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CHANGES IN THE PULMONARY FUNCTION PARAMETERS DURING PREGNANCY

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Abstract

Background: Lung function tests are crucial for assessing respiratory functions, as changes during pregnancy can affect maternal mortality, morbidity, and the outcome of pregnancy. Pulmonary disorders are a leading cause of indirect obstetric deaths. The study assessed pulmonary function changes in pregnant women, validated expected physiological changes, and compared pregnant and non-pregnant states to define normalcy. **Materials and Methods:** This cross-sectional observation study was conducted in the Department of Obstetrics and Gynaecology and the Department of Respiratory Medicine at SRM Medical College Hospital and Research Center from May 2016 to Dec 2017. Patient's age, gestation period, height, weight, heart rate, respiratory rate, blood pressure, SpO2, Hb, and PFT (FVC, FEV1, FEV1/FVC, FEF2575, MVV, PEFR) were recorded. Spirometry was performed according to standard methods approved by ATS/ERS Guidelines. **Result:** The difference in BMI and weight between the two groups was statistically significant ($p<0.001$). There was no significant difference in height and haemoglobin between groups. There was a significant difference in forced expiratory volume in the first second and forced vital capacity between the groups ($p<0.001$). There was no significant difference in FEV1R and Forced expiratory time between groups. The difference in PEFR, FEF25-75 and MEF between the two groups was statistically significant ($p<0.001$). There was no significant difference in pulse rate, respiratory rate, systolic BP and diastolic BP between groups. **Conclusion:** The present study concluded that pregnancy causes changes in PFTs; the mechanical and hormonal changes in pregnancy lead to a decrease in all parameters of PFTs except FEV1/FVC.

INTRODUCTION

Pregnancy is a "physiological state of adaptation" which causes hormonal, mechanical and cardiorespiratory changes.[1] These adjustments are required to meet the metabolic needs of the mother and embryo. Their exact learning enables the physician to confirm the degree of adjustment in pregnant women. It stays away from the excessive treatment of physiological changes confounded as pathological changes about pre-pregnancy status.[2] Lung function tests are a powerful tool in assessing respiratory functions. The changes in the respiratory system during pregnancy can affect maternal mortality, morbidity and the outcome of pregnancy.[3] Pulmonary disorders are a leading cause of indirect obstetric deaths.[4] The gradually growing fetus poses increasing metabolic demands on the mother, requiring delicate physiological adjustments in circulation and respiration, and hence, it is important to detect them earlier.

Dyspnoea or shortness of breath is usually seen in normal pregnant women in their day-to-day activities, even in the early trimester.[5] Such an early onset time rules out pregnancy-induced mechanical changes from playing a role in the genesis of dyspnea.[6] A possible reason might be more attention to the new impression of the physiological hyperventilation related to pregnancy and a higher central perception of breathing discomfort with an increasing combination of these two.[7]

Pregnancy-induced hyperventilation was recently demonstrated to be due to the consequence of complex interactions between changes in chemo-reflex drives, acid-base balance, metabolic rate, and cerebral blood flow.[8] It isn't easy to distinguish whether the breathlessness is due to physiological and pathophysiological conditions.[7] Since there is a need to assimilate and measure, the total volume of gas in the lungs is classified into volumes and combinations of two or more volumes are capacities. Lung volumes and capacities are depicted schematically in the tracing, obtained using a spirometer.[9]

The study aimed to assess the pulmonary function changes in normal pregnant women, to validate the physiological expected and accepted changes in pulmonary function brought by pregnancy, and to compare the pregnant and non-pregnant states to define a standard for normalcy in pregnant women.

MATERIALS AND METHODS

This cross-sectional observation study was conducted in the Department of Obstetrics and Gynaecology and the Department of Respiratory Medicine at SRM Medical College Hospital and Research Center from May 2016 to Dec 2017. Ethical approval and informed consent were obtained before the start of the study.

Inclusion Criteria

Patients willing to give informed consent, aged 18-35, and pregnant women in the first, second and third trimesters were included.

Exclusion Criteria

Non-pregnant women, patients with known respiratory diseases, patients with known cardiac diseases, women with obstetric complications, and patients not giving informed consent were excluded.

Patient's age, gestation period, height, weight, heart rate, respiratory rate, blood pressure, SpO2, Hb, and PFT (FVC, FEV1, FEV1/FVC, FEF2575, MVV, PEFR) were recorded. Proforma with detailed History and clinical examination was used. Spirometry was performed according to standard methods approved by ATS/ERS Guidelines. FVC, FEV1, FEV1/FVC, FEF2575, MVV, and PEFR were the parameters assessed.

The selected subjects were explained about the purpose of the study. The relaxed subject was prepared to grip the sterile mouthpiece sitting, and a nose clip was attached to block the nose. When the subject was confident and familiar with the procedure, they were asked first to perform maximal inspiration after a deep expiration. The subject was then instructed to expire with maximal effort (maximal expiration). The mouthpiece was then removed, and the actual, predicted and percentage of predicted values were printed for analysis.[10]

Statistical Analysis

Descriptive analysis was carried out by mean and standard deviation for quantitative variables frequency and proportion for categorical variables. The association between categorical explanatory variables and quantitative outcomes was assessed by comparing the mean values. The mean differences, along with their 95% CI, were presented. ANOVA test and independent sample t-test were used to assess statistical significance. A p-value < 0.05 was considered statistically significant. IBM SPSS version 22 was used for statistical analysis.

RESULTS

Among the study population, 50 (25%) were controlled, the first trimester was 50 (25%), the second trimester was 50 (25%), and 50 (25%) belonged to the third trimester. The mean age was 25.67 ± 3.7, with a minimum of 19 years and a maximum of 37 years. The mean BMI was 25.58 ± 3.74, with a mean height of 153.47 ± 5.09 cm, a mean weight of 60.12 ± 8.56 kg, and a mean haemoglobin of 10.43 ± 1.52.

The study population had a mean forced expiratory volume of 66.08 ± 14.55, a mean forced vital capacity of 71.01 ± 14.1, a mean FEV1R of 93.36 ± 8.62, a mean forced expiratory time of 5.33 ± 1.4, a mean PEFR of 62.55 ± 17.56, a mean FEF25-75 of 59.85 ± 23.95, and a mean MEF of 66.66 ± 20.75.

The study population had a mean pulse rate of 66.08 ± 14.55, ranging from 41 to 91. A mean respiratory rate of 17.03 ± 2.67, ranging from 16.66 to 17.4. The mean systolic BP was 119.48 ± 4.93, ranging from 118.79 to 120.16. The mean diastolic BP is 80.71 ± 5.5, ranging from 79.94 to 81.48 [Table 1].

The difference in BMI and weight between the two groups was statistically significant ($p<0.001$). There was no significant difference in height and haemoglobin between groups.

There was a significant difference in forced expiratory volume in the first second and forced vital capacity between the groups ($p<0.001$). There was no significant difference in FEV1R and Forced expiratory time between groups.

The difference in PEFR, FEF25-75 and MEF between the two groups was statistically significant ($p<0.001$). There was no significant difference in pulse rate, respiratory rate, systolic BP and diastolic BP between groups [Table 2].

The mean age and height difference across the groups was also statistically insignificant. The Mean weight in the control group was 53.548; it was 59.68 in the first trimester, 60.06 in the second and 60.62 in the third. The mean weight difference across the groups was also statistically significant ($p<0.001$).

The Mean BMI in the control group was 22.61; it was 25.11 in the first trimester, 25.75 in the second and 25.88 in the third. The mean difference in BMI across the groups was also statistically significant ($p<0.001$). The mean haemoglobin difference across the groups was also statistically insignificant ($p=0.772$) [Table 3].

The forced expiratory volume in the control group was 81.16, 67.74 in the first trimester, 57.9 in the second trimester and 57.48 in the third trimester. The mean difference of expiratory volume in the first across the groups was also statistically significant ($p<0.001$).

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The Mean forced vital capacity in the control group was 87.16; it was 73.06 in the first trimester, 62.12 in the second and 61.68 in the third. The mean difference in forced vital capacity across the groups was also statistically significant ($p<0.001$). The mean difference of FEV1R and forced expiratory time across the groups was also statistically insignificant.

The Mean PEFR in the control group was 70.92; it was 64.62 in the first trimester, 58.52 in the second and 56.02 in the third trimester. The mean difference in forced expiratory time across the groups was statistically insignificant ($p=0.060$).

The Mean FEF25-75 in the control group was 73.68; it was 56.9 in the first trimester, 54.34 in the second and 54.26 in the third. The mean difference of FEF25-75 across the groups was also statistically significant ($p<0.001$).

The Mean MEF in the control group was 74; it was 66.3 in the first trimester, 63.8 in the second and 62.3 in the third. The mean difference of MEF across the groups was statistically insignificant ($p=0.06$) [Table 4].

The mean difference in pulse and respiratory rates across the groups was also statistically insignificant. The Mean systolic BP in the control group was 120.44; it was 120.78 in the first trimester, 118.92 in the second and 117.76 in the third. The mean difference in systolic BP across the groups was statistically significant ($p=0.006$). The mean difference in diastolic BP across the groups was statistically insignificant ($p=0.125$) [Table 5].

Table 1: Descriptive analysis of all parameters of the study

Parameter	Mean ±STD	95% C.I. for EXP(B)	
		Lower	Upper
Age	25.67 ± 3.7	25.07	26.26
BMI	25.58 ± 3.74	24.98	26.18
Height	153.47 ± 5.09	152.65	154.3
Weight	60.12 ± 8.56	58.74	61.5
Haemoglobin	10.43 ± 1.52	10.18	10.67
Forced expiratory volume in the first second	66.08 ± 14.55	64.05	68.11
Forced vital capacity	71.01 ± 14.1	69.04	72.98
FEV1R	93.36 ± 8.62	92.16	94.57
Forced expiratory time	5.33 ± 1.4	5.13	5.52
PEFR	62.55 ± 17.56	60.09	65
FEF25-75	59.85 ± 23.95	56.5	63.2
MEF	66.66 ± 20.75	63.76	69.56
Pulse Rate	75.43 ± 10.59	73.95	76.9
Respiratory Rate	17.03 ± 2.67	16.66	17.4
Systolic BP	119.48 ± 4.93	118.79	120.16
Diastolic BP	80.71 ± 5.5	79.94	81.48

Table 2: Comparison of all parameters between two groups

Parameter	Mean ±SD		P-value
	Control (N=50)	Pregnant women (N=150)	
BMI	22.61 ± 3.25	25.58 ± 3.74	<0.001
Height	154.38 ± 6.61	153.47 ± 5.09	0.315
Weight	53.54 ± 5.58	60.12 ± 8.56	<0.001
Haemoglobin	10.4 ± 1.75	10.43 ± 1.52	0.92
Forced Expiratory Volume in the first second	81.16 ± 6.23	61.04 ± 12.92	<0.001
Forced vital capacity	87.16 ± 10.05	65.62 ± 10.7	<0.001
FEV1R	93.24 ± 8.18	93.4 ± 8.76	0.91
Forced expiratory time	5.18 ± 1.41	5.38 ± 1.4	0.394
PEFR	70.92 ± 11.68	59.72 ± 18.27	<0.001
FEF25-75	73.68 ± 13.52	55.17 ± 24.83	<0.001
MEF	74 ± 8.28	64.13 ± 22.93	<0.001
Pulse rate	75.16 ± 10.32	75.51 ± 10.71	0.839
Respiratory rate	16.76 ± 2.5	17.12 ± 2.73	0.411
Systolic BP	120.44 ± 5.35	119.15 ± 4.76	0.11
Diastolic BP	82.32 ± 5.53	80.17 ± 5.4	0.016

Table 3: Comparison of mean age, height, weight, BMI, and haemoglobin across study groups

(I) Trimester		Mean ± Std. Dev	Mean difference	95% Confidence Interval for Mean		P value
				Lower Bound	Upper Bound	
Mean age	First trimester	26.42 ± 4.03				
	Second trimester	25.42 ± 3.65	1	-0.46	2.46	0.177
	Third trimester	25.16 ± 3.34	1.26	-0.2	2.72	0.089
Mean height	Control	154.38 ± 6.61				
	First trimester	154.32 ± 6.58	0.06	2.11	2.23	0.957
	Second trimester	152.9 ± 4.07	1.48	0.69	3.65	0.181
	Third trimester	153.2 ± 4.23	1.18	0.99	3.35	0.286
Mean weight	Control	53.54 ± 5.58				
	First trimester	59.68 ± 11.17	6.14	3	9.28	<0.001

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	Second trimester	60.06 ± 8.43	6.52	3.38	9.66	<0.001
	Third trimester	60.62 ± 5.13	7.08	3.94	10.22	<0.001
Mean BMI	Control	22.61 ± 3.25				
	First trimester	25.11 ± 4.59	2.5	1.08	3.94	<0.001
	Second trimester	25.75 ± 3.83	3.148	1.72	4.58	<0.001
	Third trimester	25.88 ± 2.52	3.27	1.84	4.7	<0.001
Mean haemoglobin	Control	10.4 ± 1.75				
	First trimester	10.61 ± 1.27	0.21	0.41	0.83	0.508
	Second trimester	10.36 ± 1.76	0.04	0.58	0.66	0.9
	Third trimester	10.31 ± 1.5	0.09	0.53	0.72	0.772

Table 4: Comparison of mean Forced Expiratory Volume in the first second, forced vital capacity, FEV1R, forced expiratory time, PEFR, FEF25-75, and MEF across study groups

(I) Trimester		Mean ± Std. Dev	Mean difference	95% Confidence Interval for Mean		P value
				Lower Bound	Upper Bound	
Mean forced expiratory volume	Control	81.16 ± 6.23				
	First trimester	67.74 ± 15.13	13.42	9.11	17.73	<0.001
	Second trimester	57.9 ± 10.13	23.26	18.95	27.57	<0.001
	Third trimester	57.48 ± 10.35	23.68	19.37	27.99	<0.001
Mean Forced vital capacity	Control	87.16 ± 10.05				
	First trimester	73.06 ± 14.44	14.1	10.34	17.86	<0.001
	Second trimester	62.12 ± 5.22	25.04	21.28	28.8	<0.001
	Third trimester	61.68 ± 5.24	25.48	21.72	29.24	<0.001
Mean FEVIR	Control	93.24 ± 8.18				
	First trimester	93.06 ± 9.83	0.18	3.24	3.6	0.917
	Second trimester	93.54 ± 7.97	0.3	3.12	3.72	0.863
	Third trimester	93.6 ± 8.55	0.36	3.06	3.78	0.836
Mean forced expiratory time	Control	5.18 ± 1.41				
	First trimester	5.53 ± 1.21	0.35	0.21	0.91	0.217
	Second trimester	5.32 ± 1.49	0.14	0.42	0.7	0.62
	Third trimester	5.28 ± 1.5	0.1	0.46	0.66	0.723
Mean PEFR	Control	70.92 ± 11.68				
	First trimester	64.62 ± 18.82	6.3	0.27	12.87	0.06
	Second trimester	58.52 ± 18.69	12.4	5.83	18.97	<0.001
	Third trimester	56.02 ± 16.47	14.9	8.33	21.47	<0.001
Mean FEF25-75	Control	73.68 ± 13.52				
	First trimester	56.9 ± 26.01	16.78	7.84	25.72	<0.001
	Second trimester	54.34 ± 23.65	19.34	10.4	28.28	<0.001
	Third trimester	54.26 ± 25.2	19.42	10.48	28.36	<0.001
Mean MEF	Control	74 ± 8.28				
	First trimester	66.3 ± 21.64	7.7	0.33	15.73	0.06
	Second trimester	63.8 ± 23.67	10.2	2.17	18.23	0.013
	Third trimester	62.3 ± 23.71	11.7	3.67	19.73	0.005

Table 5: Comparison of mean pulse rate, respiratory rate, systolic BP, and diastolic BP across study groups

(I) Trimester		Mean ± Std. Dev	Mean difference	95% Confidence Interval for Mean		P value
				Lower Bound	Upper Bound	
Mean pulse rate	Control	75.16 ± 10.32				
	First trimester	77.16 ± 10.62	2	2.18	6.18	0.347
	Second trimester	75.56 ± 10.19	0.4	3.78	4.58	0.851
	Third trimester	73.82 ± 11.25	1.34	2.84	5.52	0.528
Mean respiratory rate	Control	16.76 ± 2.5				
	First trimester	17.62 ± 2.32	0.86	0.19	1.91	0.108
	Second trimester	17.18 ± 3.15	0.42	0.63	1.47	0.431
	Third trimester	16.56 ± 2.61	0.2	0.85	1.25	0.708
Mean systolic BP	Control	120.44 ± 5.35				
	First trimester	120.78 ± 3.74	0.34	2.24	1.56	0.724
	Second trimester	118.92 ± 4.7	1.52	0.38	3.42	0.116
	Third trimester	117.76 ± 5.29	2.68	0.78	4.58	0.006
Mean diastolic BP	Control	82.32 ± 5.53				
	First trimester	79.88 ± 4.72	2.44	0.29	4.59	0.026
	Second trimester	80 ± 5.87	2.32	0.17	4.47	0.035
	Third trimester	80.64 ± 5.62	1.68	0.47	3.83	0.125

Table 6. Comparison of our study with other study's demographic data

	Age	Height	Weight	BMI	Hb
Our study	25.66	1.53	59.98	25.58	10.43
Hemalatha Patil et al,[11]	23.2±3.3	1.5±1	62±4.4	25.09±1.7	10.9±0.8
Neeraj et al,[12]	25.27±3.06	1.54±5.15	64.5±10.35	27.04±4.11	11.01±0.81

Table 7: Comparison of our study with other study's parameters

	FEV1	FVC	FEV1R	PEFR	FEF25-75
Our study	61.04±12.92	65.62±10.7	93.4±8.76	59.72±18.27	55.17±24.83
Hemalatha Patil et al,[11]	89.69±6.9	88.35±8.7	82.9±5.6	-	-
Neeraj et al,[12]	91.84±7.78	90.48±9.55	83.46±6.62	90.77±9.38	87.89±9.95
Khan et al,[15]	96.99	91.36	107.896	-	-

DISCUSSION

Our study has targeted and completed a comparison of PFT values between control and age-matched pregnant women and the variation in PFT values within the first, second and third trimesters. In our study, participants exhibited an average age of 25.66 years, a height of 1.53 meters, a weight of 59.98 kg, a BMI of 25.58, and an average haemoglobin level of 10.43 g/dL. Contrasting this with Hemalatha Patil et al.'s findings, their study featured slightly younger participants with similar BMI and haemoglobin levels but a marginally higher weight.[11] On the other hand, Neeraj et al.'s research reported slightly higher values for height, weight, BMI, and haemoglobin levels among their participants [Table 6].[12]

There was little difference in haemoglobin, pulse rate, respiratory rate and height, but BMI tends to increase progressively. This may be due to pregnancy-induced weight gain.

Although the mean haemoglobin level in our study group was greater than 10gm/dl, a slight decline in value can lead to a significant reduction in PEFR and MVV. Anaemia, inadequate nutrition and altered eating habits lead to muscular weakness.[12]

Our study found an average pulse rate of 75.51 ± 10.71 beats per minute, slightly higher than Neeraj et al.'s 80.76 ± 3.72 and Hemalatha Patil et al.'s 82.73 ± 5.3.[11,12] There is not much difference in pulse rate between our study and other studies. Our study's average systolic blood pressure was 119.15 ± 4.76 mmHg, and diastolic blood pressure was 80.17 ± 5.4 mmHg. Neeraj et al. reported similar SBP but lower DBP, while Hemalatha Patil et al. found slightly higher SBP and DBP values.[11,12] There is not much difference in Systolic Diastolic Blood Pressure between our study and other studies.

Our study's average respiratory rate was 17.12 ± 2.73 breaths per minute. This contrasts with the higher average respiratory rates Vanitha Panchal et al,[13] (23.0 ± 1.52) and Gupta L et al,[14] (21.28 ± 3.65) reported in their studies. Dyspnoea is common in almost 70% of healthy pregnant women during the early trimester of gestation.[12] Similar to other studies, our study had a reduction in FEV1 and FVC, but the ratio was higher in our study. Thus, our study demonstrates a restrictive pattern and increased restriction in further trimesters.

There is a reduction in FEF25-75 in corresponding trimesters, and IT was found to be lower in our study group than that of Khan et al,[15] and Neeraj et al,[12] There is a reduction in PEFR in corresponding trimesters. PEFR was lower in our study group than that of Khan et al,[15] and Neeraj et al. [Table 7].[12] The reduction in PEFR might be caused by upward displacement of the diaphragm, reduced strength of expiratory muscles and mechanical effect of the growing uterus. There was a rapid decline in pulmonary function parameters such as FEV1, FVC, FEF25-75, MEF, and PEF, whereas FEV1R tends to increase in each trimester progressively. There was a significant decline in FEV1 and FVC, whereas the ratio has increased considerably. This is because the relative decrease in FVC is more.

CONCLUSION

In our study, we have a progressive decline in pulmonary function parameters. FVC and FEV1 decrease due to the gravid state in advanced pregnancy. The present study concluded that pregnancy causes changes in PFTs; the mechanical and hormonal changes in pregnancy lead to a decrease in all parameters of PFTs except FEV1/FVC.

The clinician needs to be acquainted with the typical physiologic changes in pregnancy. Understanding these progressions is basic in recognising the regular dyspnea that happens in a normal pregnancy from pathophysiologic states related to the cardiopulmonary disease that can occur in pregnancy and predicting disease intensifying during pregnancy and the peripartum period in those women with cardiopulmonary ailments.

Interventional systems like antenatal exercises for strengthening respiratory muscles, proper nutrition, and iron and calcium supplements should be advanced. This study paves the way for drawing a normal scale inclusive of the physiological changes brought about by pregnancy.

Limitations

A scale PFT in normal pregnancy could be achieved by extending the study to a broad-spectrum multicentre level involving a greater sample size.

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