# Fetal Growth in Maternal Anaemia

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## Summary

**The effect of maternal iron deficiency anemia on fetal growth was studied in 54 anaemic (haemoglobin < 11.0 g/dl) mothers. Twenty-two mothers served as controls (haemoglobin ≥ 11.0 g/dl). All the women had singleton live births at term gestation. The maternal iron status was assessed by serum ferritin estimation. The birth weight, head circumference, chest circumference, mid-arm circumference, and crown heel length were significantly low in infants born to women with moderate (haemoglobin 6.1 ± 8.5 g/dl) and severe anaemia (haemoglobin ≤ 6.0 g/dl), in comparison to infants born to non-anaemic women. Similarly, birth weight, mid-arm circumference, and crown-heel length were significantly low in infants of women with depleted iron stores (serum ferritin < 10 μg/l) than in infants of women with serum ferritin levels of 20 μg/l or more. All indices of fetal growth showed linear relationships with maternal haemoglobin, as well as with serum ferritin. The growth retarding effect of maternal anaemia was more on fetal birth weight and mid-arm circumference than on other anthropometric indices of the newborn.**

## Introduction

Anaemia in pregnancy constitutes a significant public health problem in developing countries. Recent reports indicate that 88 per cent of pregnant women in India suffer from anaemia,[1] mostly due to iron deficiency. The consequences of iron deficiency anaemia during gestation include increased risks of preterm delivery, lower birth weight, and perinatal mortality.[2] Studies on the effect of maternal anaemia on fetal birth weight have yielded conflicting results.[3–8] There is lack of information in the literature about the influence of maternal anaemia on the anthropometric indices of the newborn. This study was undertaken to discover the effect of maternal iron deficiency anaemia on fetal growth.

## Materials and Methods

Fifty-four anaemic (haemoglobin < 11.0 g/dl) and 22 non-anaemic (haemoglobin ≥ 11.0 g/dl) pregnant women were selected randomly from the University Hospital, Banaras Hindu University, Varanasi. All women had singleton live births at term gestation (37–41 weeks). The gestational age of the newborns was calculated by using maternal menstrual dates and the Dubowitz method. All babies were born in the hospital. Women with preterm delivery, antepartum haemorrhage, toxaemia of pregnancy, hypertension, diabetes mellitus, infection, multiple gestation, hepatitis, and heart disease were excluded from the study.

Maternal blood was collected during the first stage of labour for the determination of haemoglobin[9] and serum ferritin by the ELISA method[10] (Ferrizyme, Abbott Laboratories, Chicago, Illinois). Anthropometric indices, namely, birth weight, head circumference, chest circumference, mid-arm circumference, and crown-heel length of the newborn, were measured for assessing the fetal growth. Weight was measured to the nearest 20 g, while other indices were measured to the nearest 0.1 cm.

Statistical analysis was done by Student's *t*-test and correlation coefficient. Since maternal serum ferritin values were highly skewed, the differences in maternal ferritin groups were assessed by Mann–Whitney test, and correlations of various anthropometric indices of the newborn with maternal ferritin were evaluated by Spearman's rank correlation coefficient.

## Results

The birth weight, head circumference, chest circumference, mid-arm circumference, and crown-heel length were significantly low in infants born to mothers with moderate (haemoglobin 6.1 ± 8.5 g/dl) and severe (haemoglobin ≤ 6.0 g/dl) anaemia, in comparison to infants born to non-anaemic (haemoglobin ≥ 11.0 g/dl) mothers (Table 1). On the other hand, infants of mothers with depleted iron stores (serum ferritin < 10.0 μg/l) differed significantly from infants of mothers with serum ferritin 20.0 μg/l or more only in relation to birth weight, mid-arm circumference and crown-heel length (Table 2). There was a linear relationship between maternal haemoglobin and serum ferritin

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TABLE 1
*Effect of maternal haemoglobin on fetal anthropometry (mean ± SD)*

| Group | Range of maternal haemoglobin (g/dl) | Maternal haemoglobin (g/dl) | Newborn infant: Birth weight (g) | Head circumference (cm) | Chest circumference (cm) | Mid-arm circumference (cm) | Crown-heel length (cm) |
|---|---|---|---|---|---|---|---|
| I ($n=15$) | ≤6.0 | 4.5±1.0 | 2107±92 | 32.6±0.7 | 29.9±0.5 | 7.9±0.4 | 46.4±1.4 |
| II ($n=19$) | 6.1–8.5 | 7.6±0.6 | 2363±237 | 33.2±0.9 | 30.6±0.9 | 8.7±0.5 | 47.4±1.4 |
| III ($n=20$) | 8.6–10.9 | 9.7±0.7 | 2710±262 | 33.7±0.9 | 31.0±0.8 | 9.0±0.4 | 48.5±1.4 |
| IV ($n=22$) | ≥11.0 | 13.3±1.1 | 2844±345 | 34.0±1.2 | 31.1±1.0 | 9.3±0.5 | 48.9±1.4 |
| *P*-value | | | | | | | |
| I *v*. IV | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| II *v*. IV | | <0.001 | <0.001 | <0.01 | NS | <0.001 | <0.05 |
| III *v*. IV | | <0.001 | NS | NS | NS | NS | NS |
| Correlation coefficient | | | +0.708 | +0.416 | +0.358 | +0.684 | +0.485 |
| Regression coefficient | | | +81.530 | +0.139 | +0.109 | +0.125 | +0.250 |
| *P*-value | | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |

NS = not significant.

respectively with various anthropometric indices of the newborn. The fetal anthropometric indices can be predicted from the maternal haemoglobin as well as from the maternal serum ferritin by the regression equations given in Table 3.

## Discussion

The linear relationship between maternal haemoglobin and different components of fetal anthropometry indicates that fetal growth is compromised in maternal anaemia, particularly when it is moderate

TABLE 2
*Effect of maternal serum ferritin on fetal anthropometry (mean ± SD)*

| Group | Range of maternal serum ferritin (μg/l) | Maternal serum ferritin (μg/l) | Newborn infant: Birth weight (g) | Head circumference (cm) | Chest circumference (cm) | Mid-arm circumference (cm) | Crown-heel length (cm) |
|---|---|---|---|---|---|---|---|
| I ($n=51$) | <10.0 | 1.97±2.48 | 2431±352 | 33.3±1.2 | 30.6±1.0 | 8.6±0.7 | 47.5±1.6 |
| II ($n=10$) | 10.0–19.9 | 13.50±2.42 | 2775±320 | 33.7±1.2 | 30.7±1.0 | 9.2±0.4 | 48.8±1.5 |
| III ($n=15$) | ≥20.0 | 42.57±16.17 | 2767±345 | 33.6±0.5 | 30.9±0.7 | 9.2±0.5 | 48.7±1.3 |
| *P*-value | | | | | | | |
| I *v*. III | | <0.001* | <0.01 | NS | NS | <0.001 | <0.01 |
| II *v*. III | | <0.001* | NS | NS | NS | NS | NS |
| Spearman's rank correlation coefficient | | | +0.526 | +0.367 | +0.294 | +0.500 | +0.348 |
| Regression coefficient | | | +11.740 | +0.024 | +0.017 | +0.018 | +0.035 |
| *P*-value | | | <0.001 | <0.01 | <0.01 | <0.001 | <0.01 |

**P*-value determined by Mann–Whitney test. NS = not significant.



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TABLE 3
*Regression equations of fetal anthropometric indices on maternal haemoglobin (g/dl) and maternal serum ferritin (μg/l)*

| Parameter | Equation of regression on maternal haemoglobin ($x$) | SE of the predicted value | Equation of regression on maternal serum ferritin ($x$) | SE of the predicted value |
|---|---|---|---|---|
| Birth weight (g) | $1792.93+81.530\,x$ | 92.3941 | $2416.44+11.740\,x$ | 44.4767 |
| Head circumference (cm) | $32.12+0.139\,x$ | 0.3448 | $33.14+0.024\,x$ | 0.1405 |
| Chest circumference (cm) | $29.70+0.109\,x$ | 0.3205 | $30.52+0.017\,x$ | 0.0173 |
| Mid-arm circumference (cm) | $7.65+0.125\,x$ | 0.1519 | $8.58+0.018\,x$ | 0.0706 |
| Crown-heel length (cm) | $45.60+0.250\,x$ | 0.5119 | $47.52+0.035\,x$ | 0.2189 |

to severe in nature. Since only those babies born at term gestation were included in the study, the growth retarding influence of maternal anaemia on fetus was independent of its well known effect on the duration of gestation.[11] The finding of reduced birth weight in infants of anaemic mothers is in agreement with the results of previous authors,[3–6] but contrary to the observations of others.[7,8] We could find no study in the literature examining the effects of maternal anaemia on other indices of fetal anthropometry, apart from birth weight. Our data suggest that all indices of fetal anthropometry are affected in maternal anaemia. However, the effect of maternal anaemia was more on fetal birth weight and mid-arm circumference than on other parameters, as revealed by high correlation coefficients between maternal haemoglobin and birth weight ($r=-0.708$, $P<0.001$), and between maternal haemoglobin and mid-arm circumference ($r=-0.684$, $P<0.001$). The effect of maternal anaemia on intra-uterine growth is attributed to chronic deprivation of oxygen to the developing fetus.[12–14] Furthermore, severe maternal anaemia, if present from early gestation, may be associated with reduced placental weight[4] and structural abnormalities of the placenta.[15,16] Placental weight is closely associated with the surface area of peripheral villi[17] which, in turn, is a determinant of nutrient transport from the mother to the fetus.[18] This may be another mechanism by which maternal anaemia adversely affects fetal growth. In addition, maternal anaemia may be a marker for nutritional, social, and environmental deprivations which may independently influence fetal growth.

The present study also showed a significant relationship between maternal serum ferritin and fetal anthropometry. This observation is contrary to the findings of previous studies[6,19,20] which reported lack of effect of maternal serum ferritin on fetal birth weight. It is to be noted that mean serum ferritin levels in women with depleted iron stores were very low ($1.97\pm2.48$ μg/l) in this study, in comparison to other studies.[6,19] Furthermore, some of these studies[6] also had the drawback of including women with active infection, which might have influenced their results. In conclusion, our findings indicate that iron deficiency anaemia during pregnancy adversely affects fetal growth, and that both maternal haemoglobin and serum ferritin are positively correlated with anthropometric indices of the newborn.

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