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Effects of different trimesters of pregnancy on pulmonary function test

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Abstract

Background: Pregnancy is a state of physiological adaptation. A number of anatomical, biochemical, and hormonal changes occurring during normal pregnancy have its effect on the lung volume and capacities, lung function and parameters. Tidal volume (Vt) increases up to 40%, Expiratory reserve(ER) decreases, Alveolar ventilation increases, Total lung capacity (TLC) and vital capacity (VC) remains unchanged and closing capacity also decreases.

Method: Study involved 30 pregnant women aged between 20-30 years, i.e. 10 pregnant women of each trimester. Pulmonary function test was performed. Data analysis was done using unpaired t test.

Result: In the study it was observed that FEV_1, FVC and FEV_1/ FVC ratio remain unchanged throughout pregnancy. A slight variation was statistically insignificant. The opposing change in MVV was statistically highly significant ($p < 0.05$).

Conclusion: From the present study we concluded that different trimesters of pregnancy have no effect on the pulmonary function test parameters.

Keywords: Trimesters, PFT: FEV_1, FVC, FEV_1/ FVC ratio and MVV

Introduction

Pregnancy is a period from conception to birth. After the egg is fertilised by a sperm and then implanted in the lining of uterus it develops into the placenta and embryo and later into the foetus. Pregnancy causes many visible and invisible changes in human body [1]. It is a state of physiological adaptation [2]. The adaptations are seen in all major and minor system of female

The efficient respiratory system becomes vulnerable with profound changes during pregnancy [1]. A number of anatomical, biochemical and hormonal changes occur during normal pregnancy which exerts its effect on lung volume and capacities [3] during the course of pregnancy, the foetus gradually grows and therefore, brings about generalized systemic changes in the mother to accommodate and adapt to the needs of developing foetus [4]. The female reproductive system includes the external and internal genital organs. The external genital organs are Mons pubis, Labia majora, Labia minora, Clitoris, and Vestibules, Greater vestibular glands. The internal genital organs includes the ovaries, the fallopian tubes, the uterus and the vagina [5].

Amenorrhoea is first sign of pregnancy. The changes of pregnancy are orchestrated by female's hormones like progesterone, oestrogen and relaxin. Progesterone decreases the tone of smooth muscles, increases the temperature, causes hyperventilation and increases fat storage. Oestrogen increases the size of uterus and breast ducts, increases the level of prolactin to prepare breast for lactation whereas relaxin replaces the collagen in target tissue.

During the course of pregnancy the blood volume increases by 40%, haemoglobin decreases to about 80% causing physiological anaemia, the size of heart increases to accommodate more blood, cardiac output increases, blood pressure falls in 2nd trimester. In the 3rd trimester weight of foetus may compress the aorta and inferior vena cava causing dizziness. Nausea and vomiting are the response to Human Chorionic Gonadotropic hormone restricted to early morning, salivation increases. There is also increase in size of kidney, dilation of renal pelvis and increase in the frequency of micturition [6].

Profound local and systemic changes in maternal physiology are initiated by conception and continue throughout pregnancy [7]. The increasing size of foetus with advancing gestation constitutes a mechanical impediment to the normal process of maternal ventilation. Pregnancy is associated with physiological changes in control of breathing, in lung volumes, mechanics of respiration and in acid-base balance [4]. Antero-posterior and transverse diameter increase which in turn increases the chest wall circumference[4]. There is increase in transverse diameter of the chest due to widened subcostal angel[3]. Lower costal girth is increased by 10cm to 15cm as is the subcostal angle. Level of diaphragm is raised up to 4 cm this causes the decrease in FRC [3, 9]. The displacement of the diaphragm is most significant where the foetus is large or abdominal component of maternal torso is short [6]. Respiratory excursion is limited at the lung base and greater movement is observed in the midcostal and apical region therefore women exhibit breathlessness on modest exertion. Cross sectional area of the upper airway is also reduced; the upward pressure of the foetus affect the ribs causing them to flare [6].

No changes are seen in respiratory muscle strength during

pregnancy despite the cephalad displacement of the diaphragm and changes in the chest wall configuration. Increased diaphragmatic excursion and preserved respiratory muscle strength are important adaptations, therefore there is increase in tidal volume and minute ventilation that accompanies pregnancy. Improved diaphragm mechanics in pregnancy are explained by an increased area of apposition of the diaphragm to the rib cage [10].

Pulmonary function is affected by changes of the airway, thoracic cage and respiratory drive [8]. It is affected by total respiratory compliance which is decreased at term as a result of a reduction in chest wall compliance [12]. Tidal volume (Vt) increases by up to 40%, Expiratory reserve(ER) decreases, Alveolar ventilation increases, Total lung capacity (TLC) and vital capacity (VC) remains unchanged and closing capacity is also decreased [9, 13].

The majority of these changes are initiated and maintained by gestational hormones, almost fully established by the end of the first trimester and necessary to accommodate the increased demands of the growing foetus and, to a lesser extent, maternal organs and tissues. In pregnancy hormonal changes and increase in the abdominal volume have impact on respiratory system [11]. The timing and magnitude of the Minute Ventilation (MV) is also increased due to excess of the oxygen requirement for foetal development which may be due to the stimulatory effect of progesterone on the respiratory center [12]. This expansion in Minute Ventilation leads to a slight decrease in alveolar PCO2 and lower PaCO2 from 38 torr to approximately 30 torr at term [8]. This adjustment is required to satisfy the increase in oxygen consumption of 30-35% by the growing foetus. Respiratory rate goes up from about 15-18 breaths/min and there is lowering by 25% of maternal blood carbon dioxide tension which cause breathlessness on activity [9].

The tracheobronchial smooth muscle tone is altered by the hormone so that pulmonary function is protected throughout the pregnancy [14]. Hormonal changes like increase in progesterone cause hyperventilation, by increasing the sensitivity of the respiratory center to the changes in PCO2 and thus increases the demand for oxygen [13]. It also influences the total minute ventilation and its subcomponents. Tidal volume and Maximum voluntary ventilation increases because of increase in level of progesterone [3]. Ventilation is significantly greater in luteal phase of ovulatory cycle, than in oestrogen dominated follicular phase [13]. Relaxin softens the costochondral junction and renders them more mobile [6]. Progesterone, Corticosteroid and Relaxin cause certain degree of bronchodilation due to relaxation of smooth muscle [13]. Respiaratory alkalosis caused by hyperventilation is compensated by metabolic acidosis to maintain pH at 7.44. The increased minute ventilation of pregnancy has been attributed primarily to the combined stimulatory effects of progesterone and oestrogen (both of which increase throughout gestation) on ventilatory drive [11].

PFT determines the functional status of lung, stiffness of lung and chest wall and the diffusion characteristic of the alveolar-capillary membrane; it is also used to determine patient's ability to tolerate the surgical procedure. Spirometry is the most essential part of any pulmonary function study and provides the most information. In spirometry, a machine called a spirometer is used to measure certain lung volumes, called dynamic lung volumes. The two most important dynamic lung volumes measured are the forced vital capacity (FVC) and the forced expiratory volume in the 1st second (FEV_1). Besides understanding the physiology of lung function during pregnancy the study also provides a control, on the background of which any respiratory problem which may appear during pregnancy can be evaluated with greater precision. Parameters which are assessed in PFT are Forced Expiratory Volume in One Second (FEV1), Forced Vital Capacity (FVC), FEV1/ FVC ratio and Maximum Voluntary Ventilation (MVV), Tidal Volume (TV), Inspiratory Reserve Volume (IRV), Expiratory Reserve Volume (ERV), Residual Volume (RV), Vital Capacity(VC), Inspiratory Capacity(IC), Functional Residual Capacity (FRC), Total Lung Capacity (TLC) [15].

Forced Expiratory Volume (FEV1) measures the maximal volume of air exhaled during 1st second of expiration. It is highly significant and best indication of obstructive disease. Its normal value 4.20l. Interpretation of % predicted FEV1 are > 75% normal, 60-75% mild obstruction, 50-59% moderate obstruction and < 49% severe obstruction [15].

Forced Vital Capacity (FVC) is total volume of air that can be exhaled forcefully from Total Lung Capacity. It measured in litres. Its normal value is 4.80l. Interpretation of % predicted FVC are, >79% normal, 65-79% mild restriction, 50-65% moderate restriction and <50% severe restriction [15].

FEV_1 /FVC Ratio. This ratio is used to differentiate obstructive from restrictive

lung disorders; In obstructive disorders, FEV_1 drops much more significantly than FVC and the ratio will be low, while in restrictive disorders, the ratio is either normal or even increased as the drop in FVC is either proportional to or more marked than the drop in FEV_1 [15].

Maximum Voluntary Ventilation (MVV) it measures the endurance of the respiratory muscles. Normal MVV for healthy adult is 170l/min. Tidal Volume (TV) is the volume of air inspired and expired during normal quite breathing. Its normal value is 350-500 ml [15].

A precise knowledge of the pulmonary function tests and the gradual maternal compromises in these parameters helps to understand and manage the course and the gestational outcome for a safe delivery [12]. PFT permits an accurate and reproducible assessment of functional state of respiratory system during different trimesters [1]. Many evidence have been present regarding the effect of pregnancy on the lung volumes and capacities, therefore the present study has been undertaken to evaluate the effect of trimesters on different lung parameters.

Materials and Methods

A Randomized control trial of 30 participant (pregnant women) using convenient sampling with systemic allocation was done. Pregnant women of 1st, 2nd and 3rd trimesters between 20-30 years were included according to inclusion and exclusion criteria. The participants were divided in three groups, Group A were participants of 1st trimester, Group B were participants of 2nd trimester and Group C were participants of 3rd trimester. Their height, weight and BMI was recorded and PFT was preformed within 20-30 minutes. Parameters which were assessed were Forced Expiratory Volume in One Second (FEV_1), Forced Vital Capacity (FVC), FEV_1/ FVC and Maximum Voluntary Ventilation (MVV).

The inclusion criteria for this study were both pregnant

women of 1st, 2nd and 3rd trimester, age between 20 to 30 years, those willing to participate in this study. And the exclusion criteria were neuromuscular disease affecting the thorax, known cases of cardiac and respiratory disorder and complicated pregnancy.

Data Analysis and Results

Statistical analysis was carried out utilizing the demo version of INSTAT software and $p<0.05$ is considered as level of significance. Unpaired't' test was applied to analyse the data.

Table 1: Grades of Restriction in 1st, 2nd And 3rd Trimister

Trimester	Grades of Restriction			
	Normal	Mild	Moderate	Severe
1st Trimester	9	1	0	0
2nd Trimester	2	6	2	0
3rd Trimester	5	3	2	0

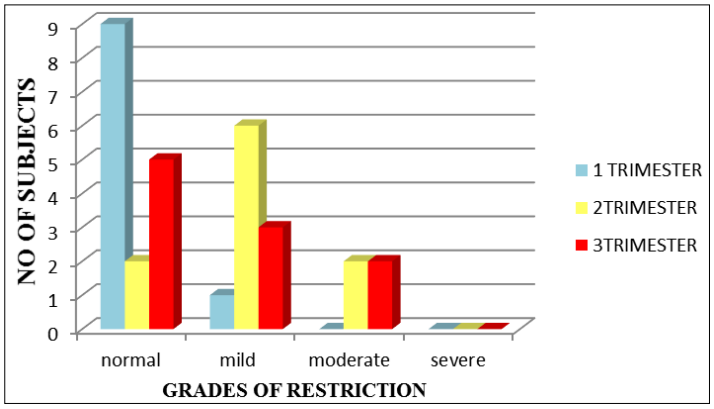

Fig 1: Demographic Representations of Grades of Restriction in Subjects of 1st, 2nd and 3rd Trimister

Table 2: Showing Mean Values of Fev_1, Fvc, Fev_1/ Fvc Ratio and Mvv in % Pred During Pregnancy (X ± S.D)

Trimester	Fev_1	Fvc	Fev_1/ Fvc	Mvv
1st Trimester	94.7 ± 6.557	85.1 ± 6.557	111.1 ± 1.828	18.4± 6.077
2nd Trimester	84.5 ± 12.686	73.1 ± 13.136	115.1 ± 2.418	32.5 ± 18.106
3rd Trimester	87.5 ± 11.778	77.4± 14.073	112.8 ± 3.140	36.7± 14.158

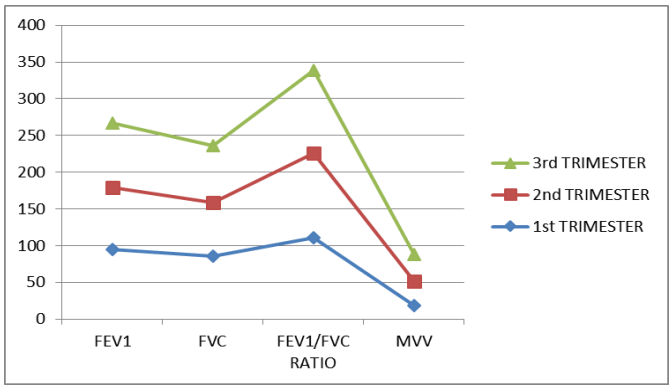

Fig 2: Demographic representation of mean of FEV_1, FVC, FEV_1/FVC ratio and MVV of subjects of 1st, 2nd and 3rd trimesters.

- **Forced Expiratory Volume In One Second (FEV_1):** In group A, mean difference was 94.7 ± 7.379 in % predicted, in group B, mean difference was 84.5 ± 12.686 in % predicted and in group C the mean difference was 87.5 ± 11.778 in % predicted.
- **Forced vital capacity (FVC):** In group A, mean difference was 85.1 ± 6.557 in % predicted, in group B, mean difference was 73.1 ± 13.136 in % predicted and in group C the mean difference was 77.4 ± 14.073 in % predicted.
- **FEV1/FVC Ratio:** In group A, mean difference was 111.1 ± 1.828 in % predicted, in group B, mean difference was 115.1 ± 2.418 in % predicted and in group C the mean difference was 112 ± 3.140 in % predicted.
- **MVV:** In group A, mean difference was 18.4 ± 60.77 in % predicted, in group B, mean difference was 32.5 ± 18.106 in % predicted and in group C the mean difference was 36.7 ± 14.158 in % predicted.

Discussion

The result obtained in this study indicated that, there was no significant difference in FEV_1, FVC and FEV_1/ FVC but significant difference was seen in MVV when compared between the groups. Differences seen within groups were statistically insignificant.

- **Forced Expiratory Volume in One Second (FEV_1)**: There was no significant difference between the three groups.
- **Forced Vital Capacity (FVC):** There was no significant difference between the three groups. Significant reduction in FVC may be obtained due to restrictive effect of enlarging uterus. In pregnancy abdominal compliance is progressively decreased despite of this maintenance of FVC is attributed to augmentation of ribcage displacement, relative mobility of the thoracic cage and unimpaired diaphragmatic movement ($p<0.005$).
- **Fev_1/ fvc ratio**: There was no change was significant difference between the three groups. The mechanical disadvantage to the respiratory system due to advancing pregnancy is compensated by decrease in airway resistance

and improved airway conductance due to smooth muscle relaxation produced by progesterone, corticosteroids and relaxin[8]($p>0.005$).

- **Maximum Voluntary Ventilation (MVV):** There was significant difference between the three groups.

Similar results were obtained when study was carried out by B. M. PURANIK and he observed that VC, FVC and FEV remained unchanged throughout pregnancy. Slight variations observed were statistically insignificant. The opposing changes in IC and ERV were statistically very highly significant and were responsible for maintaining the VC. The increment in VE as well as VT was statistically very highly significant and the small increase in frequency was statistically significant. According to the above literature and the results obtained from the present study we can conclude that different trimesters of pregnancy has no significant effect on lung function parameters.

Similar results were obtained when study was conducted by MRUNAL and he observed that the antenatal changes in percent FVC and FEV1were insignificant, but the decline in ERV and PEFR were very highly significant and the increment in IC was significant. It was concluded that there are adaptive changes in lung functions in the antenatal period. We stress the importance of regular graded active exercises in the postpartum period for the speedy recovery of these changes. According to the above literature the and the results obtained from the present study we can conclude that different trimesters of pregnancy has no significant effect on lung function parameters.

Similar results were obtained by SUSHMA JADHAV where FEV1, FVC and MVV readings when compared of first and second trimester, second and third trimester and first and second trimester no significant decrease was seen in first trimester as compared to second and third trimester. According to the above literature the and the results obtained from the present study we can conclude that different trimesters of pregnancy has no significant effect on lung function parameters.

Conclusion

The present study shows that the different trimesters of pregnancy have no effect on the pulmonary function test parameters FEV_1, FVC, FEV_1/FVC ratio but changes are seen in MVV.

References

1. Dr. Lata Gupta. Evaluation of Pulmonary Function Tests in Normal Pregnant (II & III Trimester) & Non Pregnant Women.
2. Ganesh Pradhan BC, Vastrad Nishita Mendonca *et al*. Evaluation and Comparison of Lung Function Parameter during Pregnancy. IJCRR. 2014; 6(07):38.
3. Puranik BM. Longitudinal Study of Pulmonary Function Tests during Pregnancy. Indian J Physiol Phannacol. 1994; 38(2):129-132.
4. Neeraj John Pramod, Joydeep Singh. Effect of Advanced Gestation on Cellular Activity in Respiratory System in Female. A Study of Alveolar Ventilation in Pregnant Women of North India. International Journal of Pharma and Bio Sciences. 2012; 03(1):31-37
5. Chaurasia BD. Human Anatomy, 2.
6. Polden M, Mantle J. Physiotherapy in Obstetrics and Gynaecology.
7. Mrunal Phatak S. A Longitudinal Study of Antenatal Changes In Lungfunction Tests And Importance Of Postpartumexercises In Their Recovery Indian J Physiol Pharmacol. 2003; 47(3):352-356. Evaluation Of Pulmonary Function Tests
8. Izci B. Sleep-Disordered Breathing and Upper Airway Size in Pregnancy and Post-Partum. Eur Respir J. 2006; 27:321-327.
9. Matthew Hegewald J, MDa b, Robert Crapo O. MDc. Respiratory Physiology in Pregnancy.
10. Dr. Shailaja Y, Dr. Shrikanth S. Lung Function Test in Different Trimester of Pregnancy. Indian Journal of Basic and Applied Medical Research. 2013; 3(1):285-292.
11. Dennis Jensen, Katherine Webb A, Denis Donnell EO. Chemical and mechanical adaptations of the respiratory system at rest and during exercise inhuman pregnancy
12. Dr. Jetty Jerusha, Dr. Harika Priyadarshini K, Dr. Malleswaramma *et al*. A Comparative Study of Lung Function Test in Pregnant and Non Pregnant Individual. Journal of Medical Sciences and Clinical Research. 2016; 4(02):9387-9391.
13. Milne JA. The Respiratory Response to Pregnancy. Post Graduate Medical Journal. 1979, 318-324A
14. Dr. Vandana Dudhamal B, Dr. Smita Pathare. Study of Pulmonary Function Test in Different Trimester of Pregnancy. ISSN-2321-127x. 2015; 3(10):1239.
15. West JB. Respiratory Medicine, the Essentials, Seventh Edition. Lippincott Williams & Wilkins, Philadelphia, PA, 2004.