Iron status of babies born to iron-deficient anaemic mothers in an Iranian hospital

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وضعيَّة الحديد في الرضَّع لدى أمهات مصابات بفقر الدم بعوز الحديد في أحد المستشفيات الإيرانية

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الخلاصـة: للتعرف على العلاقة بين فقر الدم لدى الأمهات ووضعيَّة الحديد في ولدانهن، أجرى الباحثان دراسة شملت 97 أماً في جناح الولادة مع أطفالهن المولودين في تمام الحمل. وتم تعيين مقدار كلٍّ من الهيموغلوبين وحديد المصل والسعة الإجمالية الرابطة للحديد، وفيريتين المصل. وقد قسمت الأمهات إلى ثلاث مجموعات: أمهات مصابات بفقر الدم وعَوَز الحديد (22.7٪) وأمهات غير مصابات بفقر الدم ولكنهن مصابات بعَوَز الحديد (27.8٪) وأمَّهات غير مصابات بفقر الدم ولا بعَوَز الحديد (49.5٪). ولم يكن هناك فرق ملحوظ بين متوسط الأعمار للمجموعات الثلاثة من الأمهات، ولكن الاختلافات كانت هامة بالنسبة لعدد مرات الحمل، ومستوى الهيموغلوبين ومستوى الفيريتين في المصل في المجموعات الثلاث من الأمهات، ولم يكن هناك فروق هامة في القيمة الوسطية لحديد المصل أو السعة الإجمالية الرابطة للحديد، بين المجموعات الثلاث من الولدان. ولوحظ في الرضع من أمهات مصابات بفقر الدم، انخفاضٌ ملحوظ في فيريتين المصل (115.3 نانو غرام/ميلي لتر) وذلك بالمقارنة بالمجموعة غير المصابة بفقر الدم ولا بعوز الحديد (204.8 نانوغرام/ميلي لتر) [مَنْسَب الاحتمال P = 0.014] ولم تتم مقارنتهم بالمجموعة التي تعاني من عوز حديد المصل دون الإصابة بفقر الدم. وقد استنتج الباحثان أن عَوَز الحديد لدى الأمهات قد يؤثِّر على وضع الحديد في أطفالهن ويؤهبهم للإصابة بعَوَز الحديد.

ABSTRACT We investigated the relation between maternal anaemia and neonatal iron status in 97 mothers and their babies. Haemoglobin (Hb), serum iron, total iron binding capacity and serum ferritin were determined. Mothers were divided into 3 groups: iron-deficient anaemic (22.7%), non-anaemic iron-deficient (27.8%) and non-anaemic non-iron-deficient (49.5%). There was no significant difference in the mean ages of the 3 groups but there were significant differences in relation to parity, Hb and serum ferritin levels. There was no significant difference in the mean value of serum iron or total iron binding capacity among the neonates of the 3 groups. Babies of iron-deficient anaemic mothers had significantly lower levels of serum ferritin (115.3 ng/mL) than non-anaemic, non-iron-deficient mothers (204.8 ng/mL) but not compared with the non-anaemic iron-deficient group. Maternal iron deficiency may affect iron status in their babies and predispose them to iron deficiency.

Le bilan en fer des enfants nés de mères anémiques ayant une carence martiale dans un hôpital iranien

RÉSUMÉ Afin d'examiner la relation entre l'anémie maternelle et le bilan en fer des nouveau-nés, nous avons effectué une étude de 97 mères et des bébés. L'hémoglobine, le fer sérique, la capacité totale de fixation du fer et la ferritine sérique ont été mesurés. Les mères ont été réparties en trois groupes : mères anémiques ayant une carence martiale (22,7 %), mères non anémiques ayant une carence martiale (27,8 %) et mères non anémiques n'ayant pas de carence martiale (49,5 %). Il n'y avait pas de différence significative dans l'âge moyen des trois groupes de mères mais il y en avait pour la parité, le taux d'hémoglobine et celui de ferritine sérique. Il n'y avait pas de différence significative dans la valeur moyenne du fer sérique ou la capacité totale de fixation du fer chez les nouveau-nés des trois groupes. Les bébés des mères anémiques ayant une carence martiale avaient un taux de ferritine sérique significativement plus faible (115,3 ng/mL) par rapport aux bébés des mères non anémiques n'ayant pas de carence martiale (204,8 ng/mL) mais non par rapport à ceux des mères non anémiques ayant une carence martiale. La carence martiale chez la mère peut affecter le bilan en fer de son bébé et prédisposer l'enfant à la carence martiale.

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Introduction

Iron-deficiency anaemia is the most common type of anaemia among pregnant women, especially in developing countries [*1–4*]. The risk of iron deficiency is particularly high in women with high parity and short intervals between pregnancies [*5*].

Iron transfer from mother to fetus occurs against the concentration gradient. Maternal iron is the only source of fetal iron; it is logical, therefore, that maternal iron status will affect the iron status of the neonate.

Several studies have been done to investigate the relationship between maternal and neonatal iron status. Based on the results, no significant relationship exists [*6*]. On the other hand, severe maternal iron deficiency has been shown to adversely affect neonatal iron status, and subsequently growth and development [*7*].

Iron-deficiency anaemia is a common problem in the Islamic Republic of Iran. Health care centres recommend regular iron supplementation during pregnancy, but this advice is often ignored. Because there are doubts regarding the relationship between maternal and neonatal iron status and the lack of data regarding maternal iron status in Jahrom, this study was carried out to evaluate overall prevalence of iron deficiency in pregnant women without medical problems, regardless of their iron supplementation and nutrition status, and to evaluate the effects on neonatal iron status.

Methods

We carried out a cross-sectional study between April and September 2003 in Mottahary Hospital (a referral hospital serving all pregnant women referred from clinics, health care centres and medical practices) of Jahrom School of Medical Sciences in Jahrom, in the southern part of the Islamic Republic of Iran. Ninety-seven pregnant women aged 17–38 years were included in the study. None of the women refused to participate. All the participants had been admitted to the labour ward after 37 weeks gestation. Exclusion criteria were having a chronic medical condition, bleeding during pregnancy, premature labour pain, high-risk pregnancy (e.g. history of repeated abortion, history of trauma and severe infection during pregnancy, severe hyperemesis, pre-eclampsia) and previous history of haemoglobinopathy.

Blood samples were obtained from mothers before delivery and cord blood was taken immediately after clamping and before delivery of the placenta. EDTA tubes were used for blood samples for haemoglobin and red blood cell indexes. For total iron binding capacity and serum iron measurement, tubes were washed with acid chloride and distilled water. Then serum was separated by centrifugation. Serum iron was measured using a spectrophotometer (Spectronic 20D, Milton Roy, Ostend, Belgium) according to the method of Hork and Sanderm [*8*]. We measured total iron binding capacity by the iron exchange resin method (Stat-Fax 2100, Awareness Technology, Palm City, Florida) and serum ferritin by an enzyme-linked immunosorbent assay. Serum ferritin was standardized according to the international standards included with the kit.

Age, parity, residence, iron supplementation and duration of prenatal care were recorded for each mother. Weight, length and head circumference of neonates were also recorded. We did not record information about the mother's weight gain during pregnancy.

The mothers were divided into 3 groups based on the pre-delivery haemoglobin (< 11 g/dL) and serum ferritin (< 12 ng/mL) levels: iron-deficient anaemic mothers, non-anaemic iron-deficient mothers, and non-anaemic non-iron-deficient mothers (normal group). Neonatal anaemia was defined based on cord haemoglobin level < 14 g/dL [*9*].

Statistical analysis was carried out using *SSPS,* version 11.5. The mean and standard deviation were calculated for each group. Duncan's and Scheffe's tests were applied and $P < 0.05$ was considered significant.

Results

Of the 97 mothers in the study, 51.5% were from urban areas and 48.5 % from rural areas. Age range was 17–38 years (mean 25.1 years). More than 92% had received routine iron supplementation from the antenatal clinic during their pregnancy. Parity ranged from 1 to 8 (mean 2.0). Table 1 gives overall data on the mothers and neonates in the study group. All pregnancies were singleton pregnancies.

On the basis of the serum ferritin and haemoglobin levels, 48 (49.5%) mothers were classified as non-anaemic non-iron-deficient, 27 (27.8%) were non-anaemic iron-deficient and 22 (22.7%) iron-deficient anaemic.

There was no significant difference between the mean ages of the 3 groups of mothers but there were significant differences in relation to parity, haemoglobin and serum ferritin levels (Table 2). Babies of iron-deficient anaemic mothers were heavier ($P = 0.006$) and had greater head circumference than the 2 other groups ($P = 0.009$). In addition, babies of iron-deficient anaemic mothers had significantly lower levels of serum ferritin, 115.3 ng/mL, compared to the non-anaemic non-iron-deficient group, 204.8 ng/mL ($P = 0.014$), but comparing babies of iron-deficient anaemic mothers with babies of non-anaemic iron-deficient mothers, the difference was not significant. Similarly, there was no significant difference comparing babies of non-anaemic iron-deficient mothers and babies of non-anaemic non-iron-deficient mothers. There was no significant difference in haemoglobin level

Table 1 **Characteristic of mothers and neonates**

Variable	Mean (SD)	Range
Mothers		
Age (years)	25.1 (5.0)	17–38
Parity	2.0 (1.3)	1–8
Prenatal care (months)	4.8 (2.0)	0–8
Hb (g/dL)	13.9 (1.3)	10.1–17.2
Serum iron (µg/dL)	115.8 (53.5)	23–286
Serum ferritin (ng/mL)	30.1 (32.8)	1–330
Total iron binding capacity (µg/dL)	487.7 (121.0)	213–780
Neonates		
Head circumference (cm)	34.73 (1.3)	31–38
Weight (g)	3289 (444)	2400–4800
Height (cm)	50.04 (2.5)	44–56

SD = standard deviation.

Table 2 **Characteristics of 97 neonates and mothers in 3 groups according to maternal iron deficiency and anaemia status**

Characteristic	Maternal group IDA (*n* = 22)	NAID (*n* = 27)	NC (*n* = 48)	*P*-value
Neonates				
Mean weight (g)	3517[a]	3211[a]	3254[a]	0.069
Mean height (cm)	50.1	50.2	50.1	0.009
Mean head circumference (cm)	35.6[a]	34.6[a]	34.5	0.009
Mean Hb (g/dL)	15.2	14.8	15.4	0.35
Mean serum ferritin (ng/mL)	115.3[a]	151.5	204.8[a]	0.014
Mothers				
Mean age (years)	26.0	25.4	24.9	0.73
Mean parity	2.6[a]	2.2[a]	1.7[a]	0.032
Mean Hb (g/dL)	10.2[a]	13.2[a]	13.8	< 0.01
Mean serum iron (µg/dL)	103.7	104.2	122.9	0.27
Mean serum ferritin (ng/mL)	7.8[a]	10.4	46.6[a]	0.04

IDA = iron-deficient anaemic.
NAID = non-anaemic iron-deficient.
NC = non-iron-deficient non-anaemic.
Hb = haemoglobin.
[a]Indicates groups that differed significantly.

between the 3 groups of neonates (*P* = 0.35).

We did not find any correlation between serum iron, total iron binding capacity or haemoglobin of mothers and haemoglobin of the neonates.

Discussion

About half the pregnant women in our study were iron deficient and 22.7% had iron-deficiency anaemia. This prevalence is high, and is at variance with reports from India and Turkey [*10–13*]. In a study in Istanbul and Izmit the prevalence of iron deficiency in pregnant women was 52.3% [*10*]. In 2 separate studies in South Africa and Israel, prevalence of anaemia in pregnant women was 3.0% and 21.6% respectively [*11*]. Shukla et al. studied 246 pregnant and non-pregnant women in 7 villages in India and showed prevalence of anaemia to be between 25% and 68% [*12*]. Molina et al. studied 88 pregnant women of lower and middle economic status and found significantly lower ferritin and Hb levels in the poorer group [*13*].

Multiparity was a factor in iron deficiency in mothers but we found no relationship with age. It has been observed that younger mothers, especially teenage mothers, are prone to iron-deficiency anaemia [*14*], but in our study mean age was similar in the 3 groups of mothers.

For evaluation of the effect of maternal iron deficiency on neonates, we considered neonatal weight, height and head circumference as growth indexes.

Scholl et al. showed that mothers with iron-deficiency anaemia had a 3 times greater risk of giving birth to infants with low birth weight [*15*]. In contrast, in a study by Preziosi et al., no significant difference was found between birth weight and maternal iron status; there was, however, a significant difference for mean birth length [*16*]. The effect of iron deficiency in mothers on fetal growth has been reported to be especially striking in teenage mothers [*14*].

Micronutrient consumption during pregnancy has an appreciable effect on neonatal growth and development; mothers who received iron supplements have been reported to have heavier babies [*17*]. Our study showed a significant relationship between neonatal head circumference and maternal iron status; however, the relationship was borderline significant for neonatal weight. The babies of iron-deficient anaemic mothers had greater head circumference (35.6 cm versus 34.5 cm; $P = 0.006$) and were heavier (3517 g versus 3254 g; $P = 0.069$) than babies of non-anaemic non-iron-deficient mothers. Cogswell et al. showed that for mothers with severe iron deficiency, using iron supplements improved fetal growth, but maternal iron storage indexes may not change [*17*]. The majority of the mothers in our study had received iron supplementation, so iron-deficient anaemic mothers were actually even more severely deficient because they were taking iron supplements. This iron may have had an effect on their fetus and improved growth while having less effect on the maternal iron indexes. Another explanation for this observation could be that the greater amount of iron needed by larger fetuses resulted in a greater level of iron deficiency in their mothers.

Many studies, with differing results, have been done on the relationship between maternal and neonatal iron status [*18–23*]. Rios et al. did not report any significant difference in serum ferritin level in infants of iron-depleted and non-depleted mothers [*24*]. Kelly, MacDonald and McDougall observed a significantly lower ferritin level in cord serum when mothers were iron deficient [*25*]. We found a significant correlation between maternal and neonatal iron status. Babies of iron-deficient anaemic mothers had lower iron storage: ferritin was 115.3 ng/mL compared to 204.8 ng/mL in babies of non-anaemic, non-iron-deficient mothers ($P = 0.014$).

Because of the poor outcome of pregnancy in iron-deficient anaemic mothers and the resultant high cost burden on health care services [*26–28*], and taking into consideration the high prevalence of iron deficiency in pregnant women in our area, more emphasis is needed on the benefits of regular iron supplementation during pregnancy and improving supervision of the consumption of the supplements.

In 1993, the Institute of Medicine, Food and Nutrition recommended that maternal iron prescription must be based on iron status evaluation, including serum iron, total iron binding capacity, serum ferritin and haemoglobin, and supplements would only be prescribed to iron-deficient pregnant women [*29*]. This approach is expensive and not available in many health care centres. The best way to reduce iron deficiency in pregnant women in our country would be regular iron supplementation during pregnancy and between pregnancies in high parity women. We did, however, find that even though, according to the data on the questionnaires and clinical data from antenatal care files, 92% of the mothers we studied were being given iron supplements, 23% were anaemic and 29% were iron deficient. It needs to be established whether mothers prescribed iron supplements are actually taking them, and if not, why not.

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