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Ankoor Yogesh Shah Date

Prevalence of Anemia and Malnutrition among Refugee Children entering DeKalb County, Georgia

By

Ankoor Yogesh Shah
Master's of Public Health

Department of Epidemiology

____
Carolyn Drews-Botsch, Ph.D.
Faculty Thesis Advisor

____
Susan Reines, MD
Thesis Field Advisor

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Ankoor Yogesh Shah

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Faculty Thesis Advisor: Carolyn Drews-Botsch, Ph.D.

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Abstract

Prevalence of Anemia and Malnutrition among Refugee Children entering DeKalb County, Georgia

By Ankoor Yogesh Shah

Background: Refugee children arrive in the United States from conflicted, food-insecure, and hostile environments from all over the world. Though there is much data about the prevalence of malnutrition and anemia at specific refugee camps or populations in certain countries, there is scant information in the literature about the current malnutrition and anemia prevalence of pediatric refugees arrive to the United States.

Methods: This retrospective study reviewed medical records of pediatric refugees (ages 0-18 years) screened at the DeKalb County Board Refugee Screening Clinic in Decatur, Georgia, USA between October 1st, 2010 and July 1st, 2011. Malnutrition was categorized by less than -2 SD from the median as wasting (height for weight), stunting (height for age), and underweight (weight for age) with World Health Organization (WHO) indices used for children under 5 years of age and Centers for Disease Control and Prevention (CDC) indices for those over 5 years of age.

Results: Of the 558 (306 males and 252 females) refugees analyzed, the largest groups of refugees were from the regions of Burma (270), Bhutan (167), and Africa (83), respectively. There was an anemia prevalence of 17.7%, with the Bhutanese having 20.1% compared to the Burmese of 14.2%. The Burmese refugees that came from Thailand had a higher prevalence of anemia than the Burmese refugees that came from Malaysia (20.2% vs 9.6%, $p=0.02$). There was a stunting prevalence of 18.7% and underweight prevalence of 17.1% among all pediatric refugees. In the under-five age group, the Burmese from Thailand had significantly higher prevalence of severe stunting and underweight compared to their Malaysian counterparts (6.3% and 3.1% vs. 5.0% and 0.0%, $p< 0.05$). Giardia was the most common stool parasites (75%), but there was no association between stool parasites and anemia or underweight status.

Discussion:. The prevalence of malnutrition and anemia are shockingly high among African, Bhutanese, and Burmese refugee children, especially the Burmese from Thailand. And it is essential for pediatricians to be actively aware of these issues in order to provide culturally sensitive and competent care.

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Abbreviations

CDC: Centers for Disease Control and Prevention
WHO: World Health Organization
SD: Standard Deviation
IRB: Institutional Review Board
IOM: International Organization for Migration
UNHCR: United Nations High Commissioner for Refugees
DHR: Department of Human Resources for the State of Georgia

Table of Contents

Background--**Pg. 1**

Methods--**Pg. 6**

Results--**Pg. 10**

Discussion--**Pg. 15**

References---**Pg. 19**

Tables---**Pg. 21**

Figures---**Pg. 27**

Background

Significance of Anemia and Malnutrition

Worldwide, 9.7 million children under the age of 5 years die each year. According to the World Health Organization (WHO), 53% of those deaths are associated with malnutrition (1). These children live mainly in sub-Saharan Africa, Middle East, and Southeast Asia. Malnutrition, specifically under nutrition, generally consists of either having deficiencies in micronutrients, proteins, or energy, or all three. Severe malnutrition can cause death in its own right, but it is also a significant contributor to deaths caused by diarrhea, respiratory illnesses, malaria, and other infections (2). Decreased height for age, as an indicator for chronic under nutrition, has been linked to decreased cognitive ability, economic activity, and overall human capital (3).

Anemia is an important indicator for micronutrient malnutrition caused by iron-deficiency anemia, which is the leading cause of anemia affecting 47% of all pre-school age children globally (4,5). In fact, anemia is commonly considered a proxy for iron deficiency anemia due to the high prevalence of iron deficiency anemia, difficulty in accurately measuring iron deficiency, and ease of measuring hemoglobin. Therefore, anemia can also be a proxy for malnutrition. However, it is important to note that parasitic infections and blood loss through menstruation can lower hemoglobin too. Anemia can cause death via shock and heart failure, but more commonly it insidiously affects morbidity. Evidence shows that anemia has negative impact on cognitive, behavioral, and psychomotor development in children (4-9). As with under nutrition, The WHO considers anemia to be a severe public health problem in sub-Saharan Africa, Middle East, and Southeast Asia.

These global problems of malnutrition and anemia may not seem directly applicable to the care US pediatricians provide. US children have a prevalence of anemia of 4-14% and malnutrition of 3-4% (29, 30). However, pediatricians from all over the country are seeing a specific vulnerable pediatric population that are coming from food insecure and poverty-stricken situations in regions with high malnutrition and anemia rates. These are refugee children that arrive to the US from their home countries who are displaced due to fear of ethnic, religious, or political persecution (10).

State of Refugees

By 2010, there were 10.5 million refugees located around the world and about half were children (11). Twenty-two industrialized countries accepted 98,000 refugees with the United States accepting 71,000 of them (11). In 2010, most of the refugees resettled to the US are originally from either Bhutan (~12,000 refugees) or Burma (~16,500 refugees) (12). According to the United States Office of Refugee Resettlement, the state of Georgia resettled over 3,200 refugees in 2010 (5^{th} largest resettlement state) (12). In 2010, 1,253 pediatric (ages 0-18 years) refugees resettled in DeKalb County, Georgia (13). Like the rest of the United States, most of the refugees resettling in DeKalb County were originally from Bhutan or Burma.

Of particular note, Bhutanese refugee situation had its origins during a large Nepali migration to Bhutan for work in the late 19^{th} century and early 20^{th} century

(14,15). In 1958 and subsequently 1985, the Bhutanese government passed the Citizenship Act, which required proof of long-term residence. A large ethnic population—the Lhotsampa—in Bhutan was forced to flee to neighboring Nepal. However, this ethnic group included 2nd and 3rd generational Bhutanese as well as recently immigrated from Nepal. Because the government of Nepal did not recognize this group as Nepali, the UNHCR created refugee displacement camps for them (16). By 2009, the UNHCR relocated 200,000 refugees to third party countries, including the United States(17).

Those who fled Burma escaped from conflict between the Burmese government and the ethnic minority insurgencies, which initially fought for the creation of a separate state (18). Today, over 400,000 Burmese of various ethnic groups have left the country due to ethnic persecution (19). Ninety-six thousand of these refugees reside in nine refugee camps within Thailand near the Burma border (20). Eighty thousand Burmese refugees fled to Malaysia in which the UNHCR provides urban settlements for them (21).

Malnutrition and Anemia among Refugees

Malnutrition and anemia prevalence among pediatric refugees has been studied while the refugees were displaced in refugee camps. Researchers at the CDC found a chronic malnutrition prevalence of 27% and anemia prevalence of 43% among Bhutanese refugee children residing in Nepal in 2007 (22). Burmese refugee children under the age of 5 years of age in Thailand refugee camps have a prevalence of iron-deficiency anemia of 65% (23). Internally displaced children under 5 years of age in Kenya have been found to have stunting prevalence (height-for-age z-score less than -2 standard deviations from the median according to the WHO) as high as 47% and underweight prevalence of 12% (24).

Malnutrition and anemia prevalence have also been studied after refugee children resettled to third party countries. A study looking at refugee children in 2006 who resettled to Sydney, Australia found a 15% prevalence of anemia (25). Whereas a quarter of refugee children in New South Wales, Australia had anemia (26). This difference could be due to a sicker hospital-based population in New South Wales. A study researching refugee children in Massachusetts in the late 1990s found a 12% prevalence of anemia and 8% prevalence of stunting (27). However, the population of refugees during this time mainly came from the former Soviet Union.

There is no literature that captures the severity of malnutrition and anemia among refugee children resettling currently in the United States. Also refugees from different regions may have different malnutrition and anemia rates. With such an abundance of refugee children resettling in the United States every year, it is imperative for pediatric providers to understand the enormous nutritional public health problem facing these children and to be able to distinguish which children are the most at risk. Because of the large pediatric refugee population that DeKalb County resettles, the epidemiological information gained will be applicable to providers across the United States.

In this paper, we aim to:

1) Present an accurate picture of the prevalence of anemia and malnutrition among refugee children resettling in the United States.
2) Determine if certain refugee populations have significantly higher prevalence of anemia and malnutrition, and specifically determining the health differences among the Burmese refugees from Thailand versus Malaysia.
3) Assess the prevalence of stool parasites among refugee children and its effect on anemia and malnutrition.

Methods

Participants and Data Collection

This retrospective study reviewed medical records of pediatric refugees (ages 0-18 years) screened at first visit at the DeKalb County Board Refugee Screening Clinic in Decatur, Georgia, USA between October 1st, 2010 and July 1st, 2011. Each medical record included the International Organization of Migration (IOM) overseas medical screening exam performed by an IOM physician prior to departure to the US. This screening exam included the refugee's date of birth, sex, country of origin and country of residence prior to departure to the US as well as other medical conditions. If the refugee or the refugee's adult caregiver did not know his or her exact birthday, then the IOM physician gave a date of January 1st was given with a year corresponding to the age. Only 39 (7.2%) refugees had this date assigned to them. Date of arrival information was added to this record once the refugee entered the US. The medical record also included the medical screening exam performed by a licensed nurse at DeKalb County Board of Health after entering the US. This screening exam included demographic information confirming date of birth, date of arrival, country of origin, country of residence, and sex. It also included data on hemoglobin, results of stool parasites, anthropometric information including height, weight and general nutritional status, as well as other pertinent medical information. Length was recorded via an infantometer or recumbent measuring device for infants less than 2 years of age and height was measured via a stadiometer for children over 2 years of age. Weight was measured in kilograms by a Tanita infant scale (BD-585) for those under 2 years of age and an upright Seca scale for those over 2 years of age. Hemoglobin was measured by a Hemocue. Stool for ova and parasites were collected by the screening nurse and analyzed by the Georgia Public Health Laboratory. It is important to note that all refugees over the age of 1 year receive presumptive treatment for parasites prior to departure from their country of residence (28).

Defining Indicators

Anemia was defined by WHO standards, which includes thresholds of hemoglobin at 110g/l for children ages 0.5 to 4.9 years, 115g/l for children 5 to 14.9 years, 120g/l for children 12 to 14.9 years and all females over 15 years, and 130g/l for males over 15 years (4). The cut-off for anemia is not well defined for children under 0.5 years of age and therefore infants less than 6 months of age were not included in the anemia measurements. Anthropometric indices were calculated using reference medians recommended by the WHO and classified according to standard deviation units (z-scores), based on the WHO criteria for children under 5 years using WHO Anthro software (Version 3.2.2). For children between the ages of 5 to 18 years, anthropometric indices were calculated using reference medians recommended by the CDC using EpiInfo 7.

Malnutrition was defined as a z-score < -2 standard deviations from the median for weight-for-height (e.g., wasting), height-for-age (e.g., stunting), or weight-for-age (e.g., underweight). A z-score of < -3 standard deviations from the median was used to identify severely malnourished children.

Sample size calculation and statistical analysis

An a priori sample size calculation was made using OpenEpi Version 2.3.1.The population size was estimated from the total number of refugees entering the United States in 2010, which were 71,000. Given the most recent literature concerning pediatric refugee nutrition in the United States, anticipated prevalence of anemia and stunting were estimated at 12% and 8%, respectively (27). An alpha level of 5% was considered to be significant. Given these assumptions, a sample size of at least 162 ensured a +/- 5% range for the 95% confidence intervals (CIs) of prevalence. Thus, records from October 2010 to July 2011 were used to ensure an ample sample size overall and especially among the Bhutanese and Burmese sub-populations. Also it was used to provide the most recent and comprehensive estimates of anemia and malnutrition.

All data were analyzed using SAS version 9.3 and EpiInfo 7 with anthropometry software of the WHO and CDC used. Chi-squared tests were used for categorical data while one-way analysis of variance (ANOVA) techniques were used to compare means for continuous data. For accurate analysis, all assumptions regarding data independence, normality and homoscedasticity were met. When analyzing measures of association, the Mantel-Haenszel technique for estimating odds ratios was used for instances of sparse data. Because of small numbers of refugees from some countries, countries were grouped together for comparative analysis. Bhutan and Burma were left as individual countries. The African countries—Somalia, Ethiopia, Eritrea, Democratic Republic of Congo, Sudan, Cameroon, and Liberia—were grouped as ‘Africa’. The rest of the countries had numbers too small to group by geographic region. Thus, an ‘Other’ group was created for refugees coming from Afghanistan, Colombia, Cuba, Iraq, Laos, Palestine, and Sri Lanka. The Burmese were stratified into those arriving from Thailand and those arriving from Malaysia for further analysis because of the different experiences each country provides to the Burmese refugees.

The Emory University IRB, Kaiser Permanente IRB, and the State of Georgia DHR IRB approved this study. All recorded data was de-identified and proper confidentiality precautions were taken.

Results

Demographics

Data was collected for 573 subjects but 15 subjects were excluded because they were over 18.0 years of age at the time of health screening. The remaining 558 (306 males and 252 females) refugees were 0 to 18 years of age. The largest groups of refugees were from Bhutan (29.9%) and Burma (48.3%), with 21.3% of the children arriving from Burma via Thailand and 24.7% arriving via Malaysia [Table 1]. The other 2.3% of Burmese refugees came directly from Burma. Data were also collected on refugees from Laos, Sri Lanka, Somalia, Ethiopia, Eritrea, Democratic Republic of Congo, Sudan, Cameroon, Liberia, Afghanistan, Iraq, Palestine, Cuba and Colombia. The distribution of sexes was generally equal by country with 55% of all refugees being male. The average number of days in the United States prior to each refugee's health screening at the Health Department was 30 days (Range: 7-58 days), and the average age at the time of their visit was 8.6 years of age (Range: 0.5-18.0 years). Two hundred ten (37.6%) refugees were between 6 months and 5 years of age.

Anemia Prevalence

Slightly more than 15% (17.7%) of the children were found to be anemic [Table 2]. The prevalence of anemia was higher in pre-school age children than children over five (22.4% vs. 15.3 %, p= 0.04). Mean hemoglobin for all children was 128 g/L. In the Bhutanese population, anemia prevalence was 20.1% (95% CI: 14.8, 27.1), while in the Burmese population, it was 14.2% (95% CI 10.0-18.4) [p=0.07]. The Burmese refugees that arrived via Thailand had a significantly higher prevalence of anemia than the Burmese refugees that arrived via Malaysia (20.2% vs 9.6%, p=0.02). The total prevalence of anemia for refugees from Africa was 22.6% (95% CI: 14.2, 32.8). The mean hemoglobin of African refugees (124 g/l) was significantly lower than those from Bhutan (130 g/l) and Burma (128 g/l) [p=0.02]. The prevalence of anemia in Bhutanese and Burmese refugees aged 0.5-5 years (25.7% and 16.0% respectively) was also significantly lower than refugees from Africa (35.9%) [p=0.04].

There is no significant difference in the prevalence of anemia by sex except in the Bhutanese population. Bhutanese females had a 31.8% prevalence compared to 8.7% in the male population **[p=0.01]**, though the exact reason why this particular population has such a difference is unknown. Refugees from countries other than Africa, Bhutan, or Burma had anemia prevalence comparable to the rest of the refugee population, with 17.7% (95% CI: 14.5, 20.8) anemia.

<u>Malnutrition Prevalence</u>

<u>All Refugees</u>

The prevalence of stunting among all pediatric refugees was 18.7% (95% CI: 15.5-22.4) and one in twenty were severely stunted [Table 3A]. The prevalence of underweight status was 17.1% (95% CI: 14.0, 20.6) and the severe underweight prevalence was 1.7% (95% CI: 0.8, 3.2). The stunting prevalence in the African refugees (9.1%, 95% CI: 3.7, 17.8) was significantly lower than the refugees from Bhutan (19.0%, 95% CI: 12.1, 26.1) and Burma (22.0%, 95% CI: 17.1, 27.6) [p=0.03]. Interestingly, the underweight prevalence in the Burmese refugees (16.1%, 95% CI: 11.9, 21.1) was significantly lower than the Bhutanese refugees (23.9%, 95% CI: 17.4, 31.4) [p=0.05], whereas the underweight prevalence of the African refugees (10.0%, 95% CI: 4.4, 18.8) was much lower than both Bhutan and Burmese refugees [p=0.02].

The Burmese refugees arriving via Thailand had a higher prevalence of stunting and underweight status than their counterparts arriving via Malaysia. Specifically, those arriving via Thailand had a stunting prevalence of 26.3% with 7.9% having severe stunting, compared to 19.7% and 5.3% respectively for those refugees coming from Malaysia. The largest disparity is in the underweight prevalence with those arriving from Thailand having a prevalence of 23.5% (95% CI: 16.1, 32.3) and those arriving from Malaysia having a prevalence of 8.3% (95% CI: 4.2, 14.3) [p-value: 0.001]. Also none of the Burmese refugees in our cohort arriving via Malaysia were severely underweight.

<u><5-year age group</u>

Given the importance of malnutrition in the 0-5 year old population, malnutrition prevalence was evaluated specifically in this age range [Table 3B]. Wasting was found in 12.4% (95% CI: 7.2, 17.5), with 0.6% of severe wasting, of the pediatric refugees in the 0-5 year age range. Stunting was found in 18.0% (95% CI: 12.1, 23.9), with 4.5% of severe stunting, and underweight prevalence was 9.0% (95% CI: 4.5, 13.5), with 0.6% who were severely underweight. In the Bhutanese population specifically, 14.3% (95% CI: 1.3-27.3) suffered from wasting compared to 10.4% (95% CI: 3.8, 17.0) in the Burmese population. Moreover, no Bhutanese or Burmese children were found to have severe wasting.

Bhutanese refugees had significantly higher prevalence of stunting (21.9%, 95% CI: 13.1, 30.7) compared to Burmese refugees (10.4%, 95% CI: 3.8, 17.0) [p=0.04]. The African refugees in this age range had a moderate prevalence of wasting (7.9%, 95% CI: 1.7, 21.4) and high prevalence of stunting (18.9%, 95% CI: 9.0, 35.2), with 8.1% having severe stunting.

Again, in refugees ages 0-5 years of age, the Burmese refugees coming from Thailand had a higher amount of malnutrition, except stunting, than those coming from Malaysia. The prevalence of wasting was 12.5% and 8.3% for the Thailand and Malaysia group respectively. The Burmese refugees from Thailand had a higher prevalence of severe stunting (6.3%) compared to those from Malaysia (5.0%) [p=1.0]. In terms of underweight status, the Thailand group had a prevalence of 12.5% with 3.1% being severely underweight, compared against the Malaysia group with a prevalence of 6.7% with no cases of severe underweight status [p=0.0001].

Stool Parasites

Of the 536 refugees that were tested, one quarter (23.7%) of pediatric refugees tested positive for stool parasites with Giardia *lamblia* (75%), Dientamoeba *fragilis* (17%), and Trichuris *trichiura* (12%) being the most common parasites [Figure 1]. About a quarter of pediatric refugees that were underweight also tested positive for stool parasites with the Bhutanese, Burmese, and African refugees closely representing the total[Table 4]. However there was essentially no association between positive stool parasites and being underweight (OR=1.2, 95% CI: 0.7, 2.0). The Bhutanese (OR 1.5, 95% CI: 0.6, 3.6), Burmese (OR=1.1, 95% CI: 0.5, 2.4), and African refugees (OR=0.6, 95% CI: 0.1, 3.3) all also showed very little association between being underweight for age and having parasites in the stool.

28% of pediatric refugees who were anemic also tested positive for stool parasites with the African refugees having the highest prevalence (50%), followed by the Burmese (33%), and then the Bhutanese (15%). 37% of Burmese refugees arriving via Thailand had a positive stool parasites, and nearly half of those who were anemic had evidence of stool parasites. Interestingly, none of the Burmese refugee arriving via Malaysia who were tested positive for stool parasites were underweight or anemic. However, there is little to no association between positive stool parasites and anemia overall and within the Africa, Bhutan, and Burma populations.

Discussion

The alarmingly high prevalence of anemia and malnutrition among refugee children within the United States provides a stark contrast with estimates of 4-14% of anemia and 3-4% of malnutrition among the general population of children in the US (29, 30). However, within the pediatric refugee population, African children have by far the highest rates of anemia followed by Bhutanese children. Interestingly, African children have lower rates of stunting and underweight compared to their refugee counterparts. It is important for providers to know that for the high risk age group of children less than 5 years, Bhutanese children are both more chronically malnourished (stunted) and underweight than Burmese children. It is also important to understand the role intestinal parasites play with regards to acutely causing anemia or under nutrition. Though nearly a quarter of the underweight refugee children tested positive for stool parasites, an association between being underweight and having stool parasites could not be made. Also there is no strong association between anemia and having stool parasites.

Perhaps the most important information gained from this study is the apparent difference among Burmese refugees that arrive via Thailand versus those that arrive via Malaysia. In almost every evaluation, the Burmese via Thailand have higher prevalencies of malnutrition measures as anemia, stunting, and underweight than the Burmese via Malaysia. Among the underweight and anemic, none of the children arriving via Malaysia had positive stool parasites as oppose to nearly a third and half of those arriving via Thailand, respectively. It is unclear whether these differences are due to genetic, environmental, microorganism, or cultural factors. It is fair to assume that those in Thai refugee camps have more food insecurity and unstable medical care compared to those in urban resettlements in Malaysia. Previous Studies have indicated that Asian refugees in particular have a high prevalence of under nutrition markers more due to economic and cultural factors than genetic ones (31).

According to the literature, our overall rates of malnutrition and anemia are not as high as displaced refugees within camps (23, 24, 31,32,33). However, this study shows much higher rates of anemia and malnutrition than pediatric refugees settling in other countries like Australia, and higher rates than pediatric refugees in the United States in the 1990s and 1980s (27,34,35). This could be due to the change in demographics among refugees in the United States during the last two decades with more Southeast Asian refugees and less from the former Soviet Union.

Strengths of this study include accuracy of the data, the large and diverse sample size, and the generalizability of pediatric refugees in DeKalb County to the rest of the United States. However, this study does have some limitations. First as a retrospective study, there are issues of selection bias and the inability to show true risk. Second, proper malnutrition estimates rely on accurate birthdates, however 7.2% of the refugees had a birth date of January 1st (with the year corresponding to their age) given to them because their true birth date was unknown. However, results do not significantly change if this subset is removed. Also, hemoglobin is a convenient indicator for iron-deficiency anemia, but other causes can also be responsible. Blood loss through menstruation among adolescent girls can account for anemia as seen with the 32% prevalence of anemia among Bhutanese females versus 9% among Bhutanese males. The pre-pubescent children had no significant difference in anemia prevalence by sex. It is unclear why menstruation would affect Bhutanese adolescents causing anemia more than the Burmese or Africans. Infections, such as malaria, and hemoglobinopathies can also cause anemia. Refugees from Latin America and the Middle East were combined into the 'other' group. However, the sample size was often too small in this group to make accurate estimates regarding their nutritional status.

Given these limitations, further studies should be prospective and longitudinal. Also investigation of specific micronutrient deficiencies, like iron, is needed to further define the exact nature of malnutrition faced by this population. To identify which environment (country of origin, refugee camp, or both) is most responsible for malnutrition in these children, the time spent in refugee camps would be important to know. One of the most important aspects that still needs to be studied is evaluating follow-up data to determine if nutritional indices improve after residing in the US for some time.

Conclusion

If this study provides one overarching theme, it is that not all refugee children in the United States are the same. Each population and sub-population has its own unique history and culture that directly affects the health of their children. Cultural differences, education, and food insecurity are some of the barriers faced by these refugee families (36,37,38). Individual states' Medicaid, The Special Supplementation Program for Women, Infants, and Children (WIC), and refugee health services policies must be amended to address to these growing and urgent issues. Because the United States has chosen to accept these families, the government must also make sure that proper nutritional and medical services are available to them. The prevalence of malnutrition and anemia are shockingly high among African, Bhutanese, and Burmese refugee children, especially the Burmese from Thailand. And it is essential for pediatricians to be actively aware of these issues in order to provide culturally sensitive and competent care.

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Tables

TABLE 1. Demographic information by age group of pediatric (ages 0-18 years) refugees entering DeKalb County, GA from October 2010 to July 2011

Country	Total % (N)	Males % (N)	Days in US Mean (SD)	Age in years			
				0.5-5yrs % (N)	6-12yrs % (N)	13-18yrs % (N)	All Mean (SD)
Asia							
Bhutan	29.9 (167)	52.7 (88)	30.4 (14.6)	24.5 (41)	34.1 (57)	34.1 (57)	10.8 (5.3)
Burma	48.3 (270)	52.2 (141)	29.6 (17.8)	41.1 (111)	38.1 (103)	17.0 (46)	7.74 (5.3)
(Thailand)`	21.3 (119)	57.1 (68)	30.4 (17.8)	34.5 (41)	45.4 (54)	16.8 (20)	8.4 (4.8)
*(Malaysia)**	24.7 (138)	47.1 (65)	29.6 (18.2)	47.1 (65)	31.9 (44)	60.5 (23)	7.1 (5.7)
Laos	0.9 (5)	80.0 (4)	26 (-)	--	40.0 (2)	40.0 (2)	13.6 (4.7)
Sri Lanka	1.1 (6)	50.0 (3)	33.2 (14.9)	33.3 (2)	50.0 (3)	16.7 (1)	8.8 (4.2)
Africa							
Somalia	6.8 (38)	76.3 (29)	27.0 (13.4)	50.0 (19)	28.9 (11)	13.2 (5)	7.9 (5.6)
Ethiopia	2.6 (15)	46.7 (7)	38.7 (20.1)	73.3 (11)	13.3 (2)	13.3 (2)	5.9 (4.7)
Eritrea	2.2 (12)	58.3 (7)	28.1 (12.1)	58.3 (7)	33.3 (4)	8.3 (1)	5.8 (3.5)
Democratic Republic of Congo	2.0 (11)	54.6 (6)	22.9 (6.2)	40.0 (5)	27.3 (3)	27.3 (3)	7.3 (5.7)
Sudan	0.7 (4)	50.0 (2)	30.5 (9.1)	50.0 (2)	50.0 (2)	--	6.0 (5.5)
Cameroon	0.4 (2)	50.0 (1)	27 (-)	100.0 (2)	--	--	3.5 (3.3)
Liberia	0.2 (1)	100 (1)	12 (-)	--	--	100.0 (1)	17.6 (-)
Middle East							
Afghanistan	0.4 (2)	50.0 (1)	41.5 (29.0)	--	50.0 (1)	50.0 (1)	11.7 (6.7)
Iraq	3.0	64.7	31.2	47.1 (8)	29.4 (5)	11.8 (2)	7.2

	(17)	(11)	(21.2)				(5.9)
Palestine	0.4 (2)	100 (2)	36 (-)	50.0 (1)	50.0 (1)	--	8.2 (5.2)
Americas							
Cuba	0.5 (3)	33.3 (1)	51 (15.6)	33.3 (1)	33.3 (1)	33.3 (1)	8.5 (5.7)
Colombia	0.4 (2)	50.0 (1)	30 (5.7)	--	100.0 (2)	--	10.2 (1.5)
Total	**100 (558)**	**306 (54.8)**	**30.0 (16.3)**	**37.6 [210]**	**35.5 (198)**	**21.9 (122)**	**8.6 (5.4)**

` Burmese refugees that arrived from Thailand
* Burmese refugees that arrived from Malaysia

TABLE 2. Prevalence of anemia by age group of pediatric refugees (ages 0.5-18 years) entering DeKalb County, GA

Region	Total Prevalence of Anemia		Hemoglobin (g/L)	Prevalence of Anemia by Age Group		
	% (N)	95% CI	Mean (SD)	**0.5-5yrs** % (N)	**5-18yrs** % (N)	**P-Value**
Burma *(n=167)*	14.2 (38)	10.0, 18.4	128 (15)	16.0 (16)	13.1 (22)	0.21
Burma [Thailand][3] *(n=119)*	20.2 (24)	13.0, 27.4	127 (15)	22.9 (8)	19.1 (16)	0.30
Burma [Malaysia][4] *(n=138)*	9.6 (13)	4.6, 14.5	129 (15)	11.5 (7)	8.0 (6)	0.09
p-value	**0.016**	--	0.18	0.14	**0.04**	
Bhutan *(n=270)*	20.1 (35)	14.8, 27.1	130 (14)[5]	25.7 (9)	19.7 (26)	0.02
Africa *(n=84)*[1]	22.6 (19)	14.2, 33.1	124 (16)	35.9 (14)	9.1 (4)	0.03
Other Refugees *(n=36)*[2]	16.7 (6)	6.4, 32.8	128 (15)	22.2 (2)	14.8 (4)	0.76
Total (n=558)	**17.7 (98)**	**14.5, 20.8**	**128 (15)**	**22.4 (41)**	**15.3 (57)**	**0.02**

[1] Includes refugees from Cameroon, Democratic Republic of Congo, Eritrea, Ethiopia, Liberia, Somalia, and Sudan
[2] Includes refugees from Afghanistan, Colombia, Cuba, Iraq, Laos, Palestine, and Sri Lanka
[3] Burmese refugees who arrived via Thailand
[4] Burmese refugees who arrived via Malaysia
[5] Mean hemoglobin higher than prevalence of anemia would suggest due to more Bhutanese teenagers than Burmese (34% v 17%) and than African (34% v 14%); according to the WHO teenagers have a higher hemoglobin threshold to determine anemia than younger children.

TABLE 3A. Prevalence of malnutrition, by region of all pediatric refugees entering DeKalb County, GA—stratified by severity.

Region	Stunting Prevalence % (95% CI) [1]		Underweight Prevalence % (95% CI) [2]	
	< 2 SD[1]*	< 3 SD[1]^	< 2 SD[2]*	< 3 SD[2]^
Burma	22.0 (17.1, 27.6)	6.18 (3.6, 9.8)	16.1 (11.9, 21.1)	0.8 (0.1, 2.7)
Burma [Thailand]	26.3 (18.5, 35.4)	7.9 (3.7, 14.5)	23.5 (16.1, 32.3)	1.7 (0.2, 6.1)
Burma [Malaysia]	19.7 (13.3, 27.5)	5.3 (2.2, 10.6)	8.3 (4.2, 14.3)	0.0 (-)
p-value	0.22	0.45	**0.001**	0.21
Bhutan	19.0 (12.1, 26.1)	2.6 (0.7, 6.6)	23.9 (17.4, 31.4)	1.94 (0.4, 5.6)
Africa *(n=84)*	9.1 (3.7, 17.8)	3.9 (0.8, 11.0)	10.0 (4.4, 18.8)	2.5 (0.3, 8.7)
Other Refugees *(n=37)*	14.7 (5.0, 31.0)	8.8 (1.9, 23.7)	11.4 (3.2, 26.7)	5.7 (0.7, 19.2)
Total *(n=558)*	**18.7 (15.5, 22.4)**	**5.0 (3.2, 7.2)**	**17.1 (14.0, 20.6)**	**1.7 (0.8, 3.2)**

[1]Determined on the WHO height for age growth chart for children under 5 years of age and on the CDC weight for height growth chart for children 5 years and older.

[1]*CDC/WHO height for age Z score less than 2 standard deviations from the median

[1]^Severe, CDC/WHO height for age Z score less than 3 standard deviations from the median

[2]Determined on the WHO weight for age growth chart for children under 5 years of age and on the CDC weight for height growth chart for children 5 years and older

[2]*CDC/WHO weight for age Z score less than 2 standard deviations from the median

[2]^Severe, CDC/WHO weight for age Z score less than 3 standard deviations from the median

TABLE 3B. Prevalence of malnutrition by region of pediatric refugees ages 0-5 years entering DeKalb County, GA—stratified by severity.

Region	Wasting Prevalence % (95% CI) [1]		Stunting Prevalence % (95% CI) [2]		Underweight Prevalence % (95% CI) [3]	
	< 2 SD[1]*	< 3 SD[1]^	< 2 SD[2]*	< 3 SD[2]^	< 2 SD[3]*	< 3 SD[3]^
Burma *(n=102)*	10.4 (3.8, 17.0)	1.0 (0.0, 3.6)	21.9 (13.1, 30.7)	5.2 (0.2, 10.2)	9.4 (3.0, 15.7)	1.0 (0.0, 3.6)
Burma [Thailand] *(n=35)*	12.5 (0.0, 25.5)	0.0 (-)	21.9 (6.0, 37.8)	6.3 (0.0, 16.2)	12.5 (0.0, 25.5)	3.1 (0.0, 10.7)
Burma [Malaysia] *(n=63)*	8.3 (0.5, 16.2)	0.0 (-)	23.3 (11.8, 34.9)	5.0 (0.0, 11.3)	6.7 (0.0, 13.8)	0.0 (-)
p-value	0.22	0.11	**0.2**	**1.0**	**0.0001**	**0.0001**
Bhutan *(n=35)*	14.3 (1.3, 27.3)	0.0 (-)	11.4 (0.0, 23.4)	0.0 (-)	14.3 (1.3, 27.3)	0.0 (-)
Africa *(n=39)*	7.9 (1.7, 21.4)	0.0 (-)	18.9 (8.0, 35.2)	8.1 (1.7, 21.9)	7.9 (1.7, 21.4)	0.0 (-)
Other Refugees *(n=10)*	10.0 (0.3, 44.5)	10.0 (0.3, 44.5)	0.0 (-)	0.0 (-)	10.0 (0.3, 44.5)	10.0 (0.3, 44.5)
Total *(n=186)*	**12.4 (7.2, 17.5)**	**0.6 (0.0, 1.9)**	**18.0 (12.1, 23.9)**	**4.5 (1.2, 7.8)**	**9.0 (4.5, 13.5)**	**0.6 (0.0, 1.9)**

[1]Determined on the WHO weight for height growth chart
[1]*WHO weight for height Z score less than 2 standard deviations from the median
[1]^Severe, WHO weight for height Z score less than 3 standard deviations from the median
[2]Determined on the WHO height for age growth chart
[2]*WHO height for age Z score less than 2 standard deviations from the median
[2]^Severe, WHO height for age Z score less than 3 standard deviations from the median
[3]Determined on the WHO weight for age growth chart
[3]*WHO weight for age Z score less than 2 standard deviations from the median
[3]^Severe, WHO Weight for age Z score less than 3 standard deviations from the median

TABLE 4. Associations of positive stool parasites among underweight and anemic pediatric refugees in DeKalb County, GA

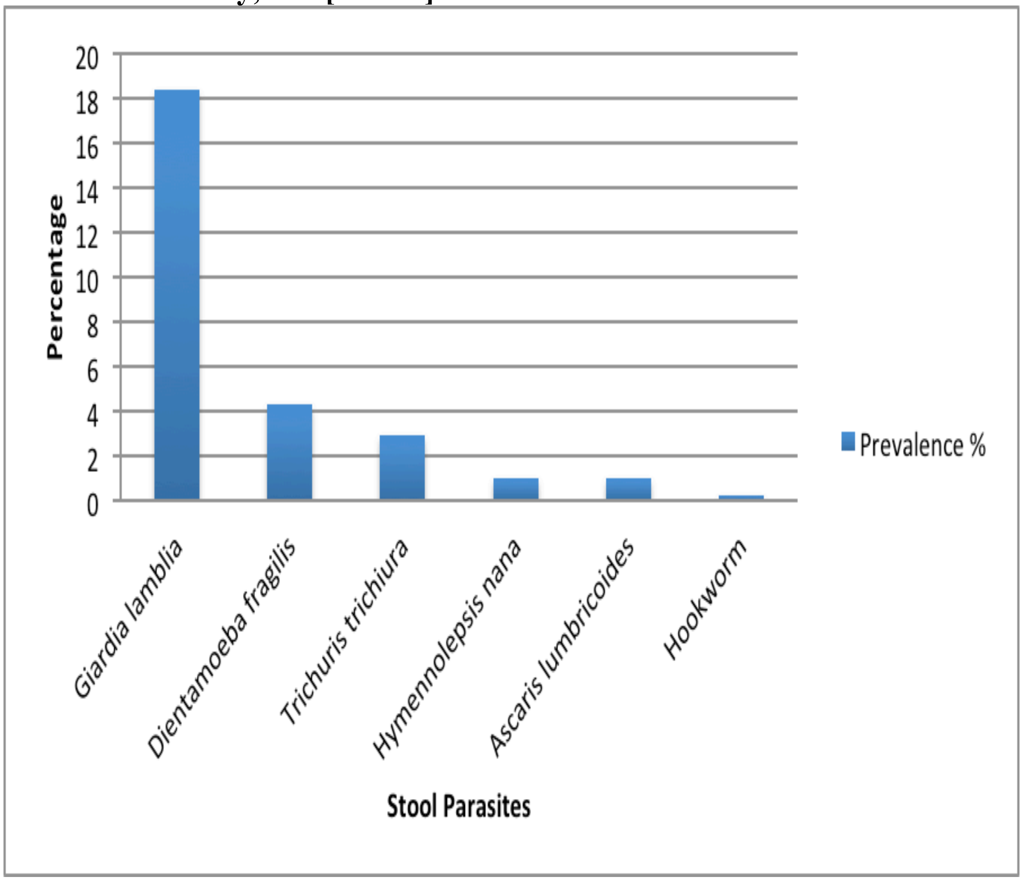
Region	Positive Stool Parasites Among the Underweight			Positive Stool Parasites Among the Anemic		
	N[1]	Preval-ence (%)	Odds Ratio (95% CI)	N[1]	Preval-ence (%)	Odds Ratio (95% CI)
Burma *(n=270)*	42	26.2%	1.1 (0.5, 2.4)	36	33.3%	1.7 (0.8, 3.6)
Burma [Thailand] *(n=119)*	27	37.0%	1.1 (0.4, 2.7)	23	47.9%	2.0 (0.8, 4.9)
Burma [Malaysia] *(n=138)*	11	0.0%	0.0	12	0.0%	0.0
Bhutan *(n=167)*	36	25.0%	1.5 (0.6, 3.6)	33	15.2%	0.6 (0.2, 1.8)
Africa *(n=84)*	8	25.0%	0.6 (0.1, 3.3)	18	50.0%	2.3 (0.8, 6.7)
Other *(n=37)*	4	25.0%	--*	5	0.0%	--*
Total	**90**	**25.6**	**1.2 (0.7, 2.0)**	**92**	**28.3**	**1.3 (0.8, 2.2)**

[1]Number of underweight or anemic refugees who were also tested for stool parasites

* Due to the extremely small sample size, a measure of effect cannot accurately be reported.

Figures

Figure 1. Stool parasites* represented in pediatric refugees (ages 0-18 years) in DeKalb County, GA [N=536]



*No organisms significantly vary by region, each parasite is not mutually exclusive