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Analysis of Haemoglobin Level during Gestation Period using Equilibrium State

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Abstract

During the preceding three decades the researches have drawn much attention about the haemoglobin level during the maternity. The level of haemoglobin is denotation of good health for mother and baby. The objective of this paper is to analyse the haemoglobin level during pregnancy period using Markov chain. The haemoglobin level is one of the vital roles in the health of mother and baby during gestation period

Keywords: Haemoglobin, maternity, stationary distribution.

Introduction

Haemoglobin is a protein that carries oxygen to various parts of body. The haemoglobin level is expressed as the amount of haemoglobin in grams per decilitre of blood. The normal ranges of haemoglobin depends on the age, gender of the person and other factors like adolescence. Generally the normal ranges are New born : 14 – 22 gm/dl, first week of new born : 15 – 20 gm/dl one month of age : 11 – 15 gm/dl and Children : 11 – 13 gm/dl . Children from 6 months to 6 years : 9.5 – 14 gm/dl, Children from 6 years to 18 years : 10 – 15.5 gm/dl, Adult males : 14 – 18 gm/dl , Adult female : 12 – 16 gm/dl and Pregnant women : 11 – 12 gm/dl. The health of mother and foetus depends on haemoglobin count. If the count is low, it indicates less intake of oxygen which results in general weakness and low birth weight of the baby, Nagarajan et al (2010). Low haemoglobin level leads to anaemia which must be investigated and promptly corrected at all times, especially during pregnancy.

Gestational period can be classified into three stages (i) first trimester (ii) second trimester and (iii) third trimester. In the first trimester, a pregnant woman is anaemic when the haemoglobin level is less than 11 gm/dl. In the second trimester she is anaemic if haemoglobin level is < 10.5 gm/dl and in the third trimester she is anaemic if the haemoglobin level is < 10 gm/dl. Anemia was defined using the CDC criteria for anemia during pregnancy. With these criteria the haemoglobin cut off used to define anemia during the first and third trimesters was 110 g/L and during the second trimester was 105 g/L. The corresponding cut off for hematocrit was 0.33 during the first and third trimesters, and 0.32 during the second trimester, Chapman Abet al (1997).

Gestation anaemia results because of the added requirements of developing foetus. Iron requirements go up significantly during pregnancy. Also the amount of blood increase almost 50 % more than usual. So the necessity of iron to build more haemoglobin, for the growing foetus and placenta increases. But excess iron cannot be attained through diet alone. So a daily supplement must be taken as a preventive dose, Meenapanth et al (1990).

Extremes of iron status during pregnancy may adversely impact birth outcomes. Relationships between anemia and adverse birth outcomes have been inconsistent. Some studies have found anemia to significantly increase the risk of adverse birth outcomes, whereas others have not. At the other end of the spectrum, elevated haemoglobin concentrations during pregnancy also increase the risk of adverse birth outcomes, including preterm delivery, low birth weight (LBW), foetal death and intrauterine growth retardation . This U-shaped distribution, with higher risks of adverse birth outcomes at both extremes of the hemoglobin or hematocrit distribution, has been described primarily in adult populations. At this time, limited data are available on the impact of iron status on birth outcomes in pregnant adolescents, Barrett et al (1994).

Pregnant women are particularly vulnerable to anemia due to the increased iron demands of pregnancy. In pregnant adolescents, risk of iron deficiency is increased, because the adolescent must supply adequate iron for not only her own growth but also that needed for foetal demands and expansion of the red-cell mass The low income pregnant women who entered prenatal care during the first, second and third trimesters was 11, 16 and 37%, respectively These values were higher than those found in adult women at similar stages of gestation (8.9–10, 12.7–13.5 and 30.2–32.8%, respectively).

Several studies have indicated that the highest risk of early childbearing have increased risks of anemia and adverse birth outcomes. However, few studies have described haemoglobin concentrations and birth outcomes in this vulnerable group.

Data

The hospital based study was conducted in 220 pregnant women and the information were collected which were promptly maintained for both mother and child

Model description

Chapman-Kolmogrov equation were used to assess haemoglobin level during gestation. The equation is given as the ultimate given vectors containing four components, so these vectors produce four equation and sum of all unknown is equal to one. When these equations are solved simultaneously we get the equilibrium vector, Bartholomew.D (1993).

The data are classified into four states based on haemoglobin level
State 1: less than 10 gm/dl
State 2: 10 – 12 gm/dl
State 3: 12 – 14 gm/dl
State 4: greater than 14 gm/dl

The observation matrix for pregnancy women haemoglobin level is

$$A = \begin{bmatrix} 8 & 10 & 27 & 16 \\ 4 & 7 & 35 & 24 \\ 3 & 2 & 19 & 17 \\ 1 & 4 & 7 & 36 \end{bmatrix}$$

The transition probability matrix is

$$p = \begin{bmatrix} 0.1311 & 0.1639 & 0.4426 & 0.2623 \\ 0.0571 & 0.1000 & 0.5000 & 0.3429 \\ 0.0732 & 0.0488 & 0.4634 & 0.4147 \\ 0.0208 & 0.0833 & 0.1458 & 0.7500 \end{bmatrix}$$

$$0.1311\,X_1 + 0.0571\,X_2 + 0.0732\,X_3 + 0.0208\,X_4 = X_1$$
$$0.1639\,X_1 + 0.1000\,X_2 + 0.0488\,X_3 + 0.0833\,X_4 = X_2$$
$$0.4426\,X_1 + 0.5000\,X_2 + 0.4634\,X_3 + 0.1458\,X_4 = X_3$$
$$0.2623\,X_1 + 0.3429\,X_2 + 0.4147\,X_3 + 0.7500\,X_4 = X_4$$

and

$$X_1 + X_2 + X_3 + X_4 = 1$$
$$X_1 = 0.0427, \quad X_2 = 0.0786, \quad X_3 = 0.2730, \quad X_4 = 0.6054$$

The above result reveals that the highest probability is 0.6054 where state 1 goes to state 4, which means the haemoglobin concentration from less than 10 gm to greater than 14 gm is 60.54 %. The haemoglobin level from less than 10 gm to 12 – 14 gm is 27.3 %,from less than 10 gm to 10 – 12 gm is 7.86 % and from less than 10 gm to the same state is 4.27 %.

H0 : No significant difference between the expected and observed frequencies for the pregnancy women haemoglobin level.

Table I: Comparison of expected and observed frequency.

State	Observed frequency	Expected proportion	Expected frequency
1	16	0.0427	9.4
2	23	0.0786	17.3
3	88	0.2730	60.1
4	93	0.6054	133.2

A χ^2 test of goodness of fit with 3 degree of freedom when

$$\chi^2 = \sum_{I=1}^{4} \frac{(O-E)^2}{E} = 31.8$$

and where O = observed frequencies, E = expected frequencies and I is the number of state. The tabulated at 5% level of significance with 3 degree of freedom is 7.815. The null hypothesis is not accepted. Therefore there is significant difference between the expected and observed frequencies for the pregnancy women haemoglobin level. After a long time, the probability of less than 10 permissible into the same state is 0.0427, the probability moving to 10-12 is 0.0786, the probability moving to 12-14 is 0.2730, the probability moving to 14-16 is 0.6054.

Conclusion

The stationery distribution of gestation period is according to the result. It reveals that the highest probability is 0.6054 which is from less than 10 gm to greater than 14gm. Low haemoglobin level leads to anaemia which could cause complications during pregnancy resulting in low birth weight. Iron and foliate deficiency is by far the most important logical factor. So it is better that they start having iron rich foods like spinach, legumes, methi ,pulses, meat, fruits etc.

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