Iron Deficiency Is Unacceptably High in Refugee Children from Burma[1–3]

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ABSTRACT Iron-deficiency anemia (IDA) in refugees is reported to be among the major medical problems worldwide. Because food rations are typically inadequate in iron, long-term reliance is a key predictor of anemia among displaced people. Comprehensive nutritional assessments of refugee children from Burma have not previously been completed. Refugee children aged 6–59 mo were studied to determine *1*) the prevalences of anemia, iron deficiency (ID) and IDA and *2*) the factors associated with anemia and ID. Cluster sampling in three camps and convenience sampling in two additional camps were used. Hemoglobin (Hb) levels were measured and μmol zinc protoporphyrin/mol heme were determined in 975 children. Logistic regression analyses (95% CI) determined predictors of anemia and ID. The prevalences of IDA, anemia and ID in these refugee children were 64.9, 72.0 and 85.4%, respectively. Predictors of anemia included young age ($P < 0.001$), food ration lasting <1 mo ($P = 0.001$), daily consumption of dietary iron inhibitors ($P < 0.05$), weight-for-height Z-score of <-2 ($P < 0.05$), male gender ($P < 0.05$) and uneducated father ($P < 0.001$). Predictors of ID were young age ($P < 0.001$) and recently reported illness ($P < 0.05$). Laboratory tests confirmed that anemia and ID are major health problems among these refugee children and that ID is the leading cause of anemia. A comprehensive nutrition and public health-focused approach to combating anemia and ID is essential. Following the presentation of results to policy makers, the improvement of the micronutrient content of rations has been initiated. J. Nutr. 133: 4143–4149, 2003.

KEY WORDS: • *anemia* • *iron deficiency* • *refugee* • *micronutrient* • *zinc protoporphyrin*

It is estimated that one-half of the children in developing countries are iron deficient and the highest risk groups are preterm and low birthweight infants, infants and children during periods of rapid growth (1). Southeast Asia has one of the highest overall prevalence rates of anemia with ~616 million at risk and affected by iron deficiency (ID)[6] (6) or anemia (2). Studies that compared the prevalence of anemia by geographic regions found that between 2 and 87% (mean 49%) of children ($n = 10{,}450$) aged 0–5-y-old in Southeast Asia were anemic (3).

Very limited data on the prevalence of anemia and ID within refugee populations exist. However, it has been commonly reported that the micronutrient content of refugees' diet is often inadequate (4). Refugee rations are typically deficient in many essential micronutrients, including iron, and situations in which refugees are not able to supplement rations produce major outbreaks of deficiency diseases (5). Micronutrient deficiencies are typically seen in refugee populations in which there is limited access to foods other than the staple ration and diversity of the diet is limited. Rations provided to refugees may meet the requirements for energy, but not for essential micronutrients. In some refugee populations where ra-

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[6] Abbreviations used: BBC, Burmese Border Consortium; HAZ, height-for-age *Z*-score; Hb, hemoglobin; ID, iron deficiency; IDA, iron deficiency anemia; IDE, iron-deficient erythropoiesis; MUAC, mid-upper arm circumference; WHZ, weight-for-height *Z*-score; SPSS, Statistical Package for the Social Sciences; ZPP/H, μmol zinc protoporphyrin/mol heme.

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tions were provided, the prevalence of protein energy malnutrition, vitamin A deficiency and anemia actually increased (2).

Clinical studies of refugee populations addressing their unique issues are an essential part of program evaluation. Programs implemented to aid refugees must be evaluated before the impact on food, health and other critical interventions can be improved. Relating interventions to potential benefits is necessary for humanitarian relief planners to select appropriate interventions and to budget wisely for an overall relief effort (6).

The refugees in camps located along the Thailand/Burma border have never been evaluated for dietary deficiencies. Burma has been affected by civil war for >40 y, during which time large minority groups including the Karen, Karenni and Mon have fled the country to escape armed aggression and persecution by the State Peace and Development Council (7). The Burma regime is among the world's worst human rights violators for abuses including murder, arbitrary executions, torture, rape, detention without trial, massive forced relocations and forced labor. Human suffering is incalculable and the resultant mass migrations have created major regional disruptions and tensions. The ethnic minorities, ~40% of the countries population, are the military's primary target of abuse and children particularly have suffered (7).

Since 1984, refugees from Burma have arrived gradually in Thailand (8). It is estimated that nearly 300,000 Burmese are refugees in Thailand, Bangladesh and India. In addition, as many as 1,000,000 Burmese are internal refugees who have been displaced from their homes (7). An estimated 135,000 of those refugees are now seeking refuge in camps along the Thailand/Burma border.

Ten camps housing refugees from Burma are located within Thailand and have populations ranging from 2,600 to >30,000. The camp populations are continually growing. Within the camps the refugees are provided a monthly ration consisting of 16,000 g of rice (children <5 y receive 8000 g), 1000 g of fermented fish paste, 1500 g of hulled mung beans (children <5 y receive 750 g), 1 L of soybean oil (children <5 y receive 500 mL), 330 g of iodized salt and 125 g of dried chilies. Refugees have limited or no income and are typically not allowed outside the camps. Access to farmland, gardens, fishing, hunting, gathering, raising animals and jobs is very limited. There are a number of international organizations and nongovernmental organizations working with the refugees to provide food, shelter and medical supplies. The Thailand Ministry of Interior is the approving authority for rations and the relief program is coordinated through the Coordinating Committee for Services to Displaced Persons in Thailand and the Burmese Border Consortium (BBC). Funding support is provided from a variety of sources and governments.

This study was designed to assess the nutritional status and to determine the prevalence of anemia and ID in refugee children aged 6–59-mo-old from Burma (Myanmar[7]) (9) using interviews and field-friendly measurements for anemia, iron status and anthropometrics. A second objective was to identify nutrition, health, socioeconomic and demographic factors that might be associated with anemia and ID.

MATERIALS AND METHODS

Human subjects approval. The Human Subjects Division, University of Washington, Seattle, Washington, approved this project. The study was conducted in compliance with the Declaration of Helsinki. Authorization to access the refugee camps was provided by the Ministry of Interior for all Karen and Karenni camps located within Thailand. Access to the camps was coordinated with the Karen and Karenni Refugee Committees.

Participants. Study participants were refugee children aged 6–59-mo-old from Burma living within camps along the Thailand/Burma border. Cluster sampling (10) was used for household selection within the Karen camps (Tham Hin, Ban Don Yang and Mae La) and convenience sampling, to ensure an equal distribution of individuals from within each camp zone, was used within the Karenni camps (Ban Kwai and Ban Mai Nai Soi). In all camps only one child in the designated age category was randomly selected from within each household. The reported number of children aged <5-y-old per camp was Tham Hin, 1,163; Ban Don Yang, 370; Mae La, 3,692; Ban Kwai, 1,389; and Ban Mae Nai Soi, 491. Data were obtained for children of these camps as follows: Tham Hin (n = 215), Ban Don Yang (n = 214), Mae La (n = 214), Ban Kwai (n = 244) and Ban Mai Nai Soi (n = 88).

Blood samples, anthropometric measurements and interviews with the child's primary caregiver were obtained for 857 children. Blood samples and anthropometric data were collected without complete interviews for an additional 118 children from Ban Kwai and Ban Mai Nai Soi to increase the sample size for evaluation of anemia and ID because convenience sampling was used within these two camps. Hemoglobin (Hb) data were available for all 975 participants, however, μmol zinc protoporphyrin/mol heme (ZPP/H) were available for only 906 participants because some samples were damaged in transit, were of insufficient quantity or clotted.

Data collection. The study was coordinated and carried out with the assistance of the Thai Red Cross Society. The preliminary working arrangements, initial site survey and preliminary testing of the interview questionnaire were completed in advance during an initial site visit to Thailand. Team member training was conducted at the Thai Red Cross Society, Bangkok, Thailand, prior to data collection and covered the following areas: consent form, introduction at the household, data collection form, anthropometrics [weight, height and mid-upper arm circumference (MUAC)], refugee issues, interviews, blood collection and sampling.

Written consent was obtained for each of the participants from the primary caregiver (typically the mother) prior to data collection. Only three households from the five camps interviewed declined to participate. The interview of the primary caregiver was completed using a tool previously tested on this population to ascertain nutrition, demographic, health and socioeconomic indicators; a trained interviewer completed the interviews. Reviewed forms lacking completeness, having questions left unanswered or requiring additional clarification were resolved with the interviewee the following day. Completed interview forms were scanned into the Statistical Package for the Social Sciences (SPSS) and data were reviewed at the U.S. Army Research Institute of Environmental Medicine prior to analysis.

The Infant/Child Shorrboard (Shorr Productions, Olney, MD) was used to measure both child stature and recumbent infant length (if the child was <85 cm). Participants' weights were obtained using the Seca Model 881 scale (Seca, Vogel & Halke, Germany). For MUAC measurement, arm circumference tapes (single-slotted insertion tapes, tricolored, 25 cm × 0.1 cm) were used on the left arm of participants throughout the data collection. One previously trained individual completed all MUAC measurements.

Blood was obtained from participants by a finger prick. Hb, used to determine anemia status, was measured in the field using the HemoCue Blood Hemoglobin Photometer (HemoCue US, Mission Viejo, CA). The calibration of the HemoCue machine was completed daily using control cuvettes. An EDTA-coated microcapillary tube was used to collect blood for later analysis of ZPP/H, a marker used to diagnose ID. The ZPP/H analyses were performed at the Harborview Medical Center, University of Washington Clinical Nutrition Research Unit Laboratory. The ZPP/H was measured on a ProtoFluor-Z hematofluorometer (Helena Laboratories, Beaumont, TX) following standardized procedures (11). Identical procedures for

[7] The name of the country was officially changed from Burma to Myanmar in 1989 by the military government and is not accepted or used by development or human rights organizations or by Burmese opponents of the regime.

interviewing, anthropometric measurements and blood collection were followed for both cluster and convenience sampling.

The presence and severity of anemia was diagnosed using the age-based Hb criteria for children aged 6-mo–5-y-old designated by WHO (12). Moderate and severe anemia was defined as Hb < 110 and <80 g/L, respectively. The diagnosis of iron deficiency anemia (IDA) was defined as a Hb < 110 g/L and ZPP/H > 80 μmol/mol. Evidence of iron-deficient erythropoiesis (IDE) was determined by a ZPP/H > 80 μmol/mol in nonanemic individuals (Hb ≥ 110 g/L), and ID by a ZPP/H > 80 μmol/mol (13). The traditional diagnosis of simple ID is based on the biochemical indicators of iron metabolism, which includes determination in serum or plasma of iron, transferrin, tansferrin saturation and ferritin (14). ZPP/H is a useful test for identifying ID in population studies (15,16). An increase in ZPP/H is the first biochemical change that is readily measurable following a decline in iron status and has merit as the primary laboratory diagnosis of ID (17).

Wasting was diagnosed by a weight-for-height ratio of <-2 to -3 Z-scores (moderate acute) or <-3 Z-scores (severe acute) (18). Wasting was also assessed using MUAC with a fixed cut-off value between 11.0 and <12.5 cm (moderate) or <11.0 cm (severe) (10) and MUAC-for-age < -2 Z-scores (poor) based on children in the U.S. aged 6–60 mo (18). Stunting was defined as a Z-score < -2 for height-for-age (19).

Statistical analyses. Statistical analyses were conducted using SPSS version 10.0.7 and EPINUT in Epi Info 2000 (CDC, Atlanta, GA). Descriptive statistics were completed for all the variables. Histograms were used to visually determine the normality of the distributions. Using the two independent samples *t*-tests, the two groups cluster versus convenience sampled, were not different with respect to gender and age, therefore, the data were analyzed as one data set. Primary analysis of the data evaluated the relationships between anemia and ID and the variables of interest. Individuals were stratified into dichotomous groups (with and without anemia and ID) and the data were analyzed using joint contingency tables followed by Chi-square statistics. Chi-square or two-tailed *t*-tests were completed at the 95% level to determine significance prior to analyzing the data in a logistic regression model. MUAC, weight-for-height Z-score (WHZ) and height-for-age Z-score (HAZ) measurements were also evaluated as dichotomous variables. Backwards logistic regression using the likelihood-ratio test was used to determine nutrition, health, socioeconomic and demographic factors associated with anemia and ID. EPINUT 2000 was used to calculate Z-scores. SPSS was used to calculate all of the additional statistical analyses. All data are presented as means $\pm$ SD.

RESULTS

Participant characteristics. Of the 975 children, 52.3% were male and the mean age was 29.3 $\pm$ 14.1 mo. The mean WHZ was -0.84 ± 0.80 with 5.7% of the children considered wasted (WHZ < -2), whereas HAZ was -1.84 ± 1.29 and 45.7% were considered stunted (HAZ < -2). Using MUAC-for-age, 6.5% of the children were considered wasted. In contrast, only 0.8% of the children were wasted as defined by a MUAC < 12.5 cm; mean MUAC was 14.9 $\pm$ 1.0 cm.

Overall participant prevalences for ID, anemia, IDA and IDE were 85.4, 72.0, 64.9 and 20.5%, respectively (**Fig. 1**). Overall, the prevalence of anemia was higher in boys than girls ($P < 0.05$). Boys had a higher prevalence of IDA ($P = 0.01$) and girls had a higher prevalence of IDE ($P = 0.02$), but the prevalence of ID did not differ between boys and girls ($P > 0.05$). Children $<$ 24 mo-of-age had a higher prevalence of anemia ($P < 0.001$), IDA ($P < 0.001$) and ID ($P < 0.001$) than children older than 24 mo-of-age, however, children $>$ 24 mo-of-age had a higher prevalence of IDE ($P < 0.001$).

The Hb level was 99.8 $\pm$ 16.0 g/L. Severe anemia (Hb < 80 g/L) was diagnosed in 10.4% of participants and was similar in boys (10.8%) and girls (9.9%). Chi-square analyses indicated an association between ZPP/H and severe anemia ($P < 0.001$); all individuals with severe anemia ($n = 92$) had an elevated ZPP/H. In addition, severe anemia was positively associated with WHZ < -2 ($P = 0.01$). Among children with WHZ < -2, 49 of 56 (87.5%) were anemic and 13 of 56 (23%) were severely anemic.

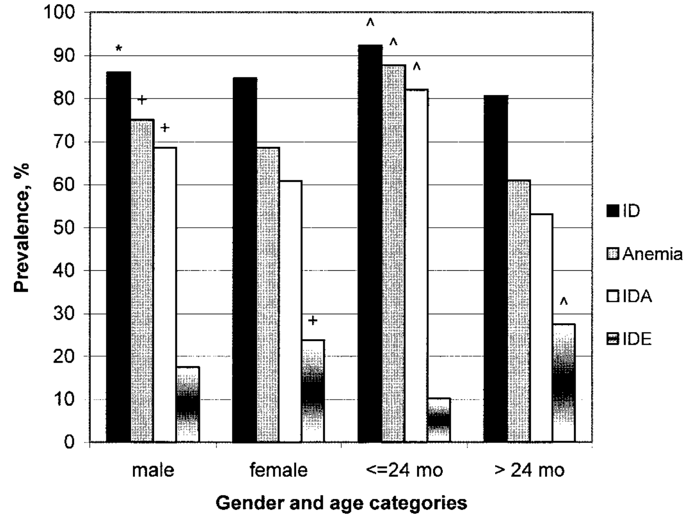

FIGURE 1 Prevalence of ID, anemia, IDA and IDE in 975 children aged 6–59 mo in refugee camps along the Thailand Burma border by gender and age categories, $\leq$24 and $>$24-mo-of-age. * $P > 0.05$, + $P < 0.05$, $\wedge$ $P < 0.001$.

Dietary intake and ration availability. Of the 857 participants interviewed, only 1.3% (11 infants) were exclusively breast-fed at the time of the interview; however, 53.8% of the children were currently being breast-fed. There was no association between breast-feeding for <6 mo and anemia or ID, even though the iron in breast milk is highly bioavailable (20,21). As expected, there was a low prevalence of children never breast-fed (1.3%) within this population. The mean age for introducing solid foods was 5.5 $\pm$ 4.9 mo, with 66% of participants introduced to solid foods other than breast milk at <6 mo of age.

Within the camps, the refugee families are provided a monthly ration consisting of rice, hulled mung beans, soybean oil, fish or prawn paste, iodized salt and dried chilies. The rations provide a mean of 10,150 kJ/d for adults and 5,146 kJ/d for children <5-y-old. Based on nutrient composition data obtained from the BBC, the ration does not meet the overall Dietary Reference Intakes for children <5 y of age for iron, calcium, vitamin A, vitamin C, thiamin, riboflavin and niacin (**Table 1**) (22). Vitamin A capsules have been provided to the medical agencies for distribution to children in the camps since 1996.

Dietary frequency data were used to determine the daily intake of iron containing foods (meat, fish, poultry, eggs, soybean, yellow beans, green leafy vegetables, milk and groundnuts), highly bioavailable sources of heme iron (meat, fish and poultry), vitamin C containing foods, and iron inhibitors (phytates, polyphenols, tannin, calcium and phovitin). The reported daily dietary frequency intakes were: iron containing foods, 47.7%; heme iron, 21.1%; vitamin C, 4.4%; and iron inhibitors, 42.5%. Because fish and prawn paste are used more as a condiment than a meat serving, they do not provide a large portion of heme iron, however, the iron that they do provide is highly bioavailable and can enhance the iron absorption from nonheme iron sources (23). Of the 21.1% of the children consuming a source of highly bioavailable iron on a

TABLE 1

Daily nutrient composition of the refugee ration for children aged <5 y compared with the Dietary Reference Intakes (DRI)[1]

	Calcium	Iron	Vitamin A	Thiamin	Riboflavin	Niacin	Vitamin C
	mg/d		*μg/d*	*mg/d*			
Child Ration	302	6.3	62	0.33	0.25	5.4	0.46
DRI:							
Age 7–12 mo	270	11	500	0.3	0.4	4	50
Age 1–3 y	500	7	300	0.5	0.5	6	15
Age 4–18 y	800	10	400	0.6	0.6	8	25

[1] Food and Nutrition Board and the Institute of Medicine. Published by National Academy Press (2002), pp. 770–773 (22).

daily basis, only 9% consumed a source of bioavailable iron other than fish or shrimp paste; 16% reported consuming meat two to five times per week.

Information on general rations received was obtained during the interview ($n = 857$). Of those, 61% ($n = 523$) did not have enough food to last the entire month, and at least one ration item did not last until the next ration delivery; 7.5% of children had no food to eat for at least one meal during the month.

Only 6% of those interviewed reported receipt of the weekly supplemental feedings consisting of 1000 g of rice, 500 g of beans and 7 eggs, in addition to the ration items. However, none of the children with WHZ < -3 and only 4 of the 44 children with WHZ < -2 received the supplemental feeding.

Demographics and health status. Of the families interviewed, 88.8% of the children had been born in the camp or lived there for >1 y. Men were head of the household in 90% of the families and 60.5% had some source of income. With respect to parental education, 62% of fathers and 68.2% of mothers had no primary education. The reported literacy rate was 58.3 and 63.2% for mothers and fathers, respectively.

The primary care provider was interviewed to ascertain the health status of the children during the preceding week. Approximately 45% of the children were reported to have experienced an illness during the previous week. Illnesses reported included fever (36.6%), diarrhea (16.8%) and vomiting (7.6%).

Logistic regression analysis to determine characteristics associated with anemia and ID. Separate logistic regression models were completed to determine the predictors of anemia and ID. The model predicting anemia included young age, male gender, daily intake of dietary iron inhibitors, ration does not last until the next ration delivery, WHZ < -2 and father was not formally educated (**Table 2**). Factors shown to be associated with anemia within this population included dietary factors, wasting and socioeconomic characteristics. Reported illnesses were not associated with anemia in this model, but age and gender were.

The model for the prediction of ID included young age, reported illness within the last 7 d and child was not born in the camp (**Table 3**). Although the logistic regression model on the outcome of ID showed no dietary effect based on the indicator values incorporated, the general ration is low in bioavailable iron and there is little variation in the iron intake within the population.

DISCUSSION

Iron deficiency is considered the most prevalent micronutrient deficiency in refugee populations (24). Overall, in areas where the prevalence of anemia exceeds 30–40%, the majority of anemia appears to be caused in part or exclusively by ID (1).

Previous studies have shown that anemia is a major public health problem in Southeast Asian children (3). The current study supports and extends previous findings by demonstrating that anemia is an important public health problem and ID, based on ZPP/H, is also a major concern in refugee children from Burma. The prevalence of anemia in these children was 72%; a value higher than the mean prevalence reported for children aged 0–5 y in Southeast Asia (49%) (3). Additionally, based on the ration currently provided by the BBC and evaluated using the Sphere Project minimum standards as a reference (25), micronutrient deficiencies in these camp populations would be expected (26). Overall, the General Findings from the Health Information Systems Evaluation conducted in the camps noted that the overall food ration was insufficient (27). These findings indicate a need for both further assessments as well as the development of measures to reduce the prevalence of anemia.

Anemia is clearly prevalent among refugee children. A previous study of refugee children aged 6–35 mo from Syria, Jordan, the West Bank, the Gaza Strip and Lebanon reported

TABLE 2

Logistic regression for nutrition, health, socioeconomic and demographic predictors of anemia in refugee children age 6–59 mo (n = 857)[1]

Indicator Variable	Standardized B	OR	95% CI	*P*-value
Male gender	0.38	1.46	1.05–2.03	<0.05
Age, *mo*	−0.06	0.94	0.93–0.96	<0.001
Daily intake of dietary iron inhibitors	0.37	1.45	1.04–2.02	<0.05
Ration does not last until next ration delivery	0.57	1.78	1.28–2.47	0.001
WHZ[2] <−2	1.07	2.92	1.14–7.47	<0.05
Father has not received any formal education	0.62	1.85	1.33–2.57	<0.001

[1] Anemia, Hb < 110 g/L.
[2] Weight-for-height *Z*-score.

TABLE 3

Logistic regression for the nutrition, health, socioeconomic and demographic predictors of iron deficiency in refugee children age 6–59 mo (n = 857)[1]

Indicator variable	Standardized B	OR	95% CI	*P*-value
Age, *mo*	−0.05	0.96	0.94–0.97	<0.001
Reported illness in last 7 d	0.66	1.94	1.05–3.59	<0.05
Child was not born in camp	0.80	2.23	1.37–3.62	0.001

1 Iron Deficiency, ZPP/H > 80 μmol/mol.

an overall anemia prevalence rate of 67% (54 to 75%) (28). The mean Hb in a population of nonrefugee children from Uzbekistan following the breakup of the former Soviet Union was 97.8 g/L, a value similar to that found in this study (99.8 g/L) (29).

Severe anemia, defined by WHO standards as Hb < 80.0 g/L, is also a health problem among refugee children. Burundian refugee children < 5-y-old (*n* = 526) had a 48% prevalence of Hb levels between 50.0 and 80.0 g/L, with mean Hb levels of 79.0 g/L (30). In the present study we found that 10.4% of the children had severe anemia.

Children < 24-mo-old were more likely to have anemia and ID than older children. This is consistent with the literature reporting that ID is common among children around the time of growth spurts and especially in children between the ages of 6 to 24 mo (31,32). Children < 24-mo-old from Syria, Jordan, the West Bank, the Gaza Strip and Lebanon also had a higher risk of anemia and boys had a higher prevalence of anemia (28). In the current study, boys were also more likely than girls to have anemia and IDA.

Factors other than nutrition that may be associated with the high prevalence of anemia within this population are hookworm, malaria and thalassemia. Hookworms, a major cause of iron deficiency anemia, cause intestinal blood loss and can lead to a considerable loss of iron (2). Medical agencies (Aide Medicale Internationale, American Refugee Committee, International Rescue Committee, Malteser-Hilfsdienst Auslandsdienst E.V., and Medecins Sans Fronieres–France) working within the camps provide medical care and report routine treatment of children for parasite infection.

The prevalence of thalassemia within this pediatric refugee population was not determined. Thalassemia is considered to be particularly high in Southeast Asia with a reported prevalence of 4.8–10% in Thailand (33). The use of ZPP/H as the diagnostic tool for ID within this study population was appropriate because free erythrocyte protoporphyrin levels remain normal in individuals with thalassemias (31,33).

In developing countries over one-half of the children suffer from anemia resulting primarily from malaria and ID (34). Iron deficiency can be exacerbated by infection with malaria (24). Malaria is endemic in this region, but the prevalence was not determined from this study, however, the medical agencies and the Shoklo Malaria Research Unit are actively screening and treating malaria within the camps (35).

To determine the factors that contribute to anemia, logistic regression analyses were carried out. A combination of factors including nutrition were found to impact the outcome of anemia in these refugee children. These findings suggest that the prevalence of anemia could be decreased by improving overall nutritional status and enhancing the micronutrient content of rations.

No nutrition variables remained in the logistic regression base model for predicting ID. However, the interpretation of these findings and the results of the odds ratio and chi-square analyses suggest that illness and inadequate intake of dietary iron are the primary contributors to anemia and ID. It is likely that health status indicators mask the effects of nutrition predictors that may be important. Population levels of anemia and ID as high as those found in these children would not be seen unless diet was a contributing factor. There is adequate documentation on efficacious options to control and prevent anemia and ID, i.e., food fortification, micronutrient pills, dietary quality improvement, dietary diversity and public health measures can make differences with relatively little investment (36). In large populations, fortification has been a very effective measure. Because the food consumed by these refugees is already controlled and channeled through international aid agencies, it is an unusually good opportunity to pilot fortification of staples. In addition, this high-risk population subgroup should be targeted for treatment and long-term prevention using micronutrient pills and/or liquid drops.

Others have also discussed the importance of predictor variables. In children of Southeast Asian descent, the high prevalence of severe IDA was attributed to a diet consisting primarily of milk, rice and soup, with very little meat (37). In contrast, a study conducted in young children of the Muynak District of Darakalpakistan, Uzbekistan, found no significant dietary predictors of anemia, but reported that age, history of pica and the primary household water source were important (29). Within refugee camps in Syria, Jordan, the West Bank, the Gaza Strip and Lebanon, the location of the refugee camp, never having been breast-fed, male sex, maternal illiteracy, having recent or current illness and stunting were predictors of anemia (28). Some of these predictors are consistent with the findings of this study.

In the Karenni refugee camps, malnutrition was reported as one of the major health problems; 10% of children 2–5-y-old were found to be below the reference standards for WHZ or wasted (38). The current study found 5.7% of the children were considered wasted using WHZ and 6.5% using MUAC-for-age; 45.7% of the children were stunted, according to International Standards. Thus, our study confirms the concerns of the International Rescue Committee and highlights the need for assistance.

The provision of a supplemental feeding ration in the camps varied, depending on the degree of malnutrition. However, we found that the targeted supplemental feeding program missed the children at greatest nutritional risk; no child with WHZ < −3 and only 4 of the 44 children with WHZ < −2 reported receiving the supplemental feeding. This finding confirms the concerns noted in the Mission Evaluation Report completed in the Burmese refugee camps that current supplementary feeding programs have a variety of problems, including inadequate nutritional expertise to identify and treat children at risk (39). The increased risk of anemia associated with a high ZPP/H and malnutrition, determined by WHZ, implicates anemia of malnutrition within this subset of the children (40).

In conclusion, the results of this study confirm that anemia and ID are very prevalent, yet preventable health problems, among the refugee children from Burma, aged 6–59 mo who are provided a ration and are living within the five Thai/Burma border camps evaluated. The results revealed a severity index of poor for malnutrition based on the prevalence of wasting (18) using WHZ (5.7%) and MUAC-for-age (6.5%);

however, the very high prevalence rates of anemia (72%) and ID (85%) within these refugee children point out the importance of evaluating micronutrient malnutrition or hidden hunger in all vulnerable populations. Furthermore, the existence of micronutrient deficiencies where general wasting is not serious underscores the gap in attention by relief agencies who give disproportionate attention to energy and protein needs while taking minimal responsibility for basic vitamin and mineral requirements.

Two primary issues need to be addressed to help decrease the high prevalence of anemia and ID within this population: *1*) control of infection and *2*) provision of a diet that contains bioavailable dietary iron, specifically heme iron and iron enhancers. A diverse diet that meets energy and micronutrient requirements must be available to all children. An appropriate mix of interventions may be the ideal way to approach a comprehensive ID or general micronutrient control program. A variety of well-defined actions, if implemented in combination, should dramatically decrease or prevent ID. Food fortification, micronutrient pills, dietary quality improvement, dietary diversification and public health measures should be considered. To help resolve the nutritional issues of the refugee children raised during this research, a collaborative effort is required of all those that have an impact on the ration and health care provided.

The results of this research have been provided to the policy makers: Thai Ministry of Interior, Coordinating Committee for Services to Displaced Persons in Thailand, and the Burmese Border Consortium Nutrition Director; in addition to other influential groups: Thai Red Cross Society, refugee camp committees, Institute of Nutrition at Mahidol University, International Life Sciences Institute–Thailand, and Dr. Cynthia Maung (Dr. Cynthia's Clinic). Following this research project and additional nutrition-focused research conducted within the Mae La Camp by the Institute of Nutrition at Mahidol University and the BBC, efforts have progressed on ration improvement. To date, iodized salt remains the only fortified food item provided in the ration but an initiative has been launched to introduce fortified wheat/soy blend flour as a pilot project within one of the camps in October 2003. There is an additional focus in supporting a border-wide agriculture project emphasizing organic gardening in small spaces and community level nutrition education. Iron supplementation for preschool children is being considered but has not been implemented. Further research should be directed toward the feasibility, efficacy, cost effectiveness and sustainability of various measures for the prevention of IDA in refugee children.

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