National Journal of Physiology, Pharmacy and Pharmacology

RESEARCH ARTICLE

A comparative study to evaluate effect of advanced uncomplicated pregnancy on forced vital capacity and peak expiratory flow rate on healthy North Indian women

Narendra Gupta, Shashi Kant Verma, Sushmita Dutta

Department of Physiology, Rohilkhand Medical College and Hospital, Bareilly, Uttar Pradesh, India

Correspondence to: Shashi Kant Verma, E-mail: skdonn@gmail.com

Received: July 06, 2018; **Accepted:** August 02, 2018

ABSTRACT

Background: Pregnancy is characterized by profound changes in the function of several integrated physiological control systems. During pregnancy due to various physical, hormonal, and physiological changes, there is the effect on pulmonary function. There are documented variations among western and Indian women toward changes in forced vital capacity (FVC) and peak expiratory flow rate (PEFR) in advanced pregnancy. **Aims and Objectives:** The objectives are as follows: (i) To evaluate the extent of changes of lung function in pregnancy in comparison to non-pregnant counterpart and (ii) to determine the effect of gestational age on the pulmonary function of pregnant women. **Materials and Methods:** A total of 150 study participants comprising 50 pregnant women of gestational age 29–34 weeks, 50 pregnant women of gestational age >34 weeks, and 50 height and age-matched controls (non-pregnant ladies) were included in the study. FVC, forced expiratory volume in one second and PEFR were taken using HELIOS 401 (Spirometer) in standing position. **Results:** A reduction in percentage predicted values of FVC is seen in the pregnant females as compared to their non-pregnant counterpart. There is also a gradual not significant decline in the values of FVC as a period of gestation increases. There was no significant difference observed between non-pregnant and pregnant subjects. PEFR was found to decrease as a period of gestation increased. PEFR was found to be significantly decreased during pregnancy in comparison to non-pregnant state. **Conclusion:** Decline in FVC and PEFR during pregnancy among Indian women was found in this study which is in contrary to literature of western countries. Clinicians should be take care of these changes while dealing with Indian pregnant women.

KEY WORDS: Pregnancy; Forced Vital Capacity; Peak Expiratory Flow Rate

INTRODUCTION

During pregnancy, there occur changes in several physiological systems in the body. These changes, i.e., respiratory, circulatory, and hematological changes can be seen both at rest and during exercise.[1-5] Gestational hormones secreted during pregnancy are responsible for initiation and maintenance of these changes in physiological systems. Changes in physiological processes are necessary for progression of pregnancy and in utero growth of fetus. These changes are almost fully established by the end of 1st trimester.[5]

Approximately 60–70% of pregnant females experience breathlessness even during activities of daily living by the 30th week of gestation even without a history of the cardiac or pulmonary disease.[6]

Due to these hormonal changes, there are structural changes in rib cage as well;[7] there is a relaxation of the ligaments

Access this article online

Website: www.njppp.com

DOI: 10.5455/njppp.2018.8.0722702082018

Quick Response code

attachments to ribs which causes an increase in the subcostal angle of the rib cage form 68 to 103° even in early pregnancy before the uterus enlarged enough. During the late stages of pregnancy, enlarges uterus elevates the diaphragm approximately 3–4 cm and thus the circumference of the lower rib cage increases approximately 4–5 cm.[7]

This displacement and structural changes effect forced vital capacity (FVC) of pregnant ladies. Other than this, hormonal influences affect the pulmonary flow parameters and alter them during pregnancy.

In western medical literature, vital capacity and peak expiratory flow rate (PEFR) did not show significant changes throughout the course of pregnancy in spite of structural changes.[7,8] Whereas some studies on Indian populations show that the vital capacity and the PEFR increase in the later stages of pregnancy.[9,10]

Increased nutritional demand, altered eating habits due to morning sickness and advancing gestation result in muscular weakness and decreased contraction force of voluntary and involuntary muscles. Decreased force of contraction by main respiratory muscles, i.e., the anterior abdominal wall muscles and internal intercostals muscles contributes to decline in PEFR during pregnancy apart from decline in alveolar PCO_2 which acts as bronchoconstrictor. However, enlarged uterus during 3rd trimester further reduces PEFR by limiting movements of the diaphragm. In addition, some degree of obstruction to the expiratory flow, especially late in pregnancy also contributes to the decrease.

Physiological changes in the pulmonary system during pregnancy can be assessed by various parameters of pulmonary function tests, and thus proper evaluation of any respiratory ailment can be done if normal physiological changes in pulmonary function tests are kept in mind. Moreover, precise knowledge regarding these tests helps the clinician to diagnose the extent of adaptation in pregnant women and thus helps them to prevent overtreatment of normal physiological changes.[11] In addition, to diagnose respiratory illness, pulmonary function test also helps the clinician for providing better antenatal care, in the assessment of fitness for anesthesia and to record the worsening of pre-existing lung disease.

Therefore, this study was conducted to assess less studied physiological changes, i.e., changes in FVC and PEFR among Indian antenatal women during advanced pregnancy and to determine the effect of gestational age on these pulmonary function parameters.

MATERIALS AND METHODS

The study was carried out at patients came to Outpatient Department of Obstetrics in Rohilkhand Medical College and Hospital, Bareilly (UP), India, by the Department of Physiology.

Ethical Approval

Prior approval was taken from Institutional Ethical Committee of Rohilkhand Medical College and Hospital, Bareilly.

Study Design

This was a **c**ross-sectional study.

Study Groups

The subject of the proposed study was selected randomly from a pregnant subject attending the antenatal clinic of Rohilkhand Medical College and Hospital Bareilly within the study period from January 2014 to December 2014. Every day maximum of 2 patients was taken provided their age and height matched control were available. Systemic random sampling was used to obtained daily patients. First patient was selected by lottery method, and 2nd patient was 30th patient from 1st chosen patient. Timing of registration was used for placing patients chronologically. Chronological gap was taken depending on previous year average of 60 new patient's registration every day.

The controls were taken from the relatives of pregnant women participating in the study and from among hospital staff from the same socioeconomic group according to modified Prasad's Social Classification criteria for socioeconomic status.[12]

Exclusion Criteria

1. Women with previous diagnosed disease or symptoms of respiratory or cardiovascular diseases, anemia.
2. Antenatal ladies with multiple pregnancy, hydramnios, and any other pregnancy-related disorders.
3. Women on therapy for any other ailments were excluded from the study.
4. Those subject who are doing regular exercise or yoga beyond normal population average were also excluded from the study.

Inclusion Criteria

1. Only female subject in the 3rd trimester of pregnancy free from any complication and systemic diseases were included in this study.

Sample size

Statistically, accurate **s**ample size was calculated using G-Power software came out as 146 based on extend of difference in FVC in previous studies. Hence, the study was conducted on 100 pregnant ladies in 3rd trimester as the case (50 subjects in Group A [29–34 weeks of gestation],

50 subjects in Group B [35–40 weeks of gestation] and 50 non-pregnant women as a control.

After taking informed written consent from each subject, a detailed history was recorded. A thorough clinical examination was done to rule out complications.

Pulmonary function test (spirometry) was done by HELIOS 401 in standing position after making both cases and controls comfortable and relaxed. Both the case and the control were evaluated at the same time to rule out any effect of environmental factors.

RESULTS

In the present study 150 subjects, 100 cases of third-trimester normal pregnancy and 50 non-pregnant as controls were included after applying inclusion and exclusion criteria.

Table 1 shows the distribution of participants according to age and height in relation to their groups. In Group A, majority participants were in a group of 20–20 years followed by 23–25 years. In Group B majority participants were in the age group 23–25 years and in Group C as well majority participant work was also in the age group of 23–25 years. All three groups were statistically similar according to the age wise distribution of participants.

Majority of participants in Group A and Group C had a height in the range of 141–150 cm, whereas majority participants of Group B had height in the range of 151–160 cm. This difference in distribution according to the height among participants of different groups was statistical insignificance.

Table 2 shows distribution of participants according to age and anthropometric indices. Mean age in Group A participant was 24.14, whereas the mean age of Group B and Group C participants was 24.86 and 24.02, respectively. All three groups were statistically similar according to the mean age and mean height. However, body mass index was significantly higher in Group B participants (women with gestation period >35 weeks) as compared to Group C (non-pregnant women) and women of Group A (women with gestation period 29–35 weeks).

Table 3 shows the mean FVC values for all three groups. These three groups were statistically difference according to mean FVC, and on Tukey *post hoc* analysis, this difference was found statistically significant between Group B (women with gestation period >35 weeks) and Group C participants (Non-pregnant women).

Table 4 shows the mean forced expiratory volume in one second (FEV1)/FVC ratio of participants of different groups. There was no statistical difference between the participants of these groups according to FEV1/FVC ratio.

Table 1: Distribution of participants of different groups according to age and height

Factors	Frequency (%)			*P* value
	Group A	Group B	Group C	
Age group wise distribution				
≥19.00	4 (8.0)	1 (2.0)	6 (12.0)	Chi-square=5.74
20.00–22.00	17 (34.0)	15 (30.0)	13 (26.0)	Monte carlo Simulated *P*=0.67
23.00–25.00	15 (30.0)	16 (32.0)	15 (30.0)	
26.00–28.00	5 (10.0)	9 (18.0)	9 (18.0)	
29.00–30.00	9 (18.0)	9 (18.0)	7 (14.0)	
Height range wise distribution				
≤140.00	0 (0)	1 (2.0)	0 (0)	Chi-square=4.48
141.00–150.00	27 (54.0)	21 (42.0)	29 (58.0)	Monte carlo Simulated *P*=0.70
151.00–160.00	22 (44.0)	27 (54.0)	20 (40.0)	
161.00–170.00	1 (2.0)	1 (2.0)	1 (2.0)	
Total	50 (100.0)	50 (100.0)	50 (100.0)	

SD: Standard deviation

Table 2: Comparison of participants of different groups according to age, height, and BMI

Parameters	Mean±SD			*P*-value (ANOVA test)
	Group A	Group B	Group C	
Age	24.14±3.6	24.86±3.41	24.02±3.29	0.419
Height	150.68±4.24	151.6±4.9	150.24±3.32	0.26
BMI	25.05±3.3	27.89±3.65	20.45±2.24	<0.001

SD: Standard deviation, BMI: Body mass index

Table 5 shows a comparison of mean PEFR of participants of different age group. The difference in PEFRs of participants in different age group was statistically significant. By *post hoc* analysis statistically significant difference was found between pregnant (Group A and Group B) and non-pregnant (Group C).

DISCUSSION

In our study, the percentage predicted value of FVC was found to be remain unchanged during whole pregnancy (Group A - 90.58 ± 13.42 and Group B - 89.34 ± 15.8) and in controls (Group C - 96.66 ± 14.97). A reduction in percentage predicted values of FVC is seen in the pregnant females (Group A and Group B) as compared to their non-pregnant counterpart (Group C). There is also a gradual decline in the values of FVC as a period of gestation increases which was not significant ($P = 0.9$). FVC values were significantly lower in late pregnancy as compared to non-pregnant state ($P = 0.03$). Our study endorsed previous studied facts about adaptations and decline in pulmonary function during pregnancy especially more profound during the past trimester. In our study, there was no significant difference observed between non-pregnant and pregnancy. Even during the pregnancy no significant changes in FEV1/FVC ration observed. In our study, PEFR was found to decrease as a period of gestation increased. PEFR values were found to be significantly decreased during pregnancy in comparison to non-pregnant state.

Studies done by Milne *et al*.[6] and Grindheim *et al*.[13] show a significant rise in FVC in the third trimester. A few studies

Table 3: Comparison of FVC of participants of different group

FVC			
Group A	**Group B**	**Group C**	***P*-value (ANOVA test)**
Mean±SD	**Mean±SD**	**Mean±SD**	
90.58±13.42	89.34±15.80	96.66±14.97	0.03
Tukey's *post hoc* test analysis of FVC between different exposure groups			
Exposure group	Comparison group		
Group A	Group B		0.9
Group A	Group C		0.1
Group B	Group C		0.03

SD: Standard deviation, FVC: Forced vital capacity

Table 4: Comparison of FEV1/FVC ratio of participants of different group

FEV1/FVC (%)			
Group A	**Group B**	**Group C**	***P*-value (ANOVA Test)**
Mean±SD	**Mean±SD**	**Mean±SD**	
105.3±18.10	107.08±17.48	112.16±16.80	0.13
Tukey's *post hoc* test analysis of FVC between different exposure groups			
Exposure group	Comparison group		
Group A	Group B		0.87
Group A	Group C		0.13
Group B	Group C		0.32

SD: Standard deviation, FVC: Forced vital capacity

Table 5: Comparison of PEFR of participants of different group

PEFR			
Group A	**Group B**	**Group C**	***P*-value (ANOVA test)**
Mean±SD	**Mean±SD**	**Mean±SD**	
58.08±9.87	51.96±12.56	66.28±18.81	<0.001
Tukey's *post hoc* test analysis of FVC between different exposure groups			
Exposure group	Comparison group		
Group A	Group B		0.08
Group A	Group C		0.01
Group B	Group C		<0.001

SD: Standard deviation, FVC: Forced vital capacity

such as those done by Mokkapatti *et al.*,[14] Puranik *et al*.,[15] and Monga and Kumari.[16] show a decrease in FVC in the third trimester. A study of FVC in pregnant women by Sunyal *et al.*[17] and workers showed reduced FVC in all trimesters as compared to control with maximum decreases in the third trimester. A study by Deepal *et al*.[18] showed no significant changes in FVC during all trimesters of pregnancy. A study by Grindheim *et al*.[13] shows an increase in FVC as pregnancy progresses and this increase persists postpartum. Our study correlates with that of Mokkapatti *et al*.,[14] Monga and Kumari,[16] Puranik *et al*.,[15] Phatak and Kurhade[19] and Harirah *et al*.,[20] and Neeraj *et al*.[21] A few studies like those by Deepal *et al*.[18] found that difference in the FEV_1/FVC ratio in the pregnant women in comparison to non-pregnant women was statistically insignificant. Dash S FEV_1/FVC showed no significant alteration in comparison to non-pregnant status. On the other hand, few studies showed a reduction in the FEV_1/FVC ratio such as Mokkapatti *et al.*,[14] Siddique, and Sunyal *et al*.[17] PEFR has been widely studied previously with varied results. As per studies on PEFR by Neeraj *et al.,*[21] there was a decrease in PEFR in the third trimester. A work on PEFR by Sunyal *et al*.[17] showed that there was a gradual decrease in PEFR during all trimesters of pregnancy, but the decline was significant in the 2nd and 3rd trimesters of pregnancy. Other studies showing decline are by Shailaja and Srikanth,[22] Phatak and Kurhade,[19] Mokkapatti *et al*.,[14] Monga and Kumari[16] Puranik *et al*.,[10] Sroczyński,[23] and Harirah *et al*.[20] A study by Brancazio *et al*.[24] and Deepal *et al*.,[18] however, showed that PEFR does not change with pregnancy.

Robust sampling system, i.e., statistically correct sample size and scattered sample throughout the year, individual matched control and application of quantitative statistical tests are important strengths of this study as these eliminate factors like environment and draining area of patients from Pulmonary functions. By eliminating these factors, this study tried to give a real insight into the effects of pregnancy on pulmonary functions. In spite of this external validity of the study can vary as this is a hospital-based study. For better validity a community-based study should be planned further based on findings of the present study.

CONCLUSION

In our study, we found that there was a decline in FVC and PEFR during pregnancy among Indian women. These may be due to lack of proper nutrition, less height, and other factors such as lack of adequate care and lack of exercise habits. Clinicians should be take care of these changes while dealing with Indian pregnant women.

REFERENCES

1. Weinberger SE, Weiss ST, Cohen WR, Weiss JW, Johnson TS. Pregnancy and the lung. Am Rev Respir Dis 1980;121:559-81.
2. Lotgering FK, Gilbert RD, Longo LD. Maternal and fetal responses to exercise during pregnancy. Physiol Rev 1985;65:1-36.
3. Wolfe LA, Walker RM, Bonen A, McGrath MJ. Effects of pregnancy and chronic exercise on respiratory responses to graded exercise. J Appl Physiol (1985) 1994;76:1928-36.
4. Wise RA, Polito AJ, Krishnan V. Respiratory physiologic changes in pregnancy. Immunol Allergy Clin North Am 2006;26:1-2.
5. Wolfe LA, Weissgerber TL. Clinical physiology of exercise in pregnancy: A literature review. J Obstet Gynaecol Can 2003;25:473-83.
6. Milne JA, Howie AD, Pack AI. Dyspnoea during normal pregnancy. Br J Obstet Gynaecol 1978;85:260-3.
7. Despande H, Madhkar C, Dahiya P. A study of pulmonary function tests in different stages of pregnancy. Int J Biol Med Res 2013;4:1713-6.
8. Gilroy RJ, Mangura BT, Lavietes MH. Rib cage and abdominal volume displacements during breathing in pregnancy. Am Rev Respir Dis 1988;137:668-72.
9. Chhabra S, Nangia V, Ingley KN. Changes in respiratory function tests during pregnancy. Indian J Physiol Pharmacol 1982;32:56-60.
10. Puranik BM, Kurhade GA, Kaore SB, Patwardhan SA, Kher JR. PEFR in pregnancy: A longitudinal study. Indian J Physiol Pharmacol 1995;39:135-9.
11. Shaikh RM, Deshpande DR, Ganeriwal SK, Reddy BV. Effect of pregnancy on vital capacity and FEV1. J Obs Gyn India 1983;33:495-9.
12. Prasad BG. Social classification of Indian families. J Indian Med Assoc 1961;37:250-1.
13. Grindheim G, Toska K, Estensen ME, Rosseland LA. Changes in pulmonary function during pregnancy: A longitudinal cohort study. BJOG 2012;119:94-101.
14. Mokkapatti R, Prasad EC, Venkatraman, Fatima K. Ventilatory functions in pregnancy. Indian J Physiol Pharmacol 1991;35:237-40.
15. Puranik BM, Kaore SB, Kurhade GA, Agrawal SD, Patwardhan SA, Kher JR, *et al.* A longitudinal study of pulmonary function tests during pregnancy. Indian J Physiol Pharmacol 1994;38:129-32.
16. Monga U, Kumari K. Pulmonary functions test in Punjabi pregnant women. Indian J Physiol Pharmacol 2000;44:115-6.
17. Sunyal DK, Amin MR, Ahmed A, Begum S, Begum M. Peak expiratory flow rate in pregnant women. J Bangladesh Soc Pysiol 2007;2:20-3.
18. Deepal S, Sekara W, Ruberu DK, Sivayogan S. Pulmonay function test in pregnant Srilankan women. Sabaragamuwa Univ J 2011;2:57-60.
19. Phatak MS, Kurhade GA. A longitudinal study of antenatal changes in lung function test and importance of post parted exercise in their recovery. Indian J Physiol Pharmacol 2003;47:352-6.
20. Harirah HM, Donia SE, Narsallh FK, Saade GR, Belfort MA. Effect of gestational age and position on peak expiratory flow rate: A longitudinal study. Obst Gynaecol 2005;105:372-6.
21. Neeraj, Sodhi C, Pramod J, Singh J, Kaur V. Effect of advanced uncomplicated pregnancy on pulmonary function parameters of North Indian subjects. Indian J Physiol Pharmacol 2010;54:69-72.

22. Shailaja Y, Srikanth S. Lung function tests in different trimesters of pregnancy. Indian J Basic Appl Med Res 2013;3:285-92.
23. Sroczyński T. Evaluation of respiratory tract function in healthy women in the last month of uncomplicated pregnancy. Ann Acad Med Stetin 2002;48:331-50.
24. Brancazio LR, Laifer SA, Schwartz T. Peak expiratory flow rate in normal pregnancy. Obstet Gynecol 1997;89:383-6.

How to cite this article: Gupta N, Verma SK, Dutta S. A comparative study to evaluate effect of advanced uncomplicated pregnancy on forced vital capacity and peak expiratory flow rate on healthy North Indian women. Natl J Physiol Pharm Pharmacol 2018;8(10):1451-1456.

Source of Support: Nil, **Conflict of Interest:** None declared.