

A STUDY OF PULMONARY FUNCTION TESTS DURING PREGNANCY†

by

S. C. SAXENA,* M.S.

V. S. C. RAO,** M.D.

and

S. MUDGAL,** M.S.

Pregnancy constitutes one of the most severe states of physiological adaptation. The increasing size of the foetus constitutes a mechanical impediment to normal process of ventilation. With a view to elucidate the various physiologic adaptations in pulmonary functions during pregnancy, the present study was undertaken.

Material and Methods

The present study was conducted in the Departments of Obstetrics & Gynaecology and Physiology of Medical College Jabalpur, M.P. from 1-12-1973 to 10-3-1975. The ventilatory function tests were carried out in 110 pregnant patients—30 in first trimester, 30 in second trimester, and 30 in third trimester of pregnancy, while 20 were studied in all the 3 trimesters of pregnancy. Fifty non-pregnant patients of similar age, parity and socio-economic group formed the control group, and were studied in follicular and luteal phases of menstrual cycle. Subjects with history of diseases likely to affect respiratory system and with projecting incisor teeth were excluded from study. The following pul-

monary function tests were carried out on PCI Spirometer D.S. II;—Tidal volume, minute volume, vital capacity, inspiratory and expiratory reserve volume (I.R.V. & E.R.V.).

Observations

(A) *Control group*: From Table I it is evident that Tidal volume, I.R.V. and E.R.V. and vital capacity showed a rise during luteal phase over the follicular phase values, but, there was no significant change in respiratory rate.

(B) *Study group*: From the Table it is evident that the respiratory rate was higher in the pregnant group than in the non-pregnant control group and went on increasing as the pregnancy advanced. The tidal volume, minute volume, and vital capacity are higher during pregnancy, but there was a fall in vital capacity during the third trimester of pregnancy. I.R.V. and E.R.V. continue to fall during pregnancy. I.R.V. was lower and E.R.V. was higher in pregnant than in non-pregnants. When the values at 36th and 40th weeks of pregnancy are compared, it is found that there is a fall in the respiratory rate, tidal volume and minute volume at 40th week as compared to 36th week of pregnancy. This is due to the descent of foetal head in the pelvis, and 'lightening effect', thus causing descent of diaphragm and permitting its free movements. There was no correlation

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* Reader in Obst. & Gynaecology,

** Reader in Physiology,

*** Asst. Surgeon, Family Planning, Medical College, Jabalpur, M.P.

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TABLE I
Pulmonary Function Tests in Non-pregnant and Pregnant Females

	Resp. rate per minute	Tidal Vol. (ml)	I.R.V. (ml)	E.R.V. (ml)	Minute Vol. (ml)	Vital capacity (ml)
Non-pregnant						
Follicular phase	14.1	263.7	1390.8	543.8	3648.9	2467.9
Luteal phase	14.08	283.6	1395.8	532.6	3892.6	2473.5
Pregnancy						
I trimester	13.7	397.5	1360.6	625.4	5420.9	2526.5
II trimester	14.8	444.3	1337.5	591.4	6043.1	2542.2
III trimester	15.4	516.0	1244.1	575.2	7586.1	2521.9
36th week	14.0	570.5	1139.3	675.8	7895.2	2529.7
40th week	13.0	502.4	1475.8	832.1	6384.0	2731.0

between weight gain in pregnancy and pulmonary function.

Comments

Fluctuations of ventilation and alveolar pCO₂ in various phases of menstrual cycle have been ascribed to the action of progesterone, though the exact mechanism is not fully known (Doering, 1949 and 1950; Heerhaber, *et al*, 1948; Loeschcke, 1950; Goodland *et al*, 1952). Such fluctuations in respiratory rate are not to be found in postmenopausal women but can be induced by administration of progesterone (Heerhaber, 1948, Goodland, *et al*, 1953). Hyperventilation in luteal phase is due to the action of progesterone on respiratory centre. The present study clearly demonstrates hyperventilation during pregnancy, reaching maximum near term.

Respiratory Rate: There is a constant rise in the respiratory rate with advancing pregnancy. Knuttgen and Kendell (1974) did not observe this change.

Tidal Volume: It also shows a constant rise with advancing pregnancy (Windlund, 1945; Cugell, *et al*, 1953 and Pandya and Nishith, 1972).

Minute Volume: There was hyperventilation during pregnancy reaching

maximum at term (Windlund, 1945; Rossier and Holz, 1953; Cugell, *et al*, 1953 and Knuttgen and Kendell, 1974).

Minute Volume in Pregnancy is augmented by tidal volume rather than respiratory rate. This hyperventilation has been attributed to increasing abdominal girth and upward displacement of diaphragm, changes in lung volume, hypervolaemia, increased cardiac output, and increased demand of foetus. Other possible explanations are response to lowered oxygen saturation and inadequate gas mixing in lungs, augmented dead space, unsatisfactory intrapulmonary distribution of gases, defective diffusion across alveolar capillary membrane. But, none of them are proved (Cugell, *et al*, 1953). The only other factor which could be responsible for altered diffusion are circulatory. 'Acidosis of pregnancy' has been held responsible for hyperapnoea (Rows, *et al*, 1931). Other causes could be altered threshold of respiratory centre and action of progesterone on respiratory centre (Heerhaber, *et al*, 1948, Loeschcke, 1950).

Inspiratory and Expiratory Reserve Volume: There was a decrease in these values with advancing pregnancy (Pandya and Nishith, 1972; Pande *et al*,

1973; Rubin, 1953). This is due to increased minute ventilation and forcing of diaphragm upward by enlarging uterus.

Vital Capacity

It is increased in second trimester, but there was a slight decrease in third trimester of pregnancy. Probable factors which might affect changes in vital capacity are, training, increase in body weight, changes in chest wall, position and movement of diaphragm, residual air, mobility of thoracic cage, changes in intra-abdominal and intra-pleural pressures, changes in accessory muscles of respiration, and mechanical effects of enlarging breasts. Increase in pulmonary vascular bed tends to decrease the vital capacity.

There was no direct relation of height of patient, surface area changes in pregnancy and weight gain during pregnancy to pulmonary function tests.

Summary

Pulmonary function tests were performed during pregnancy and non-pregnant state.

Respiratory rate, minute volume, tidal volume, and vital capacity showed a rise during pregnancy, while, inspiratory and expiratory reserve volumes showed a fall. The 'Lightening effect' in pregnancy due to descent of diaphragm is noted.

An attempt is made to find suitable explanations for these alterations.

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