Original Articles

Iron Status in Preschool Jordanian Children of 12-59 Months of Age

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Abstract: A national cross-sectional study was conducted in Jordan in 2002 to assess the iron status of 12- to 59- month-old preschool children, using a multistage cluster sampling design that included a total of 1253 of all eligible children.

The prevalence rate of anemia (Hemoglobin (Hb) < 11.0 g/dL), Iron Deficiency (ID; serum ferritin (SF) <12µg/L) and Iron Deficiency Anemia (IDA; Hb< 11.0 g/dL + SF <12µg/L) were found to be 20.1%, 26.1%, and 10.1%.The respective prevalence rates in toddlers of 12 to 23 months of age attained higher levels of 34.4%, 45.9%, and 21.3%.

This is the first national study whereby Hb and SF were used to assess the iron status of preschool children. It is concluded that more attention should be given to the iron status of preschool Jordanian children particularly those who are less than two years old since this is a period during which lack of iron causes impairment to mental development.

Keywords: Iron deficiency anemia, preschool Jordanians, a national study.

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Introduction and Objectives:

Iron, iodine, and vitamin A have been identified by renowned international nutrition and health experts as the three micronutrients that deserve particular attention and priority in developing as well as developed countries. [1] Iron Deficiency Anemia (IDA) is the most common nutrition disorder in developing countries especially among preschool children, pregnant women and women of reproductive age. [2]

It is estimated that 40% to 60% of children in developing countries are iron deficient between the ages of 6 months to 2 years, a period during which lack of iron causes impairment to mental development. [3]

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Scrimshaw [2] reviewed the effect of IDA on infants and children and concluded that it retards their psychomotor development and impairs their cognitive performance. These adverse effects on IDA have been also asserted in two recent studies reported by Walter. [4]

The serious point is that long-term impairment was observed in follow- up studies at 5 and 10 years of age. [5, 6]

Iron is a growth factor and consequently its supplementation improved physical growth in anemic children. [7, 8] Iron deficiency is also associated with impaired immunity and enhanced susceptibility to infection. [9, 10]

No recent comprehensive national study for the assessment of iron status in preschool children has been conducted in Jordan. Studies on samples of a limited number of Jordanian infants and children showed that the proportion of anemia (hemoglobin < 10.5g/dL) among them ranged between 34% and 45%. [11- 13]

A rather recent national study was carried out by UNICEF and the Jordanian Ministry of Health (MOH) in 1992. [14] It was based on blood hematocrit. Another quite recent national study which coincided with the study we are reporting herein was based on hemoglobin only. Unfortunately, neither hematorcit nor hemoglobin is a specific indicator for evaluating iron status and thus cannot be used as proxy indicators of iron deficiency. Serum ferritin is the indicator of choice for measuring iron deficiency. [15, 16] Our study is based on hemoglobin and serum ferritin.

Based on the recently applied strategy of flour fortification in Jordan and the foreseen need for future evaluation of its impact, the study we are reporting is meant to be a national baseline study, with the main objective of estimating the prevalence of anemia, Iron Deficiency (ID), and IDA in preschool Jordanian children of 12 to 59 months of age. [17]

Subject and Methods

Subjects and Sampling: This is a national cross-sectional survey using a multistage cluster sampling. Sampling frame as updated for the 2000 Demographic Health Survey was obtained from Jordan's General Department of Statistics (DOS). A total of 1253 of all eligible preschool children aged 12-59 months (628 males and 625 females) participated in the study. Sample size was calculated from the following equation $n=^{z^2pqe/d^2}$, as based on the following assumptions: prevalence of IDA, 10%; precision, 0.03; a response rate, 0.85; a design effect, 2; and an estimated number per household, 0.7; wherein, n= sample size.

z= standard normal deviate. A value of 1.96 was used for a level of confidence of 95%.
p= expected prevalence in the target population.

q = 1-p, e = design effect and d= precision of anticipated prevalence of 5%.

The protocol of the survey was approved by the Jordanian MOH. Written informed consent was obtained from all mothers of children participants. Confidentiality was strictly maintained.

The field team was composed of six pairs, each of whom comprised of a nurse and a research assistant affiliated with MOH. All members of the team were subjected to an intensive training program. A pilot study was first carried out on a limited number of households. The study was completed in four weeks.

Iron Analysis: A blood sample of about 2 to 3 ml was drawn by venipuncture using sterile disposable needles. A portion of blood was collected in sterile plain tubes and another in sterile EDTA vacutainer tubes for the analysis of complete blood count (CBC), using an automated cell counter (COBAS ABX) .The blood samples in plain tubes were centrifuged at 3000 rpm for 5 minutes in the field as soon as it was possible but within 5 hours of sample collection. Serum ferritin was measured by the electro-chemical luminescence immunoassay using the 'ECLIA' technique.

All collected blood samples were kept in an ice box and were transported for analysis in the central laboratory of the Ministry of Health in Amman. Not a single blood sample was allowed to stay overnight away from the central laboratory. CBC was determined as soon as the blood samples were received; the working hours of the lab technician(s) were modified to meet the needs of analysis.

The cut-off point for anemia was a blood Hb concentration of 11.0 g/dL and that for Iron Deficiency (ID) was < 12µg/L of Serum Ferritin (SF). A combined criterion of Hb<11.0 g/dL and SF<12µg/L was chosen as an indicator for IDA. A questionnaire was filled on certain aspects of breastfeeding.

Data were initially reviewed for completeness and logical checks were performed for error detection.

Statistical Analysis: Data amenable to statistical analysis were carried out using Epi Info 6.04 d program. Confidence intervals (95% CI) were used for testing of significance at $p<0.05$. [18]

Results

A total of 1253 children participated in this study with a response rate of 85.3% for blood collection and 95.5% for the questionnaire.

Table (1) shows the distribution of children by gender according to age groups, residence and region. The sample was almost equally distributed among both genders and age groups. Most children (65%) lived in urban areas.

The variation of Hb concentration is described in Table (2). The mean Hb concentration among study children was found to be 11.7g/dL, with no significant difference between gender or place of residence; it varied to some extent by region and age group, however. Children in north of Jordan had significantly less hemoglobin than those in the middle region. Quite importantly, children of 12-23 months of age had significantly less hemoglobin concentration (11.2) than of all other age groups.

The level of serum ferritin (SF) was not influenced by either gender or place of residence (Table 2). However, it varied to some extent with age; the proportion of 12- to 23- month- old children had significantly less SF than all other age groups.

Table (3) reveals that 10.1% of the study children had IDA, showing a progressive decrease in the prevalence of IDA with increasing age as was already observed for the prevalence of ID but without being affected by either gender or residence.

The overall average prevalence rate of anemia (Hb < 11.0 g /dL) in the study children was 20.1% (Table 3). It was not influenced by either gender or place of residence (rural or urban). It varied by age, however, with the highest prevalence rate of 34.4% was attained by the youngest group of 12 to 23 months of age. It progressively decreased to 23.3%, 13.2%, and 10.6% for the respective age groups of 24 to 35, 36 to 47, and 48 to 59 months. The decrease was significant ($p<0.05$) between all age groups except that between the last two groups.

The rate varied also according to region. Although the prevalence of anemia (14.9%) in the middle governorates was significantly lower than that of the northern governorates (30.0%), it was not significantly lower than that of the southern governorates. The overall prevalence rate of iron deficiency (ID; serum ferritin < 12µg/ dL) was 26.1%. It was not affected by either gender, place of residence, or region. Regarding age, the youngest age group (12 to 23 months) had the highest prevalence rate of ID of 45.9%. It was significantly different from all other groups. There was a progressive decline with age increase uptill the age group of 36 to 47 months, where it leveled off. The decline between the 26-to-35- month old group and that of the older two groups almost attained statistical significance.

The overall prevalence rate of IDA was 10.1% and its trend was remarkably similar to that of ID.

Table 1: General characteristics of 12-59 months old children participants, according to gender and demographic characteristics.

	Male		*Female*		*Total*		
Characteristic	***n***	***Weighted %***	***n***	***Weighted %***	***n***	***Unweighted %***	***Weighted %***
Age groups(mon)							
12-23m	167	27.5	145	24.1	312	24.9	25.8
24-35m	153	24.5	146	22.9	299	23.9	23.7
36-47m	145	21.7	173	27.9	318	25.4	24.8
48-59m	163	26.2	161	24.9	324	25.7	25.6
Place of residence							
Urban	408	75.7	412	76.3	820	65.4	76.0
Rural	220	24.2	213	23.6	433	34.6	23.9
Region							
North	207	30.3	176	26.4	383	30.6	28.4
Middle	260	58.0	286	61.7	546	43.6	59.9
South	161	11.5	163	11.7	324	25.9	11.6
Total	***628***	***100***	***625***	***100***	***125***	***100***	***100***

Table 2: Mean and median concentration of blood hemoglobin and serum ferritin according to selected characteristics of 12-59 months old children.

Characteristics	***Hemoglobin (g/dL)***		***Serum Ferritin (µg/L)***	
	Mean	***Median***	***Mean***	***Median***
Gender	n=1060	n=1060	n=1056	n=1066
Male	11.7 (±0.12)*	11.8	22.4 (±0.17)	18.7
Female	11.7 (±0.14)	11.8	23.4 (±0.17)	19.7
Age groups	n=1060	n=1060	n=1056	n=1056
12-23m	11.2 (±0.16)	11.3	16.6 (±2.0)	13.5
24-35m	11.7 (±0.23)	11.8	24.1 (±2.6)	19.6
36-47m	11.9 (±0.13)	12.0	25.1 (±2.6)	21.4
48-59m	12 (±0.14)	12.1	25.5 (±1.9)	22.3
Place of residence	n=1061	n=1061	n=1057	n=1057
Urban	11.7 (±0.11)	11.8	22.2 (±1.4)	18.8
Rural	11.6 (±0.16)	11.8	25.3 (±3.4)	20.8
Region	n=1061	n=1061	n=1057	n=1057
North	11.4 (±0.16)	11.4	23.5 (±3.0)	19.1
Middle	11.9 (±0.11)	12.0	22.1 (±1.7)	18.9
South	11.7 (±0.30)	11.9	25.6 (±3.5)	22.8
	n=1070	n=1070	n=1066	n=1066
Total	11.7 (±0.09)	11.8	22.9 (±1.4)	19.2

**** Values in parenthesis indicate 95% confidence intervals (95% CI).***

Table 3: Prevalence of anemia, iron deficiency, and iron deficiency anemia in 12-59months old children according to selected some characteristics.*

Characteristics	*Anemia*	*ID*	*IDA*
Gender	n=1060	n=1056	n=1051
Male	22.1% (±4.2)**	29.1% (±4.6)	10.6% (±3.3)
Female	18.1% (±4.1)	23.3% (±4.6)	9.6% (±3.5)
Age groups	n=1060	n=1056	n=1051
12-23m	34.4% (±6.8)	45.9% (±7.2)	21.3% (±6.0)
24-35m	23.3% (±6.0)	26.8% (±6.4)	10.8% (±4.2)
36-47m	13.2% (±3.7)	16.7% (±6.1)	3.8% (±2.5)
48-59m	10.6% (±4.3)	16.2% (±5.2)	5.1% (±3.3)
Place of residence	n=1061	n=1057	n=1052
Urban	19.4% (±3.4)	22.6% (±4.0)	9.9% (±2.7)
Rural	22.4% (±5.7)	24.7% (±5.2)	10.6% (±3.2)
Region	n=1061	n=1057	n=1052
North	30.0% (±5.9)	25.9% (±5.5)	13.6% (±4.3)
Middle	14.9% (±3.4)	27.1% (±4.6)	8.2% (±2.9)
South	23.4% (±8.3)	22.1% (±6.0)	11.2% (±4.4)
	n=1070	n=1066	n=1061
Total	**20.1%** (±2.9)	**26.1%** (±3.2)	**10.1%** (±2.2)

**** Anemia means Hb < 11 g/dL Iron Deficiency (ID) means serum ferritin < 12 µg/L Iron deficiency anemia (IDA)means ,low Hb with low serum ferretin ** Values in parenthesis indicate 95% confidence intervals (95% CI).***

Discussion

This is the first national study wherein hemoglobin and serum ferritin were used as indicators for the evaluation of iron status in Jordanian preschool children aged 12 to 59 months. Serum ferritin is considered the most sensitive indicator for the evaluation iron stores in the body. [16] Nutritional anemia may be caused by a deficiency of several hematopoietic nutrients other than iron, such as vitamin B12, folic acid, pyridoxine, copper, vitamin A, or protein. [15, 16]

The overall prevalence rate of 20.1% for anemia and that of 26.1% for iron deficiency in Jordanian preschool children constitutes a health problem that should be attended by applying strategies that protect against the development of iron deficiency.

This is due to the serious consequences of iron deficiency that were briefly mentioned in the introduction. A more serious problem appears in the repeated observation of the highest prevalence rate of anemia of 34.5%, iron deficiency of 45.9%, and of IDA of 21.3 in the youngest children of 12 to 23 months of age, coinciding with a period during which lack of iron causes impairment to mental development. In fact, bridging the "iron gap" during this period is considered one of the most crucial issues in the world nutrition. [3] Moreover, the age range from 6 to 24 months is an important period in child health and development and it becomes a critical period in developing countries when infection and malnutrition are rather common in developing countries. [19]

A similar trend for the prevalence of anemia in non-refugee preschool Jordanian children (0-5 years of age) was observed in a national study that was conducted in 1962 when the Hashemite Kingdom of Jordan comprised the West Bank of Palestine and Jordan of today.

The prevalence rate of anemia was then 21.5% (Hb<10.0 g/dL) as compared to a rate of 30.2% among Palestinian refugees. The highest level attained among non-refugee Jordanians aged one year was 41.0%. This level decreased progressively to lower rates of 31.7%, 15.9% and 5.9% for children aged 2, 3 and 5 years, respectively. Anemia prevalence for four-year-old children was out of line with a value of 20.3. [20]

According to the 2002 Jordan Population and Family Health Survey (JPFHS), the prevalence rate of anemia in preschool children (6 months to 5 y) was 34.2%. The highest rate was found 64.5% in children aged 10-11 months, followed by a rate of 51% in children aged 12-23 months, with a progressive decline to 31.2%, 22.1%, and 18.1% in children of the age groups of 24-35, 36-47, and 48-49 months, respectively. Once again, the overall pattern of anemia prevalence as affected by age is quite similar to that in the preceding national surveys of the 1962 and 2002. Regarding the high rate of anemia of 34.1% found in the JPFHS as compared to that of 20.1% observed in our study, which may be partly due to the fact that in the JPFHS two additional younger age groups of children with a higher prevalence rate of anemia were included. These comprised the 6 to 9 month age group with a rate of anemia of 47.2% and the 10-11 month age group with the highest prevalence rate of 64.5%. We did not study these two groups.

Expected causes for the rather high prevalence of anemia observed in preschool Jordanian children can be discerned from the observation that exclusive breastfeeding from birth uptill 4 to 6 months of age is the strategy of choice to protect against the development of IDA. [21] While breastfeeding had been reported to be universal in Jordan, [22] and it is still so, [23] exclusive breastfeeding is not. For example, in the most recent 2002 JPFHS, it was observed that only 55% of Jordanian children below 2 months of age were exclusively breastfed. This is quite an improvement to a value of 20% that was found in the 2001 JPFHS for similar children less than 2 months of age.

By the age of 4 to 5 months, only 3% of children were exclusive breastfed as revealed by the 2002 JPFHS.

Several weaning practices and dietary patterns of young Jordan children are conducive to iron deficiency anemia. For example, the early introduction of solid foods coupled with shorter periods of exclusive breastfeeding deprive the Jordanian child from breast milk, although iron is quite low in amount, [16] yet it has a high bioavailability that ranges from 50% to 70%. [24] Bread, biscuits, and tea are commonly consumed by Jordanian children and infants at quite an early age. [14, 25, 26] These cereals are not fortified. They are soaked in tea or milk and are eaten together even as weaning food. The phytates in bread and tannins in tea are inhibitory to iron absorption. [16, 27, 28, 29]

Legumes including chickpeas, lentils, eggs, and cow's milk are also commonly given as weaning foods for young Jordanian children. [14, 29] The high phytate and polyphonic content of lentils are inhibitory to the absorption of non-haem iron. [30]

Contrary to common knowledge, eggs have little bioavailable iron and reduce the bioavailability of non-haem iron. [27] Iron in cow's milk is poor in amount and bioavailability. [16] Several foods given to Jordanian infants and young children are based on cow's milk such as yogurt, labneh and rice pudding. Currently, the American Academy of Pediatrics recommends not to introduce whole cow's milk to children before 12 months of age. [31] Meat provides haem iron that is highly bioavailable in addition to its enhancing effect on dietary non-haem iron. [27] Meat and iron-fortified formulas are not commonly consumed by young Jordanians especially in families of low socio-economic status due to their high prices. [14, 26, 32] Such a weaning food pattern lead to the conclusion that medicinal iron supplementation during the weaning period of exclusively breastfed infants for 4 to 6 months was protective against the development of IDA at 9 and 12 months of infant's age during a period when the strategy of dietary counseling was not effective. [33]

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