HHS Public Access

Author manuscript

Eur J Clin Nutr. Author manuscript; available in PMC 2015 November 17.

Published in final edited form as:

Eur J Clin Nutr. 2014 October ; 68(10): 1124–1128. doi:10.1038/ejcn.2014.100.

Micronutrient status in Jordan: 2002 and 2010

MK Serdula[1], **EK Nichols**[1,2], **NJ Aburto**[1,2], **H Masa'd**[3], **B Obaid**[4], **J Wirth**[5,6], **M Tarawneh**[3], **R Barham**[3], **B Hijawi**[3], **KM Sullivan**[1,7], and **the Jordan Fortification Working Group**[8]

[1]Division of Nutrition, Physical Activity and Obesity, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention (CDC), Atlanta, GA, USA [2]Epidemic Intelligence Service Program, US Centers for Disease Control and Prevention, Division of Nutrition, Physical Activity and Obesity, Atlanta, GA, USA [3]Department of Non-communicable Disease, Ministry of Health, Amman, Jordan [4]Department of Statistics, Amman, Jordan [5]Global Alliance for Improved Nutrition, Geneva, Switzerland [6]GroundWork LLC, Crans-pres-Celigny, Switzerland [7]Department of Epidemiology, Rollins School of Public Health, Emory University, Atlanta, GA, USA [8]The Jordan Fortification Working Group members are listed before the references

Abstract

BACKGROUND/OBJECTIVES—Two national surveys were conducted in Jordan in 2002 and 2010 to investigate the micronutrient status in women and children. To determine the prevalence of anemia, iron and folate deficiency among women and children in 2010 and compare with the prevalence of anemia and iron deficiency in 2002.

SUBJECTS/METHODS—A nationally representative survey was conducted in 2002 (1023 women, 15–49 years of age; 1059 children, 12–59 months of age) and a second survey in 2010 (2035 women; 940 children). Venous blood samples were used to measure hemoglobin, ferritin and red blood cell folate (the latter on a subsample of 393 women).

Correspondence: Dr MK Serdula, Division of Nutrition, Physical Activity and Obesity, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, 4770 Buford Highway, MS F77, Atlanta, GA 30341, USA. mks1@cdc.gov.

THE JORDAN FORTIFICATION WORKING GROUP

A Haddadin[1]
I Khatib[2]
TM Al-Sanouri[1]
J Galvez[3]
A Faqih[4]
RD Whitehead Jr[5]
1 Laboratory Directorate, Ministry of Health, Amman, Jordan
2 Department of Community Medicine, Jordan University of Science and Technology, Irbid, Jordan
3 Department of Epidemiology, Rollins School of Public Health, Emory University, Atlanta, GA, USA
4 Department of Nutrition and Food Technology, University of Jordan, Amman, Jordan
5 Divsion of Laboratory Sciences, CDC, Atlanta, GA, USA

CONFLICT OF INTEREST

The authors declare no conflict of interest.

DISCLAIMER

The findings and conclusions of this report do not necessarily represent the official position of the US Centers for Disease Control and Prevention. Use of trade names is for identification only and does not imply endorsement by the US Department of Health and Human Services.

RESULTS—Among women in 2010, the prevalence of folate deficiency and insufficiency was 13.6% and 82.9%, respectively. Geometric mean serum ferritin was higher in 2010 compared with 2002 (21.3 ng/ml vs 18.3, $P = 0.01$); there was no significant change in the prevalence of iron deficiency (35.1% vs 38.7%, $P = 0.17$), iron deficiency anemia (19.1% vs 20.0%, $P = 0.61$) or anemia (29.2% vs 29.3%, $P = 0.96$). Among children, a significantly lower prevalence was observed in 2010 compared with 2002 for iron deficiency (13.7% vs 26.2% $P < 0.001$) and iron deficiency anemia (4.8% vs 10.1%, $P < 0.001$); a nonsignificant lower prevalence was observed for anemia (16.6% vs 20.2%, $P = 0.09$).

CONCLUSIONS—In 2010, approximately one of seven women was folate deficient and six out of seven were folate insufficient for the prevention of neural tube defects. Between 2002 and 2010, significant improvement was observed in the prevalence of iron deficiency in children, but not in women.

BACKGROUND

To decrease the prevalence of deficiency of various micronutrients, the Hashemite Kingdom of Jordan initiated a national wheat flour fortification program in 2002. Bread made from wheat flour is a staple food and Jordanians consume, on average, 270 g of wheat flour per day, mostly from bread.[1] Since the inception of the program, the government of Jordan has provided premix for fortification of wheat flour at no cost to mills in support of the government's mandate that all mills fortify wheat flour. Wheat flour millers fortify Mowahad wheat flour (73–78% extraction rate), which is subsidized in Jordan and constitutes 92.5% of Jordan's wheat flour production. At the inception of the program in 2002, millers were to fortify Mowahad wheat flour with iron in the form of ferrous sulfate (32.25 parts per million (p.p.m.)) and folic acid (1.3 p.p.m.). In 2006, the government expanded the program by increasing the amount of folic acid to 1.5 p.p.m. and adding zinc (20.0 p.p.m.), niacin (35.0 p.p.m.) and vitamins A (1.5 p.p.m.), B_1 (3.575 p.p.m.), B_2 (3.6 p.p.m.), B_6 (4.4 p.p.m.) and B_{12} (0.007 p.p.m.). No change was made to the iron level and type.[2] The government-mandated levels of fortification for folic acid and iron meet those recommended by the World Health Organization for populations consuming 150–300 g of flour per day.[3]

In addition to the wheat flour fortification program, the Ministry of Health (MOH) also conducts clinic-based interventions to improve iron and folate status. The MOH has instituted a routine screening and treatment program for anemia in 10-month-old children attending clinics for measles immunization. Furthermore, the MOH provides folic acid supplements to pregnant women attending antenatal clinics and routinely screens them for anemia. Women with anemia are given a supplement containing iron, folic acid and zinc.

To monitor the wheat flour fortification program, the Jordanian MOH established a system for monitoring all 13 flour mills to measure the extent of compliance to the fortification program and to identify strengths and weaknesses to improve the program.[2] All flour mills report monthly to the MOH on the quantity of premix and the rate of addition of the premix to the flour at the mill. The MOH also conducts mill inspections bi-monthly.

In addition to monitoring the fortification program through information collected at the mills, the MOH has conducted two nationally representative nutrition surveys assessing iron status, anemia and other micronutrients. In 2002, 4–5 months after the initiation of the fortification program, a national micronutrient survey measured the prevalence of anemia and iron deficiency in women of childbearing age (15–49 years) and in preschool children (12–59 months).[4] In 2010, ~ 8 years after the initiation of the wheat flour fortification program, the MOH conducted a second national survey to assess the micronutrient status of the population.

The objectives of this report are (1) to document the prevalence of folate deficiency and insufficiency (women only) and anemia, iron deficiency and iron deficiency anemia in a nationally representative sample of women and children in Jordan in 2010 and (2) to compare estimates of anemia, iron deficiency and iron deficiency anemia from the 2010 survey with those from the 2002 survey.

SUBJECTS AND METHODS

Survey populations and sampling design

The target populations in both surveys were Jordanian women of reproductive age (15–49 years of age) and children 12–59 months of age. The MOH conducted the 2002 survey in October and the 2010 survey in March and April. Taking into account the average household size, the population proportion of the target groups and an estimated response of 80%, it was decided that a survey with 166 clusters and 12 households per cluster (for a total of 1992 households) would provide the ability to determine statistically significant differences if the prevalence estimates of iron deficiency differed from 2002 to 2010 by ≥ 5%. The sample size for the red blood cell (RBC) folate measurement was based on the anticipated population average RBC folate value, an estimated variance of 17.0 ng/ml and desired level of precision (9.6 ng/ml) for a sample size of 400.[5]

Both surveys used a three-stage stratified, probability proportionate to size, cluster design. The sampling frame excluded non-Jordanian households, those living in the most remote areas (most of whom are nomads) and those living in collective dwellings. In 2002, the country was divided into 29 strata and in 2010, 30 strata. In each survey, 166 clusters were selected and allocated proportionally to the population size of the strata. A cluster in an urban area was usually one city block and in a rural area it was a section or an entire community depending on the population density. From each cluster, 12 households were randomly selected for participation. In the 2002 survey, all eligible children from all 12 households and eligible women from 6 randomly selected households were invited to participate. In the 2010 survey, all eligible children and women from all 12 households were invited to participate. Detailed methods for the 2002 and the 2010 surveys have been previously described.[1,4] For both surveys, verbal informed consent was obtained. This survey was considered a public health practice by the Institutional Review Board of the US Centers for Disease Control and Prevention. All survey procedures were approved by the MOH in 2002 and by the Al Basheer Hospital Human Ethical Committee in 2010.

Biochemical testing

In the 2002 survey, blood was collected from children and from both selfidentified pregnant and non-pregnant women. In the 2010 survey, blood was not collected from women reported to be pregnant. Analyses presented here for the 2002 survey are restricted to children and non-pregnant women. In both surveys, venous blood was collected and sent to the MOH Central Public Health Laboratory where samples were aliquoted for separate analyses. Hemoglobin concentration was determined using a Beckman Coulter Cell Counter (Indianapolis, IN, USA) and serum ferritin was measured using electro-chemoluminescence (Cobas, Tokyo, Japan) on the same day as blood collection.

In the 2010 survey, an aliquot from a systematically selected subsample of 20% of women (n = 393) was sent to the St James Hospital laboratory in Dublin, Ireland where RBC folate was measured using the microbiological assay.[6] In the 2010 survey, analytical coefficients of variation were 2.9% for serum ferritin (n = 50 assays) and 9.7% for RBC folate (n = 3 assays). Central Public Health Laboratory participated in Centers for Disease Control and Prevention's VITAL-EQA program, an external quality assurance program that assesses laboratory performance during the course of analyzing survey samples (http://www.cdc.gov/labstandards/vitaleqa.html). For serum ferritin, laboratory performance showed only minimal bias and was optimal with regard to precision (<8.7%). Quality control data are not available for the 2002 survey.

Statistical Analysis

Anemia and iron status were assessed using the continuous variables of hemoglobin and ferritin concentrations and the categorical variables of anemia, iron deficiency and iron deficiency anemia. Anemia was defined as hemoglobin concentration of <120 g/l for non-pregnant women and <110 g/l for children.[7] Individuals with an extreme hemoglobin value (<40 or >180 g/l) were excluded.[8] Iron deficiency was defined as serum ferritin concentration < 15.0 ng/ml for women and < 12.0 ng/ml for children.[9] Iron deficiency anemia was defined as having both a hemoglobin and serum ferritin value below the appropriate groupspecific cutoff point for anemia and iron deficiency. Folate deficiency, as measured by RBC folate, has been defined as < 151 ng/ml.[10] We defined folate insufficiency for the prevention of neural tube defects as RBC folate ≤ 400 ng/ml. Owing to the lack of an internationally recognized value, we drew this value from a prospective study, which found that the prevalence of neural tube defects in an Irish population was lowest when RBC folate concentrations were > 400 ng/ml.[11]

We performed statistical analyses by treating both surveys as multistage-stratified cluster surveys. We calculated the sample weights for the 2002 survey using the original analyses based on stratification only[4] and for the 2010 survey based on stratification and nonresponse at the cluster level. We present means and confidence intervals for indicators with a normal distribution within the population. When a continuous variable's distribution was not normal (serum ferritin and RBC folate), a natural log transformation was used to approximate normality. The log means and confidence intervals were calculated and then backtransformed to the original scale, and the geometric means presented. Means and geometric means between survey years were compared using the Student's t-test. The

prevalence of categorical indicators was compared between surveys using the χ^2 analysis. We used an alpha value of 0.05 for defining statistical significance. We used SPSS (v 14.0, Chicago, IL, USA 2005) for statistical analyses accounting for the stratified cluster design and sample weights.

RESULTS

For the 2002 survey, the response rate was not reported. In 2010, a total of 1992 households were invited to participate in the survey. Among these, 1741 (87.4%) households agreed to participate. Among the households that agreed to participate, 2607 eligible women were invited to participate, of whom 2039 (78.2%) provided a blood specimen. Of the 1077 children invited, 947 (87.9%) provided a blood specimen.

In 2002, only one woman was excluded from the hemoglobin analyses because of an unlikely value. In 2010, one child was excluded because of a hemoglobin value >180 g/l and one woman was excluded because of a hemoglobin value <40 g/l. In 2010, because of missing or inadequate samples, an additional 43 children and 8 women were excluded from hemoglobin analyses, and 6 children and 4 women were excluded from ferritin analyses.

Women

Among women, mean serum ferritin concentrations were significantly higher in 2010 compared with 2002 (21.3 vs 18.3 ng/ml, $P = 0.01$) (Table 1). On comparing 2010 with 2002, there was no statistically significant difference in mean hemoglobin concentrations ($P = 0.70$) or prevalence of anemia (29.2% vs 29.3%, $P = 0.96$), iron deficiency (35.1% vs 38.7%, $P = 0.17$) or iron deficiency anemia (19.1% vs 20.0%, $P = 0.61$) (Table 2).

Among the subsample of women ($n = 393$) for whom RBC folate concentrations were measured in 2010, geometric mean RBC folate was 290.2 ng/ml (95% confidence interval (CI): 270.2, 310.2); 13.6% (95% CI: 10.2, 17.8%) of women were deficient, whereas 82.9% (95% CI: 77.7, 87.1%) of the women were folate insuficient (Table 2).

Children

Among children, mean serum ferritin concentration was significantly higher in 2010 compared with 2001 (24.4 vs 18.1 ng/ml, $P < 0.001$), but there was no statistically significant difference in mean hemoglobin (Table 3).

In 2010 and 2002, the prevalence of anemia was 16.6% vs 20.2% ($P = 0.09$), prevalence of iron deficiency was 13.7% vs 26.2% ($P < 0.001$) and prevalence of iron deficiency anemia was 4.8% vs 10.1% ($P < 0.001$), respectively (Table 4).

DISCUSSION

One possible influence on the changing iron status noted in children of Jordan during this period could be the national fortification program. In 2002, the government of Jordan introduced a program for fortification of Mowahad wheat flour with iron and folic acid and in 2006 expanded the program to include zinc and vitamins A and B. Thus far, there have

been two nationally representative surveys to assess the micronutrient status of Jordanian children and women conducted in 2002 and 2010. Among children in 2010, approximately one in seven was iron deficient and one in twenty had iron deficiency anemia. Among reproductive age women, approximately one in three was iron deicient, one in seven was folate deficient and six of seven women were folate insufficient for the prevention of neural tube defects.

The RBC folate concentrations found in women in the 2010 survey are below those needed to prevent neural tube defects.[11] As the folate level was measured only once in 2010, the interpretation of survey results is complex and somewhat speculative. In the United States, RBC folate concentrations were monitored by NHANES before (1988–1994) and after (1999–2010) folic acid fortification. Among women 15–44 years of age, the geometric mean concentration of RBC folate increased from 303 ng/ml before fortification to 468 ng/ml after fortification.[12] The mean concentration of RBC folate among Jordanian women in 2010 was 290 ng/ml, which was similar to the concentration found in women in the United States before fortification. A retrospective review of records from a hospital in the northern region of Jordan detected a decline in the birth prevalence neural tube defects from before the fortification program (2000–01), during program implementation (2003–04) and after program implementation in 2005–06: 1.85, 1.07 and 0.95 per 1000 births, respectively.[13] These data support the possibility of a beneficial effect of the fortification of wheat flour with folic acid during the early years of the fortification program well before the 2010 survey. It is conceivable that the decline in neural tube defects occurred only in the hospital catchment area of the northern region or during a time period when the wheat flour program was well implemented.

Less than optimal mill compliance may have influenced the effectiveness of the fortification program. Mill monitoring data collected by the MOH indicate that fortification compliance by the mills was incomplete before the 2010 survey. Of the 13 mills producing Mohawad flour, two did not fortify at all because one mill lacked a premix feeder and the other was under construction. There was no premix available and thus no fortification during 5 of the 16 months leading up to the 2010 survey. For the periods that premix was available, reported premix addition rates averaged 197.5 g per metric ton or 79% of the target 250 g per metric ton.

Among children, between 2002 and 2010, mean ferritin increased and the prevalence of iron deficiency and iron deficiency anemia was nearly halved. Among women, mean ferritin increased; however, there was no significant change in the prevalence of iron deficiency or iron deficiency anemia. One possible reason for the smaller improvement in women compared with children could be that the mandated level of iron fortification provides a lower percentage of the estimated average requirement (EAR) in women compared with children. On the basis of the estimate of 79% compliance, researchers estimated that, during the months in which the premix was distributed, fortification provided 20% of the EAR for iron to women and 52% of the EAR to children aged 36-59 months.[14] However, the actual percentage of the EAR consumed by the population was not monitored.

In any case, causal inferences cannot be made when comparing the two cross-sectional surveys. During the 8 years between surveys, changes independent of the fortification program also likely affected population micronutrient status. For example, during the interval between surveys, the MOH began a routine screening and treatment program for anemia in children attending clinics for measles immunization. In addition, the MOH provided folic acid supplements and also conducted an anemia screening and treatment program for pregnant women attending antenatal clinics. These programs would have positively influenced the iron status of women and children enrolled and compliant. Unfortunately, there are no estimates available regarding the numbers of women and children who benefited from these treatment programs, and, thus, their potential public health impact cannot be assessed. Conversely, it is also possible that decreased access to food caused by the economic crises, which began in 2008 and led to a 30% increase in the food price iniation index, could have negatively affected the iron status in the population.[15] Without more information on dietary intake, including supplement use and the actual content of folate and iron in foods, it is not possible to attribute population changes in iron status to the fortification program.

Several other factors should also be considered when interpreting differences observed between the 2002 and 2010 surveys in regard to the possible effect of the wheat flour fortification program. First, the 2002 survey was conducted 4–5 months after the initiation of the fortification of wheat flour, and it is possible that the population hemoglobin and ferritin concentrations were already somewhat affected by that time.[16] In addition, the response rate for the 2002 survey is unknown and this may have compromised its comparison with the 2010 survey. Although seasonality is not expected to affect anemia or bread consumption in Jordan to any great extent, to eliminate the possibility of seasonal effects on eating patterns and micronutrient status, it would have been ideal for the surveys to be conducted during the same season. Finally, because it was not possible to determine altitude for the clusters selected for the 2002 survey, anemia and iron deficiency anemia were not adjusted for altitude in the comparison between the 2002 and 2010 surveys; however, because most of Jordan is below 1000 meters, any bias introduced by not adjusting for altitude has little effect on the findings.[8]

Between 2002 and 2010, significant improvement was observed in the prevalence of iron deficiency in children, but not in women. Given the influence of secular change, the implementation of other micronutrient interventions and the lack of dietary intake data, it is not possible to attribute improvement in children to the fortification program. The wheat flour fortification program was designed to meet World Health Organization recommendations in regard to the type of iron and mandated level of fortification for both iron and folic acid;[3] furthermore, the premix is provided at no cost to the mills. However, the mill monitoring data show that the program was only partially implemented. When fully implemented, the program could be expected to improve the micronutrient status of the population.[16] To accomplish improved coverage, there must be a consistent supply of premix, adequate addition of premix to the flour by the mills, and full and consistent participation in the fortification program by all mills in the country. On the basis of combined monitoring information from the mills and the surveys, the MOH identified and

addressed gaps in the fortification program and will continue to monitor the program carefully at the mill level.

ACKNOWLEDGEMENTS

The 2010 survey was funded through a grant agreement between GAIN and the Government of Jordan Ministry of Health (MOH) and a Memorandum of Understanding between GAIN and the CDC. Additional support was provided by the UNICEF Jordan office. We would especially like to acknowledge Nadera Al-Shareff and Ruba Nabulsi for their help in the laboratory and lab technicians Gaia Alwahdan, Lamees Janineh and Shefa Saleh for their dedicated work. We acknowledge Adnan Ishaq and Mohammad Anees for their contributions during the early stage of survey preparations. Finally, we are grateful to Adel M Belbeisi, Usha Mandava, Wissam Qarqash, Nicolas Tsikhlakis and Barbara Macdonald for their invaluable support throughout the survey.

REFERENCES

1. Kingdom of Jordan Ministry of Health. National Micronutrient Survey, Jordan 2010. Ministry of Health; Amman: 2011. http://www.gainhealth.org/reports/national-micronutrient-survey-jordan
2. Wirth JP, Nichols E, Mas'd H, Barham R, Johnson QW, Serdula M. External mill monitoring of wheat flour fortification programs: an approach for program managers using experiences from Jordan. Nutrients. 2013; 5:4741–4759. [PubMed: 24284616]
3. World Health Organization. Meeting Report: Interim Consensus Statement. World Health Organization; Geneva, Switzerland: 2009. Recommendations on wheat and maize flour fortification. http://www.who.int/nutrition/publications/micronutrients/wheat_maize_fort.pdf
4. Kingdom of Jordan Ministry of Health. A national survey on iron deficiency anemia and vitamin A deficiency. Amman, Jordan: 2002.
5. Rosner, B. Fundamentals of Biostatistics. 6th. Duxbury Press; Pacific Grove, CA: 2005.
6. O'Broin S, Kelleher B. Microbiological assay on microtitre plates of folate in serum and red cells. J Clin Pathol. 1992; 45:344–347. [PubMed: 1577973]
7. World Health Organization. Haemoglobin Concentrations for the Diagnosis of Anaemia and Assessment of severity. Vitamin and Mineral Nutrition Information System (WHO/NMH/NHD/MNM/11.1). World Health Organization; Geneva, Switzerland: 2011. http://www.who.int/vmnis/indicators/haemoglobin/en/index.html
8. Sullivan KM, Mei Z, Grummer-Strawn L, Parvanta I. Haemoglobin adjustments to define anaemia. Trop Med Int Health. 2008; 13:1267–1271. [PubMed: 18721184]
9. World Health Organization. Iron deficiency anemia assessment, prevention, and control- a guide for programme managers. United Nations University, UNICEF; Geneva, Switzerland: 2001.
10. de Benoist B. Conclusions of a WHO Technical Consultation on folate and vitamin B12 deficiencies. Food Nutr Bull. 2008; 29:S238–S244. [PubMed: 18709899]
11. Daly LE, Kirke PN, Molloy A, Weir DG, Scott JM. Folate levels and neural tube defects. Implications for prevention. JAMA. 1995; 274:1698–1702. [PubMed: 7474275]
12. Pfeiffer CM, Hughes JP, Lacher DA, Bailey RL, Berry RJ, Zhang M, et al. Estimation of trends in serum and RBC folate in the U.S. population from pre- to post-fortification using assay-adjusted data from the NHANES 1988-2010. J Nutr. 2012; 142:886–893. [PubMed: 22437563]
13. Amarin ZO, Obeidat AZ. Effect of folic acid fortification on the incidence of neural tube defects. Paediatr Perinat Epidemiol. 2010; 24:349–351. [PubMed: 20618724]
14. Harvey PW, Dary O. Governments and academic institutions play vital roles in food fortification: iron as an example. Public Health Nutr. 2012; 15:1791–1795. [PubMed: 22974677]
15. Jones, N.; Harper, C.; Pantuliano, S.; Pavanello, S.; Kyunghoon, K.; Mitra, S., et al. Impact of the economic crisis and food and fuel price volatility on children and women in the MENA region. Overseas Development Institute; London: 2009. Working Paper 310
16. Hurrell R, Ranum P, de Pee S, Biebinger R, Hulthen L, Johnson Q, et al. Revised recommendations for iron fortification of wheat flour and an evaluation of the expected impact of current national wheat flour fortification programs. Food Nutr Bull. 2010; 31:S7–S21. [PubMed: 20629349]

Table 1

Mean hemoglobin, serum ferritin and RBC folate concentrations in non-pregnant women, aged 15–49 years, Jordan 2002 and 2010.

Indicator	2002		2010		P-*value*[a]
	N	*Mean (95% CI)*	n	*Mean (95% CI)*	
Hemoglobin (g/l)[b,c]	1023	124.4 (123.5, 125.3)	2030	124.7 (123.7, 125.6)	0.70
Ferritin (ng/ml)[d]	1021	18.3 (17.0, 19.8)	2035	21.3 (20.1, 22.78)	0.01
RBC folate (ng/ml)[d]		NA	393	290.2 (270.2, 310.2)	

Abbreviations: CI, confidence interval; NA, not applicable; RBC, red blood cell. Note: the n's are unweighted denominators for each subgroup. Means are weighted. CI, adjusted for cluster sampling design.

[a] 2002 and 2010 means for each indicator compared using weighted t-tests.

[b] Hemoglobin is not adjusted for altitude.

[c] Arithmetic mean.

[d] Geometric mean (note: RBC folate was measured on a subsample in 2010).

Table 2

Prevalence of anemia and deficiency of iron and RBC folate in non-pregnant women, aged 15–49 years, Jordan 2002 and 2010.

Indicator	*2002*		*2010*		P-*value*[d]
	n	*% (95% CI)*	n	*% (95% CI)*	
Anemia[a]	1023	29.3 (26.3, 32.6)	2030	29.2 (26.8, 31.7)	0.96
ID[b]	1021	38.7 (34.6, 42.9)	2035	35.1 (32.2, 38.1)	0.17
IDA[c]	1021	20.0 (17.3, 22.9)	2026	19.1 (17.3, 21.2)	0.61
RBC folate (deficiency)[e]		NA	393	13.6 (10.2, 17.8)	
RBC folate (insufficiency)[f]		NA	393	82.9 (77.7, 87.1)	

Abbreviations: CI, confidence interval; ID, iron deficiency; IDA, iron deficiency anemia; NA, not applicable; RBC, red blood cell. Note: the n's are unweighted denominators for each subgroup. Percentages are weighted. CI, adjusted for cluster sampling design.

[a] Anemia, defined as hemoglobin (Hb) <120 g/l, not adjusted for altitude.

[b] ID defined as serum ferritin <15ng/ml.

[c] IDA defined as low Hb (<120 g/l) with low serum ferritin (<15 ng/ml).

[d] 2002 and 2010 percentages for each indicator compared using the Wald statistic for the difference between prevalence estimates in 2002 and 2010.

[e] RBC folate deficiency defined as <151 ng/ml.

[f] RBC folate insufficiency defined as ≤400 ng/ml.

Table 3

Mean hemoglobin and ferritin in children aged 12–59 months, Jordan 2002 and 2010.

Indicator	*2002*		*2010*		P-*value*[a]
	n	*Mean (95% CI)*	n	*Mean (95% CI)*	
Hemoglobin (g/l)[b,c]	1059	117.2 (116.3, 118.1)	902	118.4 (117.5, 119.3)	0.07
Ferritin (ng/ml)[d]	1056	18.1 (17.1, 19.2)	940	24.4 (23.0, 25.9)	<0.001

Abbreviation: CI, confidence interval. Note: the n's are unweighted denominators for each subgroup. Means are weighted. CI, adjusted for cluster sampling design.

[a] 2002 and 2010 means for each indicator compared using weighted *t*-tests.

[b] Hemoglobin is not adjusted for altitude.

[c] Arithmetic mean.

[d] Geometric mean.

Table 4

Comparison of percent anemia and iron deficiency in children aged 12–59 months, Jordan 2002 and 2010.

Indicator	*2002*		*2010*		**P-value**[a]
	n	*% (95% CI)*	**n**	*% (95% CI)*	
Anemia[b]	1059	20.2 (17.3, 23.3)	902	16.6 (13.9, 19.6)	0.09
ID[c]	1056	26.2 (23.1, 29.6)	940	13.7 (11.1, 16.7)	<0.001
IDA[d]	1050	10.1 (8.1, 12.5)	898	4.8 (3.6, 6.5)	<0.001

Abbreviations: CI, confidence interval; ID, iron deficiency; IDA, iron deficiency anemia. Note: the n's are unweighted denominators for each subgroup. Percentages are weighted. CI, adjusted for cluster sampling design.

[a] 2002 and 2010 percentages for each indicator compared using the Wald statistic for the difference between prevalence estimates in 2002 and 2010.

[b] Anemia, defined as Hb<110 g/l, not adjusted for altitude.

[c] ID defined as serum ferritin <12 ng/ml.

[d] IDA defined as low Hb (<110 g/l) with low serum ferritin (<12 ng/ml).