ORIGINAL ARTICLE

Changes of Partial Pressure of Carbon-Dioxide in Arterial Blood ($Paco_2$) and Respiratory Rate (RR) in Pregnant Women

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Abstract:

In the present study the partial pressure of carbon dioxide in arterial blood ($PaCO_2$) and respiratory rate (RR) were studied in pregnant and non-pregnant women in Dhaka city. For this purpose a total 32 women for $PaCO_2$ and 100 women for RR with age ranging from 25 years to 35 years without any recent history of respiratory diseases were selected. Normal pregnant women were taken as experimental group and healthy non-pregnant women as control. Data was collected during first trimester, second trimester and third trimester in pregnant women and also in non-pregnant women. The $PaCO_2$ was determined by using "EASY BLOOD GAS AUTO ANALYZER" and RR was recorded. The $PaCO_2$ and RR during different trimesters of pregnant women were compared with that of non-pregnant women. Statistical analysis was done with students 't' test. The $PaCO_2$ was significantly lower in first trimester, second trimester and third trimester of pregnant women than that of non-pregnant women. Similarly, RR was significantly higher in first trimester, second trimester and third trimester of pregnant women than that of non-pregnant women. Again RR was significantly higher in third trimester than in first trimester and second trimester of pregnant women. There were no statistically significant difference of $PaCO_2$ among first trimester, second trimester and third trimester of pregnant women. Similarly, there were no statistically significant difference of RR between first trimester and second trimester of pregnant women. It may be concluded from the study that the progressively decreased $PaCO_2$ and increased RR throughout the pregnancy were most likely to be related to the effect of progesterone-induced hyperventilation. Hyperventilation in pregnancy is due to hypersensitivity of respiratory centre. Due to hyperventilation there is expel out of CO_2 causing decrease in $PaCO_2$ and increase in RR during pregnancy.

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Introduction:

Pregnancy produces physiological changes that affect respiratory performance. Alterations occurring in lung volumes and capacities during pregnancy include larger tidal volume and smaller residual volume causing increased alveolar ventilation. Functional respiratory changes include a slight increase in respiratory rate, a 50% increase in minute ventilation with the increase in respiratory tidal volume associated with a normal respiratory rate, and an increase in respiratory minute volume of approximately 26%. As the respiratory minute volume increases, hyperventilation occurs, causing a decrease

in alveolar CO_2. This decrease in alveolar CO_2 lowers the maternal blood CO_2 tension. Maternal hyperventilation is probably due to the action of progesterone on the respiratory centre[1].

Pregnancy is associated with an increase in ventilation; consequently, the arterial pressure of carbon dioxide falls[2,3]. Maternal ventilation and blood gases undergo substantial changes in pregnancy. There is a 40% increase in minute ventilation, resulting in a fall in $PaCO_2$. This increased ventilation is thought to be mediated by progesterone, which lowers the threshold of and increases the sensitivity of the respiratory centre. The higher minute ventilation is due to an increase in respiratory rate. $PaCO_2$ was found lower in pregnant women at sea level compared with the non-pregnant women; these things change with gestation[4].

During pregnancy, hyperapnoea occurs leading to decrease in $PaCO_2$ including constriction of bronchial muscles, but changes in respiratory rate are insignificant[5]. During pregnancy, hyperventilation causes the arterial carbon dioxide ($PaCO_2$) to fall[6]. A linear decrease in the $PaCO_2$ from 35.5 to 28 mm of Hg occurs from the tenth to the 40th week[7]. So, it is important to observe the $PaCO_2$ and RR in pregnant women. Although this type of works have been done in different countries by different workers but no established data is available in this country on this issue.

Therefore, the aim and objective of this study was to observe the changes in $PaCO_2$ and RR during the different trimesters of normal pregnant women.

Materials and method:

$PaCO_2$ and RR were measured in normal pregnant and healthy non-pregnant women. For this purpose a total 32 women for $PaCO_2$ and 100 women for RR with age ranged from 25 years to 35 years without any recent history of respiratory diseases were selected. Normal pregnant women were taken as experimental group and healthy non-pregnant women as control. All the subjects were taken from different areas of Dhaka city.

The subjects were selected by careful history taking and physical examination which revealed no evidence of past or recent significant respiratory diseases. The measurement of $PaCO_2$ and RR were done both in normal pregnant women during first trimester, second trimester and third trimester, and also in healthy non-pregnant women.

The $PaCO_2$ was measured by EASY BLOOD GAS AUTO ANALYZER and RR was recorded. The mean of measured values of $PaCO_2$ and RR were analyzed by unpaired Student's "t" test between and among the study groups. P value <0.05 was accepted as significant.

Results:

The mean (±SD) of measured values of $PaCO_2$ were 36.89±3.70, 32.73±3.16, 32.46±3.61 and 31.03±3.20 mm Hg in non-pregnant women and in pregnant women during first, second and third trimester. The mean (±SD) of measured values of $PaCO_2$ were significantly lower in first trimester, second trimester and third trimester of pregnant women than in non-pregnant women as shown in Table-I and Figure-1.

On the other hand, the mean (±SD) of measured values of RR were 13.20±1.25, 16.88±2.45, 18.08±2.25 and 20.76±1.17 breaths/minute in non-pregnant women and in pregnant women during first, second and third trimester. The mean (±SD) of measured values of RR were significantly higher in first, second and third trimester of pregnant women than that of non-pregnant women. Again RR were significantly higher in third trimester than those of first trimester and

second trimester of pregnant women as shown in Table-II and Figure- 2.

There were no statistically significant difference of $PaCO_2$ among first, second and third trimester of pregnant women. Similarly, there were no significant difference of RR between first and second trimester of pregnant women.

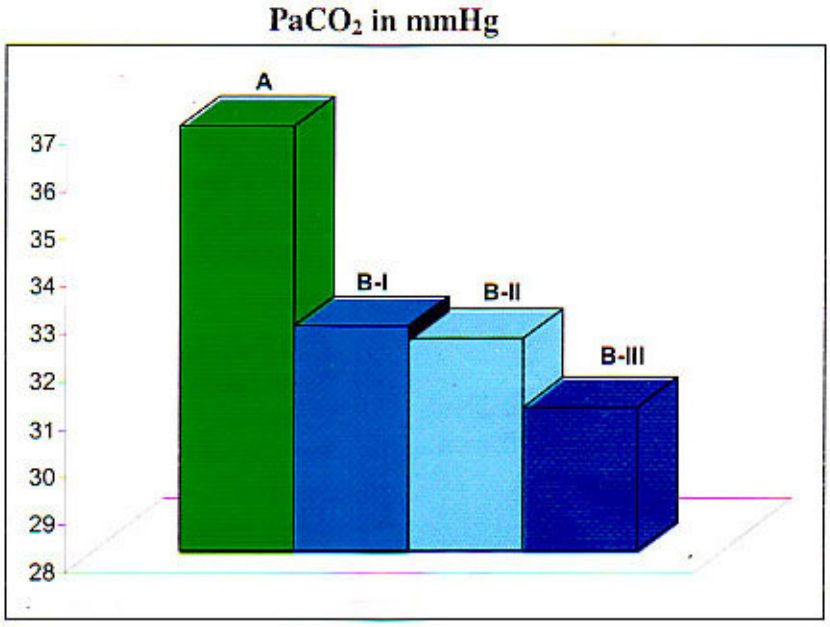

Figure-1: The mean (±SD) of measured values of $PaCO_2$ in different groups of subjects

Table-I : The statistical analysis of mean (±SD) of measured values of $PaCO_2$ in different groups of subjects

Statistical analysis (measured value)	
Groups	**P value**
A vs B-I	$<0.05^{*}$
A vs B-II	$<0.05^{*}$
A vs B-III	$<0.01^{***}$
B-I vs B-II	$>0.50^{ns}$
B-I vs B-III	$>0.10^{ns}$
B-II vs B-III	$>0.10^{ns}$

A : Healthy non-pregnant women (control)
B-I : First trimester of pregnant women (experimental)
B-II : Second trimester of pregnant women (experimental)
B-III : Third trimester of pregnant women (experimental)

P values were obtained by unpaired Student's "t" test
* = significant *** = highly significant ns = non significant

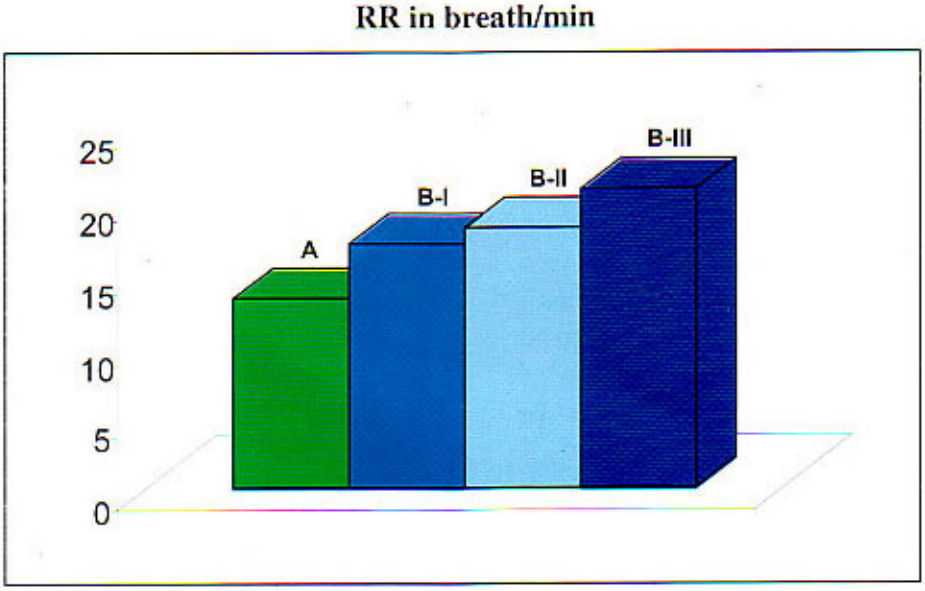

Figure-2: The mean (±SD) of measured values of RR in different groups of subjects.

Table-II: The statistical analysis of mean (±SD) of measured values of respiratory rate in different groups of subjects

Statistical analysis (measured value)	
Groups	**P value**
A vs B-I	$<0.001^{***}$
A vs B-II	$<0.001^{***}$
A vs B-III	$<0.001^{***}$
B-I vs B-II	$>0.50^{ns}$
B-I vs B-III	$<0.001^{***}$
B-II vs B-III	$<0.001^{***}$

A : Healthy non-pregnant women (control)
B-I : First trimester of pregnant women (experimental)
B-II : Second trimester of pregnant women (experimental)
B-III : Third trimester of pregnant women (experimental)

P values were obtained by unpaired Student's "t" test
* = significant *** = highly significant ns = non significant

Discussion:

In the present study, the mean (±SD) of measured values of $PaCO_2$ were significantly lower in first, second and third trimester than that in non-pregnant women. Similarly, the mean (±SD) of measured values of RR were also significantly higher in first, second and third trimester. Again, RR was significantly higher in third trimester than those of first trimester and second trimester of pregnant women. However, $PaCO_2$ gradually decreased and

RR gradually increased throughout the pregnancy from first to third trimester of pregnancy. These results are in agreement with other workers[2-9].

Pregnancy is associated with an increase in ventilation; consequently, the arterial pressure of carbon dioxide falls[2]. It was stated that pregnancy was associated with 'over breathing' as the increase in ventilation and consequently the arterial pressure of carbon dioxide fell. Hyperventilation in pregnancy is attributed to the effects of progesterone on respiratory drive, both increasing the sensitivity and reducing the threshold of the respiratory centre[3]. It was noted that $PaCO_2$ were lower in pregnant women at sea level compared with the non-pregnant women due to maternal ventilation, and that blood gases underwent substantial changes in pregnancy. There is a 40% increase in minute ventilation, resulting in a fall of $PaCO_2$. This increased ventilation is thought to be mediated by progesterone, which lowers the threshold of and increases the sensitivity of the respiratory centre. Minute ventilation was higher in pregnant women and did not change with gestation. The higher minute ventilation was due to an increase in respiratory rate[4-5].

It was opined that normal pregnancy was associated with a 20% increase in O_2 consumption and a 15% increase in the maternal metabolic rate. This extra demand is achieved via a 40-50% increase in resting minute ventilation, resulting mainly from a rise in tidal volume rather than respiratory rate. This hyperventilation causes the arterial carbon dioxide tension ($PaCO_2$) to fall[6-7]. Increased tidal volume is almost always observed during pregnancy and is the cause of hyperventilation and a major increase in alveolar ventilation. This hyperventilation is probably due to increased chemosensitivity of the CO_2 respiratory centres induced by the hyperprogesteronism observed during pregnancy[8,9].

There is no statistically significant difference of $PaCO_2$ among first, second and third trimester of pregnant women. Similarly, there is no statistically significant difference of RR between first trimester and second trimester of pregnant women.

In this study, it may be concluded that $PaCO_2$ were significantly lower and RR were significantly higher in first trimester, second trimester and third trimester of pregnant women than in non-pregnant women due to the effect of progesterone causing hyperventilation. Hyperventilation in pregnancy is due to hypersensitivity of respiratory centre. Due to hyperventilation there is expel out of CO_2 causing decrease in $PaCO_2$ and increase in RR during pregnancy.

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