

# The Association between Anemia in Infants, and Maternal Knowledge and Adherence to Iron Supplementation in Southern Israel

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**Key words:** anemia, iron supplementation, children, adherence, maternal knowledge

## Abstract

**Background:** Iron deficiency is the most prevalent anemia in infants and is known to be a major public health problem.

**Objective:** To examine mothers' knowledge and adherence with recommendations regarding iron supplementation and assess their association with the prevalence of anemia in infants.

**Methods:** Data on 101 infants and mothers of infants born between November 2000 and February 2001 and living in a small Jewish town in southern Israel were collected using a structured questionnaire and the infants' medical charts. Anemia was defined as serum hemoglobin less than 11 g/dl. Independent variables include socioeconomic data, mothers' knowledge, and adherence to treatment as reported by them. Chi-square test was used to analyze categorical variables, t-test was used for continuous variables, and hemoglobin was tested at 9–12 months of age.

**Results:** Of the 101 infants in the study, 47% had serum hemoglobin under 11 g/dl. Of the mothers, 62 (62%) were partially or completely non-compliant with iron supplementation; 34 (34%) had low level of knowledge regarding anemia. Multivariate logistic regression analysis revealed a significant and inverse relationship between the presence of anemia and the level of maternal knowledge (odds ratio = 5.6, 95% confidence interval 1.6–9.7;  $P = 0.006$ ) and reported adherence with iron supplementation (3.2, 1.1–9.7;  $P = 0.04$ ) after controlling for confounding factors: maternal education, socioeconomic status, breastfeeding, and meat consumption.

**Conclusions:** The presence of iron deficiency anemia in infants in southern Israel is inversely affected by the level of maternal knowledge of anemia and adherence to iron supplementation. Low level of knowledge is also directly related to low adherence.

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Iron deficiency is the most prevalent anemia in infants and is known to be a major public health problem in both undeveloped and developed countries [1,2]. Serum hemoglobin is a simple accepted screening test for anemia [3]. Recent studies have emphasized the long-term negative effects of iron deficiency anemia on growth and psychomotor and intelligence development [4,5].

In Israel, as well as in other western countries, the prevalence of anemia has declined in the last few decades [6,7]. Prevalence is greater among high risk populations such as low socioeconomic groups and minority ethnic groups, for example the Bedouin. In one study, 27% of healthy Bedouin children under 5 years old were anemic (hemoglobin < 11 mg/dl) [8]. An additional large-scale study covering more than 3000 infants in the Negev desert area in southern Israel revealed that anemia rates among 1 year

olds were 24% in Jewish infants and 35% in Bedouin infants (unpublished results, A. Fraser, MSc thesis, 2003). Other studies revealed the negative outcome effects of anemia on the rate of hospital admissions and infectious disease, as well as the long-term effects on growth and development, especially among those with low socioeconomic status and minority groups such as the Bedouin [9].

In 1985 the Israel Ministry of Health recommended that all infants aged 4 to 12 months be given iron supplementation (1 mg/kg/day) [10]. There is evidence that the prevalence of anemia declined among infants who received iron supplementation [11]. However, adherence with iron supplementation is still low in Israel [12]. The present study was undertaken to determine the prevalence of anemia in infants at age 1 year, to assess reported adherence of families to recommended daily iron supplementation, and to identify the association between the presence of anemia and the level of maternal adherence and knowledge regarding iron deficiency anemia. Our hypothesis was that mothers of anemic infants have scant knowledge about anemia and are less adherent to recommended iron supplementation.

## Subjects and Methods

One year old infants (born between November 2000 and February 2001) and their mothers, who attended the Maternal and Child Health Clinic in a small Jewish town (Netivot) in southern Israel were eligible for the study. Only infants who had their hemoglobin level recorded in their medical charts were included in the study after the mother's consent was obtained. Data on the sociodemographic status of families, breastfeeding, maternal meat intake, mother's knowledge regarding anemia, and reported adherence to recommended iron supplementation were collected using a structured questionnaire. Knowledge questions regarding anemia and iron deficiency related to the cause of anemia, signs and symptoms, short-term consequences such as weakness and reduced appetite, long-term consequences such as developmental and behavioral problems, iron-rich food, and to the MCH recommendations for iron supplementations. Low, intermediate, and high levels of maternal knowledge were defined as the low, middle, and upper third of correct answers' distribution, respectively. Mothers' adherence with iron supplement recom-

MCH = Maternal and Child Health

mentations was assessed by questions on the frequency of using iron preparations. Complete adherence was defined as daily iron supplementation, as advised by the public health nurse at the MCH clinic, reported by the mother. No adherence was defined as no or only partial iron supplementation (not every day). In addition, we used municipality definitions regarding neighborhood socioeconomic status: low, intermediate, and high. Neighborhood socioeconomic status definitions took into account factors such as tax payments, private homes vs. multi-story buildings, the number of families that receive welfare, and unemployment rates. Appropriate meat consumption was defined as eating at least 350 g of meat products per week (Ministry of Health recommendations) as reported by the mothers.

The infants' medical MCH clinic charts were used to obtain the hemoglobin measurement from the blood test at 9–12 months of age. Anemia was defined as Hb < 11 g/dl, using the standard World Health Organization definition. Statistical analysis was performed using SPSS, version 12. We compared mothers' knowledge and adherence to iron supplement recommendations between the groups of infants with and without anemia. We also compared sociodemographic variables between these two groups. For comparing categorical variables we used chi-square or Fisher's exact test, and Student's *t*-test for continuous quantitative variables. Finally, to determine the independent association between anemia in the infants and maternal knowledge and adherence to recommendations, we performed a multivariate logistic regression analysis.

The study was approved by the ethics committee of Soroka University Medical Center and Ben-Gurion University of the Negev as a study in the Masters of Public Health program.

## Results

Of the 230 mother-infant pairs eligible for the study, 101 infants (44%) and their mothers met the inclusion criteria. Most families were ultra-Orthodox Jews. The average maternal age was  $27 \pm 5$  years (range 18–40 years). Almost all mothers (97%) were married. Ninety mothers were born in Israel, 8 in Ethiopia, 2 in Russia, 1 in Canada. The average number of years of education among the women who studied was  $12 \pm 2$  (range 0–17); 45 mothers (45%) had a college education. Socioeconomic status was low in 38 mothers (38%), average in 39 (38%), and high in 24 (24%). One-third (34%) of the mothers had inadequate knowledge regarding anemia, 38 (38%) mothers had average knowledge, and only 29 (28%) expressed a high level of knowledge. Sixty-two mothers (61.4%) reported partial or non-adherence to iron supplementation, compared to 39 mothers (38%) who were adequately compliant. Approximately half (47%) of the infants in this study were anemic (Hb < 11 g/dl). The background characteristics of anemic and non-anemic children were compared. A comparison of socioeconomic status and feeding data (reported breastfeeding and meat intake) between infants with and without anemia is presented in Table 1.

Maternal education and socioeconomic status were significantly related to the prevalence of anemia. Anemic infants, compared with non-anemic infants, had mothers with lower education

**Table 1.** Socioeconomic level and feeding data among anemic and non-anemic children

|  | Children with anemia (n=47) | Children without anemia (n=54) | 95% CI       | P       |
|--|-----------------------------|--------------------------------|--------------|---------|
| Maternal age (yrs)*                      | 27.0 ± 5.0                  | 27.0 ± 5.3                     | -2.04; 2.04  | 0.9     |
| Maternal education (yrs)*                | 11.0 ± 5.0                  | 13.0 ± 5.0                     | -3.98; -0.02 | 0.047   |
| Socioeconomic level of neighborhood**    |                             |                                |              |         |
| Low                                      | 32 (68.0)                   | 6 (11.0)                       | 2.86; 13.62  | < 0.001 |
| Intermediate                             | 14 (30.0)                   | 25 (46.0)                      | 0.38; 1.09   | 0.09    |
| High                                     | 1 (2.0)                     | 23 (43.0)                      | 0.01; 0.36   | <0.001  |
| Length of exclusive breastfeeding (mos)* | 5.0 ± 4.1                   | 4.2 ± 3.0                      | -0.61; 2.21  | 0.3     |
| Eating at least 350 g meat per week**    | 14 (29.8)                   | 19 (35.8)                      | 0.48; 1.50   | 0.5     |

\* Mean ± SD

\*\* n (%)

**Table 2.** Association between anemia and maternal knowledge regarding anemia and adherence with iron supplementation

|                     | Children with anemia (n=47) | Children without anemia (n=54) | Odds ratio | 95% confidence interval | P       |
|---------------------|-----------------------------|--------------------------------|------------|-------------------------|---------|
| Maternal knowledge  |                             |                                |            |                         |         |
| Low                 | 26 (55.3%)                  | 8 (15.0%)                      | 11.9       | 3.13; 48.6              | < 0.001 |
| Intermediate        | 15 (31.9%)                  | 23 (42.5%)                     | 2.4        | 0.7; 8.5                | 0.1     |
| High                | 6 (12.8%)                   | 23 (42.5%)                     | 1.0        |                         |         |
| Adherence with iron |                             |                                |            |                         |         |
| None                | 37 (78.7)                   | 25 (46.3%)                     | 4.1        | 1.6; 11.1               | < 0.001 |
| Complete            | 10 (21.3)                   | 29 (53.7%)                     | 1.0        |                         |         |

and belonged to families with lower socioeconomic status. There were no differences in exclusive breastfeeding duration between anemic and non-anemic children at the age of 12 months.

The relationship between anemia and maternal knowledge and adherence to iron supplementation among infants is presented in Table 2. There was a significant association between reported maternal knowledge regarding anemia in children and prevalence of anemia, as well as between reported adherence to recommended iron supplementations and anemia. Children of mothers with low knowledge regarding anemia had a 12-fold prevalence of anemia as compared to mothers with high knowledge ( $P < 0.001$ ), with a dose-response effect.

We also examined the association between background factors and maternal knowledge regarding anemia and adherence to recommendations. Maternal age and education were not associated with the level of knowledge, but socioeconomic status had a significant direct effect on the level of knowledge. Of mothers from families with low, intermediate, and high status, 62%, 35%, and 3% respectively had low knowledge about anemia ( $P < 0.001$ ). There was no statistically significant association between adherence and socioeconomic status and feeding data. Since socioeconomic status can act as a confounding factor, being

**Table 3.** Results from multivariate logistic regression analysis for predicting anemia by knowledge about anemia

|                               | Beta    | OR   | 95% CI    | P       |
|-------------------------------|---------|------|-----------|---------|
| Knowledge about anemia        |         |      |           |         |
| Low vs. intermediate and high | 0.2324  | 5.6  | 1.6; 19.7 | 0.006   |
| Maternal education (yrs)      | -0.2959 | 0.7  | 0.6; 0.99 | 0.049   |
| Socioeconomic status          | 2.5712  | 13.0 | 4.0; 43.2 | < 0.001 |
| Low vs. intermediate and high |         |      |           |         |

**Table 4.** Results from multivariate logistic regression analysis for predicting anemia by adherence

| Variable                      | Beta    | OR   | 95% CI    | P       |
|-------------------------------|---------|------|-----------|---------|
| Adherence                     |         |      |           |         |
| Complete vs. non-adherence    | 0.5161  | 3.2  | 1.1; 9.7  | 0.04    |
| Maternal education (yrs)      | -0.3177 | 0.7  | 0.5; 1.01 | 0.06    |
| Socioeconomic status          |         |      |           |         |
| Low vs. intermediate and high | 2.6171  | 13.7 | 4.2; 44.2 | < 0.001 |

significantly related both to anemia and to level of knowledge, we performed multivariate logistic regression analysis to examine the independent association between anemia in infants and maternal knowledge regarding anemia. The independent significant relationship between anemia and maternal level of knowledge and adherence to recommended iron supplementation is described in Tables 3 and 4. Both knowledge and adherence were independently associated with anemia, even after controlling for background data, such as socioeconomic status, maternal age and education, breastfeeding, and meat consumption.

Low socioeconomic status was found to be an independent risk factor associated with an approximately 13-fold increased prevalence of anemia. Years of maternal education were a protective factor for anemia, but with borderline significance.

## Discussion

Iron deficiency anemia is the most common nutritional anemia worldwide and has become a public health issue, especially in developing countries and low socioeconomic status populations. In this study, only 101 out of a cohort of 230 infants had their hemoglobin tested. About half of the tested children were anemic (Hb < 11 g/dl). Other surveys in Israel showed a similar or lower prevalence [6,11,13]. These results resemble the prevalence of anemia in undeveloped populations, for example Malaysia, where recorded anemia rates in preschool children were 40–50% [14,15]. Our rates were much higher than in developed countries, even among low income populations [16,17]. In a very recent large-scale study conducted in Israel on 34,512 infants from all over the country, the average rate of anemia was 15.5%. The prevalence was significantly higher among the non-Jewish population (22.5%). The authors used hemoglobin lower than 10.5 g/dl as the cutoff for anemia [18]. Unfortunately, despite clear recommendations from the Israel Ministry of Health for daily iron supplementation to infants 4–12 months of age, adherence

to these recommendations is poor. In our study, only 38% of the mothers reported full adherence, and 76% of them had high socioeconomic status. These findings resemble other studies dealing with compliance or adherence to treatment [19,20]. In contrast to our study, Amsel et al. [12] found that parents with high status were less adherent, compared to those with low status. One possible explanation is that the high status population uses nutrition and food additives instead of iron preparations. Our study population included mostly ultra-Orthodox Jews who use food additives very infrequently.

Our study results demonstrate a strong and independent association between the presence of anemia and maternal knowledge regarding anemia, after controlling for socioeconomic level, maternal age, breastfeeding, and meat consumption. A high level of maternal knowledge was significantly related to higher reported adherence to iron treatment and lower prevalence of anemia. These results are similar to a study by Palti [11]. In contrast to a study by Khor [14], we found no significant association between the duration of breastfeeding and the presence of anemia. This can be explained by the use of iron-fortified formulas by the majority of parents.

The main limitation of this study was that only 101 mothers (those whose infants had a complete blood count done) out of a cohort of 230 were included. It is worth noting that in Israel the systems of preventive care (MCH clinics) and primary care (health management organizations) are separate. Infants have to be referred by the MCH clinic nurse to their primary physician at the HMO for a complete blood count. Therefore, reasons for not having the blood results recorded in the MCH clinic medical charts could be that: a) mothers did not take their infants to have their blood count done, b) results were normal and therefore were not reported to the MCH clinic, and c) abnormal results were treated by the primary physician (namely, prescribing iron preparations) without reporting to the MCH clinic nurse. Unfortunately, even with the recent introduction of advanced computerized medical charts among the HMO clinics, these two systems do not interact. Our study was conducted in the MCH setting only, and therefore blood test information was partially lacking. Information regarding infants who did not have their blood count taken was not available. It is reasonable to speculate that a significant proportion of the excluded group, who did not have their infants' hemoglobin tested, would have lower knowledge and adherence. This emphasizes and supports our findings. Another limitation of the study is that we used reported adherence instead of the number of iron preparation refills used by parents. Reported adherence might be overestimated; but still, a high percentage of parents do not follow the MCH clinic recommendations. One other limitation of our study was the use of hemoglobin level as the indicator of iron deficiency anemia: there are other causes of anemia [1], although the majority of anemic infants have iron deficiency [2,21].

In conclusion, anemia in infants was significantly associated with low level socioeconomic level, poor maternal knowledge, and

HMO = health management organization

self-reported poor adherence. Our study emphasizes the need for better interaction and cooperation between the MCH clinics and HMO system to share information. Also, more interventional education programs are needed to encourage hemoglobin testing of all infants and improve maternal knowledge about iron deficiency anemia and its negative effects, especially in low socioeconomic populations, and thus improve adherence with iron supplementation. If future research on such programs does not prove their efficacy, policy changes regarding earlier anemia detection and supplementation should be considered.

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