

## RESEARCH ARTICLE

# A comparative study of arterial oxygen saturation in pregnant and non-pregnant women

Prema K Joshi, Milind S Chitale

Department of Physiology, A.C.P.M. Medical College, Dhule, Maharashtra, India

Correspondence to: Prema K Joshi, E-mail: drprema83@yahoo.co.in

Received: May 05, 2017; Accepted: May 22, 2017

### ABSTRACT

**Background:** Pregnancy is a stressful condition with considerably altered physiological and metabolic functions. Several authors have reported that oxygen consumption increases by 30-40% during pregnancy. Maternal ventilation and blood gases undergo substantial changes in pregnancy. During pregnancy, the rib cage undergoes structural changes in response to progressive relaxation of the ligamentous attachments of rib increasing the subcostal angle from 68° to 103°. In pregnancy, the diaphragm is elevated by about 4 cm, and the lower ribcage circumference is increased by about 5 cm. Hence, the functional residual capacity (FRC) and residual volume are reduced in pregnancy. Decreased FRC with increased oxygen demand lowers oxygen reserve of the mother. The increased metabolic rate and low oxygen reservoir in the lung at end expiration make the pregnant women particularly susceptible to develop hypoxemia. The blood gas analyzers require blood sample from the patient, hence invasive and painful. Whereas, pulse oximetry is a non-invasive, inexpensive, bedside technique and an alternative for arterial blood gas measurement. There is conflicting evidence concerning arterial oxygen saturation during pregnancy, hence the present study was done. **Aims and Objectives:** The aim of this study is to assess and compare the arterial oxygen saturation in pregnant and non-pregnant women. **Material and Methods:** This study was done on 60 non-pregnant women and 60 pregnant women in each trimester of the age group 20-35 years. The arterial oxygen saturation was measured with pulse oximeter. **Result:** The arterial oxygen saturation did not show any statistically significant difference in pregnant women in any trimester as compared to non-pregnant women. **Conclusion:** The decreased FRC and increased oxygen demand does not affect the arterial oxygen saturation in pregnant women as progesterone mainly lowers the threshold of respiratory center and increases their sensitivity to carbon dioxide.

**KEY WORDS:** Oxygen Saturation; Pregnant Women; Pulse Oximeter

### INTRODUCTION

Pregnancy is a stressful condition with considerably altered physiological and metabolic functions.<sup>[1]</sup> Several authors have reported that oxygen consumption increases by 30-40% during pregnancy.<sup>[2]</sup> The progressive rise is

due primary to the metabolic needs of the fetus, uterus, and the placenta and secondarily to increased cardiac and respiratory work.<sup>[2]</sup>

Maternal ventilation and blood gases undergo substantial changes in pregnancy.<sup>[3]</sup> During pregnancy, the rib cage undergoes structural changes in response to progressive relaxation of the ligamentous attachments of rib increasing the subcostal angle from 68° to 103°.<sup>[4]</sup> In pregnancy, the diaphragm is elevated by about 4 cm, and the lower rib cage circumference is increased by about 5 cm.<sup>[4]</sup> Hence, the functional residual capacity (FRC) and residual volume are reduced in pregnancy.<sup>[4]</sup>

Access this article online	
Website: <a href="http://www.njppp.com">www.njppp.com</a>	Quick Response code 
DOI: 10.5455/njppp.2017.7.0517722052017	

National Journal of Physiology, Pharmacy and Pharmacology Online 2017. © 2017 Prema K Joshi and Milind S Chitale. This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material for any purpose, even commercially, provided the original work is properly cited and states its license.

Decreased FRC with increased oxygen demand lowers oxygen reserve of the mother.<sup>[5]</sup> The increased metabolic rate and low oxygen reservoir in the lung at end expiration make the pregnant women particularly susceptible to develop hypoxemia.<sup>[4]</sup> Nearly 70% of the healthy pregnant women are reported of having dyspnea or breathlessness during daily activity.<sup>[5]</sup>

Pulse oximetry is a non-invasive method of measurement of arterial oxygen saturation for monitoring clinical patients.<sup>[6]</sup> Whereas, blood gas analyzers require blood sample from the patient, hence invasive and painful. Pulse oximetry is a non-invasive, inexpensive, bedside technique and an alternative for ABG measurement.<sup>[6]</sup>

There is conflicting evidence concerning arterial oxygen saturation during pregnancy, hence the present study was done to assess the arterial oxygen saturation in pregnant women as compared to non-pregnant women using a pulse oximeter.

## MATERIAL AND METHODS

This case-control study was done in the Department of Physiology and outdoor patient Department of Obstetrics and Gynecology, A.C.P.M Medical College, Dhule. The study was done on 180 pregnant and 60 non-pregnant women of age group 20-35 years. Pregnant women were randomly selected from the females coming for the antenatal checkup. 60 pregnant females in each trimester were selected. The non-pregnant females were randomly selected from the relatives accompanying them.

### Procedure

The arterial oxygen saturation percentage was measured using L and T planet 40 monitor with Nellcor pulse oximeter probe. The probe was connected to the index finger of the right hand in lying position and reading was taken.

### Group 1: Cases (Pregnant Women)

#### Inclusion criteria

Healthy pregnant women, 20-35 years of age, without any complication were included in the study.

#### Exclusion criteria

The pregnant women with

- History of smoking or any addiction
- Anemia, asthma, pneumonia, or any other systemic illness
- Pregnancy-induced hypertension, diabetes, endocrinological pathology, and cardiovascular or respiratory illness
- Athlete.

The cases were divided into following three groups.

A1 - First trimester - 1-12 weeks of pregnancy

A2 - Second trimester - 13-28 weeks of pregnancy

A3 - Third trimester - 29-40 weeks of pregnancy.

### Group 2: Control (Non-pregnant Women)

#### Inclusion criteria

Women of age 20-35 years in the follicular phase of menstrual cycle where the hormone variations are not influenced by progesterone were included in the study.

#### Exclusion criteria

- Women on oral contraceptive pills or any medication that can alter cardiovascular or endocrine function
- Lactating women
- Women within 2 years of post-partum
- Women with any systemic illness
- Athlete or women doing regular exercise
- Women with mehendi on hand or nail paint

All the ethical viewpoints were considered and a written informed consent was obtained from each subject after explaining the procedure and study in detail

The statistical analysis of the data was performed by unpaired *t*-test.<sup>[7]</sup>

## RESULT

The arterial oxygen saturation did not show any statistically significant difference in pregnant women in any trimester as compared to the non-pregnant women (Tables 1 and 2).

## DISCUSSION

In the present study, it was observed that the arterial oxygen saturation did not show any statistically significant difference in pregnant women in any trimester as compared to the non-pregnant women (Table 2).

**Table 1: Mean of the arterial saturation of oxygen in percentage in both groups**

Groups	Mean±SD
Group 1 (cases) pregnant	
First trimester A1	97.7±1.34
Second trimester A2	97.78±1.30
Third trimester A3	97.83±1.08
Group 2 (control) non-pregnant	
Non-pregnant	98.13±1.05

SD: Standard deviation

**Table 2:** Comparison of the arterial saturation of oxygen (percentage) in pregnant and non-pregnant women

Comparative groups	P value	Significance
A1 (first trimester) and Group 2 (non-pregnant)	0.0513	Not significant
A2 (second trimester) and Group 2 (non-pregnant)	0.1078	Not significant
A3 (third trimester) and Group 3 (non-pregnant)	0.1247	Not significant

This is in contrary to the observation of Sunyal et al.<sup>[8]</sup> They observed that the percentage saturation of oxygen increased gradually from the first to the third trimester of pregnancy.<sup>[8]</sup> The value of percentage saturation of oxygen was statistically significantly increased in all the three trimesters of pregnancy as compared to the non-pregnant women.<sup>[8]</sup> Bourne et al. found that the pregnant women suffer from significant prolonged nocturnal hypoxemia (desaturation).<sup>[9]</sup>

The increased oxygen demand and decreased FRC may lead to hypoxemia in pregnant women.<sup>[4]</sup> However, we observed no significant change in arterial oxygen saturation in pregnant women as compared to non-pregnant women. This may be due to the increased tidal volume as the apposition of diaphragm to the chest wall is increased in pregnancy.<sup>[4]</sup> Increased tidal volume increases the resting minute ventilation, and thereby the alveolar ventilation also increases.<sup>[4]</sup>

Moreover, the dead space may be decreased in pregnancy because of increased cardiac output and better perfusion in the apices, so the ratio of dead space volume to the tidal volume becomes even more advantageous.<sup>[4]</sup> Lung compliance remains unaffected by pregnancy.<sup>[4]</sup>

There is evidence suggesting that progesterone is a respiratory stimulant.<sup>[10]</sup> The administration of exogenous progesterone in males caused increased minute ventilation and sensitivity to carbon dioxide.<sup>[10]</sup> Progesterone decreases the threshold and increases the sensitivity of the central ventilator chemoreflex response to carbon dioxide.<sup>[10]</sup> Moreover, progesterone gradually increases during pregnancy from 25 ng/ml at 6 weeks to 150 ng/ml at 37 weeks of gestation.<sup>[5]</sup> Moreover, increase in metabolic demands of the fetus, uterus, and the maternal organ causes increased oxygen consumption and production of carbon dioxide.<sup>[10]</sup>

Progesterone also stimulates central neural sites in the medulla oblongata, thalamus, and hypothalamus which control ventilation. Progesterone directly increases the peripheral ventilator response of carotid body to hypoxia.<sup>[10]</sup>

Thus, the mechanical effects of gravid uterus cause relatively little change in pulmonary mechanics. All the changes

are mediated by the high progesterone level influencing respiratory center through lowering the threshold and increasing the sensitivity. However, the limitation of the study is that a detailed spirometry analysis of the subjects was not done.

## CONCLUSION

There is no significant change in arterial saturation of oxygen in pregnant women as compared to non-pregnant women. Thus, the increased oxygen demand and a decrease in FRC does not affect the arterial oxygen saturation in physically fit pregnant women due to hormone-mediated changes but may be prone to hypoxemia in stress.

## REFERENCES

1. Tiwari D, Akhtar S, Garg R, Manger PT, Khan MM. A comparative study of oxidative status in pregnant and non-pregnant women. *Int J Basic Appl Med Res.* 2016;5(3):225-30.
2. Morcos E. Pregnancy: Respiratory changes. In: Cannors DF, editor; 2003-2004. Available from: <http://www.circabook.com/pregnancy-changes-ehab-morcos-md>. [Last accessed on 25 Jan 2017].
3. McAuliffe F, Kametas N, Krampfl E, Ernsting J, Nicolaidis K. Blood gases in pregnancy at sea level and at high altitude. *BJOG.* 2001;108(9):980-5.
4. McCormack MC, Wise RA. Respiratory physiology in pregnancy. In: Bourjeily G, Rosene-Montella K, editors. *Pulmonary Problems in Pregnancy.* Leberian University; 2009. p. 419. DOI: 10.1007/978-1-59745-445-2\_2. Available from: <http://www.springer.com/978-1-934115-12-1>. [Last accessed on 25 Jan 2017].
5. LoMauro A, Aliverti A. Respiratory physiology of pregnancy: Physiology masterclass. *Breathe (Sheff).* 2015;11(4):297-301.
6. Mendelson Y. Pulse oximetry: Theory and applications for noninvasive monitoring. *Clin Chem.* 1992;38(9):1601-7.
7. Mahajan BK. *Methods of Biostatistics.* 6<sup>th</sup> ed. New Delhi: Jaypee Brothers Publication; 2006. p. 127-36.
8. Sunyal DK, Amin MR, Molla MH, Ahmed A, Ferdousi S, Khatun F. Assessment of percentage saturation of haemoglobin with oxygen in arterial blood of pregnant women. *J Bangladesh Soc Physiol.* 2006;1:10-3.
9. Bourne T, Ogilvy AJ, Vickers R, Williamson K. Nocturnal hypoxaemia in late pregnancy. *Br J Anaesth.* 1995;75(2):678-82.
10. Mathew JH, Robert OC. Respiratory physiology in pregnancy. *Clin Chest Med.* 2011;32(1):1-13.

**How to cite this article:** Joshi PK, Chitale MS. A comparative study of arterial oxygen saturation in pregnant and non-pregnant women. *Natl J Physiol Pharm Pharmacol* 2017;7 (Online First): Doi: 10.5455/njppp.2017.7.0517722052017

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