Prevalence of anemia in First Nations children of northwestern Ontario

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ABSTRACT

OBJECTIVE To estimate the prevalence of anemia among First Nations children of northwestern Ontario.

DESIGN Retrospective review of all hemoglobin determinations between 1990 and 1992 in the Sioux Lookout Zone.

SETTING The Sioux Lookout Zone Hospital, a secondary care referral hospital for 28 remote First Nations communities in northwestern Ontario, affiliated with the University of Toronto's Sioux Lookout Program.

PARTICIPANTS All First Nations children age 3 to 60 months who had produced venipuncture or fingerprick blood samples between 1990 and 1992 (614 children had a total of 1223 hemoglobin determinations).

MAIN OUTCOME MEASURES Prevalence of anemia by age, sex, geographical location, and diagnosis. Anemia was defined as a hemoglobin value less than 110 g/L.

RESULTS Prevalence of anemia peaked in the age range of 6 to 24 months with prevalence rates of 51.7% to 79.3%. Conditions most commonly associated with anemia were respiratory tract infections. Children living in communities in the western part of the Sioux Lookout Zone were 1.64 times more likely to have anemia (95% confidence interval 1.15, 2.35) than children in the other communities.

CONCLUSIONS Anemia appears to be a serious public health problem among preschool children in the Sioux Lookout Zone.

RÉSUMÉ

OBJECTIF Estimer la prévalence de l'anémie chez les enfants des Premières nations du nord-ouest de l'Ontario.

CONCEPTION Revue rétrospective de tous les dosages d'hémoglobine effectués entre 1990 et 1992 chez les patients de la zone Sioux Lookout.

CONTEXTE Le Sioux Lookout Zone Hospital, centre hospitalier de référence pour soins de niveau secondaire desservant 28 communautés des Premières nations vivant en régions éloignées du Nord-ouest de l'Ontario, et rattaché au programme Sioux Lookout de l'Université de Toronto.

PARTICIPANTS Tous les enfants des Premières nations âgés de 3 à 60 mois chez qui on avait prélevé entre 1990 et 1992 des échantillons de sang par ponction veineuse ou piqûre du doigt (614 enfants ont fourni 1 223 dosages d'hémoglobine).

PRINCIPALES MESURES DES RÉSULTATS Prévalence de l'anémie par groupes d'âge, de sexe, de localisation géographique et de diagnostic. On posait le diagnostic d'anémie lorsque le taux d'hémoglobine était inférieur à 110 g/L.

RÉSULTATS Le pic de prévalence de l'anémie s'est retrouvé entre les âges de 6 et 24 mois avec des taux de prévalence variant de 51,7 % à 79,3 %. Les infections respiratoires furent les conditions les plus fréquemment associées à l'anémie. Les enfants qui vivaient dans les communautés les plus occidentales de la zone Sioux Lookout étaient 1,64 fois plus à risque d'être anémiques (intervalle de confiance à 95 %, de 1,15 à 2,35) comparativement aux enfants vivant dans les autres communautés.

CONCLUSIONS L'anémie semble constituer un grave problème de santé publique chez les enfants d'âge préscolaire de la zone Sioux Lookout.

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RESEARCH

Prevalence of anemia in First Nations children of northwestern Ontario

Iron deficiency has been identified as the most prevalent nutritional problem in the world.[1] One third of iron-deficient children have the more severe form of the disorder, anemia. Both in developing countries and in Canada, moderate iron-deficiency anemia (hemoglobin levels below 100 g/L) has been shown to depress mental and motor functioning in affected infants.[2,3] Although there is controversy regarding the effectiveness of treatment with iron to reverse these effects, there is universal consensus that iron-deficiency anemia is associated with developmental cognitive and motor deficits and that prevention is essential for every infant.[4,5]

Among the First Nations children of northwestern Ontario, the prevalence of iron-deficiency anemia is considered to be high, but a systematic study of anemia has never been undertaken. To evaluate its importance as a public health concern in this area, we estimated the prevalence of anemia among children younger than 5 years of age in the Sioux Lookout Zone (SLZ) by reviewing hemoglobin determinations conducted from 1990 to 1992.

The study population lives in an area of Ontario defined by Health Canada's Medical Services Branch. Fourteen thousand registered Algonquin-speaking Cree and Ojibway First Nations people live in 28 scattered remote communities in northwest Ontario. Living conditions for these people are hard; adequate housing, central heating, safe water, and adequate disposal systems for sanitary waste are not universally available. Overcrowding and chronic unemployment are serious problems.

In the past, First Nations people had a nomadic lifestyle consisting primarily of hunting, fishing, and trapping as they followed the migratory supply of wildlife. Their diet was high in protein from wild meats and seasonally supplemented with berries and roots. With the development of the reservation system, they were forced to settle in one area. The primary source of food changed from wildlife to the Northern Store (a dry goods and grocery store chain).

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Health care in the town of Sioux Lookout is directed from a 42-bed hospital operated by the Medical Services Branch in conjunction with the local First Nations Health Authority. Community health nurses and physicians provide front-line care.

METHODS

The Sioux Lookout Zone Hospital (SLZH) provides all laboratory services. Blood is drawn by venipuncture (at SLZH) or fingerprick (at nursing stations) when a child presents with illness, for a preoperative check, or for a general physical checkup. Specimens are shipped to the hospital laboratory daily. According to laboratory policy, carbon copies of the laboratory slips are kept on file for 3 years; therefore, it was possible to obtain and review the results of all hemoglobin determinations for the study period. Information contained on each laboratory slip included community of residence, date of birth, date specimen was drawn, reason for blood draw, and hemoglobin value. Confidentiality of data records was maintained at all times.

Between 1990 and 1992, 1223 hemoglobin determinations were made. From these we excluded six determinations with implausible values for the child's age and 311 determinations taken from infants younger than 3 months of age. Young infants were eliminated because of the inherent difficulties in interpreting their hemoglobin values. This left 906 determinations consisting of one to 15 determinations for 614 children. One determination for each child was randomly chosen to remain in the sample, leaving a final sample size for analyses of 614.

Anemia was defined as a hemoglobin value less than 110 g/L.[6] For analysis, data were broken down into 12 categories according to months of age, and the reasons for the blood draws were grouped into seven categories: respiratory infections, other infections, preparatory for dental work, preoperative check, anemia and other nutritional conditions, unknown (unspecified), and other. The community of residence of the child was categorized according to its geographic location in the SLZ as north, south, east, or west.

The distributions of hemoglobin and the prevalences of anemia were compared across categories of each variable. Multiple logistic regression analyses were used to determine whether observed differences in the prevalences of anemia across variables remained after adjusting for age.

RESULTS

Table 1 presents the means and standard deviations of the hemoglobin values and the estimated prevalences of anemia across categories of selected variables. The prevalences of anemia vary across the age range from 79.2% for infants 9 to 12 months of age to 12.9% for children 48 to 60 months of age.

The prevalences of anemia vary by region within the SLZ; the highest prevalence is found in the west. The prevalences of anemia in Sandy Lake and Pikangikum (the principal communities in the western region) are 61.3% and 68.4%, respectively, compared with a prevalence of 52.5% for Sioux Lookout, which is located in the south.

The prevalences of anemia by reason for the hemoglobin determination are also listed in **Table 1**. The prevalences of anemia vary by diagnosis; children diagnosed with respiratory infections have the highest prevalence of anemia (65.6%), whereas those presenting for dental work or a preoperative check have the lowest prevalences of anemia (21.2% and 25.6%, respectively). Only 8.5% of the determinations were made because of anemia or other nutrition-related conditions, and the prevalence of anemia for this group was 61.5%.

The reasons for blood draw differ depending on the age of the child. For example, 42.5% of children younger than 1 year were diagnosed with respiratory infections, compared with only 3.2% of children younger than 3 years. No children younger than 1 year were tested because of future dental work as compared to 10.2% of children younger than 3 years. Because the observed differences in prevalences of anemia by diagnosis could be due to differences in the ages of children presenting with particular conditions, we compared the changes in prevalence of anemia with age for each diagnosis category. The same age-associated declines in anemia prevalence are observed irrespective of the reason for the blood draw, with the exception of children tested because of anemia or other nutritional conditions (**Figure 1**). For those children, no decline in anemia with age is observed.

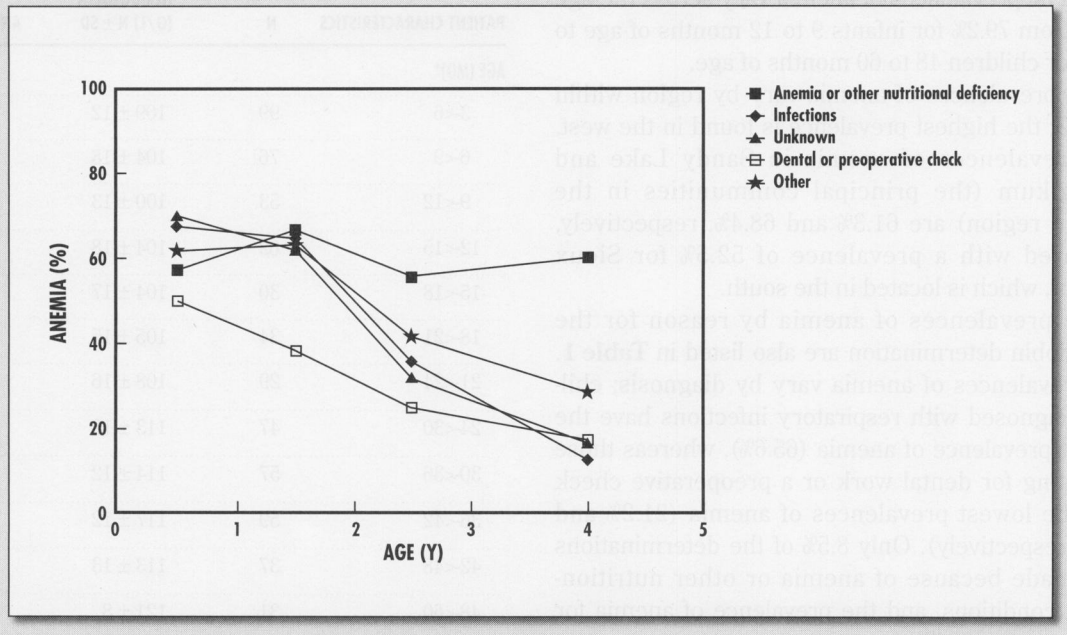
Results of the multiple logistic regression analyses revealed that, after controlling for age, children living in the west were 1.64 times (95% confidence interval [CI]: 1.15, 2.35) more likely to have anemia than children from other regions, whereas those having bloodwork done for dental work or as a preoperative check were 0.48 times (95% CI: 0.29, 0.82) less likely to have anemia than children presenting with all other conditions.

Table 1. Hemoglobin levels and prevalence of anemia (hemoglobin <110 g/L) by selected characteristics

PATIENT CHARACTERISTICS	N	HEMOGLOBIN (G/L) N ± SD	ANEMIA (%)
AGE (MO)*			
3–<6	99	109 ± 12	55.6
6–<9	76	104 ± 18	71.1
9–<12	53	100 ± 13	79.3
12–<15	62	104 ± 18	62.9
15–<18	30	104 ± 17	70.0
18–<21	34	105 ± 15	61.8
21–<24	29	108 ± 16	51.7
24–<30	47	113 ± 13	38.3
30–<36	57	114 ± 12	28.1
36–<42	59	117 ± 12	18.6
42–<48	37	113 ± 13	27.0
48–<60	31	121 ± 8	12.9
SITE OF BLOOD DRAW			
Nursing station	61	104 ± 20	55.7
Sioux Lookout Zone Hospital	553	109 ± 15	49.2
REASON FOR HEMOGLOBIN DETERMINATION*			
Respiratory infection	151	105 ± 15	65.6
Other infection	88	108 ± 15	52.1
Dental work	104	116 ± 11	21.2
Preoperative check	43	115 ± 12	25.6
Anemia or other nutritional deficiency	52	101 ± 18	61.5
Unknown	105	108 ± 14	55.2
Other	71	110 ± 17	52.1
RESIDENCE IN SLZ*			
North	113	112 ± 13	39.8
West	244	106 ± 17	59.0
East	158	109 ± 14	44.9
South	99	110 ± 15	46.5

**Significant difference across categories, $P < 0.05$.*

Figure 1. Age-associated changes in the prevalence of anemia (hemoglobin < 110 g/L) by diagnosis: *Values are plotted at the midpoint of each age interval.*



DISCUSSION

These analyses clearly substantiate the clinical suspicion of childhood anemia as a serious public health problem among preschool children in the SLZ. Overall, anemia was identified in 46.6% of the children tested. More than half the infants 3 to 6 months of age were identified as anemic. Children 6 to 24 months of age were at greatest risk of anemia with prevalences ranging from 52% to 80%. Beyond 24 months prevalences declined substantially, but were still between 10% and 40%.

Some caution should be taken in interpreting the results due to the limitations of the methodology. This was not a representative survey of children younger than 5 years living in SLZ, but rather a review of all hemoglobin determinations performed on SLZ children 3 to 60 months of age over a 3-year period. Reasons for the determinations varied greatly, but most were performed as a routine matter on children with acute illness. Thus, the prevalences of anemia are likely to be overestimated to the extent to which children who are sick are also more likely to have anemia.

Only a small proportion of determinations were done because anemia was suspected. The age-associated changes in prevalence of anemia were consistently observed regardless of the reason for blood draw (except when anemia was suspected). Thus, any selection bias is likely to be constant across the age range of children studied here. The prevalences of anemia will also be somewhat biased because hemoglobin concentrations fall by as much as 10%, even with mild infections.[7] Despite these limitations, the analyses presented here represent a reasonable first step in defining the public health importance of iron-deficiency anemia in this population, using data commonly available in many settings.

Because SLZ is a finite population, we can use information on population size to further refine our prevalence estimates. Hemoglobin determinations were performed on 614 of the estimated 2053 children younger than 5 years living in SLZ at that time. If we make the crude assumption that all anemic children were in fact identified, the overall prevalence of anemia would be re-estimated at 14%. Further, if we assume a constant birth rate of 410 births yearly and that all children with anemia were identified, new

age-specific prevalence estimates calculated for children 3 to 12 months, 12 to 24 months, and 24 to 60 months would be 49.1%, 23.4%, and 4.5%, respectively.

The assumption that all children who did not have their hemoglobin measured were nonanemic is improbable, but serves to provide a baseline to the prevalence estimates reported here. Although these new estimates are much lower than those based on children having bloodwork done, they do not refute the conclusion that anemia is a serious public health problem in SLZ, particularly for children younger than 2 years.

Our results are higher than but consistent with those reported in other studies involving First Nations populations. In 1983, Plaxton et al[8] performed a similar review of the health care provided for preschool children in the SLZ. Of the preschooler's charts they reviewed, 55% recorded a hemoglobin value, and 36% had hemoglobin levels less than 120 g/L, indicating the presence of anemia in this same study population. Moffat[9] demonstrated that 42.5% of children 6 to 24 months living in Norway House, Man, had hemoglobin levels below 110 g/L. He also reported an incidence of iron-deficiency anemia of more than 50% in urban First Nations children attending a Winnipeg clinic.[9] The prevalence of anemia among low-income First Nations people in the United States is also high. Yip et al[10] reported the prevalence of anemia among First Nations children younger than 2 years participating in the Pediatric Nutrition Surveillance System to be 15% to 20%.

Based on hemoglobin values alone, we cannot determine the predominant cause of anemia in this population. Specific hemoglobinopathies resulting in lower hemoglobin concentrations are not known to exist in this population. Research indicates that, when the prevalence of anemia is high (15% to 20%), nearly all cases of anemia can be attributed to iron deficiency.[11] The peak period of risk as well as the age-associated declines in the prevalence of anemia observed here are also consistent with patterns of anemia associated with depletion of iron stores.[12] The Nutrition Canada survey[13] in the early 1970s identified 40% of children aged 1 to 4 years with abnormal serum ferritin values. This most likely represents an underestimate due to the exclusion of infants younger than 1 year. We conclude that iron deficiency is the most likely cause of anemia in this population.

Change from traditional eating and breastfeeding patterns could be important factors in the development of anemia in this population.[14] Unlike other First Nations populations, the prevalence of breastfeeding at hospital discharge within SLZ is high (85% to 90%)[15] and has remained consistent over the past decade according to annual reports from the SLZH maternity ward.[16] Nurses in the community, however, report that breastfeeding is nearly always supplemented with other items, such as tea with sugar, condensed evaporated milk diluted with water, or juice, and that non–iron-fortified infant cereals are introduced as early as 3 weeks of age. Thus, despite a high rate of initiation of breastfeeding, many foods are being introduced during early infancy that are known to deplete iron stores and lead to the development of anemia.[17,18]

Given our results, determining the cause or causes of anemia in this First Nations pediatric population is imperative. The first 2 years of life are filled with numerous growth and developmental milestones, both mental and physical. Children experiencing anemia in this population often exhibit developmental delays that will be irreversible. Further longitudinal research is needed to document the development of iron-deficiency anemia in this population and to identify risk factors for developing iron-deficiency anemia during the first 2 years of life, with the ultimate goal of developing an effective strategy for prevention.

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