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Comparison of Maori and non-Maori maternal and fetal iron parameters

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Abstract

Aims To investigate the effect of maternal iron stores on the fetus in Maori and non-Maori neonates.

Methods Paired samples of maternal venous and fetal cord blood were compared for haemoglobin, iron, and ferritin. Women were included who had no medical complications and were delivering by elective caesarian section at Hastings Memorial Hospital.

Results The study involved 124 participants, of whom 31 were Maori. The mothers in our study had normal iron status or were mildly-to-moderately anaemic. Maori mothers had significantly lower haemoglobin levels compared to non-Maori; however there was no significant difference in maternal levels of iron or ferritin. Cord blood parameters for Maori neonates were not different for haemoglobin or iron, however ferritin was significantly lower. When Maori and non-Maori were analysed together, no statistical relationship was found between maternal and fetal cord blood for haemoglobin, iron, and ferritin levels.

Conclusions Our study suggested that, when analysing our study population of mothers with normal iron status or mild-to-moderate anaemia, iron stores in the fetus were not adversely affected by maternal haemoglobin, ferritin, or iron levels. However, separating for ethnicity, Maori mothers had significantly lower serum haemoglobin values than non-Maori. Furthermore, Maori neonates had significantly lower cord ferritin levels than non-Maori. It is possible that the lower ferritin values seen in Maori neonates compared to non Maori may ultimately contribute to higher rates of anaemia in these infants.

Iron deficiency is a preventable heath problem that affects a large number of New Zealand infants.[1,2] Little progress has been made in the last 42 years since the first paper (identifying iron deficiency as a problem) was published.[3] Iron deficiency is common amongst children living in underprivileged circumstances; children of Maori and Pacific ethnicity are highly represented in this group.[1,2]

Iron requirements are high during infancy, and it is during this time that major deleterious effects of tissue iron deficiency are seen. These include impaired brain development, altered mood, reduced weight gain, fatigue, and impaired immunity.[4] Neurological affects (such as altered behaviour and development in infants, and decreased learning in children) have been shown to occur in the presence of iron deficiency, even in the absence of anaemia.[5,6] Some studies have shown that cognitive function may not improve in iron-deficient anaemic infants following iron therapy.[7] This suggests that prevention of iron deficiency in young New Zealanders is extremely important as it may stop them from achieving their full potential.

To prevent the development of iron deficiency in infancy, it is necessary to understand whether it occurs during the pre-, peri- or postnatal period. Peri-natal acquisition of iron stores has been shown to be affected by time of cord clamping in Indian infants.[8] Postnatal iron stores have been reported to be greatly affected by diet, especially from 6 months of age.[9] There are conflicting reports regarding pre-natal acquisition of iron in the fetus, the question being whether maternal iron status affects, or is independent of, the fetal iron status.[10–19] This study was undertaken in the Hawke's Bay region where iron deficiency, especially in Maori infants, is a problem. This study investigated the associations between maternal and fetal iron stores.

Methods

The study was performed at Hastings Memorial Hospital in Hawke's Bay, New Zealand. The study period was between December 1997 and August 1999. A total of 3145 women delivered babies during this period, this included all elective and emergency caesarian sections and vaginal deliveries. 179 women, of whom 38 were Maori, had elective caesarian sections performed. 146 women were eligible, of whom 85% were consented and 15% were missed due to the consenting doctor being unavailable. 124 women participated in the study. A sample size of 27 per ethnic group would have 80% power at the 0.05 level of significance to show that a correlation of 0.5 was different from a correlation of 0.

Women who delivered by elective caesarian section were included in the study. Women were excluded if they suffered medical conditions, had complications of pregnancy, or delivered prior to 36 weeks' gestation. The decision to only include women delivering by elective caesarian section allowed a standard interval of time (less than 48 hours) between maternal and cord blood samples to be taken. This also allowed maternal blood to be taken when the mother was not in established labour. However, the results from this study must be interpreted with the consideration that only women delivering by elective caesarian section were included.

On the day prior to delivery, venous blood samples were taken from women for measurement of serum haemoglobin, ferritin, and iron. Cord blood samples were taken at caesarian section for measurement of haemoglobin, ferritin, and iron. Caesarian section and blood-taking techniques were not influenced by cultural preferences, these being the same for Maori and non-Maori. The hospital's laboratory analysed the blood samples. During 1998, the analysers were upgraded.

Haemoglobin was analysed using a Technicon H1 machine, which was replaced by a Coulter STKs. Cyanmethaemoglobin reagent was used. Ferritin was analysed using an Abbott IMX which was replaced by an Abbott Axsym. Dedicated Abbott reagents were used. Iron was analysed using a Hitachi 911 followed by a Hitachi 917. Roche reagents were used.

SAS version 6.12 was used for statistical analysis. Separate regression models for each of the parameters (haemoglobin, iron, and ferritin) were used to investigate whether maternal levels predicted cord blood levels. Ethnicity was included in the models.

Consent was obtained from all participants involved in the study. The Hawke's Bay Ethics Committee approved the study.

Results

Maori and non-Maori maternal serum and cord blood haemoglobin, ferritin, and iron were compared using T tests. Twenty-five percent of the study population was Maori, which was comparable to the percentage of Maori (22%) in the Hawke's Bay Region.[20] Maori mothers were found to have a significantly lower serum haemoglobin level compared to non-Maori ($p=0.002$). However, other blood parameters indicating maternal iron levels (ferritin [$p=0.2$] and iron [$p=0.8$]) were not significantly different between the two groups.

Thus, although Maori mothers had lower haemoglobin values, they were not more iron-deficient then their non-Maori counterparts in our study. The cord haemoglobin (p=0.9) and cord iron (p=0.8) levels of Maori and non-Maori neonates were not significantly different, however cord ferritin (p=0.01) was significantly lower (Table 1).

Table 1. Comparison of blood parameters for Maori and non-Maori

	Maori **Mean (Confidence Intervals)**	**Non-Maori** **Mean (Confidence Intervals)**	**P value**
Maternal Hb*	107.9 (102.6–113.1) n=29	117.3 (114.5–120.2) n=90	0.002
Maternal Iron	13.8 (10.7–16.8) n=25	14.3 (11.8–16.8) n=83	0.8
Maternal Ferritin	21.7 (12.3–31.08) n=25	15.8 (11.9–19.7) n=83	0.2
Cord Hb	143.6 (137.0–150.1) n=20	144.1 (140.7–147.6) n=73	0.9
Cord Iron	26.7 (23.4–30.1) n=23	26.4 (24.9–27.8) n=77	0.8
Cord Ferritin	83.6 (61.8–105.4) n=23	119.8 (101.5–138.2) n=76	0.01

*Haemoglobin.

Table 2. Regression results from models with one maternal blood predictor and ethnicity

Maternal predictor	**Cord blood outcome**	**Predictor**			**Ethnicity***		
		Slope	Standard error	p	Slope	Standard error	p
Haemoglobin	Haemoglobin	- 0.01	0.1	0.95	1.98	3.96	0.6
	Iron	0.01	0.05	0.9	-0.98	1.8	0.6
	Ferritin	-0.2	0.6	0.7	35.9	19.5	0.07
Iron	Haemoglobin	0.001	0.14	0.99	3.3	3.9	0.4
	Iron	0.07	0.07	0.3	-0.3	1.7	0.9
	Ferritin	1.0	0.8	0.2	35.3	19.7	0.08
Ferritin	Haemoglobin	0.09	0.1	0.4	3.5	3.8	0.4
	Iron	0.01	0.04	0.8	-0.1	1.7	0.9
	Ferritin	0.2	0.4	0.7	37.6	20.2	0.07

A positive slope indicates an increased cord blood outcome for Maori. A negative slope indicates a decreased cord blood outcome for Maori.

The relationship between maternal and cord blood was analysed using separate regression models for each of the parameters (haemoglobin, iron, and ferritin). Ethnicity was included in the models. The interactions of ethnicity on maternal blood were not found to be significant (p>0.5) so Maori and non-Maori data were analysed together. No relationship was found for any of the parameters investigated. Maternal haemoglobin did not predict cord haemoglobin (p=0.95), iron (p=0.9), or ferritin (p=0.7); maternal iron did not predict cord haemoglobin (0.99), iron (p=0.3), or ferritin (p=0.2); and maternal ferritin did not predict cord haemoglobin (p=0.4), iron (0.8), or ferritin (p=0.7), respectively (Table 2).

Prior to the analysis, the sample size was reduced by loss of blood samples secondary to blood clotting, and insufficient specimens taken (Table 1).

Discussion

The mothers in our study had normal iron status or were mildly-to-moderately anaemic. Analysis of the study group showed no statistical relationship between maternal venous and fetal cord blood haemoglobin, iron, and ferritin levels. This result suggested that iron stores in the fetus were not adversely affected by mild-to-moderate anaemia in the mother—thus supporting the theory that (for women with mild-to-moderate anaemia) the placenta and fetus have a special affinity for iron in the mother's circulation, and iron is transported through the placenta irrespective of the concentration gradient.[12]

Some studies have shown similar results, with the fetus gaining iron stores independently of maternal iron status. Sturgeon demonstrated that fetal-cord-blood haemoglobin levels were similar in anaemic and non-anaemic mothers.[10] Furthermore, Cantwell et al showed that mothers who were given adequate and less-than-adequate iron therapy during pregnancy had babies with similar cord-blood haemoglobin levels.[11] Turkay et al found no correlation between maternal haemoglobin and ferritin at 16 and 34 weeks' gestation and newborn haemoglobin parameters.[12] Bhargava et al found maternal iron depletion did not adversely affect newborn haemoglobin levels.[14]

However, it appears that the relationship between the mother and fetus regarding the acquisition of iron is more complex, with other studies documenting a correlation between maternal iron status and that of the fetus or newborn infant. Sisson and Lund[15] and Nhonoli et al[16] found that the newborn of iron deficient mothers had significantly lower levels of haemoglobin and iron in the cord blood. Singla et al found that maternal haemoglobin had a linear correlation with haemoglobin and iron levels in the cord blood and placental tissue.[17] Fenton et al[18] and Milman et al[13] found that maternal ferritin correlated with cord and newborn ferritin levels, respectively. Rusia et al found that maternal haemoglobin did not correlate with cord blood haemoglobin, but maternal ferritin and haemoglobin were found to correlate positively with cord ferritin.[19]

This present study suggests that, in our population of Maori and non- Maori mothers, iron parameters taken at the end of the third trimester of pregnancy did not significantly affect fetal iron parameters. However, when separating for ethnicity, Maori mothers had significantly lower haemoglobin values and Maori infants had significantly lower cord ferritin values compared to non-Maori. It is possible that these parameters may be linked and related to higher rates of anaemia in Maori infants. This possibility would require clarification with further research.

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