 2.4	25.8 ± 5.7	14.1 ± 4.4
	P	< 0.001, HS	< 0.001, HS	< 0.05, NS

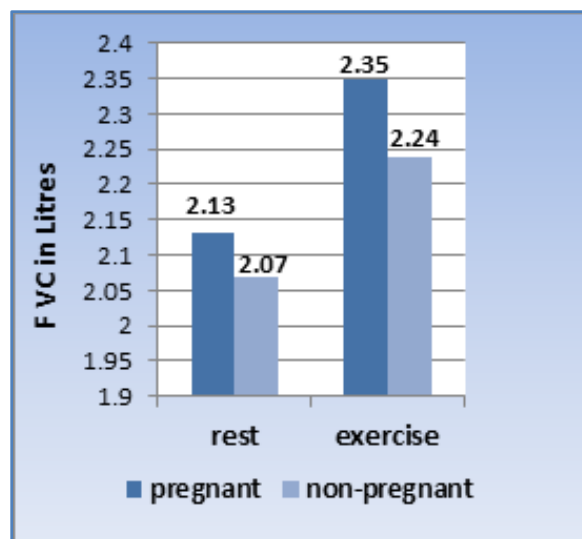
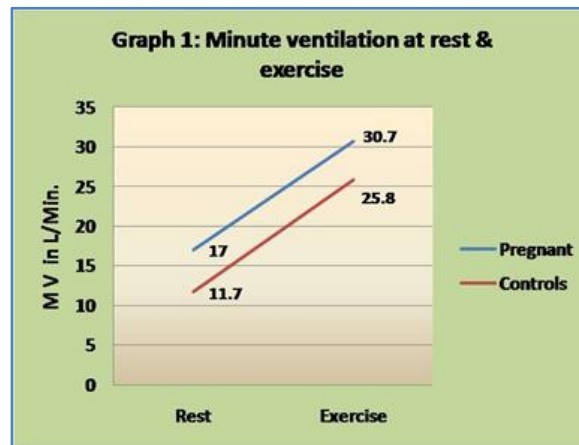
Table 1: Ventilatory changes during exercise in pregnant women and controls

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Measurement	Groups	Rest		Exercise		Diff.
		Test	% Predicted	Test	% Predicted	
FVC (L)	Pregnant women	2.13 ± 0.21	95.1 ± 6.9	2.35 ± 0.21	104.9 ± 8.2	9.8 ± 5.2
	Controls	2.07 ± 0.20	92.7 ± 5.7	2.24 ± 0.19	100.4 ± 6.4	7.7 ± 4.5
	P		> 0.05, NS		< 0.01, S	< 0.001, HS
FEV ₁ /FVC	Pregnant women	0.84 ± 0.06	-	0.74 ± 0.06	-	- 0.10 ± 0.06
	Controls	0.89 ± 0.06	-	0.80 ± 0.07	-	- 0.09 ± 0.05
	P	< 0.01, S		< 0.01, S		> 0.05, NS

Table 2: Vital capacity & FEV₁ changes to exercise in pregnant women & controls

All values expressed as mean ± standard deviation (range) analysis for all parameters within the group was done by paired t test and between the groups was done by unpaired t test. HS → Highly significant, S → Significant and NS → Not Significant.



Graph 2: Changes in FVC in pregnant and controls to exercise

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