

Prevalence of anemia among Quebec Cree infants from 2002 to 2007 compared with 1995 to 2000

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Abstract

Objective To determine if screening of infants for anemia at 9 months in the Cree region of Quebec should continue, by comparing the prevalence of anemia in the initial years of screening (1995 to 2000) with prevalence data from infants screened between 2002 and 2007.

Design Comparison of anemia prevalence from 2 cross-sectional surveys. Nonoverlapping 95% CIs were used to determine if results were significantly different.

Setting Nine Quebec Cree communities.

Participants Infants screened for anemia between 1995 and 2000 (n=716) or 2002 and 2007 (n=1325).

Main outcome measures Anemia was diagnosed based on hemoglobin concentration. An erythrocyte mean cell volume of less than 71 fL was used as a proxy for iron deficiency.

Results Hemoglobin concentration among infants screened from 2002 to 2007 was, on average, 7 g/L greater than among infants screened from 1995 to 2000 (mean [standard deviation] 121 [11] g/L vs 114 [11] g/L). The prevalence of anemia (hemoglobin <110 g/L) from 1995 to 2000 was 31.7% (95% CI 28.3% to 35.1%), but from 2002 to 2007 it was significantly lower at 12.5% (95% CI 10.7% to 14.2%). Using a hemoglobin concentration more specific to iron deficiency anemia (IDA) (hemoglobin <100 g/L), from 1995 to 2000 7.5% (95% CI 5.6% to 9.4%) of infants had IDA, whereas from 2002 to 2007 only 2.0% (95% CI 1.2% to 2.8%) had IDA. The prevalence of iron deficiency based on mean cell volume declined from 18.3% (95% CI 15.5% to 21.1%) from 1995 to 2000 to 4.2% (95% CI 3.1% to 5.3%) from 2002 to 2007.

Conclusion The 12.5% prevalence of anemia (hemoglobin <110 g/L) among Cree infants from 2002 to 2007 was much lower than the prevalence from 1995 to 2000 but somewhat higher than among nonaboriginal infants (8.0%). The low anemia prevalence among Quebec Cree infants after 2002 suggests that replacing universal screening with targeted screening of higher-risk infants needs to be considered following studies to identify risk factors for anemia.

EDITOR'S KEY POINTS

- Since screening for anemia was initiated in the Cree region of Quebec, the prevalences of anemia and iron deficiency have declined considerably.
- Based on the current low prevalence of anemia, primary prevention efforts for iron deficiency should be emphasized in Cree communities in addition to secondary prevention efforts through population or targeted screening.
- To prevent iron deficiency, mothers should be encouraged to exclusively breastfeed their infants for 6 months, and to then provide sources of bioavailable iron such as meat and iron-fortified infant cereals. Wild meats might be more culturally appropriate, available, and economical than infant cereals.

Cet article a fait l'objet d'une révision par des pairs.
Can Fam Physician 2012;58:e101-6

Prévalence de l'anémie chez les nourrissons cris du Québec examinés entre 2002 et 2007 par rapport à ceux examinés entre 1995 et 2000

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Résumé

Objectif Déterminer si on doit poursuivre le dépistage de l'anémie chez les nourrissons de 9 mois de la région Cri du Québec, en comparant la prévalence de l'anémie observée lors du dépistage initial de 1995 à 2000 aux données de prévalence chez les nourrissons étudiés entre 2002 et 2007.

Type d'étude Comparaison de la prévalence de l'anémie dans 2 enquêtes transversales. Les différences étaient jugées significatives si les intervalles de confiance à 95% qui ne se chevauchaient pas.

Contexte Neuf communautés cris du Québec.

Participants Nourrissons ayant eu un dépistage pour l'anémie entre 1995 et 2000 (n=716) ou entre 2002 et 2007 (n=1325).

Principaux paramètres à l'étude Le diagnostic d'anémie reposait sur la concentration de l'hémoglobine. Un volume érythrocytaire moyen de moins de 71 fL servait de critère pour une déficience en fer.

Résultats Les nourrissons examinés entre 2002 et 2007 avaient une concentration moyenne d'hémoglobine de 7 g/L supérieure à celle de ceux examinés entre 1995 et 2000 (moyenne [déviations standard] 121 [11] g/L c. 114 [11] g/L. Entre 1995 et 2000, la prévalence d'anémie (hémoglobine < 110 g/L) était de 31,7% (IC à 95% 28,3% à 35,1%) alors qu'entre 2002 et 2007, elle était significativement plus basse, soit 12,5% (IC à 95% 10,7% à 14,2%). En utilisant une concentration d'hémoglobine plus spécifique pour une anémie par déficience en fer (ADF) (hémoglobine < 100 g/L), 7,5% (IC à 95% 5,6% à 9,4%) des enfants examinés entre 1995 et 2000 avaient une ADF, alors que seulement 2,0% (IC à 95% 1,2% à 2,8%) de ceux examinés entre 2002 et 2007 avaient une ADF. En utilisant le volume érythrocytaire moyen, la prévalence de déficience en fer diminuait de 18,3% (IC à 95% 15,5% à 21,1%) entre 1995 et 2000 à 4,2% (IC à 95% 3,1% à 5,3%) entre 2002 et 2007.

Conclusion La prévalence de l'anémie (hémoglobine < 110 g/L) de 12,5% chez les nourrissons cris examinés entre 2002 et 2007 était beaucoup plus basse que celle observée entre 1995 et 2000, mais un peu plus haute que chez les nourrissons non autochtones (8,0%). La faible prévalence d'anémie observée après 2002 chez les nourrissons cris du Québec laisse croire qu'on doit envisager de remplacer le dépistage universel par un dépistage centré sur les nourrissons à haut risque à la suite d'études destinées à identifier les facteurs de risque pour l'anémie.

POINTS DE REPÈRE DU RÉDACTEUR

- Depuis qu'on a instauré un dépistage de l'anémie dans la région cri du Québec, la prévalence de l'anémie et de la déficience en fer a beaucoup diminué.
- Étant donné la faible prévalence actuelle de l'anémie, on devrait concentrer les efforts sur la prévention primaire de la déficience en fer dans les communautés cris, mais aussi sur la prévention secondaire au moyen d'un dépistage universel ou ciblé.
- Afin de prévenir la déficience en fer, les mères devraient être incitées à nourrir leurs nourrissons uniquement au sein pendant 6 mois, pour ensuite leur fournir des sources de fer bio-disponibles telles que la viande et les céréales pour nourrissons enrichies de fer. Les viandes sauvages pourraient être culturellement plus appropriées, plus disponibles et plus économiques que les céréales pour nourrissons.

This article has been peer reviewed.
Can Fam Physician 2012;58:e101-6

Early childhood is a period of rapid growth with high iron requirements; consequently, iron deficiency (ID) is the most prevalent nutrition problem among infants.¹ Iron deficiency resulting in anemia in infancy is associated with impaired neurodevelopment and potentially irreversible changes in brain structure and function.² Iron deficiency anemia (IDA) is a serious concern among aboriginal children in Canada and the United States.^{3,4} Dietary risk factors for anemia in aboriginal infants include bottle feeding with low-iron formula or cow's milk, the absence of iron-rich complementary foods after 6 months of age, and prolonged exclusive breastfeeding past 6 months of age.⁵⁻⁹

Given the psychomotor impairment, cognitive delay, and behavioural disturbances that can result from IDA, in 1994 the Canadian Task Force on Preventive Health Care recommended routine measurement of hemoglobin (Hb) concentration among aboriginal infants between 6 and 12 months of age—optimally at 9 months¹⁰—yet anemia screening is not routinely performed in many aboriginal communities.¹¹ Universal screening occurs in the Inuit communities of Nunavik and Nunavut (Dr Johanne Morel, e-mail communication, November 15, 2010) and in the Cree region of Quebec, where in 1995 the Cree Board of Health and Social Services of James Bay in Chisasibi, Que, instituted an anemia screening protocol for 9-month-old infants.

From 1995 to 2000, anemia prevalence among Cree infants in Quebec was 25% to 32%.⁷ A total of 22.7% had ID (serum ferritin <10 µg/L) and 7.9% had IDA (Hb <110 g/L and serum ferritin <10 µg/L).¹² Factors associated with anemia in cross-sectional studies were cow's milk feeding, breastfeeding at the time of screening, suboptimal vitamin A status, chronic infections, lead exposure,⁷ and maternal anemia.¹³ The association between breastfeeding and anemia was likely owing to insufficient iron-rich complementary foods in infants' diets; in 1 Cree community, 56% of infants aged 7 to 10 months were estimated to consume inadequate dietary iron¹⁴ and, among infants screened for anemia, only 15.1% ate meat daily and 28.5% never ate meat.⁷

Given the heightened awareness about infant anemia that results from screening, the condition is reviewed by health care professionals with infants' caregivers through the Maternal and Child Health Program checklists and materials. As part of the regional Maternal and Child Health Program, the anemia screening protocol continued in 2011 and parents who attended well-baby clinics with their infants were advised about healthy eating and the appropriate diet for infants to prevent IDA. The aim of the current study was to document if anemia prevalence and ID had declined among Cree infants since screening was initiated in 1995. The results would help the Cree Board

of Health and Social Services of James Bay to decide whether to continue anemia screening. The data would also be useful in considering if the recommendation to universally screen aboriginal infants for anemia should be maintained.

METHODS

In the Cree region of Quebec, a complete blood count (CBC) to screen for anemia is done in community clinics at an infant's 9-month well-baby appointment. The screening protocol was initiated in 1995 and continues to the present day. Screening occurs at the 12-month appointment if the infant has a fever or infection at the 9-month appointment, or if the appointment is missed at 9 months.

Laboratory results from anemia screening were in 2 separate databases. One database contained Hb concentration and erythrocyte mean cell volume (MCV) values collected by reviewing medical charts of infants screened for anemia from January 1995 to February 2000. The other database was a computerized download from the regional central laboratories, and included the Hb concentration and erythrocyte MCV of infants who had CBC evaluations from September 2002 to November 2007. The 2 databases were analyzed independently. Infants with test results before 8 months of age, after 12 months of age, or from the hospital ward or walk-in clinic setting were excluded from analysis.

Three Hb concentrations were used to estimate anemia prevalence in infants: a 110 g/L cutoff recommended by the World Health Organization (WHO) for infants 6 to 12 months of age¹⁵; a 105 g/L cutoff that eliminates cases of "statistical anemia"¹⁶; and a 100 g/L cutoff more specific to IDA in 9-month-old breastfed infants.¹⁷ Erythrocytes less than 71 fL in size were considered evidence of low iron stores, and therefore evidence of ID.¹⁷

Descriptive statistics were reported as means and standard deviations or means and 95% CIs. Because the anemia screening data from 1995 to 2000 and 2002 to 2007 were in separate databases, nonoverlapping 95% CIs were used to determine if results were different between the 2 time periods. Statistical analyses were performed using SPSS, version 17.0.

Ethics

The Directors of Professional Services of the hospital laboratories authorized the release of the electronic databases. The Research Committee of the Cree Board of Health and Social Services of James Bay and the Health Research Ethics Boards, Panel B and PER/ALES/NS, at the University of Alberta gave approval for analysis of data.

RESULTS

The database containing anemia screening data for the years 1995 to 2000 included information for 716 infants, representing 66% of infants who were eligible for screening in that time period. The database for the years 2002 to 2007 included information for 1325 infants who had CBC results, representing 76% of infants who were eligible for screening in that time period. Anemia prevalence, Hb concentration, and MCV for each time period are reported in **Table 1**. Mean Hb concentration from 2002 to 2007 was 7 g/L greater than that from 1995 to 2000 (mean [standard deviation] 121 [11] g/L vs 114 [11] g/L) and mean erythrocyte MCV was greater by 3 fL from 2002 to 2007 than from 1995 to 2000 (mean [standard deviation] 78 [5] fL vs 75 [6] fL). The nonoverlapping CIs show that anemia prevalence defined using each of the 3 Hb cutoffs (110 g/L, 105 g/L, and 100 g/L) declined significantly between 1995 to 2000 and 2002 to 2007. The prevalence of ID (erythrocyte MCV <71 fL) also declined significantly between the 2 time periods, according to the nonoverlapping 95% CIs.

Table 1. Anemia prevalence, ID prevalence, Hb concentration, and erythrocyte MCV of infants in the Cree region of Quebec who were screened for anemia during 2 separate periods (1995 to 2000 and 2002 to 2007)

CHARACTERISTICS	SCREENING PERIOD	
	1995 TO 2000	2002 TO 2007
Infants, N	716	1325
Mean (SD) infant age, mo	9.5 (0.8)	9.4 (0.8)
Mean (SD) Hb, g/L	114 (11)	121 (11)
Anemia, % (95% CI)		
• Hb < 110 g/L	31.7 (28.3-35.1)	12.5 (10.7-14.2)*
• Hb < 105 g/L	16.9 (14.2-19.7)	4.7 (3.6-5.8)*
• Hb < 100 g/L	7.5 (5.6-9.4)	2.0 (1.2-2.8)*
Mean (SD) MCV, fL	75 (6)	78 (5)
ID (MCV < 71 fL), % (95% CI)	18.3 (15.5-21.1)	4.2 (3.1-5.3)*

Hb—hemoglobin, ID—iron deficiency, MCV—mean cell volume, SD—standard deviation.

*Significantly different from the values for the 1995 to 2000 screening period based on nonoverlapping 95% CIs.

12.5%. The appropriate cutoff to define infant anemia is a matter of debate, particularly considering that mild anemia is not specific for ID.¹⁷ Hemoglobin concentration of less than 100 g/L is more specific to IDA than Hb concentration of less than 110 g/L.^{17,18} Using the 100 g/L cutoff, 7.5% of infants had anemia from 1995 to 2000 whereas only 2.0% did from 2002 to 2007. A decline in ID is supported by a decrease in the prevalence of microcytic erythrocytes (MCV <71 fL) from 18.3% to 4.2% between the 2 time periods.

The WHO estimates that half of all cases of anemia in children are caused by ID,¹⁹ so it is likely that the decrease in anemia in Cree infants was the result of increased dietary iron intake.²⁰ This might have been the consequence of dietary counseling at well-baby clinics encouraging iron-rich complementary foods such as infant cereals and meats, and among bottle-fed infants the use of iron-fortified infant formula rather than cow's milk. In addition, low-iron infant formula has been phased out by some companies since anemia screening was initiated in the 1990s.

Maternal iron sufficiency in pregnancy is important for ensuring infants' normal hematologic development postpartum.²¹ Maternal anemia is associated with anemia in Cree infants,¹³ and in nonaboriginal infants in Canada and elsewhere.^{22,23} Thus, a reduction in maternal ID could result in lower anemia prevalence in infants. Chronic and acute infections suppress Hb concentrations in Inuit, First Nations, Alaska Native, Yupik, and Inupiat infants.^{5,24-26} A reduction in infections, or fewer infants with infections being screened for anemia as per protocol recommendations by the Cree Board of Health and Social Services of James Bay, would likely contribute to a lower anemia prevalence.¹²

Recent data about anemia prevalence in aboriginal infants are sparse given that screening is inconsistent. One study done in northern Ontario and Nunavut from 2001 to 2003 included infants aged 4 to 18 months from 1 Inuit and 2 Cree communities. The 36% prevalence of anemia (Hb <110 g/L)⁵ among these infants is almost triple the 12.5% prevalence of anemia (Hb <110 g/L) in infants in the Cree region of Quebec from 2002 to 2007. The prevalence of anemia among Quebec Cree infants is only somewhat higher than the 8.0% prevalence of anemia (Hb <110 g/L) among Canadian infants tested in the 1990s (the most recent prevalence data for infants in Canada).²⁷

There is no recommendation to routinely screen the general population of Canadian infants for anemia, and it is unlikely that the systematic screening of Cree infants in Quebec would detect enough cases of IDA to make it a useful strategy. Potential harms include false-positive results, anxiety, and cost, as well as the small potential harms of treatment with oral iron.²⁸ The US Preventive Services Task Force concluded in 2006 that

DISCUSSION

Since screening for anemia was initiated in the Cree region of Quebec, the prevalences of anemia and ID have declined considerably. Using the WHO definition (Hb <110 g/L),¹⁵ from 1995 to 2000 the prevalence of anemia was 31.7% whereas from 2002 to 2007 it was

evidence is insufficient to recommend for or against routine screening for IDA in asymptomatic children aged 6 to 12 months.²⁸ Considering the pain, time, and expense of blood test screening for anemia in low-risk populations, such as Cree infants in northern Quebec, systematic screening of all infants could possibly be replaced by targeted screening aimed at early anemia detection in infants with risk factors for ID after 6 months of age. This is a more complicated approach than population screening, as it includes obtaining a health and dietary history of risk factors, such as prematurity, skin pallor, poor diet, chronic infections, and maternal anemia in pregnancy. In theory, this approach should reduce the total population of infants requiring screening to a much smaller one that contains most infants with anemia; however, the prevalence of the Cree infant population with 1 or more risk factors is unknown, meaning that a large proportion of infants might still be tested for anemia using targeted screening. Although it is possible that infants with more than 1 risk factor would be at higher risk of anemia than infants with a single risk factor, it is not clear which combination of risk factors would be the most specific to ID. Furthermore, the sensitivity of individual or multiple risk factors to detect mild or moderate anemia in infants can be low.^{29,30}


Psychomotor impairment caused by ID can be irreversible despite iron therapy.² Thus, the prevention of the neurodevelopmental consequences of IDA might require the prevention of ID rather than the detection and treatment of existing ID.²⁸ Therefore, in Quebec Cree and other aboriginal communities there should be a focus on primary interventions for anemia prevention involving multiple health promotion activities that are mutually reinforcing. Strategies to improve the iron stores of newborns could include improving women's access to nutritious foods before, during, and after pregnancy; encouraging pregnant women to take iron supplements; and delaying umbilical cord clamping at birth.^{1,31} Mothers should be encouraged to exclusively breastfeed their infants for 6 months, and to then provide sources of bioavailable iron such as meat and iron-fortified infant cereals.³²⁻³⁴ Iron-fortified cereals are expensive to purchase in remote communities¹³; however, wild meats, many of which were and continue to be part of traditional aboriginal infant feeding practices,^{5,11,35,36} might be more culturally appropriate, available, and economical than infant cereals. For this reason, the use of both cereals and iron-rich traditional meats should be encouraged. Although iron-fortified formula is an excellent vehicle for delivering iron and protecting aboriginal infants from anemia,⁶ suggesting that aboriginal women formula-feed as a means to prevent infant anemia is inappropriate considering formula's high cost,¹³ absence of immunologic factors,³⁵ association with excess weight gain in infancy,⁸ and potential to undermine breastfeeding.³⁷ Although there

are no data on anemia prevalence in young Cree children, the prevalence of anemia is 16.8% (95% CI 12.0% to 21.6%) in Inuit children 3 to 5 years old,³⁶ indicating that optimizing nutrition and reducing infections must continue following infancy to prevent early childhood anemia.

Strengths and limitations

This is the first study to report a change in anemia prevalence in an aboriginal infant population where systematic anemia screening was maintained over a long period of time. A limitation of the study is the possibility of selection bias introduced by the large number of infants who were not screened, or that the percentage of eligible infants who were screened increased over time. We also did not have the data required to examine why anemia prevalence declined among Cree infants, such as information on dietary iron intake, infection prevalence, or maternal iron stores during each infant's gestation.

Conclusion

The prevalence of anemia and ID declined among Cree infants in Quebec since the initiation of anemia screening in 1995. Based on the current low prevalence of anemia, primary prevention efforts for ID should be emphasized in Cree communities in addition to secondary prevention efforts through population or targeted screening. Nutrition education programs are required that consist of community-based communication strategies that promote a food-based approach to preventing ID and integrate local nutrition educators into well-baby care.¹⁴ In the Cree region of Quebec, further cohort studies to address variables affecting the prevalence of infant anemia should be considered to help identify patients who are the most vulnerable to anemia, and to document any future changes in anemia and ID prevalence. 

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Contributors

Dr Willows analyzed the data and wrote the manuscript. **Dr Vadeboncoeur** helped collect the data and reviewed copies of the manuscript. **Dr Dannenbaum** helped conceptualize the study, organized data collection, and made editorial changes to the manuscript.

Acknowledgment

Data collection was done in-house by the Cree Board of Health and Social Services of James Bay or was funded by the Canadian Institutes of Health Research. **Dr Dannenbaum** is employed by the Cree Health Board. We kindly thank **Dr Kent Saylor**, **Dr Chip Phi**, and **Dr Johanne Morel** for commenting on manuscript drafts. We acknowledge the support of the Iiyiyiuch and Cree Board of Health and Social Services of James Bay. Drafts of this manuscript were reviewed by the Research Committee of the Cree Board of Health and Social Services of James Bay.

Competing interests

None declared

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References

1. Lutter CK. Iron deficiency in young children in low-income countries and new approaches for its prevention. *J Nutr* 2008;138(12):2523-8.
2. Beard JL. Why iron deficiency is important in infant development. *J Nutr* 2008;138(12):2534-6.
3. Jamieson JA, Kuhnlein HV. The paradox of anemia with high meat intake: a review of the multifactorial etiology of anemia in the Inuit of North America. *Nutr Rev* 2008;66(5):256-71.
4. Gessner BD. Geographic and racial patterns of anemia prevalence among low-income Alaskan children and pregnant or postpartum women limit potential etiologies. *J Pediatr Gastroenterol Nutr* 2009;48(4):475-81.
5. Christofides A, Schauer C, Zlotkin SH. Iron deficiency and anemia prevalence and associated etiologic risk factors in First Nations and Inuit communities in Northern Ontario and Nunavut. *Can J Public Health* 2005;96(4):304-7.
6. Sawchuk P, Rauliuk M, Kotaska A, Townsend S, Wilson E, Starr M. Infant nutrition program effectively prevents iron-deficiency anemia in a First Nations community. *Int J Circumpolar Health* 1998;57(Suppl 1):189-93.
7. Willows ND. *Anemia in James Bay Cree infants of northern Quebec* [doctoral dissertation]. Montreal, QC: School of Dietetics and Human Nutrition, McGill University; 2000.
8. Willows ND, Morel J, Gray-Donald K. Prevalence of anemia among James Bay Cree infants of northern Quebec. *CMAJ* 2000;162(3):323-6.
9. Willows ND, Dewailly E, Gray-Donald K. Anemia and iron status in Inuit infants from northern Quebec. *Can J Public Health* 2000;91(6):407-10.
10. Feightner JW. Prevention of iron deficiency anemia in infants. In: Canadian Task Force on the Periodic Health Examination. *Canadian guide to clinical preventive health care*. Ottawa, ON: Health Canada; 1994. p. 244-55. Available from: www.phac-aspc.gc.ca/publicat/clinic-clinique/pdf/s2c23e.pdf. Accessed 2012 Jan 5.
11. Christofides A, Schauer C, Zlotkin SH. Iron deficiency anemia among children: addressing a global public health problem within a Canadian context. *Paediatr Child Health* 2005;10(10):597-601.
12. Willows N, Gray-Donald K. *Anemia in James Bay Cree infants of northern Quebec: a report and recommendations written for the Cree Board of Health and Social Services of James Bay*. Public Health Occasional Paper Number 5. Chisasibi, QC: Cree Board of Health and Social Services of James Bay; 2002.
13. Willows ND, Iserhoff R, Napash L, Leclerc L, Verrall T. Anxiety about food supply in Cree women with infants in Quebec. *Int J Circumpolar Health* 2005;64(1):55-64.
14. Verrall T, Gray-Donald K. Impact of a food-based approach to improve iron nutrition of at-risk infants in northern Canada. *Prev Med* 2005;40(6):896-903.
15. Michaelsen KF, Weaver L, Branca F, Robertson A. Control of iron deficiency. In: World Health Organization. *Feeding and nutrition of infants and young children. Guidelines for the WHO European region*. Copenhagen, Denmark: World Health Organization; 2000. Available from: www4.dr-rath-foundation.org/NHC/who_documents/whodoc20.pdf. Accessed 2012 Jan 6.
16. Dallman PR, Yip R, Oski FA. Iron deficiency and related nutritional anemias. In: Nathan DG, Oski FA, editors. *Hematology of infancy and childhood*. Philadelphia, PA: WB Saunders; 1993.
17. Domellöf M, Dewey KG, Lönnnerdal B, Cohen RJ, Hernell O. The diagnostic criteria for iron deficiency in infants should be reevaluated. *J Nutr* 2002;132(12):3680-6.
18. Dewey KG, Cohen RJ, Rivera LL, Brown KH. Effects of age of introduction of complementary foods on iron status of breast-fed infants in Honduras. *Am J Clin Nutr* 1998;67(5):878-84.
19. World Health Organization. *Iron deficiency anemia assessment, prevention and control: a guide for programme managers*. Geneva, Switz: World Health Organization; 2001.
20. Stoltzfus RJ. Research needed to strengthen science and programs for the control of iron deficiency and its consequences in young children. *J Nutr* 2008;138(12):2542-6.
21. Lubach GR, Coe CL. Preconception maternal iron status is a risk factor for iron deficiency in infant rhesus monkeys (*Macaca mulatta*). *J Nutr* 2006;136(9):2345-9.
22. De Pee S, Bloem MW, Sari M, Kiess L, Yip R, Kosen S. The high prevalence of low hemoglobin concentration among Indonesian infants aged 3-5 months is related to maternal anemia. *J Nutr* 2002;132(8):2215-21.
23. Savoie N, Rioux FM. Impact of maternal anemia on the infant's iron status at 9 months of age. *Can J Public Health* 2002;93(3):203-7.
24. Cruz A, Parkinson AJ, Hall D, Bulkow L, Heyward W. Associations of early childhood infections and reduced hemoglobin levels in a historic cohort of Alaska Native infants. *Arctic Med Res* 1990;49(4):175-9.
25. Willows ND, Gray-Donald K. Infection and anemia in Canadian aboriginal infants. *Can J Diet Pract Res* 2004;65(4):180-2.
26. Baggett HC, Parkinson AJ, Muth PT, Gold BD, Gessner BD. Endemic iron deficiency associated with *Helicobacter pylori* infection among school-aged children in Alaska. *Pediatrics* 2006;117(3):e396-404.
27. Zlotkin SH, Ste-Marie M, Kopelman H, Jones A, Adam J. The prevalence of iron depletion and iron-deficiency anaemia in a randomly selected group of infants from four Canadian cities. *Nutr Res* 1996;16(5):729-33.
28. US Preventive Services Task Force. *Screening for iron deficiency anemia—including iron supplementation for children and pregnant women: recommendation statement*. Rockville, MD: US Preventive Services Task Force; 2006. Available from: www.uspreventiveservicestaskforce.org/uspstf06/ironsc/ironrs.htm. Accessed 2012 Jan 6.
29. Bogen DL, Duggan AK, Dover GJ, Wilson MH. Screening for iron deficiency anemia by dietary history in a high-risk population. *Pediatrics* 2000;105(6):1254-9.
30. Kapur D, Agarwal KN, Sharma S. Detecting iron deficiency anemia among children (9-36 months of age) by implementing a screening program in an urban slum. *Indian Pediatr* 2002;39(7):671-6.
31. Dewey KG, Chaparro CM. Session 4: mineral metabolism and body composition. Iron status of breast-fed infants. *Proc Nutr Soc* 2007;66(3):412-22.
32. Krebs NF, Westcott JE, Butler N, Robinson C, Bell M, Hambidge KM. Meat as a first complementary food for breastfed infants: feasibility and impact on zinc intake and status. *J Pediatr Gastroenterol Nutr* 2006;42(2):207-14.
33. Walter T, Dallman PR, Pizarro F, Velozo L, Peña G, Bartholmey SJ, et al. Effectiveness of iron-fortified infant cereal in prevention of iron deficiency anemia. *Pediatrics* 1993;91(5):976-82.
34. Ziegler EE, Nelson SE, Jeter JM. Iron status of breastfed infants is improved equally by medicinal iron and iron-fortified cereal. *Am J Clin Nutr* 2009;90(1):76-87. Epub 2009 May 20.
35. Monterrosa EC, Frongillo EA, Vásquez-Garibay EM, Romero-Velarde E, Casey LM, Willows ND. Predominant breast-feeding from birth to six months is associated with fewer gastrointestinal infections and increased risk for iron deficiency among infants. *J Nutr* 2008;138(8):1499-504.
36. Pacey A, Weiler H, Egeland GM. Low prevalence of iron-deficiency anaemia among Inuit preschool children: Nunavut Inuit Child Health Survey, 2007-2008. *Public Health Nutr* 2011;14(8):1415-23. Epub 2010 Oct 5. DOI:10.1017/S1368980010002429.
37. Verrall T, Napash L, Leclerc L, Mercure S, Gray-Donald K. Community-based communication strategies to promote infant iron nutrition in northern Canada. *Int J Circumpolar Health* 2006;65(1):65-78.
