

Five decades of trends in anemia in Israeli infants: implications for food fortification policy

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Objective: To describe the secular trends in the prevalence rates of iron-deficiency anemia (IDA) in infants in Israel, identify population group differences and assess the effectiveness of the 1985 Public Health directives on iron supplementation and avoidance of cow's milk in the first year of life.

Design: A systematic analysis of published and unpublished cross-sectional studies.

Methods: IDA rates in 1-y-old infants between 1946 and 1997 were assessed from published papers and reports. Rates for Arab infants were available from 1984. Data on routine hemoglobin tests on 1-y-old infants for Arabs and Jews separately were obtained from four health districts for the period 1987 to 1997. Analyses were done for the periods prior to and following the Public Health directives.

Results: The prevalence of IDA in Jewish infants declined from 68% in 1946 to 50% in 1985 at an average annual rate of -1.43% . Following the iron supplementation directives, the average annual rate of decline increased to -4.0% and reached a prevalence of about 11% in 1996. IDA rates in Arab infants declined by an annual average of -3.7% , and were consistently almost twice as high as for Jewish infants.

Conclusions: Despite the contribution of the iron supplementation program to the reduction in IDA, the persistently high rates indicate inadequate iron content in the diet. This emphasizes the important role of a national food fortification program, using staple foods commonly consumed.

Descriptors: iron deficiency anemia; iron supplementation; iron fortification; Israel; Arabs; Jews
European Journal of Clinical Nutrition (2001) **55**, 82–87

Introduction

Iron deficiency is one of the most common nutritional deficiencies in the world (Demaeyer, 1989), and is manifested in its more severe form as iron deficiency anemia (IDA). The World Health Organization (WHO) has published standard criteria for IDA (World Health Organization, 1989) that indicate when iron deficiency is sufficiently severe as to interfere with hemoglobin formation. Approximately 73% of the body's iron is normally incorporated in hemoglobin and 12% in the storage complexes ferritin and

hemosiderin. The remaining 15% are incorporated into a variety of other iron-containing compounds of vital importance (Bothwell, 1995).

There is convincing evidence linking iron deficiency anemia to lower cognitive test scores and that these effects can be permanent (Pollitt *et al*, 1985; Holst, 1998). If iron deficiency in infancy is left untreated, it can limit the learning capacity and productivity of entire sub-populations (Pollitt, 1993). The growing advocacy for implementing prevention programs to avoid iron deficiency emerges from strong economic arguments that such interventions are among the most cost-effective available policies in public health and nutrition (Gillespie, 1998). Also the WHO/World Bank analyses of the Global Burden of Disease ranked IDA as the third leading cause of loss of disability-adjusted life years (DALYs) for females aged 15–44 across the globe (Murray & Lopez, 1996). The health and developmental impacts of iron deficiency, reinforced by the moral and legal aspects of human rights, should compel governments to address this issue.

In this paper we review trends in IDA among infants in the two major population groups (Jews and Arabs) since the establishment of the State of Israel more than five decades

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Contributors: DNK designed the study, coordinated the data collection, carried out the analyses and drafted the paper. AL assisted with data collection and the writing of the paper. YA carried out the literature review and assisted with data collection. SR, SH, IB, MC-D, LR and SR all contributed data and reviewed the paper. YA and HP reviewed the data analyses and the paper.

Received 9 June 2000; revised 21 September 2000;

accepted 25 September 2000

ago. Two periods are compared—prior to and following the publication of the 1985 directives of the Israeli Ministry of Health (MOH) on the prevention of IDA. These directives had three elements: they endorsed iron supplementation for infants between the age of 5 and 12 months, established routine testing of hemoglobin at 12 months and recommended avoidance of cow's milk in the diet during the first year of life. The data presented are used to assess whether there is a case for action for a 'new' national intervention program, based on food fortification.

Methods

Data on trends in the prevalence rates of IDA were obtained from several sources. We reviewed all published papers and research reports between 1946 and 1999. The search was made using MEDLINE, referenced papers, MOH reports, theses and personal communications. The Israel Central Bureau of Statistics classifies the population into two population groups: Jews (about 80%) and non-Jews (about 20%), comprising Moslems (16%), Christians (2%) and Druze (2%). Since the Arabs are the overwhelming majority of this group it is referred to as the 'Arab population' in this paper.

Between 1946 and 1982 published data were available for Jewish infants only. In addition, for the period 1987 and 1997, data on routine hemoglobin tests for Arab and Jewish 1-y-old infants attending the family health centers were obtained from four health districts and sub-districts North, Haifa, Netanya and South (Rishpon, 1986; Rubin & Rishpon, 1993). These regions represent different mixtures of populations. Urban Jewish and Arab communities, with a relatively high proportion of Christian Arabs, characterize the Haifa sub-district. In the Netanya sub-district the population comprises Jews and Moslem Arabs, both with higher proportions living in rural localities. The Arab population of

the southern district are all Bedouin, 50% of whom are nomads and live outside of established settlements, in tents and huts, without electricity, running water and easy access to food stores and health services. The Jewish population of the southern district is of middle to low socio-economic status (SES).

Trends in prevalence were examined using linear regression. The average annual change in IDA prevalence was estimated by the beta-coefficient, which is presented together with the associated coefficient of determination (r^2).

Results

The prevalence rates of IDA have decreased markedly over time (Figure 1 and Table 1). In the Jewish population, since the earliest survey, the overall IDA prevalence rate dropped from 68% in 1946 to about 7–11% in 1996, with an average annual rate of decline of 4.1% per year ($r^2=0.67$). This decrease occurred over two distinct periods—prior to and following the publication in 1985 of the Public Health Services directives for iron supplementation of infants and pregnant women and avoidance of cow's milk in the first year of life. Between 1946 and 1985 the IDA rates dropped from 68 to 50% with an average annual decrease of 1.43% ($r^2=0.09$). After 1985 they declined to the prevalence rate in 1996 of about 7–11% with a 4.0% average decrease per year ($r^2=0.73$).

The prevalence of IDA in the Arab sector has been documented since 1984. The rates declined from about 70% in 1985 to about 30% in 1993, to about 20% in 1996 (Figure 1), at an average annual decrease of 3.7% ($r^2=0.55$). The prevalence has always been substantially higher in the Arab population compared with the Jewish population, although the rates of decline were similar in both populations. These population group differences have

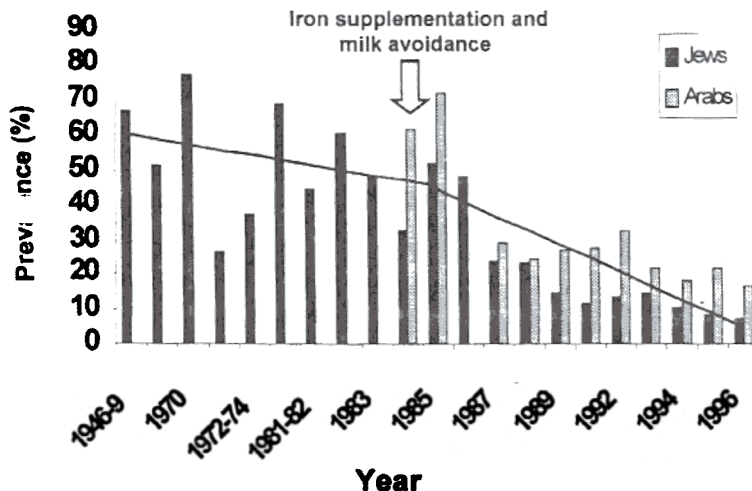


Figure 1 Trends in the prevalence of hemoglobin g/dl among 1-y-old infants for Jews and Arabs in Israel during 1946–1996 (data for Arab available from 1986; regression line shown for the Jewish population 1946–1985 and 1985–1996).

Table 1 Sources of data, study year, sample size, setting, ethnicity and age for prevalence (%) of hemoglobin under 11 mg/dl; Israel, 1946–1996

Data source	Study year	Sample size	Location	Ethnicity	Age (months)	Prevalence (%) of hemoglobin < 11 mg/dl
Kochman (1953)			Tel-Aviv			66.8
Kochman (1953)			Tel-Aviv			51.4
Izak <i>et al</i> (1971)			Kiryat-Shmoneh			76.9
Palti <i>et al</i> (1997a)			Jerusalem			26
Palti <i>et al</i> (1977a)			Jerusalem			37.3
Nordan <i>et al</i> (1980)			Haifa			68.8
Lavon <i>et al</i> (1985)			Hadera			44.7
Lavon			Hadera			60.6
Rishpon (1986)			Hadera			48.4
Rishpon (1986)		443	Hadera			32.7
Rishpon (1986)		397	Hadera			61.7
Sofer <i>et al</i> (1986)		44	Beer-Sheba			52
Sofer <i>et al</i> (1986)		107	Negev			72
Wolach <i>et al</i> (1987)		155	Sharon			48.5
Rubin and Rishpon (1993)		6093	Haifa			23.5
Rubin and Rishpon (1993)		1019	Haifa			29.3
Rubin and Rishpon (1993)		5514	Haifa			23.3
Rubin and Rishpon (1993)		982	Haifa			24.4
Rubin and Rishpon (1993)		5368	Haifa			14.3
Rubin and Rishpon (1993)		1002	Haifa			27.0
Rubin and Rishpon (1993)		5188	Haifa			11.5
Rubin and Rishpon (1993)		947	Haifa			27.5
PHS report*		991	Netanya			12.2
PHS report		700	Netanya			33
PHS report		5620	Haifa			14.2
PHS report		1021	Haifa			21.7
PHS report		5520	Haifa			10.5
PHS report		1069	Haifa			18.1
PHS report		1370	Netanya			8.4
PHS report		865	Netanya			21.5
PHS report		2703	Netanya			7.3
PHS report		1301	Netanya			16.3

*PHS report, annual Public Health Service Districts and Sub-districts reports.

been documented in different regions of the country (Figure 2). In a study in the northern district on compliance with hemoglobin testing at 1 y of age, the rate in the Arab population was higher (63%) than in the Jewish population (49%).

Discussion

We found that the overall prevalence rates of IDA in Israeli infants declined markedly between 1946 and 1996, although the rates in the Arab population remain substantially higher than that of the Jewish population. It is not easy to attribute these findings to any single factor. The factors include iron deficiency during pregnancy (Veteri, 1997; UNICEF/World Health Organization, 1994; Lozoff *et al*, 1991), lack of breast-feeding, failure to use iron-fortified formula (Yip, 1994), prolonged exclusive breast-feeding (beyond 6 months of age) or consumption of inappropriate complementary foods (due to poverty, food faddism or lack of knowledge; Disler *et al*, 1975; Merhav *et al*, 1985). Low intake of iron, iron bioavailability due to the form of iron, high inhibitors, low enhancers or combinations of them (Osiki, 1993) and intake of cow's milk (Woodruff *et al*,

1972; American Academy of Pediatric Committee on Nutrition, 1992; Pizarro *et al*, 1991) are also important. All the above-mentioned factors could be associated with SES (Osiki, 1993; Smith & Rios, 1974; Sargent *et al*, 1996).

The decline in IDA in Israel prior to the Public Health Service directives on iron supplementation occurred in parallel with the rapid national economic growth and increased availability of iron-fortified formulas (Goldberg and Reshef, 1972; Levy *et al*, 1975; Palti *et al*, 1997a,b). Since 1985 this decline has accelerated. During this period there has been a slight increase in the prevalence of low birth weight (LBW) infants, probably due to the use of *in-vitro* fertilization with more multiple births (Health Information Service, 1999). Hence, the decline in IDA cannot be explained by a reduced prevalence of LBW infants. We cannot exclude the possibility that a reduction in viral infections may have contributed to the decreasing trend in anemia (Olivares *et al*, 1989). It appears most likely that the decline is largely due to increased use of iron-fortified formulas (Yip *et al*, 1987a,b) and implementation of the directives (Wolach *et al*, 1987). Nevertheless, the persistently higher rates of IDA in the Arab population relative to the Jewish population are of concern (Lavon *et al*, 1985). The data available do not show any differences in compli-

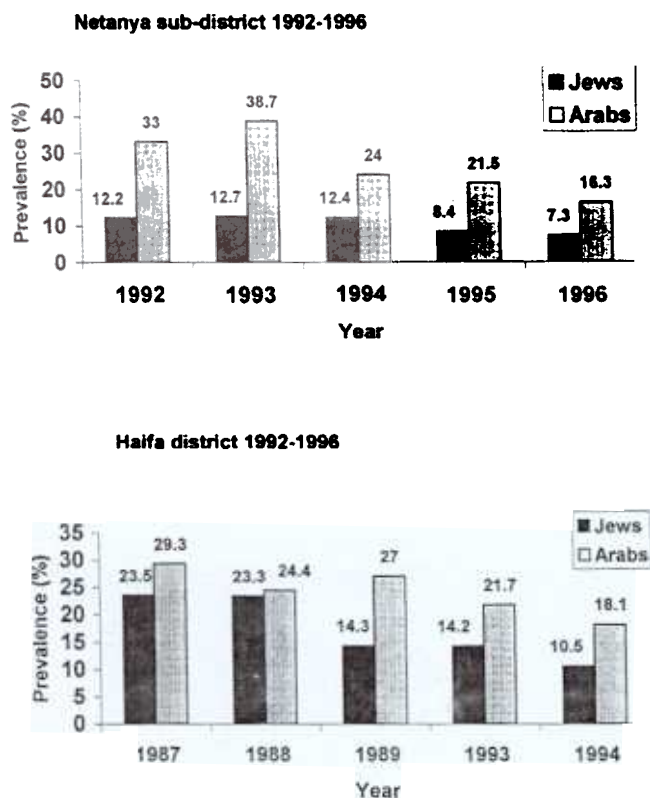


Figure 2 Prevalence (%) of hemoglobin <11 g/dl in 1-year-old infants for Jews and Arabs in two health districts in Israel over two periods between 1987 and 1996.

ance with iron supplementation. Thus, a major reason for this phenomenon could be the SES gap between the Jewish and Arab populations that could be associated with one or more of the determinants of IDA mentioned above. To support this notion, there is some evidence that IDA rates in the ultra-orthodox Jewish community are similar to those of the Moslem Arab population. Both these sub-populations have high birth rates, closely spaced pregnancies and a lower SES. On the other hand, the Christian Arab and the Jewish sub-populations are close to each other in SES, and have similar IDA rates. In the Arab population there is a higher prevalence of IDA during pregnancy and a tendency to give non-breast fed infants, cow's milk instead of iron-fortified formula, most probably due to its lower cost.

According to preliminary data from the Ministry of Health, 16% of pregnant Bedouin women have IDA in the first trimester, 33% in the second trimester and 61% in the third trimester. Deficient maternal iron stores in Bedouin women who have multiple, closely spaced pregnancies, combined with a diet of poor nutritional quality, may partly explain the high rate of IDA among Bedouin infants. In addition, the compliance with iron supplementation is low due to difficulties of access to pharmacies. An added factor is the relatively high rate of diarrheal disease among

Bedouin infants due to poor sanitary living conditions and lack of refrigeration.

In a study in the Haifa region (Habib & Rishpon, submitted), on the effect of SES and ethnic origin on various health measures among infants and toddlers, infant IDA rates were inversely correlated with SES. This phenomenon is more pronounced in the Arab population. Higher IDA rates in pregnant Arab women (40%) compared with Jewish women (24%) were documented in another study, done by the Ministry of Health in Netanya region (MOH publication, 1996). The mothers of 50% of Jewish infants and of 54% of Arab infants reported compliance with the iron directive. The daily consumption of meat was higher in the Jewish population compared with the Arab population (55% and 47%, respectively). In the Arab infants iron supplements were given more with dairy products (42%) compared to the Jewish population (26%), thus decreasing its bioavailability. Moreover, 74% of the Jewish infants received the supplement in conjunction with food rich in vitamin C, therefore increasing the amount of bioavailable iron.

Since the gaps in the prevalence of IDA between Arabs and Jews are similar in the five districts, it can be assumed that the gap and its characteristics exist nationwide. High IDA rates in infancy are also found in the ultra-orthodox Jewish sector in Israel. Prevalence rates from Netanya, reveal that about 18% of ultra-orthodox Jewish infants and 20–30% of the Arab infants had documented IDA in 1988 (MOH Publication, 1999). These observations highlight the important role of reducing socio-economic gaps in the eradication of iron deficiency. Similar SES differences between population groups have been observed elsewhere. For example, IDA is higher among black or Mexican-American children than among white American children in the USA (Looker *et al*, 1997).

A confusing issue that often impedes the development of a national health policy on the prevention of IDA is inadequate appreciation of the consequences of sub-clinical iron-related malnutrition. If the emphasis is on prevention rather on treatment, a more reasonable trigger point for action should be the occurrence of iron deficiency states rather than IDA (Rettmer *et al*, 1999). The shift for action at this stage is justified by evidence of adverse health consequences to those who are iron deficient even in the absence of anemia (Centers for Disease Control and Prevention, 1998). The rate of subclinical iron deficiency state is always much higher than IDA rates (UNICEF, 1998).

The results of several studies on iron status and supplementation carried out in Israel (Nordan *et al*, 1980, 1982) contributed to the adoption of the supplementation approach in 1985. A study carried out in 1984 revealed that only a third of the infants had received the supplemented iron until 9 months of age (Palti & Frier, 1984).

Oral iron supplementation among vulnerable groups during specific periods of life can be an effective intervention in the integrated approach to preventing iron deficiency. Major organizations, including INACG, WHO and UNICEF, recommended routine iron supplementation for young children, adolescents, women of childbearing age.

and pregnant women, when the levels of IDA* in a population exceed 40% (Stoltzfus & Dreyfuss, 1998). The poor effectiveness of iron supplementation in most developing countries has been attributed to various factors, including insufficient dose and poor adherence. Weekly dosing targeted at high-risk groups has proven efficacious in some trials (Viteri, 1997a,b).

IDA rates in Israel are now well under 40% even in the Arab population. However, despite the iron supplementation program they remain unacceptably high. Therefore, there is a need for implementation of a national food fortification program. A tailored iron fortification program requires the identification of staple foods commonly eaten by infants, adolescents and pregnant women, such as bread and pita, that can act as vehicles. When superimposed on existing dietary habits, fortification may not necessitate changes in the customary diet of the population and does not call for individual compliance (Schumann *et al.*, 1998). Fortification gives an important role to the food industry in promoting public health. A mandatory fortification program could best achieve this goal.

Fortification can rapidly yield sustained results. It can be the most cost-effective strategy for primary prevention of micronutrient deficiencies. According to one analysis, where populations are at risk of iron deficiency, fortification of cereals with iron yields \$84.00 in gained productivity for every \$1.00 spent (Levin, 1986). Iron is commonly added to foods (especially grains) in many Latin American countries and increasingly in the Middle East, North Africa and in some Asian countries. Cereal flour has been enriched with iron in the United States since the 1930s to replace the amount lost during milling (Blum, 1995). The role of governments is centered on advocacy, communication, selection of suitable vehicles, selection of an iron fortificant and its dosage, safety assurance, setting standards, regulations, control, monitoring and evaluation (FAO/WHO, 1992).

We recognize that the data on IDA in Israel used in this paper are from a variety of sources with different sampling frames, analysed by different laboratories and are not from standardized national surveys. However, we believe that the large numbers of studies reviewed, adequately demonstrate the long-term trends in the prevalence rates of IDA in infancy in Israel and are consistent in showing the population group differences.

Conclusions

Iron supplementation is recognized as a key strategy for the primary prevention of IDA. Yet, to the best of our knowledge, there are few documented examples of large-scale national iron supplementation programs that substantially reduced IDA rates among infants. Since IDA rates in Israel are still high with substantial differences between sub-populations, the implementation of a national food fortification policy is required. Reliable data are needed to optimize the planning of a food fortification program to prevent IDA

in Israel. In addition, the populations of the Palestinian Authority consume staple foods largely produced in or imported via Israel. The First National Health and Nutrition Surveys of Israel and of the Palestinian Authority are currently being carried out with the same methodology, a common food database and joint data analysis. The information from the surveys will enable the tailoring of the fortification programs for different sub-populations in Israel.

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