3953

NUTRITIONAL STATUS OF UNDER FIVE YEAR OLD BURMESE REFUGEE CHILDREN IN THAILAND

A THESIS SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAI'I IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN

NUTRITIONAL SCIENCES

MAY 2005

By

Nancy Faraj

Thesis Committee:

Carol Waslien, Chairperson
Joannie Dobbs
Rachel Novotny
Sahar Zaghloul

ACKNOWLEDGEMENTS

The author would like to express gratitude to Jack Dunford, Sally Thompson and the staff of the Burmese Border Consortium (BBC) in Bangkok and on the Thailand-Burma border for the opportunity to intern with the BBC in the spring and summer of 2002. The author would especially like to thank Andrea Menefee for her invaluable teaching and training, and her immeasurable help. In addition, the author would like to thank all of the participants in the rapid nutrition survey in the Burmese refugee camps.

The author would also like to thank Drs. A. Marsella and B. Hallett of the Disaster Management and Humanitarian Assistance Program at the Matsunaga Peace Institute at the University of Hawai'i, Manoa.

Lastly the author would like to thank the graduate committee members, Drs. C. Waslien (chair), J. Dobbs, R. Novotny, and S. Zaghloul of the University of Hawai'i, Manoa, for their insight, advice and encouragement.

TABLE OF CONTENTS

LIST OF TABLES

Table | Page

LIST OF FIGURES

ABBREVIATIONS

Abbreviations commonly used in this thesis are:

HAZ: Height for age Z-score
WHZ: Weight for height Z-score
PEM: Protein-energy malnutrition
IUGR: Intrauterine growth retardation
LBW: Low birth weight
BMI: Body Mass Index

CHAPTER 1
INTRODUCTION

Malnutrition

Good nutrition is an essential component of good health. Malnutrition is a known contributing factor to disease and death (Scrimshaw et al. 1968). In the developing world, malnutrition affects approximately 800 million people (WHO 2003), greater than 340 million of whom are children under the age of five (UNS/SCN 2004). Over six million of these children die every year from malnutrition related causes (UNICEF 1998).

In the developing world 50% of all child deaths are due to malnutrition. The most severe adult and child malnutrition is found in sub-Saharan Africa and Southeast Asia (Caulfield et al. 2004a). In Southeast Asia, almost half of all preschool children are underweight and approximately one third have two or more micronutrient deficiencies (Torlesse et al. 2003). Children in Southeast Asia have the highest prevalence of iron and vitamin A deficiencies in the world (Ramakrishnan 2002).

Scrimshaw et al. (1968) defined malnutrition as, "A pathologic state resulting from a relative or absolute deficiency or excess of one or more essential nutrients sufficient to produce disease." Malnutrition is both undernutrition and overnutrition, ranging from severe nutrient deficiencies to extreme obesity.

Undernutrition is a deficiency of kilocalories and/or nutrients and often presents as slow growth and development. Acute undernutrition is protein-energy malnutrition or low weight for height. Chronic undernutrition results in low height for age. The term malnutrition will be used to signify undernutrition for the remainder of this thesis. Malnutrition definitions can be found in Appendix A.

Problem Statement

Acute and chronic malnutrition are associated with disease and death. Prevalence of acute malnutrition is positively correlated with children's mortality rates in refugee camps (Mason 2002). Children under-five have the highest death rates of all refugees (Toole 1988 et al.). It is thought that malnutrition related morbidity and mortality is preventable (Allen and Gillespie 2001, Toole and Waldman 1993).

Assessment of nutritional status with anthropometry is practical and acceptable on an international level (Allen and Gillespie 2001) (Appendix A). Furthermore, research suggests that the ability to monitor a population over time helps identify the effectiveness of interventions (Peck et al. 1981). Baseline prevalence data and monitoring malnutrition are necessary to evaluate and implement adequate program support to refugees. At the Thai-Burmese refugee camps, nutrition assessments are not conducted regularly; however health agencies provide monthly growth monitoring.

A chronic malnutrition prevalence of 36% was found in the largest Burmese refugee camp on the Thai-Burmese border by Banjong et al. (2003). The researchers conducted a dietary assessment that included food weighing, anthropometric measurements, and a questionnaire comprising consumption patterns, resources and dietary intake questions on 182 households. It was expected that this prevalence was border wide.

Kemmer et al. (2003) collected blood samples in five out of ten Burmese refugee camps in Thailand on 857 children aged 6 to 59 months old. A high chronic malnutrition prevalence of 46% was found by convenience sampling. Utilizing simpler, more cost-effective methods would be more practical in refugee camps. Rapid assessment procedures collect essential information relative to nutritional status in approximately ten minutes per person (Appendix A).

Research Question

The purpose of this study was to determine the factors influencing nutritional status among 6 to 59 month old Burmese refugee children on the Thailand-Burma border. This thesis addressed the following question:

- What are the contributing factors to the nutritional status of the 6 to 59 month old Burmese refugee children in Thailand?

Thailand-Burma Border Background

Burma (the Union of Myanmar), is located in Southeast Asia. Since 1984, refugees from Burma have been living in neighboring Thailand refugee camps. In both Burma (de Onis and Blössner 2003, UNICEF 2001) and these camps, there is a high rate of malnutrition (Banjong et al. 2003, Kemmer et al. 2003).

The number of refugees worldwide is estimated at about 17 million (UNHCR 2004). There are almost 140,000 people living in ten refugee camps on the Thai-Burmese border (Banjong et al. 2003, BBC 2003). To minimize refugee morbidity and mortality brought about by malnutrition, 20 aid agencies have been established to provide Burmese refugees in Thai camps with food, shelter, primary health care and education assistance (BBC 2003) (Table 1.1.).

Table 1.1. Refugee Aid Agencies on Thai-Burmese Border Under Coordinating Committee for Services to Displaced Persons in Thailand (CCSDPT)

Food, Shelter and Relief	**Primary Health and Sanitation**	**Education**
Burmese Border Consortium	Aide Medicale Internationale	Adventist Development and Relief Agency
	American Refugee Committee	Burma Distance Education Programme-Thailand
	Catholic Office for Emergency Relief and Refugees	Catholic Office for Emergency Relief and Refugees
	Coordinating Committee for Services to Displaced Persons in Thailand Health Sub-committee	Community Addiction Recovery and Education Project
	Handicap International	Consortium Thailand
	International Catholic Migration Commission	Coordinating Committee for Services to Displaced Persons in Thailand Education Sub-committee
	International Rescue Committee	Internationaal Christelijk Steunfonds Asia
	Malteser-Hilfsdienst Auslandsdienst E.V.	International Rescue Committee
	Médecins Sans Frontières	Jesuit Refugee Service
		Shanti Volunteer Association
		Taipei Overseas Peace Corps
		Women's Education for Advancement and Empowerment
		ZOA Refugee Care, Netherlands

Source: Burmese Border Consortium Relief Programme 2003, p. 40

Prevalence of Malnutrition

Protein-energy malnutrition

The world wide population of children under-five is projected at 619,548,288 in 2005 (UNPD 2002). Protein-energy malnutrition (PEM) affects about one-quarter of all children, or a projected 155 million children under the age of five in 2005 (UNPD 2002, WHO 2003) (Appendix A). Of these children, 70% live in Asia (WHO 2003).

PEM is reflected in underweight and stunting (WHO 2003), and is a contributing risk factor to mortality in children under-five living in developing countries. In a cross-sectional study in Africa and Asia involving 9,011 children aged 0-6 years, three percent of the children had PEM; 26% of these children had kwashiorkor and 74% had nutritional marasmus (Van Loon et al. 1987).

Stunting

It is estimated that there will be about 148 million stunted under-five year old children in the developing world in 2005 (UNS/SCN 2004) (Appendix A). The prevalence of stunting in under-five year old children in Southeast Asia is approximately 32% and 34% in Burma (UNICEF 2002, UNS/SCN 2004). Stunting in the Burmese refugee camps in Thailand was reported at 36% by Banjong et al. (2003) and 46% by Kemmer et al. (2003).

Although the prevalence of stunting is increasing in Africa (de Onis et al. 2000), the global estimates are that the number and percentage of stunted children will decrease in developing countries from 30% in 2000 to 16% by 2020 (de Onis and Blössner 2003). The projected decrease is attributed to higher energy intake, increased female literacy rate and economic growth (de Onis et al. 2000). China showed the highest increase in energy from fat and the steepest decrease in stunting worldwide, over a twenty year period (UNS/SCN 2004).

Stunting during infancy has been attributed to stunted mothers and poor prenatal nutrition, certain breastfeeding customs, early introduction of complementary foods and parasitic infection (Moren 1995, Frongillo et al. 1997). A stunted baby's immune system is prone to remaining underdeveloped as the child grows (Allen and Gillespie 2001). This can put the child at higher risk of infection.

Food scarcity and nutrient deficiencies are contributing factors to low height for age in young children (Frongillo et al. 1997). Frongillo et al. (1997) examined data of 70 nations' under-five children. The authors found a negative correlation between available dietary energy and prevalence of stunting. They cited a 33% prevalence of stunting associated with a national average of 85% intake of required energy, and a 27% prevalence of stunting with an average of 95% intake of required energy.

Insufficient growth in the first years of a child's life leads to stunting as adults (Allen and Gillespie 2001). It is believed that children under two years of age benefit most from measures designed to prevent chronic malnutrition (de Onis and Blössner 2003, Gorstein et al. 1994). The early years in a child's life are critical because the child is in a state of rapid growth. Treatment is more effective in improving height for age if treatment is started before two years of age (Gorstein et al. 1994). By the time the child is three years old susceptibility to stunting is less and nutritional needs are lower (Allen and Gillespie 2001).

Wasting

It is estimated that there will be about 46 million wasted under-five year old children in the developing world in 2005 (UNS/SCN 2004) (Appendix A). Although the prevalence of wasting is projected to decrease in Asia, 67% of wasted children live there. Approximately ten percent of under-five children in Burma are wasted (Allen and Gillespie 2001). Banjong et al. (2003) reported 8.7% wasting in the largest Burmese refugee camp in Thailand. Kemmer et al. (2003) reported an average 5.7% wasting in five of ten Burmese refugee camps.

Wasting occurs as a result of muscle and fat loss (Fernandez et al. 2002) in children who lose weight or do not gain weight. A high incidence of wasting occurs during famines (Gorstein et al. 1994). Other factors that contribute to wasting are unsanitary living conditions (Fernandez et al. 2002), repeated infections (Frongillo et al.

1997) and brief periods of nutritional deficiencies (Allen and Gillespie 2001). Unsatisfactory maternal health care services can lead to wasted newborns (Fernandez et al. 2002) due to intrauterine growth retardation (Appendix A).

Poor maternal nutrition, late in pregnancy, leads to inadequate fat deposition of the baby; at 26 weeks gestation, a fetus is normally only one percent fat, however by 38 weeks the fetus is about 12% fat. Babies born of malnourished mothers often have low weight and low ponderal index (weight/length^3), but normal body length and head circumference. A wasted or thin baby, however, has a better chance to gain appropriate weight and survive than a stunted baby (Allen and Gillespie 2001).

According to Fernandez et al. (2002), when a child is exposed to malnutrition or infection the first consequence is weight (fat) loss in the form of wasting. The second consequence is slowing of linear growth (stunting). If there is continual exposure to infection, the child will stop linear growth and continue to lose weight. At that point the child may die, but if the child lives, he or she will probably be stunted and severely wasted.

By definition, a normal population distribution of wasting is 2.5%. When wasting goes above five percent, it is considered indicative of poor health and there is increased death (Allen and Gillespie 2001). A rate of 5 to 8% is considered worrisome and if greater than ten percent of the under-five children are wasted (less than minus 2 Z-scores weight for height), it is serious (Moren 1995). Gorstein et al. (1994) ranked a prevalence below five percent as low, 5 to 9.9% as medium, 10 to 14.9% as high and 15% or above as very high. A 15% prevalence of wasting in children is suggestive of a high mortality rate (Mason 2002).

Underweight

It is estimated that there will be about 127 million underweight under-five year old children in the developing world in 2005 (Appendix A). Thirteen million of these children live in Southeast Asia (UNS/SCN 2004). The prevalence of children who are under-five years of age and underweight is projected to decrease in Asia; however this is mainly due to improvements in child nutrition in China. In Burma, the prevalence is 36%, which is ten percent higher than the global prevalence (UNICEF/SOWC 2003). The underweight prevalence in the largest Burmese refugee camp in Thailand was 33.7% in 2002 (Banjong et al. 2003).

The rate of underweight is an indicator of poverty and hunger. In Africa, for example, there is a lot of poverty and a high prevalence of underweight children. Studies have shown that adults who were born underweight earn less in their lifetime than adults who were born healthy (UNS/SCN 2004). The undernourished-poverty cycle is perpetuated in these malnourished adults who have malnourished babies.

Underweight is the most commonly used indicator for malnutrition. However, it does not distinguish stunting from wasting. Therefore it does not distinguish between chronic or acute low food intake. Pelletier and Frongillo (2002) reported that if weight for age malnutrition is reduced by five percentage points, under-five mortality rate can be reduced by 13%. A summary of stunting, wasting and underweight prevalence based on various authors' research is in Appendix A, Table A1.1.

Micronutrient Deficiencies

A wide diversity of foods is necessary to meet all dietary requirements and promote good health (Ruel 2003). It is a misconception that obtaining sufficient energy in the diet provides adequate nutrients (Mason 2002). Even though they are required in small amounts, all essential nutrients, including micronutrients are fundamental to proper health (Black 2003, Chakravarty and Sinha 2002).

Refugee rations lacking variety lead to micronutrient deficiencies (Toole 1993); children who lack variation in their diets are susceptible to vitamin and mineral deficiencies (Toole 1999). Diets that are supplied by humanitarian agencies have been known to be deficient in riboflavin, niacin, vitamin C, iron and folic acid (Sphere 2004). Refugees receiving the same staples for 20 years may have some clinically evident nutrient deficiencies.

The Burmese rations in Thailand do not meet the Dietary Reference Intakes for iron, calcium, vitamin A, vitamin C, thiamin, riboflavin, niacin (Kemmer et al. 2003) and folate (McGready et al. 2001) (Table 1.2.). Therefore, these rations are sufficient for short term sustenance, but are inadequate for long-term survival. It is expected that the refugees supplement their food basket with other foods that they hunt, raise, grow or purchase (Banjong et al. 2003).

Table 1.2. Monthly and Daily Burmese Refugee Food Rations for Adults And Children Under-Five Supplied by the BBC on the Thailand-Burma Border

	Polished broken white rice	**Dry mung bean**	**Soybean oil**	**Iodized salt**	**Fermented fish paste**
Monthly Adult Ration	16 kilograms	1.5 kilograms	1 liter	330 g	1 kilogram
Daily Adult Ration	533 grams	33-50 grams	33 grams	11 grams	33 grams
Monthly Child Ration	8 kilograms	750 grams	500 milliliters	330 grams	1 kilogram
Daily Child Ration	266.5 grams	25 grams	16.5 grams	11 grams	33 grams

Nutrition interventions were first focused on protein deficiency, then on protein-energy deficiency, and now the focus is changing to *micronutrient deficiencies* (Allen 2003, Grillenberger et al. 2003). There has been increasing attention paid to micronutrient deficiencies in refugee populations in recent years (Toole 1993, Mason 2002). Caulfield et al. (2004b) reported that vitamin A, folate, iron and zinc deficiencies, along with undernutrition, contributed to malaria related child death.

Epidemics of scurvy, pellagra, beriberi (McGready et al. 2001, Toole 1993), xerophthalmia, iron deficiency and anemia have occurred among refugees due to the lack of sufficient nutrients supplied by ration foods (Toole 1993). This is prevalent even though there are set international nutrition guidelines to ensure diet adequacy (Toole 1992).

Several micronutrients aid in the absorption of other nutrients; riboflavin and vitamin A increase iron absorption (Ramakrishnan 2002). Others interfere with absorption; excessive zinc interferes with iron and copper absorption (Singh 2004). A deficiency of several micronutrients can occur concurrently in one child (Black 2003), and more than one nutrient deficiency normally occurs in communities (Jelliffe 1966). It is possible to mask one micronutrient deficiency with symptoms of another deficiency; folate and B12 deficiencies both lead to the same hematologic changes (DRI 1998).

A rapid clinical examination can identify severe deficiency of some micronutrients (Mason 2002). Rapid clinical surveys can detect micronutrient deficiency signs in the hair, face, eyes, mouth, thyroid gland, skin and skeleton. Anthropometric measurements, biochemical tests and diet analysis can be used to confirm macro and micronutrient deficiencies found in clinical examinations (Jelliffe 1966).

Common Trace Mineral Deficiencies

Iron

Two billion people are affected, and one million deaths are caused, by iron deficiency anemia yearly (WHO 2002a). Worldwide, almost half of all women aged 15 to

49 years old (Mora and Nestel 2000), and approximately 25% of children less than three years of age have iron-deficiency anemia (Black 2003). According to Ramakrishnan (2002), 99% of Southeast Asian children have iron-deficiency.

Newborn babies have a four to six month store of iron (ADA 1998). When infants are between six and 24 months of age, they are in a state of rapid growth and are at high risk of iron deficiency if iron is not supplied in their diet. Permanent cognitive damage has been demonstrated in otherwise healthy infants who have iron-deficiency anemia (Lozoff et al. 2000).

Pregnant women who are anemic are at increased risk of death during childbirth. About half of the children whose mothers die during childbirth, die before they are five years old. Research suggests that severe maternal iron deficiency leads to low iron stores in neonates and to iron deficiency in infants (Mora and Nestel 2000).

Children who are deficient in iron may have impaired motor development (Mason et al. 2001). Lack of iron also has an effect on overall growth and development as well as on the immune system (Black 2003); insufficient iron can lead to a weaker defense against infection (Bhaskaram 2002, Kemmer et al. 2003). Low vitality is associated with iron-deficiency, as iron is needed to produce hemoglobin and carry oxygen (DRI 2000b).

Iron is available from animal (heme) and vegetable (non-heme) sources; however, iron is more readily absorbed from animal sources. Animal iron sources also enhance bioavailability of vegetable iron sources (Kemmer et al. 2003). High iron absorption is possible from iron-fortified foods, such as fish sauce (Fidler et al. 2003).

Kemmer et al. (2003) reported up to 85% iron deficiency (> 80μmol/mol ZPP/H) and 72% anemia (<110 g/L Hgb) among children under-five in Burmese refugee camps in Thailand. Significant predictors of iron deficiency and anemia were: lack of dietary heme iron daily ($p<.01$), less than six different foods per week ($p<.001$), more than

80µmol/mol zinc protoporphyrin/heme ($p=.001$), family ration did not last until the end of the month ($p=.001$), less than –2 Z-scores weight for height ($p=.01$), and diarrhea ($p<.05$).

Iodine

In 1998, 740 million people had iodine deficiency exhibited by the presence of goiter; 172 million of these were in Southeast Asia (Mason et al. 2001). Nearly two billion people, or approximately 30% of the world, had inadequate iodine nutrition in 2003. In Southeast Asia over 60% of the population currently has iodine deficiency (UNS/SCN 2004).

Iron and iodine deficiency are interrelated as iron deficiency intensifies thyroid dysfunction. The thyroid hormones necessary for bone growth and nervous system function are dependent on iodine. Iodine deficiency has a direct effect on cognitive development. Prenatal iodine deficiency in utero leads to cretinism and fetal hypothyroidism. Neurological cretinism comprises mental retardation, diplegia and stunting (Black 2003). Iodine deficiency is cited as the principal cause of brain damage among young children (WFP 2004).

Universal iodization of salt has helped to reduce the prevalence of iodine deficiency diseases worldwide (Delange et al. 2002). Simultaneous addition of iron and iodine to salt has been shown to improve iodine function in children with goiters (Zimmerman and Kohrle 2002).

Zinc

Zinc is an essential trace mineral for growth and development, DNA synthesis and immunity (Wood 2000). In Southeast Asia the prevalence of zinc deficiency in children under-five is greater than 70% (Ramakrishnan 2002).

Deficiencies of zinc present as reduced motor function and activity (Black 2003) and delayed sexual maturation (Wood 2000). Stunting is attributed to zinc deficiency (Black 2003, Golden 2002, Umeta et al. 2003, Wood 2000). Zinc deficiency in a malnourished child may contribute to diarrhea (Black 2003, Golden and Briend 1993) and pneumonia (UNS/SCN 2004). Jones et al. (2003) reported zinc intervention could prevent five percent of under-five year old deaths, because deficiency is associated with diarrhea, pneumonia and malaria. Umeta et al. (2003) reported that concentration of zinc and calcium was less in breastmilk of mothers who had stunted infants than in mothers of non-stunted infants. The researchers also reported that after six months of lactation, zinc from breastmilk was insufficient for infant development.

Zinc absorption in the gastrointestinal tract can be reduced by phytic acid found in grains and legumes (DRI 2000b, Riddoch et al. 1998, Wood 2000). Because of this, cereal or soy sources of zinc are not absorbed by the body as well as meat sources. This can be a problem in many refugee camps where the rations are plant based, such as the Burmese camps in Thailand.

Common Major Mineral Deficiencies

Calcium

Infants have the greatest need of all ages to absorb calcium for bone growth and mineralization (DRI 1997). Calcium deficiency is rare in one year olds who are exclusively breastfed and have a sufficient supply of vitamin D from exposure to sunlight, which contributes to calcium absorption in the body. Calcium concentration in breastmilk is not affected by the mother's diet (Michaelsen et al. 2003). However, Umeta et al. (2003) reported lower calcium concentration in the breastmilk of mothers who had stunted infants.

The quality of breastmilk decreases with prolonged lactation, as babies' nutritional needs shift from exclusive breastmilk to complementary foods. Although a mother who is ill or malnourished produces poorer quality breastmilk than a healthy mother, exclusive breastfeeding remains the most important source of calcium and other nutrients for an infant under six months.

Calcium helps with B12 absorption in the body, but can compete with and thus hinder zinc (Singh 2004) and iron absorption (DRI 2000b). Calcium absorption can be blocked by foods high in oxalic and phytic acids (DRI 1997), such as the beans included in the refugee rations in the Burmese camps in Thailand.

Common Fat Soluble Vitamin Deficiencies

Vitamin A

Vitamin A deficiency is one of the most common vitamin deficiencies in children throughout the developing world (Mason et al. 2001). Sixty-nine percent of children in Southeast Asia have vitamin A deficiency (Ramakrishnan 2002).

Deficiency of vitamin A can lead to blindness (xerophthalmia) (Ramakrishnan 2002), decrease mobilization of iron from stores and impair the immune system (DRI 2000b). Vitamin A is integral to the mucosal lining of the small intestine that protects the body from bacteria; thus vitamin A deficiency is associated with higher risk of diseases, such as measles and malaria (Bhaskaram 2002).

Vitamin A supplementation is most effective when received twice a year, and is administered in bi-annual doses to children under the age of five in many developing countries (Bhaskaram 2002, Grubesic and Selwyn 2003). In the Burmese refugee camps in Thailand, children receive 50,000 IU at birth, 100,000 IU every six months in their first year, and 200,000 IU annually thereafter (personal correspondence with Menefee A., Nutritionist, BBC 2002-2005).

Common Water Soluble Vitamin Deficiencies

Vitamin C

Vitamin C (ascorbic acid) is one of the essential micronutrients most commonly lacking in refugee diets (Sphere 2004). Deficiency of vitamin C (less than 10 mg daily) can lead to scurvy (Toole 1992), characterized by poor wound healing and bleeding gums (DRI 2000a).

Scurvy was reported from 1984 to 1991 in refugee camps in Sudan, Somalia and Ethiopia (Toole 1993). A positive correlation was found with length of time in remote African refugee camps and incidence of scurvy. The refugees most affected by scurvy were female, older and pregnant. The rations consisted of two to three food items and contained insufficient vitamin C (Toole 1993).

Vitamin C functions as a cofactor for enzymes and as an antioxidant. Ascorbic acid is an electron donor for collagen hydroxylation, and biosynthesis of carnitine, hormones and amino acids. Deficiency can lead to increased oxidative damage in people who have arthritis (DRI 2000a).

Vitamin C aids absorption and utilization of dietary iron (DRI 2000a). Kemmer et al. (2003) found only 4% of children in Burmese refugee camps eat a food containing vitamin C every day and slightly more than 43% of children eat a vitamin C inhibitor food daily, such as tannins from tea.

B-vitamins

The B-vitamins comprise eight essential, water soluble vitamins. Thiamin, riboflavin and niacin are important for energy production (DRI 1998). It is sometimes difficult to distinguish one B vitamin deficiency symptom from another; glossitis can be seen in folate, niacin, vitamin B12 or riboflavin deficiency (Jelliffe 1966).

A diet with a disproportionate amount of energy compared to required micronutrients (niacin, thiamin and retinol) can lead to micronutrient deficiencies (Toole 1992). The refugee rations on the Thailand-Burma border are disproportionately high in carbohydrates (Banjong et al. 2003) and low in B vitamins (Banjong 2003).

Thiamin

Thiamin (vitamin B1) is needed for energy production, neurotransmitter function and nerve conduction (Rucker et al. 2001). Thiamin deficiency results in beriberi (DRI 1998). Symptoms of beriberi include cardiac failure, weak muscles, neuropathy, gastrointestinal disturbances and edema. These symptoms are classified as wet or dry beriberi and can be alleviated with thiamin administration (Rucker et al. 2001).

In 1981, there was a beriberi epidemic among Cambodian refugees in Thailand (Moren 1995). From 1987 to 1990, infantile beriberi caused a high rate of infant mortality in three month old infants among the Burmese refugees in Thailand (Luxemburger et al. 2003). Thiamin deficiency is prevalent in over 50% of postpartum women of Karen ethnicity (from Burma) living in Thai refugee camps, primarily attributed to highly polished rice in the ration diet (McGready et al. 2001).

Antithiamin factors hinder absorption of dietary thiamin. McGready et al. (2001) reported prevalence of antithiamin factors among the Burmese refugees in Thailand, particularly fermented fish consumption, tea drinking, and betel nut chewing. Fermented fish contain *thiaminases*, thermolabile antithiamin factors that cleave thiamin and modify its structure. Tea and betel nut contain thermostable antithiamin factors, which oxidize and modify the biological activity of thiamin (Rucker et al. 2001).

Pregnant Burmese refugees at the Thai camps who exhibit clinical thiamin deficiency symptoms are given supplemental thiamin. Lactating women are given weekly supplemental thiamin at the camps. Infants who have acute infantile beriberi are given thiamin by injection; this has helped to reduce infant mortality rates by over 30% in the Burmese refugee camps in Thailand (McGready et al. 2001).

Myoglobin, hemoglobin and hemin also bind thiamin (Rucker et al. 2001). When iron is in hemin it can deactivate thiamin. Vitamin C can prevent oxidation and aid thiamin absorption in the body (Hayes and Hegsted 1973).

Riboflavin

Isolated riboflavin (vitamin B2) deficiency is considered rare (Blanck et al. 2002); however, B2 deficiency was reported in epidemic proportions among the Royangas in Bangladesh (Moren 1995). In fact, B2 deficiency has been surfacing among refugees dependent on food aid. Riboflavin deficiency is often associated with other nutrient deficiencies (Rucker et al. 2001); therefore, it could be indicative of a higher prevalence of other B-vitamin deficiencies as well (Blanck et al. 2002).

B2 deficiency can lead to ariboflavinosis (DRI 1998), characterized by cheilosis of the lips (Jelliffe 1966) or angular stomatitis (Rucker et al. 2001). In the 1960s, nutrition surveys started to incorporate examinations for angular stomatitis (Blanck et al.

2002). Angular stomatitis can be detected with the mouth half open (Jelliffe 1966). It appears as a fissure on both sides of the mouth and can be a fresh or scarred angular wound (Jelliffe 1966). In a study of adolescent Bhutanese refugees in Nepal, Blanck et al. (2002) found greater than 25% prevalence of angular stomatitis and 85% prevalence of low serum riboflavin concentrations.

Riboflavin deficiency has been shown to be protective against malaria. This may be due to the antioxidative effect of energy production, and the vulnerability of the malaria parasite to activated oxygen species (Rucker et al. 2001).

Niacin

Niacin (vitamin B3) deficiency can lead to pellagra (DRI 1998) and was reported in 1989 among Mozambican refugees in Malawi due to inadequate groundnut rations, which is their main source of niacin. Other risk factors for pellagra were younger age, female gender, unemployed head of household, living in camp, and lack of fish, poultry or a vegetable garden (Toole 1993).

The amino acid tryptophan can be converted to niacin. Symptoms of niacin deficiency are rash on skin exposed to sunlight, diarrhea or constipation, depression and memory loss. Patients with pellagra often have a scarlet red tongue. Pellagra frequently occurs in countries where the staple is maize based. Maize is low in niacin and tryptophan (DRI 1998).

B12

Vitamin B12 deficiency can lead to slower development in children (Black 2003). Cobalamin (B12) is found in animal products. Women who do not eat animal foods are at risk of having infants with cognitive and motor development delays (Black 2003).

Van Dusseldorp et al. (1999) reported impaired cobalamin function in adolescents who consumed insufficient B12 as macrobiotic children. Although fish is sometimes consumed, macrobiotic diets are primarily plant based. There was a negative correlation of length of time on a macrobiotic diet with cobalamin concentration in blood and a significant, positive correlation of meat, chicken or dairy consumption with cobalamin concentration (Van Dusseldorp et al. 1999).

In a separate study involving macrobiotic adolescents, Louwman et al. (2000) found a significant correlation of low cobalamin stores with short term memory loss, decreased fluid intelligence (problem solving, learning ability, abstract thinking) and spatial ability. The researchers concluded that infants on a macrobiotic diet are especially vulnerable to neurologic disorders secondary to a lack of cobalamin.

Folic Acid

Folate is more bioavailable in the synthetic form than in the natural food state. Most of the folate in the United States diet comes from fortified foods (Rucker et al. 2001), whereas most folate in developing countries comes from food.

Folate is important early in pregnancy because it is needed for cell division and growth (UNICEF 2004). The megaloblastic anemia of folate deficiency results from abnormal DNA synthesis in bone marrow and can cause birth defects in babies (Rucker et al. 2001). Folate deficiency accounts for an estimated 2,300 babies born with neural tube defects in Burma, and 3,300 in Thailand, yearly (UNICEF 2004). Neural tube defects could have been prevented in these infants if adequate folate status was present at the time of conception (Viteri and Gonzalez 2002).

Immediate Causes of Malnutrition; Child Health and Diet

Illness

Exclusive breastfeeding for the first six months of an infant's life reduces the risk of allergies, chronic illness and infection. Breastmilk is free of contaminants from outside food and water and has immunoglobulin A, macrophages and antioxidants, which protect the baby from diseases such as diarrhea (Michaelsen et al. 2003).

Malnutrition and infection act synergistically (Scrimshaw et al. 1968). A poor diet contributes to reduced immunity and reduced mucosal lining (Keys et al. 1950), leading to less disease resistance, and increased duration of disease (Allen and Gillespie 2001). Illness and weak immune systems in children make them more susceptible to malnutrition and poor growth (Campbell et al. 2003).

Malnutrition related death rates are exceptionally high in some areas of the world. In India, 67% of child deaths result from malnutrition (Pelletier et al. 1995). Mortality is not usually the direct result of starvation; it is more commonly associated with poor hygiene, disease, and a lowered immunity intensified by malnutrition. Caulfield et al. (2004b) reported a nine times higher risk of death from malaria in severely malnourished children, a four times higher risk of death in moderately malnourished children and twice as high risk of death in mildly malnourished children compared to healthy children.

The principal etiology of childhood death in developing countries is diarrhea, pneumonia, measles and malaria exacerbated by undernutrition (Caulfield et al. 2004a). These childhood diseases are the same causes of death in children in refugee camps (Toole and Waldman 1990).

Kemmer et al. (2003) reported that the high prevalence of anemia and iron deficiency in the Burmese refugee children from the Thai camps was a result of a combination of illness and diet. Infection leads to decreased appetite and subsequently less food intake as well as disturbed metabolism and absorption of nutrients (Bhaskaram 2002, Scrimshaw 2003).

Both malnutrition and gastrointestinal disease increase nutrient requirements. Kurpad et al. (2003) reported a 50% increase in the requirement for the amino acid lysine, in subjects with parasitic infection, compared to healthy subjects. Kurpad et al. (2004) reported an increase in requirements of all sulfur containing amino acids in undernourished male adults. Malnourished children who are supplemented with the amino acid cysteine can make glutathione faster, which is important for immune cells (Kurpad et al. 2004).

Infection or diarrhea often precedes kwashiorkor and worsens malnutrition (Scrimshaw 2002). Death from malnutrition and disease is referred to as the "malnutrition-infection complex" (diagram 1.1) (Allen and Gillespie 2001).

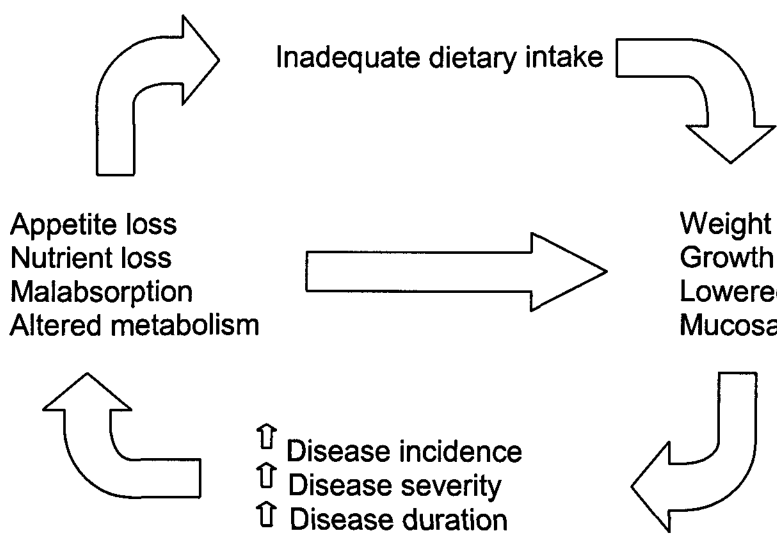


Diagram 1.1. Malnutrition-Infection Complex*

*The inadequate dietary intake-disease cycle. Adapted from Tomkins, A. & Watson, F. (1989). Malnutrition and Infection. ACC/ SCN State of the Art Series Nutrition Policy Discussion Paper No.5 Geneva: ACC/SCN (Allen and Gillespie 2001).

Aid programs are usually aimed at children aged 6 to 59 months (Coulombier et al. 1995). Young children are especially vulnerable to malnutrition and growth retardation in refugee camps, and account for a large proportion of deaths. In a survey of Kurdish refugees in mountain camps on the Turkey-Iraq border in the spring of 1991, children under the age of five made up 18% of the population, and 64% of the deaths (Toole 1999).

Yip et al. (1993) used a rapid nutrition survey and a retrospective mortality survey to investigate the reasons for the high death rates in these camps. High mortality rates were primarily due to diarrheal incidence, dehydration and malnutrition. The researchers attributed the high rates of diarrhea and subsequent mortality to inadequate food, unclean water, poor sanitation, crowded living conditions and the cold mountain temperatures. The children less than five years of age were most affected by diarrhea and malnutrition and consequently had the highest death rates (Yip 1993). In a study by Peterson et al. (1998), hand washing with soap was negatively correlated with prevalence of diarrhea related mortality among children under-five in refugee camps.

Campbell et al. (2003) reported a strong association between disease and chronic inflammation of the small intestinal mucosal lining in infants under 15 months of age in the Gambia. A longitudinal investigation of the relationship between development delay and infection in 73 children at eight weeks of age revealed infants were initially close to the mean size of same age children in the United Kingdom. However, by 64 weeks of age, the Gambian children were markedly more stunted and wasted than the English children. The intestinal permeability of the Gambian children was about double that of the English children by one year of age. Growth was positively related to permeability barriers and increased immunoglobulin concentrations and endotoxin antibody titers (Campbell et al. 2003).

All of the Gambian children were breastfed, none had any severe illnesses and there were no food shortages during the time of the study. However, the inflammatory and immune systems of the children were intensified and the concentration of the three principal immunoglobulins was raised. The authors suggested the small intestine of these children was a site of inflammation, and growth faltering was mainly caused by disease in children in underprivileged settings. Specifically, these children had chronic asymptomatic mucosal enteropathy, which lead to reduced absorption and caused growth faltering. This enteropathy may have arisen from consumption of complementary foods that contained bacteria which continued to grow, and invaded the intestinal mucosa. This caused an inflammatory reaction which altered mucosal function, allowed passage of bacterial toxins and interfered with active transport of nutrients (Campbell et al. 2003).

Diet

Food Aid

Food aid is provided based upon refugee needs, existing resources of aid organizations, and allowance of host country authorities. Because resources are limited, it is important to prioritize needs in a refugee camp. In the emergency phase of a refugee camp, it is vital to obtain sufficient energy from food to survive. Inadequate food supplies in refugee camps lead to high acute undernutrition and mortality rates (Mason 2002, Toole 1993, Toole et al. 1988).

Toole et al. (1988) analyzed data on under-five year old Cambodian refugees in Thailand from 1984 to 1985 and Tigrayan refugees in Eastern Sudan from 1979 to 1980. They established that inadequate rations lead to undernutrition and death in Thai and Sudanese refugee camps.

Toole et al. (1988) attributed high mortality rates among the Tigrayan refugees to an inadequate amount of food for the first five to six months in the camps, compared to the Thai refugee camps where food was more accessible soon after the refugees arrived. Results indicated that Cambodian mortality rates dropped from the emergency phase rate of 10/1,000 people to less than 1/1,000 after one month in the camp, while the Tigrayan mortality rates remained high at 14-24/1,000 for several months. Patterns of mortality and undernutrition were similar in the children. The researchers reported that undernutrition may have affected the ability of the children to improve their health and nutritional status. Ultimately children died of diarrhea, malaria, acute respiratory infections and measles (Toole et al. 1988).

In the post emergency phase of a refugee camp, defined as a crude mortality rate of less than 1/1,000 deaths per day, and when refugees have access to outside foods, food aid should be thus adjusted (Sphere 2004). The Burmese Border Consortium (BBC) has been providing food rations to the Burmese refugees in Thailand since 1984 (Banjong et al. 2003, BBC 2003).

When the Burmese Border Consortium (BBC) formed in 1984, they intended to cover around 50% of the refugee dietary needs. At that time, the Burmese refugees lived in Thailand without restrictions. The refugees were able to go to town to purchase or trade food at the local markets, find jobs in local farms, raise animals, garden and forage in the surrounding areas for a variety of plant and animal foods.

By the mid-1990's, it became necessary to supply 100% of the refugee diet, due to territory loss and tighter control by the Thai government (BBC 2003). As a result of changes in camp policies, refugees have become dependent on the BBC to meet almost all of their nutrient needs (Food Systems 2001). According to the BBC, the current border-wide average amount of food provides approximately 1,200 kilocalories to the 0 to 59 month old children (BBC 2003) (Table 1.2., p.9).

Animal Foods

Children consuming diets containing animal foods have higher intakes of vitamins A, B2, B12, and calcium compared to children consuming vegetarian diets (Murphy and Allen 2003). Low consumption of animal protein is associated with micronutrient deficiencies, because micronutrients are more bioavailable from animal source foods (Siekmann 2003). Meat is a good source of vitamins B2, B3, B6, B12, heme iron, and zinc. Milk is a good source of vitamins A, B2, B12, calcium, folate and phosphorous (Grillenberger et al. 2003).

A comparison of 100 grams of beef and 100 grams of cooked kidney beans show that beef has almost three times the amount of protein per gram (Murphy and Allen 2003). Protein energy malnutrition (PEM) is frequently accompanied by deficiencies in micronutrients (Bhaskaram 2002), producing multiple clinical signs of malnutrition (Jelliffe 1966).

In a two year intervention study, Grillenberger et al. (2003) reported diet enrichment with meat led to increased lean body mass in children. However, animal source foods are not always available in the developing world, especially in a refugee camp dependent on an outside supply of food.

The Karen tribe makes up about 65% of the refugees on the Thailand-Burma border (BBC 2003). They are known to eat field rats, frogs, snakes and birds. This allows them to supplement their diet with protein foods that are otherwise not readily available.

Underlying Causes of Malnutrition: Maternal and Child

Maternal Health

Greater than seven million newborn deaths occur in developing countries yearly. Poor maternal perinatal health and nutrition are contributing factors to these deaths (Mora and Nestel 2000). In developing countries, death and premature births are frequently the result of insufficient hygiene and health care, as well as the existence of trauma and stress in mothers (Allen and Gillespie 2001).

Seventeen million babies are born underweight each year due to their mothers being malnourished (WFP 2004). A stunted or underweight pregnant woman is at greater risk of having a premature or low birth weight baby than a normal weight pregnant woman (Steketee 2003). Neggers and Goldenberg (2003) cited research that attributed low birth weight in babies to low micronutrient intakes and low prepregnancy body mass indices (kg/m^2) in undernourished mothers. In Southeast Asia, approximately 17% of neonatal deaths are attributed to low maternal body mass indices (UNS/SCN 2004).

Mora and Nestel (2000) cited research that women in the developing world eat approximately two thirds of their recommended energy intakes. Energy needs increase by several thousand kilocalories throughout pregnancy and lactation. However, women who are underweight can still produce sufficient quantity and quality breastmilk to support their baby for six months (Michaelsen et al. 2003).

Multiple births and short intervals between births contribute to preterm birth (Kramer 2003), and decreased nutrient stores in the mother (Michaelsen et al. 2003). Protein malnutrition in a child can result from an unbalanced, protein-poor, carbohydrate-rich diet; this is common when a mother gives birth to a child within 18 months of a previous birth. In order to breastfeed the neonate, the older child may become malnourished when weaned to a carbohydrate-rich, protein-poor diet (Jelliffe 1966).

Low Birth Weight

Worldwide there are about 24 million babies born with low birth weight every year (Fernandez et al. 2002) (Appendix A). In a developed country, a low birthweight is often the result of a pre-term delivery. A baby born with a low birthweight in Asia is more commonly the result of intrauterine growth retardation from maternal undernutrition (UNS/SCN 2004). In a report for the United Nations, Allen and Gillespie (2001) reported that over 14 million babies were born with intrauterine growth retardation-low birth weight in developing countries every year. In Southeast Asia, they reported 21% of babies with intrauterine growth retardation-low birth weight. This may be attributed to the high prevalence of underweight and stunted women in Southeast Asia (Allen and Gillespie 2001).

Premature birth leads to a high rate of infant mortality, disease and long term consequences such as poor physical and cognitive development (Allen and Gillespie 2001, Mora and Nestel 2000). Low birth weight is associated with risks to health and development and early death (Allen and Gillespie 2001, Steketee 2003). Babies with low birth weights are at high risk of disease because they have low immune competence (Mora and Nestel 2000). It is especially important for infants born with a low birth weight to be breastfed, as they are already at increased risk of disease and death (WHO 2002b).

Female Education

Waslien and Stuart (1994) reported that adolescent female food requirements are not well understood in Asia, contributing to their malnutrition. According to UNICEF (2001), the decrease in percent of underweight children in developing countries is due in part to educating women on prevention of malnutrition.

Studies have shown that higher maternal education is related to better nutrition and survival rates in children (Mora and Nestel 2000). Low female literacy rates were associated with wasting in a Filipino study (Allen and Gillespie 2001). Frongillo et al. (1997) cited an inverse relationship between low prevalence of stunting and high female literacy rate in Asia. Vitamin A deficiency in preschool children was positively correlated with lower level of mother's education in a study in Costa Rica (Carvajal et al. 2003).

Kemmer et al. (2003) found a 58.3% literacy rate among mothers and a 46% stunting rate in the Burmese refugee camps in Thailand. The female literacy rate in Thailand in 2000 was 94%, far higher than rates in the Burmese camps (UNICEF 2002).

Age

The prevalence of malnutrition in children less than five years old is used as an indicator for the whole population (Coulombier et al. 1995). Young children are often the first to show signs of malnutrition when food availability decreases. Seventy percent of a child's brain develops in utero and the remaining 30% is developed by age three (Singh 2004). From conception until three years old, children are most vulnerable to malnutrition due to their increased nutritional needs for growth and development (Anonymous 2003, Singh 2004).

Basic Causes of Malnutrition: Environmental and Socioeconomic Status

Frongillo et al. (1997) attributed growth in children to economic structure and gross national product. The researchers included food security and increased health expenditure as underlying reasons for child growth and adequate dietary intake as immediate reasons for growth in their conceptual model.

Similarly, Torlesse et al. (2003) cited poverty as an underlying cause of malnutrition, enhanced by disease, decreased cognitive skills, delayed development and reduced productivity in adulthood. The researchers analyzed data on 81,337 children aged 6 to 59 months in Southeast Asia. They reported a positive correlation of nutrition with rice prices. Although the authors indicated that there was no correlation between rice prices with rice consumption (low demand elasticity), when rice price declined, there was an increase in non-rice food item purchases. The authors also reported a positive correlation of weekly rice expenditure with childhood underweight prevalence (p=.001), and a negative correlation of the number of underweight children with households that consumed the greatest diversity of foods as well as the most non-rice foods; such as when rice prices declined.

Rice was the staple analyzed as it provided over two-thirds of consumed calories and accounted for half of household food expenditure (Torlesse et al. 2003). The Bangladeshi children were dependent on staples from markets; when rice prices rose, they were directly affected.

Gorstein et al. (1994) attributed stunting primarily to low socioeconomic status, and secondarily to exposure to infectious agents, as well as poor quality and availability of food and water. They found that this was also true for established refugee camps where stunting may be high and wasting low (Gorstein et al. 1994), indicating adequate current food supplies. Kemmer et al. (2003) reported that socioeconomic factors are associated with prevalence of anemia in the Burmese refugee camps in Thailand.

Causes of Mortality in Children Under-Five Years Old

Factors that influenced mortality in 678,296 under-five year old children in 52 refugee camps in seven countries, including five camps in Thailand and three in Burma, were identified by Spiegel et al. (2002). The camps were all in the post emergency phase of humanitarian relief.

Adjustment was made for age, sex and seasonal differences because mortality has a seasonal pattern in most countries. Statistically significant variables for under-five mortality rate were infection related: water quantity, prevalence of diarrhea, number of refugees per health care worker, as well as age of camp, season and distance to conflict. Other researchers have found that malnutrition was related to political, economic, social and cultural issues (Fernandez et al. 2002). These considerations for the Thailand-Burma border refugee camps are addressed in Appendix B.

Physiologic Consequences of Malnutrition in Children Under-Five Years Old

Malnourished children who are approximately 50% of their expected weight for age do not eat nor grow and are totally listless (Waterlow 1989). By the time healthy children lose greater than 40% of their weight they are usually at a clinical stage of protein-energy malnutrition (Gopalan 1975).

Waterlow (1989) speculated on the earlier, progressive stages of malnutrition a child with marasmus has gone through. First the child is less physically active, then weight and height growth cease, then the child loses body fat and body muscle. As malnutrition becomes more severe, the child loses mass from visceral organs. The brain malnutrition becomes more severe, the child loses mass from visceral organs. The brain and kidney (Waterlow 1989) may lose about ten percent of mass, and the heart can lose as much as 30% (Keys et al. 1950). Finally the metabolic rate of the visceral organs decreases.

The basal metabolic rate (BMR) in these children is depressed, which means that the children cannot maintain body temperature and they have a low rate of protein turnover (Waterlow 1989). The BMR of children with protein-energy malnutrition is about half that of healthy children. Energy requirements are accordingly less. The metabolic rate in stunted children is also low compared to age-matched and height-matched children, attributed to less lean body mass (Soares-Wynter and Walker 1996) (Table 1.3.).

Table 1.3. BMR* and Energy Requirements for Healthy Children vs. Children with PEM*

Child disease state & requirements	Basal metabolic rate kcal/m²/hr	Kilocalorie requirements kcal/kg/day
Marasmus	27.5	46
Kwashiorkor	23.2	33
Healthy	50.4	59

*BMR=Basal metabolic rate, PEM=Protein-energy malnutrition
**Adapted from Gopalan (1975)

The body composition of a malnourished child is very different from that of a healthy child. A wasted marasmic child has less muscle mass and non-collagen protein, and half the fat, but more water content than a healthy child. A stunted child has slightly less fat and less water than a healthy child (Waterlow 1989).

A child with kwashiorkor typically has a loss of serum protein (Lee and Nieman 1993) and therefore has edema and overhydration (Solomons and Mazariegos 1995). As much as eight liters of fluid can be extracted from the abdominal cavity of a semi-starved child. Edema and ascites can disguise weight loss in these children (Keys et al. 1950).

A child with marasmus is starving and has relatively normal serum proteins and no edema, but a significant loss of skeletal muscle, adipose tissue and body weight (Lee and Nieman 1993). Autopsies on people who starved to death have revealed a total loss of body fat (Keys et al. 1950). Autopsies on children with kwashiorkor almost always revealed a fatty liver (Williams and Oxon 1935).

When malnourished children start to eat again, they lie down, eat, perspire from processing nutrients, and sleep (Waterlow 1989). Oxygen uptake is restored, protein is synthesized and the children slowly gain muscle, fat and bone growth. Later, the child will regain the urge to be physically active (Waterlow 1989).

Long Term Consequences of Malnutrition in Children Under-Five Years Old

Malnourished children are at risk of poor physical and cognitive growth, learning capacity, school performance and educational outcomes (Mora and Nestel 2000). Long term effects of malnutrition in adulthood include reproductive problems, decreased physical and mental work capacity, and chronic disease (Mora and Nestel 2000, Pelletier and Frongillo 2002).

Singh (2003) lists omega 3 fatty acids, docosahexaenoic and arachidonic acids, as essential for brain development. Other nutrients needed for optimal brain development are the B-vitamins, folate, vitamin C, vitamin E, iodine, iron, zinc, selenium, essential amino acids, taurine, choline and antioxidants (Singh 2003). Undernourished children may have a smaller brain and remain intellectually inferior to well nourished children.

Decreased cognitive aptitude and underdeveloped motor function were shown to be significantly correlated with malnutrition in a study involving Filipino children (Allen and Gillespie 2001). A study in Guatemala showed preliminary positive effects on child and adult educational achievements from nutrition interventions at 6 to 24 months of age (UNS/SCN 2004).

Conceptual Framework

A conceptual framework of the contributing factors to malnutrition in the Burmese refugee children aged 6 to 59 months in Thailand is in Figure 1.2.

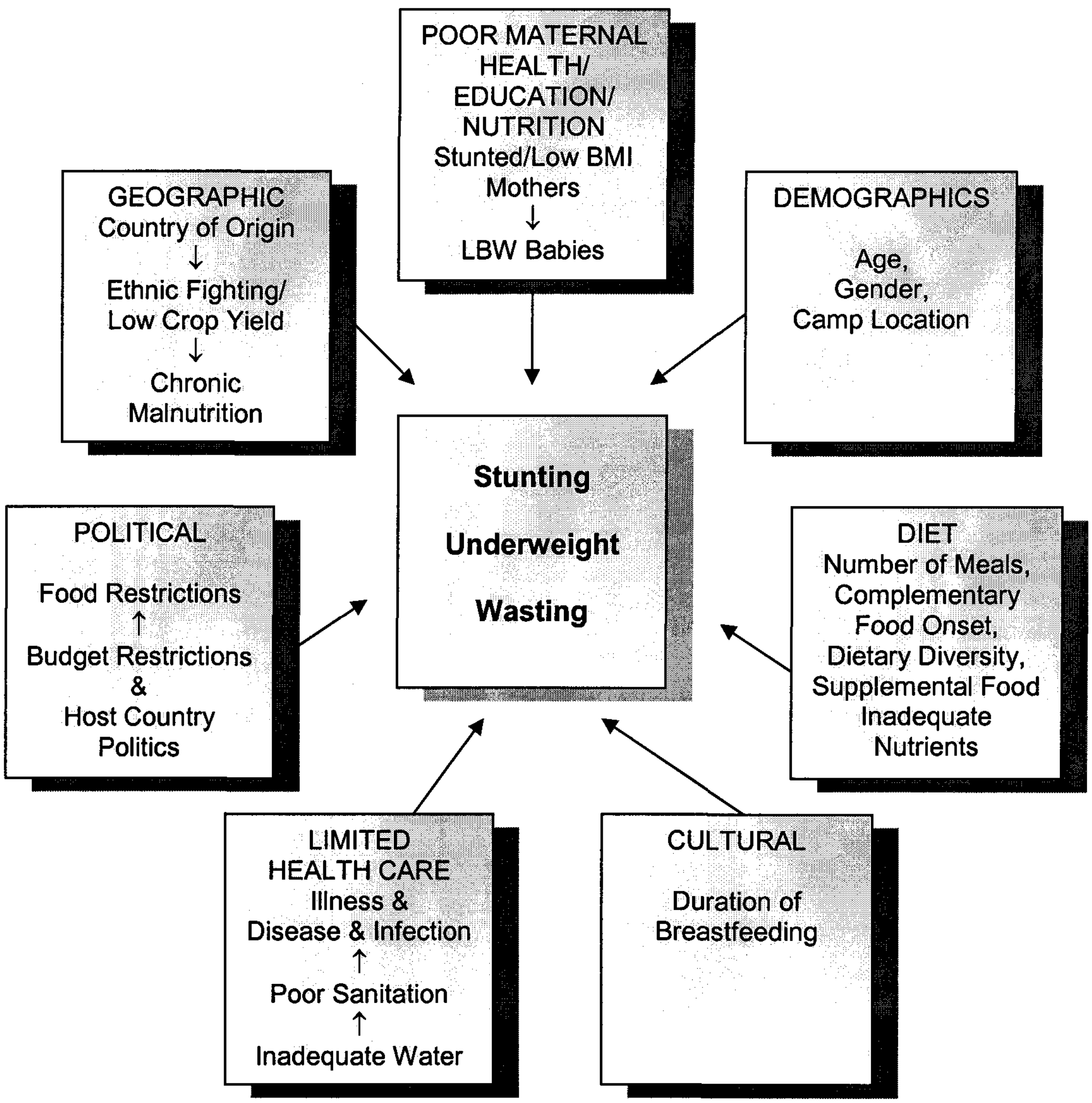


Figure 1.2. Conceptual Framework: Etiology of Malnutrition in Refugee Children (adapted from Frongillo et al. 1997).

Operational framework

An operational framework of variables that influence acute and chronic malnutrition in the Burmese refugees aged 6 to 59 months in Thailand is presented in Figure 1.3. This framework was adapted from UNICEF (1998).

Basic Causes → Underlying Causes → Immediate Causes → Outcomes

Environmental → Maternal and Child → Child

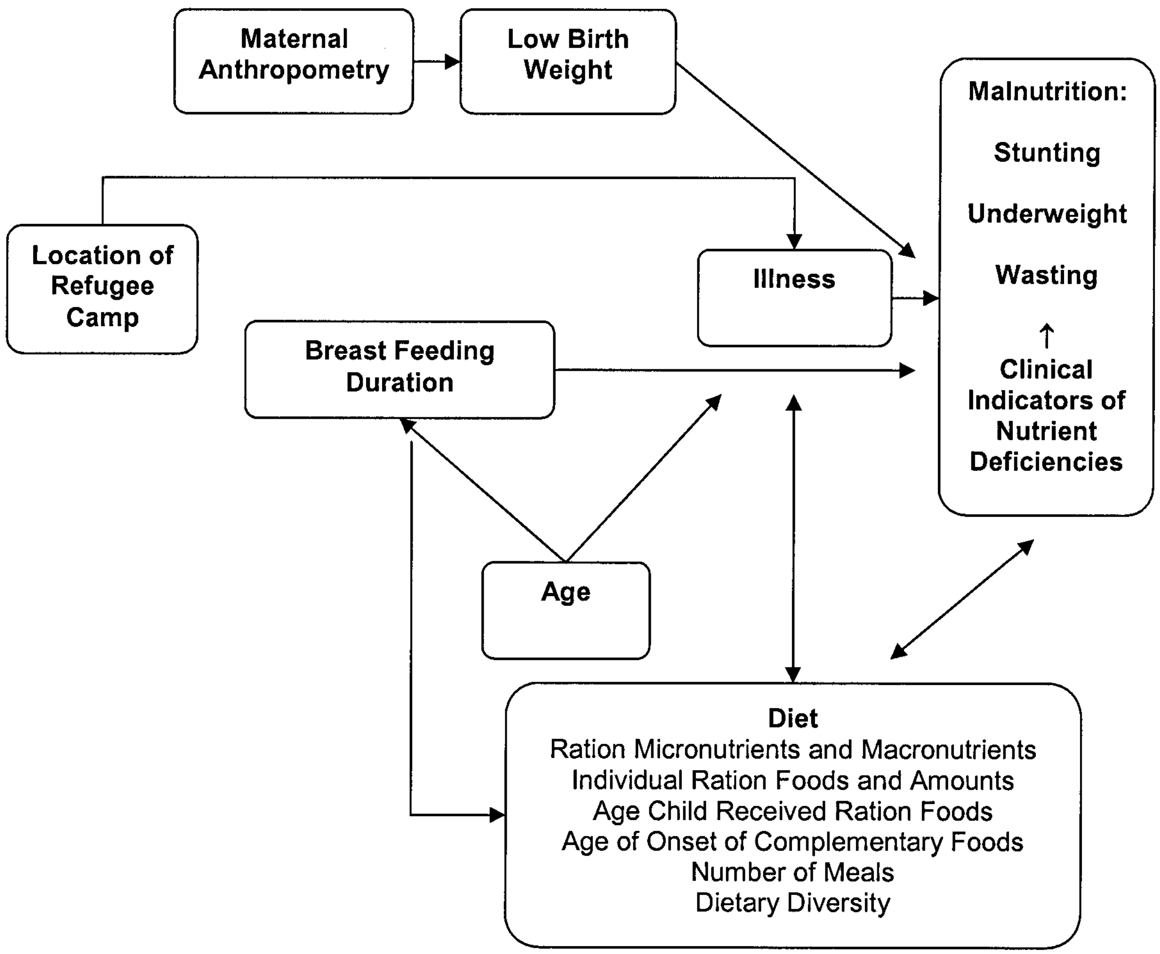


Figure1.3. Operational Framework of Causes of Malnutrition Among Burmese Refugee Camp Under-Five Children in Thailand

CHAPTER 2
MATERIALS AND METHODS

Study Location

Three camps along the Thailand-Burma border were selected for a rapid nutrition survey; Tham Hin (K7), Don Yang (K6) and Umpiem Mai (K4) (Figure 2.1.). The camps were selected by the Burmese Border Consortium because of varying size and ethnicity. These camps had different border restrictions with varied extent of access to foraged, grown and raised foods as well as varying income levels. Thai soldiers guarded all the camps.

Tham Hin was formed in May 1997 and was located in Suan Phung District, Ratchaburi province, approximately ten kilometers from the Burmese border. Don Yang was formed in May 1997 as a replacement site for two former camps and was located in Sangklaburi District, Kanchanaburi province, less than one kilometer from the Burmese border. Umpiem Mai was formed in late 1999 as a relocation site for two former camps that had been frequently attacked by Burmese rebels and was located in Pro Pra District, Tak province, approximately ten kilometers from the Burmese border.

Tham Hin camp included a school, a rice storage area, a fuel store, a hospital and community offices (BBC 2002). This camp was accessible by vehicle year round and because of this rations were sent every month. Due to difficulty accessing outside food sources, each person in this camp alternately received two kilograms of sprouting beans or 250 grams of dried chilies every four months, in addition to the regular rations.

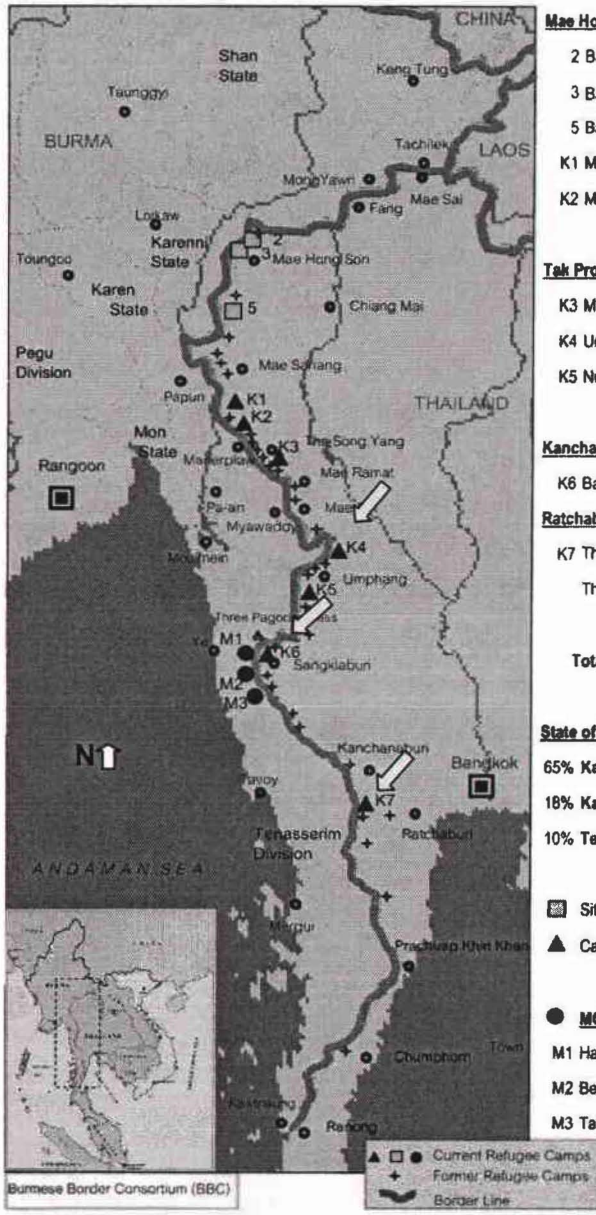
At Tham Hin water was piped in through wells and intermittently available at approximately 15 to 20 liters per person per day. Water was chlorinated and tested for turbidity, fecal coliforms and residual free chlorine by trained camp staff every three months and each house had a latrine (personal correspondence with Menefee A., Nutritionist, BBC 2002-2005 and Moungsookjareoun, A. MPH, BBC 2002-2004).

Don Yang had a school, a camp office, a library, a nursery and a hospital (BBC 2003). The two kilometer road to Don Yang was steep; four-wheel drive vehicles were needed to reach the camp, and supplies had to be delivered by ten-wheel trucks. Food and supplies could not be delivered during the rainy season; they could only be delivered about five months of the year. Rations were stockpiled the month before the rainy season, locked in a warehouse and distributed every month in the camp (BBC 2003). There was a stream running through Don Yang camp, clean water was available without restriction through water pumps and each house had a latrine (personal correspondence with Menefee A., Nutritionist, BBC 2002-2005).

Umpiem Mai was located in the North at an altitude of 1,200 meters where the climate was colder. Umpiem Mai had very tight security resulting from a 1997 attack. The refugees in this camp received extra charcoal throughout the year. There was heavy rain fall at Umpiem Mai making it difficult to walk on some of the hilly terrain. There were several stores and some restaurants in the camp as well as diverse places of worship such as mosques and churches.

At Umpiem Mai water was delivered to water points, which were located less than 100 meters from any household and served 172 people per point at approximately 40-50 liters per person per day. Water was chlorinated and tested for turbidity, fecal coliforms and residual free chlorine by trained camp staff every three months (personal correspondence with Moungsookjareoun, A. MPH, BBC 2002-2005).

Study Population



	Female	Jun-03 Male	Total	+/(-)[2] Dec-02	MOI[3] Jun-03
Mae Hong Son Province					
2 Ban Kwai (Site 1)	8,732	9,482	18,214	1,592	17,088
3 Ban Mai Nai Soi (Site 1)[4]	-	-	-	(921)	-
5 Ban Mae Surin (Site 2)	1,626	1,833	3,459	(62)	3,024
K1 Mae Kong Kha (Site 3)	8,190	8,900	17,090	820	13,847
K2 Mae Ra Ma Luang (Site 4)	5,588	6,218	11,806	831	9,481
Subtotal:	24,136	26,433	50,569	2,260	43,440
Tak Province					
K3 Mae La	22,319	22,762	45,081	3,140	32,476
K4 Umpiem Mai	9,339	9,849	19,188	1,127	15,373
K5 Nu Po	6,153	6,380	12,533	937	8,532
Subtotal:	37,811	38,991	76,802	5,204	56,381
Kanchanaburi Province					
K6 Ban Don Yang	1,861	1,796	3,657	(156)	3,633
Ratchaburi Province					
K7 Tham Hin Main Camp	4,597	4,451	9,048	(112)	8,766
Tham Hin Zone 4	68	81	149	(127)	149
Subtotal:	4,665	4,532	9,197	(239)	8,915
Total for sites in Thailand:	**68,473**	**71,752**	**140,225**	**7,069**	**112,369**

State of Origin of Registered Population

65% Karen   3% **Mon**

18% Karenni   4% **Other** (Kachin, Irrawaddy, Magwe, Mandalay, Pegu, Rakhine, Rangoon, Sagaing, Shan)

10% Tenasserim

▩ Sites 1 & 2: Karenni Refugee Committee (KnRC)

▲ Camps K1-K7: Karen Refugee Committee (KRC)

● **MON - Resettlement Sites**[5]				
M1 Halochanee	2,500	2,375	4,875	619
M2 Bee Ree	1,912	1,773	3,685	-
M3 Tavoy	1,629	1,632	3,261	-
Subtotal Mon sites:	6,041	5,780	11,821	619
Grand total all sites:	**74,514**	**77,532**	**152,046**	**7,888**

Notes: 1. BBC figures include new arrivals, births & deaths since MOI/UNHCR registration
2. Change in BBC population since previous report.
3. MOI registered camp population.
4. Closed May 2003.
5. MRDC June 2003 population.

Figure 2.1. Map of Burmese Refugee Camps on Thailand-Burma Border*. K4, K6 and K7 (indicated by the arrows) are the camps visited for the rapid nutrition survey.
*(BBC 2003)

Study participants included 540 children aged 6 to 59 months and 425 non-pregnant mothers living in one of the three refugee camps (Table 2.1.). The rapid nutrition survey took place from April to June 2002.

Table 2.1. Population Demographics in Three Surveyed Burmese Camps in Thailand, December 2001.

Camp	Number of children surveyed	Number of mothers surveyed	Camp population
Tham Hin	192	157	9,149
Don Yang	154	120	3,907
Umpiem Mai	194	148	16,758
Total	540	425	29,814

Study Approval

The Karen Refugee Committee in Thailand and the University of Hawai'i Institutional Review Board Committee on Human Studies approved this survey. Thailand's Ministry of Interior and the responsible medical agencies granted permission to enter the camps with visas and conduct the survey. Verbal and written consent for the children to participate in the survey was given by each guardian before every interview. For more details on study approval please see Appendix C.

Team Organization

The survey team was lead by an American Public Health Nutritionist/Registered Dietitian working for the Burmese Border Consortium (BBC) in Thailand. The rest of the team comprised a public health worker for the Committee for Coordination of Services to Displaced Persons in Thailand (CCSDPT), a Nutrition/Disaster Management and Humanitarian Assistance University of Hawai'i intern at the BBC (the author) and a driver. The core team at every camp was the dietitian and the intern.

Assistants to the team ranged in number from three in the first camp to approximately 13 in the third camp. All of the assistants were Karen or Burmese refugees who lived in the camps and were trained by the medical agencies responsible for the camp; Médecins Sans Frontières (MSF) at Tham Hin and the American Refugee Committee (ARC) at Don Yang and Umpiem Mai (BBC 2002).

Time Line

Accessibility to the camps and mode of transportation are described in Table 2.2.

Table 2.2. Route to Burmese Border Camps from Bangkok, Thailand

Starting point	Stops	Camp	Mode of transportation	Total time to reach camp
Bangkok	Suang Phueng District Office, Ratchaburi	Tham Hin	car	3.5 hours
Bangkok	Sangklaburi	Don Yang	car	5 hours
Bangkok	Mae Sot	Umpiem Mai	airplane and car	4.5 hours

Sampling

The sample population was randomly selected by households from camp registers. A random number table was used to determine the first household and the interval. In households where there was more than one child aged 6 to 59 months, their names were put in a hat and one was randomly drawn. The formula recommended in the Médecins Sans Frontières (MSF) Nutrition Guidelines was used to determine the sample population size for each camp (Coulombier et al. 1995).

The MSF formula was:

$$n = (t)^2 \times \frac{(p)\,(q)}{(d)^2} \qquad \text{i.e., } (1.96)^2 \times \frac{(.05)(.95)}{(.03)^2} = 203/\text{per camp}$$

N = total population
n = sample selected
t = error risk: 5%
p = expected prevalence: 5%
q = 1-p
d = precision: 3%

If the sample size was significantly greater than one-tenth of the population, such as with Don Yang camp, where there were 601 children, an adjustment in sample size was made according to the "revised n formula" (Coulombier et al. 1995):

$$\frac{n}{1 + (n/N)} \qquad \text{i.e., Don Yang: } \frac{203}{1 + (203/601)} = \frac{203}{1.34} = 151$$

A malnutrition prevalence of 5% was assumed. In order to ensure an adequate sample size, an additional 10% was added to the total sample size at each camp. The total desired sample size for all three camps was 612.

Survey Days

Three survey days were scheduled at each camp. The survey took place in community settings within the camps. On the first day, the random sample of children was selected, households were scheduled for the survey and assistants were trained. On the survey days, children's ages were confirmed and only children aged 6 to 59 months were included in the survey (Table 2.3).

Table 2.3. Station and Action in Rapid Nutrition Survey* of 540 Burmese Refugee Children and 425 Mothers in Thailand

Station	Action
Identification	Each child given identification number
Dietary inquiry	Each child's diet history taken
Clinical assessment	Each child clinically examined
Anthropometry	Each child and their mother's height and weight taken
End	A gift of fortified noodle soup was given to each child

*Adapted from Jelliffe (1966).

Survey

Standardized methods were used for data collection. The questions on the survey forms were read orally and in a consistent manner. If there was any confusion about a question, the dietitian was consulted. Some problems arose during the survey, such as birth date in child's health record indicating an age different from child's stated age. Once this was recognized, surveys were thoroughly checked for mistakes before the children left the survey area.

Agreement to participate in the survey was given first. This was indicated with a check in the "okay to survey" box. The survey forms were two pages and included demographic questions (child's name, zone/section in camp, house number, gender, date of birth), diet questions (age when child first received ration foods, age when child first started eating any type of food, age when child stopped breastfeeding or whether they were still breastfeeding, number of meals child eats per day, most frequently consumed foods, and whether child receives supplementary food) and questions on recent illness (was the child ill within the month before the survey, if yes, was the illness severe, i.e., acute diarrhea, pneumonia, etc.). Heights and weights were also taken and a clinical examination was performed (heights, weights and clinical exam described below). See a copy of the Rapid Nutrition Survey in Appendix D.

Clinical Examination

The clinical examinations lasted approximately five minutes. The dietitian trained the author and one assistant at Tham Hin camp on how to administer the clinical exam. Children remained clothed during the examination. The clinical examination started with an overall evaluation of size; children were visually appraised to be normal weight, overweight or underweight. The hair was examined for color and strength. A red tinge or weak, pluckable hair was indicative of protein-energy malnutrition (Jelliffe 1966). The eyes were examined for a triangular white and foamy "Bitot spot" on the cornea, indicative of vitamin A deficiency (Jelliffe 1966). The eyelids and the fingernails were examined for pallor; a pale color in both could indicate iron-deficiency. The sides of the mouth were examined for fresh or scarred wounds indicative of riboflavin deficiency (Rucker et al. 2001). The skin of the children's stomach, back, arms and legs was viewed and felt for signs of infection or rashes. Edema, indicative of protein-energy malnutrition, was assessed by indenting a thumbprint into the child's leg.

Height

Children's heights were taken with a Microtoise measuring tape (UNICEF No. 0114400), which was attached to a wall and brought down to the children's heads to measure height. Children who were at least two years of age or 85 centimeters tall, stood without shoes for the Microtoise measurement. The heights of the available, non-pregnant mothers were also taken using the Microtoise measuring tape to correlate their Basal Metabolic Index (kg/m^2) with children's anthropometric indices.

Recumbent lengths of children younger than two years or less than 85 centimeters were taken on a measuring board. Their head and heels touched the two ends of the board with their back and legs flat against the board. Height was measured three times and an average of all three was recorded. Two people were needed at this station, one to read the height and the other to confirm and record the measurements.

Weight

Children were weighed using a hanging Salter scale or on a standing digital scale. A hanging scale was used for a child who weighed up to 25 kilograms. When a hanging scale was not available and the children could not stand up on their own, the children were weighed with their parent on a digital scale. The parent was then reweighed and their weight subtracted. The weights of the mothers who were not pregnant were also taken using the digital scales.

Camry EB6171 scales that were made in Thailand were used. Scales were prone to error drift and were calibrated every two hours. Two people read and recorded weight and two people calibrated the scales with iron weights and recorded error drift (of up to two kilograms). Subjects' weights were adjusted if error drift was over .2 kilograms.

Data Analysis

Data were input into EPINUT, Epi Info 2000 (CDC, Atlanta, GA). The Z-score was determined by Epi Info. Data were imported from Epi Info to SPSS version 10.0.1 and from Excel to the SAS Systems 8e. Outliers were identified and cleaned in Microsoft Excel and SPSS. Statistical analysis was performed on SPSS and SAS. Variables included anthropometry, demographics, clinical examination for nutrient deficiencies, health history, maternal anthropometry and diet information.

Demographic information was entered as gender ("0"= male, "1"= female) and camp location ("0"=not living in camp, and "1"=living in camp) and age in months. Age was also categorized into five different age groups, 6 to 11.9, 12 to 23.9, 24 to 35.9, 36 to 47.9 and 48 to 59.9. Children's identification number, weight and height, and maternal weight, height and BMI were entered as continuous variables. BMI was evaluated as "1"=underweight, "2"=normal and "3"=overweight, based on the Centers for Disease Control and Prevention (CDC) BMI calculator (CDC 2004). Z-scores were entered as continuous variables. To compare risk of low birth weight, malnutrition was entered as "0"= greater than –2 Z-scores and "1" = less than –2 Z-scores. Children were considered born in camp if their birth weights were known.

Diet information was entered as "0"=no and "1"=yes for the questions on food frequency (i.e., "does the child usually eat rice, does the child usually eat eggs", etc.), as well as supplemental feeding. Duration of breastfeeding was entered in months as a continuous variable ("99"=still breastfeeding) and categorized as 0 to 5.9 months, 6 to 11.9 months, 12 to 23.9 months, and 24 months or longer. Illness variables were entered as "0"=no and "1"=yes.

In the clinical examination, general appearance was evaluated as "1"=overweight, "2"=thin. Iron deficiency was described as having pale bottom eyelids ("1"=pale), pale nailbeds ("1"=pale) or both pale eyelids and pale nail beds ("0"=not selected, "1"= selected). Signs suggestive of protein-energy malnutrition (PEM) were entered as three different variables for skin ("1"=dry rough, "2"=dry flaky, "3"=infection), two different variables for hair ("1"=red tinge, dry, "2"=thin, falls out easily), and as visible signs of edema ("0"=no, "1"=yes. If yes, refer to clinic). Riboflavin deficiency was described as current "1"=fresh wounds on both sides of mouth, or past "2"=scars on both sides of mouth. Eyes were described as "1"=Bitot spots on the cornea of the children's eyes, indicative of vitamin A deficiency, or "2"=other.

Descriptive statistics were used to describe the prevalence of children's malnutrition. Descriptive statistics were also used for clinical indicators, population demographics, maternal and child characteristics and behavioral feeding practices.

Analysis of variance (ANOVA), chi-square, correlation and regression analysis were used to answer the research question, "What are the contributing factors to the nutritional status of the 6 to 59 month old Burmese refugee children in Thailand?" Non-parametric data analysis (chi-square) was used to analyze the association of the children's nutritional status with clinical indicators, demographic variables, maternal and child characteristics, behavioral feeding practices and foods in rations. General loglinear analysis (odds ratio) was used to analyze the risk of malnutrition with presence of clinical indicators, demographic variables, and illness. ANOVA and student t-test were used to analyze malnutrition by comparing means of the three camps, demographic variables, maternal and child characteristics, behavioral feeding practices and foods in the ration diet.

Bivariate correlations were used to correlate malnutrition with maternal and child characteristics, behavioral feeding practices and foods in the ration diet. Multiple linear regression analysis was used to adjust for age, gender and location, analyze maternal and child characteristics, behavioral feeding practices and foods in the ration diet. Adjusted linear regression models included age in months, gender and camp location (living Tham Hin and Umpiem Mai camps; Don Yang was the reference camp).

Survival analysis was used to determine the risk of stopping to breastfeed on nutritional status. The ration diet was analyzed with Thai and ASEAN Food Composition Tables and Genesis 4.62 (Salem, OR). The final models of all significant variables were analyzed with stepwise multiple regression. Significance was measured at 95% ($p<.05$) minimum.

CHAPTER 3
RESULTS

Sample Population

Three of the ten Burmese camp sites in Thailand were surveyed from April to June 2002. The other seven camps were not surveyed owing to logistical constraints. The three camps combined represent 23.8% (29,814/125,118) of the total Burmese refugee population at that time (Table 3.1.).

Table 3.1. Sample Characteristics of Three Refugee Camps Surveyed on Thai-Burmese Border, April-June 2002

Camp	**Primary ethnic groups**	**Camp population**	**Total children 6 to 59 months**	**Total children surveyed (percent)**	**Mean age in months ±SD**	**Age range in months**
Tham Hin	Karen	9,149	1,382	192 (13.9)	29.2±14.6	6.5 to 59.7
Don Yang	Karen, Shan	3,907	601	154 (25.6)	31.3±14.6	6.6 to 59.5
Umpiem Mai	Karen, Burmese	16,758	2,251	194 (8.6)	31±13.9	6.7 to 59.8
Total	Karen, Shan, Burmese	29,814	4,234	540 (12.7)	30.4±14.4	6.5 to 59.8

On the survey days there was almost 100% attendance. After data were cleaned for outliers, a total of 540 children remained in the final data analysis, comprising 12.7% of children in the three Burmese camps. Children were categorized into five different age groups; 276 (51.5%) males and 264 (48.9%) females were surveyed (Table 3.2.).

Table 3.2. Age Group, Sample Size, and Gender Distribution of 540 Children in Tham Him, Don Yang and Umpiem Mai Refugee Camps on the Thailand-Burma Border

Age group (months)	**Sample size (n)**	**Percent of sample**	**Females (n)**	**Percent females in age group**
6 to 11.9	59	10.9	31	52.5
12 to 23.9	137	25.4	62	45.3
24 to 35.9	151	28	84	55.6
36 to 47.9	120	22.2	59	49.2
48 to 59.9	73	13.5	28	38.4
Total	540	100	264	48.9

Summary of Three Surveyed Burmese Refugee Camps in Thailand Based on Data Collected from April to June 2002

Prevalence of indicators of iron deficiency anemia was significantly less in Tham Hin camp than the other two camps. The number of children who were ill was significantly lower in Don Yang camp than the other two camps and the number of children who were severely ill was significantly higher in Umpiem Mai camp. Mean maternal Body Mass Index was significantly lower in Don Yang camp. Months breastfed and number of children still breastfeeding were both significantly lower in Umpiem Mai camp (Table 3.3.). The data from Table 3.3. will be discussed in more detail in subsequent sections.

Table 3.3. Summary of Three Surveyed Burmese Refugee Camps in Thailand Based on Data Collected from April to June 2002

	Tham Hin	Don Yang	Umpiem Mai	ANOVA
Background				
Camp population (N)	9,149	3,907	16,748	
Children surveyed (n)	192	154	194	
Year camp formed	1997	1997	1999	
Climate	Tropical	Tropical	Cold, rainy, 1200m	
Rations	Monthly	5 month/year	Monthly	
Extra rations	Beans/chilies	Chilies	Charcoal	
Extra perinatal Calories	300	850	850	
Medical agency	MSF[#]	ARC[#]	ARC	
Latrines	Private	Private	Shared	
Available water (liters)	15-20	Unlimited	40-50	
Clinical				
Pale eyelids (n)	0 [a]*	32 [b]	53 [b]	p<.001
Pale nails (n)	0 [a]	28 [b]	35 [b]	p<.001
Pale eyelids & nails (n)	0 [a]	12 [b]	15 [b]	p<.001
Thin: overweight (n)	1:0 [a]	19:3 [b]	28:7 [b]	p<.001
Skin: dry: infection(n)	9:10	1:15	2:21	Not significant
Hair: red: thin (n)	2:1	1:1	0	Not significant
Edema (n)	0	0	0	Not significant
Mouth: wound: scar (n)	3:4	4:3	6:4	Not significant
Eyes: Bitot spots (n)	0	0	0	Not significant
Demographics				
Age** (mean in months)	30.4 ± 14.4	31.3 ± 14.5	31.0 ± 13.9	Not significant
Gender** (male: female)	102:90	80:74	94:100	Not significant
Kilometers to Burma	10	0	10	
Zones*** with over 50% stunting/Zones surveyed	0/3	5/8	1/2	
Foods				
Rice (n; ate at least four times per week)	174 [ab]	133 [a]	186 [b]	p<.01
Rice soup (n; ate at least four times per week)	42 [a]	72 [b]	39 [a]	p<.001
Bean (n; ate at least four times per week)	143 [a]	139 [b]	169 [b]	p<.001
Fruit (n; ate at least four times per week)	33 [a]	126 [b]	127 [c]	p<.001
Vegetable (n; ate at least four times per week)	130	87	128	Not significant
Egg (n; ate at least four times per week)	161 [a]	113 [b]	165 [a]	p<.01
Meat (n; ate at least four times per week)	157 [a]	101 [b]	119 [b]	p<.001
Oil (n; ate at least four times per week)	136 [a]	133 [b]	127 [a]	p<.001
Other (n; ate at least four times per week)	12 [a]	63 [b]	67 [b]	p<.001
Dietary Diversity Score°	5.7 [a]	7.0 [b]	6.2 [c]	p<.001
Supplemental feeding (n)	15	14	14	Not significant

Table 3.3 Summary of Three Surveyed Burmese Refugee Camp…Continued

	Tham Hin	Don Yang	Umpiem Mai	ANOVA
Maternal and Child				
Birth weight (kilograms)	2.94 ± .6	2.96 ± .5	2.89 ± .6	Not significant
Born in camp (n)	184 [a]	99 [b]	167 [c]	p<.001
Maternal height (centimeters)	149.4 ± .05 [ab]	148.9 ± .05 [a]	150.5 ± .05 [b]	p=.045
Maternal BMI[1] (mean)	22.7 ± 3.2 [a]	21 ± 2.2 [b]	22.5 ± 3.4 [a]	p<.001
Children ill (n)	63 [a]	26 [b]	74 [a]	p<.001
Children severely ill (n)	15 [a]	17 [a]	50 [b]	p=.001
Malaria rates** 2001	Lowest rates			
Beriberi rates** 2001	Lowest rates	Highest rates		
LRTI[2] rates** 2001		Highest rates	Lowest rates	
Diarrhea rates** 2001		Lowest rates		
Feeding Practice				
Months breastfed	21.0 ± 12.0 [a]	19.7 ± 10.7 [a]	18.6 ± 7.8 [b]	p=.001
Still breastfeeding (n)	91 [a]	71 [a]	62 [b]	p=.002
Number of meals eaten per day	2 ± .47 [a]	2.8 ± .69 [b]	2.2 ± .64 [c]	p<.001
Age received rations (months)	2.4 ± 1.0 [a]	6.4 ± 1.9 [b]	3.3 ± 4.2 [c]	p=.001
Age started adult food (months)	4.4 ± 3.8	4.5 ± 2.8	4.9 ± 3.7	Not significant

MSF= Médecins Sans Frontières, ARC=American Refugee Committee
*Values with different superscript have significantly different values
** For children under-five years old, ***Camps are divided into zones or sections, °Dietary Diversity Score out of 9, [1]BMI=Body Mass Index (kg/m²), [2] LRTI= Lower respiratory tract infection

What is the Prevalence of Malnutrition in the 6 to 59 Month Old Burmese Refugee Children in Thailand?

Anthropometric Indicators of Malnutrition

Children who were less than or equal to –2 Z-scores height for age (HAZ) or weight for height (WHZ) were considered stunted or wasted, respectively. Table 3.4. shows the prevalence of malnutrition in the three Burmese refugee camps combined on the Thailand-Burma border.

Table 3.4. Total Prevalence of HAZ and WHZ* in 540 Children in Tham Him, Don Yang and Umpiem Mai Refugee Camps on the Thailand-Burma Border

Z-score	Percent Children ≤ 2 Z-scores	Mean	SD	Minimum to Maximum
Height for Age	46.5%	–1.85	1.18	– 4.84 to 3.43
Weight for Height	4.5%	–0.59	0.87	– 3.75 to 3.57

*HAZ=Height for age Z-score, WHZ=Weight for height Z-score

Clinical Indicators of Malnutrition

A clinical examination was done on every child during the survey. The most common clinical signs found in the Burmese children were indicative of iron-deficiency; pale eyelids (85 children), pale nail beds (64 children), and both pale eyelids and pale nail beds (27 children) (Table 3.5.).

Twelve children presented with dry, rough skin and 48 children had skin infections. Three children presented with a red tinge to their hair and two with thin hair that easily fell out for a total of five children (1%). These are signs suggestive of protein-energy malnutrition (PEM), although no children had edema (Table 3.5.).

Thirteen children had fresh wounds on both sides of their mouth and 11 children had scars on both sides of their mouth, indicative of riboflavin (vitamin B2) deficiency. No child had Bitot spots on their cornea, indicative of vitamin A deficiency. However, five children had benign black spots in their eyes and one other child had a "Pre-Bitot spot". Ten children gave the appearance of being overweight (2%) and 48 children (9%) appeared thin (Table 3.5.).

Table 3.5. Clinical Examination Results of 540 Burmese Children in Tham Hin, Don Yang and Umpiem Mai Refugee Camps on Thailand-Burma Border

Clinical examination	**Result**
Eyelids	85 pale (16%)
Nails	64 pale (12%)
Both eyelids & nails	27 pale (5%)
Skin	12 dry (2%), 0 flaky, 46 infected (9%)
Hair	3 red (.6%), 2 thin (.3%)
Edema	0
Mouth	13 wound (2%), 11 scar (2%)
Eyes	0 Bitot, 5 other (1%)
General appearance	10 overweight (2%), 48 thin (9%)

Nutrient deficiency diseases not included in the clinical survey were beriberi, goiter, pellagra, scurvy, rickets and megaloblastic anemia. The camps monitor beriberi morbidity rates (CCSDPT 2001). Radiographic examinations would have been necessary to identify rickets, and blood samples needed to differentiate megaloblastic anemia from iron deficiency anemia. Mouths were not examined for bleeding gums, indicative of scurvy, because the children were frightened of this invasive examination. Glands were not examined for signs of goiter because the children received iodized salt to prevent iodine deficiency diseases.

Association of Clinical Indicators with Anthropometry

Presence of eyelid pallor was positively associated with significant differences in prevalence of low HAZ (X^2=4.04, p=.05), severe illness (X^2=4.40, p=.04) and of not being born in camp [X^2=4.70, p=.03, Odds ratio (OR) = .51, confidence interval (CI) = .284 to .918, the odds of having pale eyelids was about half if the child was not born in camp and 95% of the time the mean difference fell within .284 to .918]. Presence of nail pallor was positively associated with prevalence of stunting (HAZ X^2=10.81, p=.001) and severe illness (X^2=4.31, p=.04, OR= 2.045, CI = 1.07 to 3.908).

Neither pale eyelids nor pale fingernail beds were significant predictors of malnutrition when adjusted for age, gender and camp location. However, presence of both pale eyelids and pale nailbeds remained a significant predictor of low HAZ (Table 3.6.). None of these variables were significant predictors of WHZ when adjusted for age, gender and camp location (F= 1.76, Adjusted R^2= .009, p=1.06).

Frequency of appearing thin was associated with significant differences in rates of WHZ (X^2=24.97, p<.001). Significantly higher prevalence of low WHZ was found in children who had at least three clinical signs of nutrient deficiencies compared with children free of clinical signs of nutrient deficiencies (X^2 = 13.42, p=.04). In Tham Hin (N=74, 38%) and Umpiem Mai camps (N=72, 37%), more children had one or more clinical indicators of a nutrient deficiency, compared to Don Yang (N=45, 29%).

Table 3.6. Linear Regression (Enter Procedure) of Clinical Indicators of Malnutrition to Height for Age Z-score in Tham Hin, Don Yang and Umpiem Mai Camps in Thailand

	B	SE	T-value	P-value	Adjusted R^2
Height for Age Z-score					.109
Age in months	–.02	.003	–6.90	<.001	
Female gender	.154	.097	1.59	.112	
Tham Hin	.251	.123	2.04	.042	
Umpiem Mai	–.07	.121	–.59	.555	
Pale eyelids and nails	–.461	.224	–2.06	.04	

Don Yang was the reference camp
Height for age Z-score F-test: 14.01 (p<.001)

Research Question: What are the Contributing Factors to the Nutritional Status of the 6 to 59 Month Old Burmese Refugee Children in Thailand?

What is the Contribution of the Ration Foods to the Nutritional Status of the Burmese Refugee Children in Thailand?

Foods in Rations

Refugee rations were provided by the Burmese Border Consortium (BBC). Food quality was monitored by an independent Thai agency. The BBC has been providing rice, fermented prawn or fish paste, and iodized salt to the refugees for twenty years, adding mung beans and oil to the rations in the mid-1990s.

The daily ration consisted of 533 grams of polished (refined) broken white rice, 33 grams of soybean oil, 33-50 grams of mung or yellow beans, 11 grams of iodized salt, and 33 grams of fermented fish paste. Children less than five years old received a half ration of rice, beans, and oil.

In Tham Hin camp, two kilograms of sprouting beans or 250 grams of dried chilies were alternately given to every person, every four months. In Don Yang camp, 250 grams of dried chilies were given every two months (BBC 2002). Two hundred and fifty grams of dried chilies add 60 µg RE of vitamin A per day to the ration analysis, based on Thai and ASEAN Food Composition Tables (BBC 2001). This is equivalent to 1% of total kilocalories, 6% of total fat and 39% of total vitamin A intake of the refugee rations (Banjong et al. 2003). Umpiem Mai camp did not receive chilies; therefore chilies were omitted from the nutrient analysis. Nutrient content of the ration diet was analyzed with data from Thai and ASEAN Food Composition Tables, and the Genesis Food Program 4.62 (Table 3.7.).

Table 3.7. Analysis of 2002 Ration Foods of the Burmese Refugee Camps in Thailand for Under-Five Year Old Children

	Broken white rice 266.5 g	**Mung bean 25 g**	**Soybean oil 16.5 g**	**Iodized salt 11 g**	**Fish paste 33 g**	**Total**
Kilocalories	955	87	136	0	32	**1210**
Protein (g)	17	6	0	0	2	**25**
Fat (g)	1	0	15	0	1	**17**
Carbohydrate (g)	211	16	0	0	10	**227**
Iron (mg)	2.1	1.7	0	0	1.5	**5.3**
Calcium (mg)	8	33	0	3	228	**272**
Zinc (mg)	3	0.7	0	0	0	**3.7**
Thiamin (mg)	.19	.16	0	0	0	**.35**
Riboflavin (mg)	.13	.06	0	0	.04	**.23**
Niacin (mg)	4.3	.6	0	0	.3	**5.2**
Vitamin A (µg RE)	0	3	0	0	0	**3**
Vitamin C (mg)	0	1	0	0	0	**1**

Nutrient content of the ration diet was compared with the Institute of Medicine, Food and Nutrition Board Dietary Reference Intakes (DRIs) for seven to 12 month old infants, one to three year, and four year old children (Table 3.8.). Energy and protein requirements were calculated using the 1989 Recommended Dietary Allowances as well as the United Nations High Commissioner on Refugees/World Food Program (UNHCR/WFP) Demographic Breakdown and Energy Requirements for developing countries (RDA 1989, UNHCR/WFP 2004).

The rations provided a mean of 1,200 kilocalories for 6 to 59 month old children. Though the rations were adequate for most nutrients except fat, iron, riboflavin, vitamin A and vitamin C for children less than one year of age, they did not meet the Dietary Reference Intakes for one to four year old children for any nutrient except zinc, protein and carbohydrates (Table 3.8.). Children received approximately 30% to 55% of the DRIs for vitamin A in the form of a supplement (Table 3.9.).

Table 3.8. Nutrient Analysis of Burmese Refugee Camp Ration Foods in Thailand Compared to American Dietary Reference Intakes for 7 to12 Month, 1 to 3 Year and 4 Year Old Children

Nutrient	Total child ration	DRI 7-12 mo	Percent DRI 7-12 mo	DRI 1-3 yr	Percent DRI 1-3 yr	DRI 4 yr	Percent DRI 4 yr
Kilocalories	1,210	820[a]	148%	1,220-1,500[a]	81%-101%	1,620[a]	75%
Protein (g)	25	13.5°	185%	13°	192%	19°	132%
Fat (g)	17	30*	57%	30-40**	43-57%	25-35**	49-68%
Carbohydrate (g)	227	95 g*	239%	130 g°	175%	130 g°	175%
Iron (mg)	5.3	11°	48%	7°	76%	10°	53%
Calcium (mg)	272	270	100%	500	54%	800	34%
Zinc (mg	3.7	3	123%	3	123%	5	74%
Thiamin (mg)	.35	0.3	117%	0.5	70%	0.6	58%
Riboflavin (mg)	.23	0.4	58%	0.5	46%	0.6	38%
Niacin (mg)	5.2	4	130%	6	87%	8	65%
Vit A (µg RE)	3	500*	1%	300*	1%	400*	1%
Vit C (mg)	1	50	0%	15	1%	25	0%

[a] UNHCR/WFP Demographic Breakdown and Energy Requirements (for a typical developing country population) (UNHCR/WFP 2004)
°RDA= Recommended Dietary Allowance (DRI 2002), *AI= Adequate intake (DRI 2002)
**Acceptable Macronutrient Distribution Range (DRI 2002)

Table 3.9. Analysis of Burma-Thailand Refugee Camp Vitamin A Supplementation Compared to American Dietary Reference Intakes for 7 to12 Months, 1 to 3 Year and 4 Year Old Children

Vitamin A	Daily DRI IU* (µg)	Yearly DRI IU	Supplementation	Percent DRI
7 to 12 months	1665 (500*)	303,865/ 6 months	100,000/ 6 months	33%
1 to 3 year	999 (300)	364,635	200,000	55%
4 year	1332 (400)	486,180	200,000	41%

* Based on AI x 3.33 IU/µg, AI= Adequate intake (DRI 2002)

The dietary reference intake for linoleic acid (omega 6 polyunsaturated essential fatty acid) ranges from 4.4 grams/day for seven month old infants to ten grams/day for four year olds (DRI 2002). The rations provided the under-five children with an average of eight grams of linoleic acid. Rough and scaly skin, an early characteristic sign of omega 6 fatty acid deficiency, was visible in six of the 73 four year old children in the clinical examination.

The dietary reference intake for linolenic acid (omega 3 polyunsaturated essential fatty acid) ranges from 0.5 grams/day for six month old infants to 0.9 grams/day for four year olds (DRI 2002). The rations provided the under-five year old children with adequate omega 3 fatty acids at an average of one gram/day.

Amino acid intakes were evaluated based on a protein digestibility corrected amino acid scoring pattern (PDCAA) in milligrams amino acid/gram protein (DRI 2002) and by the suggested amino acid requirement pattern of FAO/WHO/UNU (RDA 1989). Lysine was found to be the limiting amino acid in the protein from the rations (40 mg/g protein vs. 51 mg/g protein required, or a 71% score) (Table 3.10.).

Lysine requirements vary by age group from 107 mg/kg/day for six month old infants, to 46 mg/kg/day for children 48 to 59 months old (DRI 2002). Requirements from 630 mg to 780 mg lysine per day were calculated based on average weight for a child's age group. Thus, children appeared to be meeting their lysine requirement, as camp rations provided 1,000 mg of lysine per day (Table 3.10.).

Table 3.10. Essential Amino Acid (AA) Analysis of Burmese Refugee Camp Ration Protein Under-Five Year Old Children in Thailand

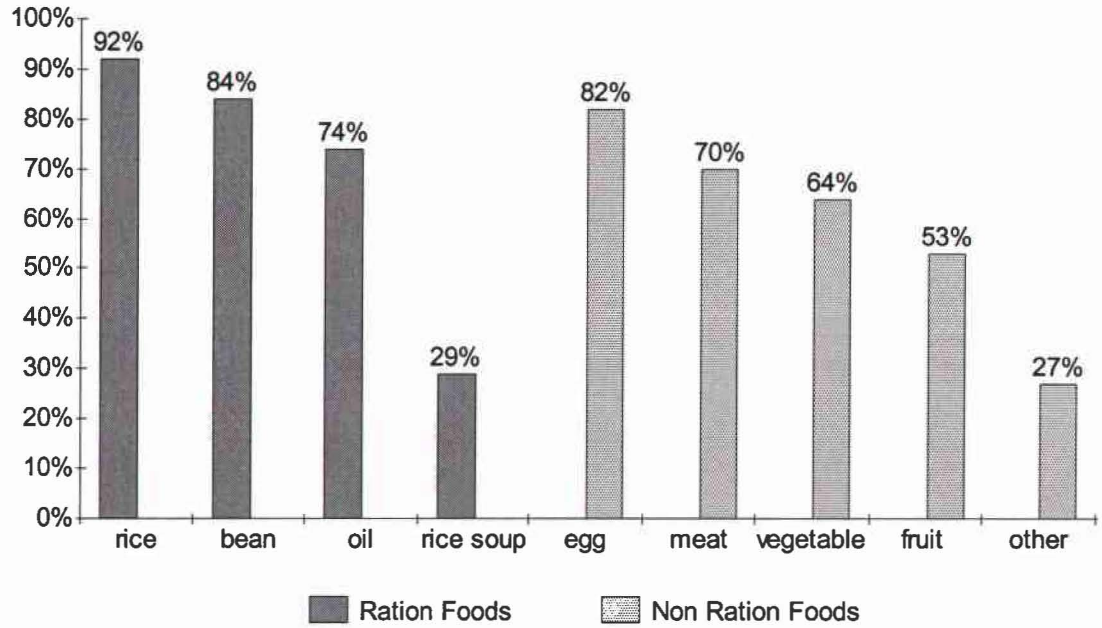
Amino acids mg	**Ration AA provision**	**PDCAA* requirement for 1 to 5 year olds mg/g protein**	**Total amino acid intake from rations mg/g**	**Ration AA score**
Histidine	500	18	20	121%
Isoleucine	1000	25	40	141%
Leucine	1900	55	76	113%
Lysine	1000	51	40	71%
Methionine	500	+ cysteine= 25	+ 400mg cystine=36	140%
Phenylalanine	1300	+ tyrosine= 47	+ 800mg tyrosine=84	128%
Threonine	800	27	32	95%
Tryptophan	300	7	12	95%
Valine	1400	32	56	154%

*PDCAA= protein digestibility corrected amino acid scoring pattern (DRI 2002)

On the orally administered food frequency questionnaire, "Frequently eaten" meant eaten at least four times per week. Ninety-two percent of children were reported to frequently eat rice, 84% to frequently eat beans and 74% to frequently eat oil. All of the children not eating rice were being breastfed and eating complementary foods, except one 17 month old child who was breastfed until 13 months and ate "other" foods. Milk and snack foods, such as crackers, cookies, candies, cakes and fried mung bean snacks were counted in the "other" food column.

Rice, rice soup (rice with water), beans and oil were supplied by the rations and are in dark bars on Graph 3.1. Rations were supplemented with meat, eggs, fruits, vegetables and snack foods by the refugees and are in light bars on Graph 3.1.

Graph 3.1. Percentage of Children Aged 6 to 59 Months Consuming Select Foods at Least Four Times a Week in Refugee Camps on Thailand-Burma Border



Dietary Diversity Score

Dietary diversity is defined as the number of foods (either individual foods or food groups) eaten over a measure of time (Ruel 2003). A dietary diversity score (DDS) was developed to evaluate the variety of food that the Burmese refugee children eat. Each individual food was given a score of one, with a maximum DDS of nine. The foods in the DDS were eggs, beans, oil, vegetables, fruits, rice (rice and/or rice soup), meat (fish, poultry, beef and pork), other food (milk, crackers, cookies, noodle snacks, etc.) and breastfeeding. Mean of the dietary diversity score was 5.9 ± 1.6 SD. The range was one to nine different foods a week. The DDS was not associated with frequency of low values for chi-square on HAZ or WHZ ($p>.05$), nor was it a predictor of HAZ or WHZ ($p>.05$).

Supplementary Feeding

Moderately malnourished children were given take-home supplementary feedings: additional dry rations of rice and beans, as well as peanuts, dry fish, eggs, sardines, fruits and vegetables. Severely malnourished children received the same supplementary feeding plus a ration of sugar and full cream milk powder. Supplementary feeding was not a significant contributor to frequency of low Z-score or to mean values for any anthropometric indicators (X^2, t-test, linear regression; p>.05).

Children who were less than or equal to 80 percent of the median weight for height were supposed to receive supplementary feeding. Forty-three children (8%) received camp-provided supplementary feeding at the time of the survey. However nine children out of ten identified as less than or equal to 80 percent of the median weight for height were not receiving the supplementary feeding at the time of the survey.

Consumption of Rations and Growth Indices

ANOVA testing between the three camps showed that rice, rice soup, bean, fruit, egg, meat and oil were all significantly different (Table 3.3.). However, only the consumption of rice remained a positive predictor of HAZ when adjusted for age, gender and camp location (Table 3.11.).

Table 3.11. Multiple Regression (Enter Procedure) of Rice Consumption to HAZ* in Tham Hin, Don Yang and Umpiem Mai Refugee Camps in Thailand

	B	SE	T-value	P-value	Adjusted R^2
Height for Age Z-score					.11
Age in months	–.027	.004	–7.48	<.001	
Female gender	.145	.097	1.49	.14	
Tham Hin	.269	.123	2.19	.03	
Umpiem Mai	–.009	.123	–.76	.45	
Rice consumption	.5	.198	2.52	.012	

Don Yang was the reference camp
*HAZ=Height for age Z-score, HAZ F-test: 14.67 (<.001)

What is the Contribution of the Demographic Variables to the Nutritional Status of the Burmese Refugee Children in Thailand?

Age

The 6 to 11.9 month old infants had significantly higher mean values for HAZ (F= 14.06, p<.001) and WHZ (F= 3.99, p=.003) than the four other age groups. The one year olds had significantly greater frequency of low WHZ (X^2=14.25, p<.01) and the four year olds had significantly greater frequency of low HAZ (X^2=33.10, p<.001) than the four other age groups. The children in the 12 to 23.9 month age group had a substantial increase in stunting and wasting compared to the 6 to 11.9 months old infants (Table 3.12.).

Table 3.12. Age Distribution of HAZ and WHZ* of 540 Children in Tham Him, Don Yang and Umpiem Mai Refugee Camps on Thailand-Burma Border

Z-score	Age group (months)	N	Mean	SD
Height for Age	6 to 11.9	56	**–.995****	1.4
	12 to 23.9	134	–1.722	1.2
	24 to 35.9	152	–1.790	1.0
	36 to 47.9	120	–2.203	.9
	48 to 59.9	73	**–2.273°**	1.2
Weight for Height	6 to 11.9	56	**–.289****	1.2
	12 to 23.9	133	**–.769[a]**	.9
	24 to 35.9	152	–.657	.8
	36 to 47.9	120	–.487	.7
	48 to 59.9	73	–.503	.7

*HAZ=Height for age Z-score, WHZ=Weight for height Z-score
**Significant for highest mean values at the .01 level, ° Significant for greatest frequency of low HAZ at the .01 level, [a]Significant for greatest frequency of low WHZ at the .01 level

Gender

Mean HAZ was higher in females (–1.75 HAZ) than males (–1.95 HAZ). Mean WHZ was also higher in females (–.56 WHZ) than males (–.61 WHZ). However, gender was not associated with significant differences either in mean or frequency of abnormal values for HAZ or WHZ by chi-square or t-test.

Camp Location

The camps were divided into zones or sections. Children in Tham Hin camp had a significantly higher mean value for HAZ (F=6.204, p=.002), and less frequency of low HAZ (X^2=16.5, p<.001) than the other two camps. Children in Umpiem Mai camp had a significantly higher mean value for WHZ (F=3.392, p=.03) although the indicators only varied by 3% (Table 3.13.).

In zone 2e in Don Yang camp, 67% of children were male and 75% (27/36) were stunted. Of these stunted children, 70% (19/27) were not born in camp. The average HAZ of the children in zone 2e was –2.52 ± .78 SD. Their average age was 33.3 ± 13.8 months and over 50% (18/34) of children were still being breastfed. The average height of their mothers was 146.49 ± .03 centimeters.

Table 3.13. Prevalence of HAZ and WHZ* in 540 Children in Tham Him, Don Yang and Umpiem Mai Refugee Camps on the Thailand-Burma Border

	Percent Children ≤ 2 Z-scores	Mean	SD
Height for Age			
Tham Hin	34.7%	–1.61[a]	1.19
Don Yang	53.0%	–1.96	1.02
Umpiem Mai	53.1%	–2.00	1.25
Weight for Height			
Tham Hin	3.7%	–0.68[a]	0.81
Don Yang	2.6%	–0.64	0.87
Umpiem Mai	6.7%	–0.46	0.91

*HAZ=Height for age Z-score, WHZ=Weight for height Z-score,
[a] Significantly different from Umpiem Mai camp

Association of Demographic Variables with Malnutrition

Linear regression models that included age, gender and camp location were conducted for each anthropometric indicator. These models were predictors of HAZ (F=16.54, p<.001), but not WHZ (F=2.02, p=.09). In these age-adjusted models for HAZ, residence in Tham Hin was a significant positive predictor (Table 3.14.).

Table 3.14. Multiple Regression (Enter Procedure) of Demographics to HAZ and WHZ* in Tham Hin, Don Yang and Umpiem Mai Refugee Camps in Thailand

	B	SE	T-value	P-value	Adjusted R^2
Height for Age Z-score					.104
Age in months	–.02	.003	–7.05	<.001	
Female gender	.156	.097	1.6	.11	
Tham Hin	.287	.122	2.35	.02	
Umpiem Mai	–.07	.122	–.54	.59	
Weight for Height Z-score					.008
Age in months	.002	.003	1.013	.31	
Female gender	.044	.075	.589	.56	
Tham Hin	–.03	.095	–.349	.73	
Umpiem Mai	.178	.094	1.893	.06	

*HAZ=Height for age Z-score, WHZ=Weight for height Z-score,
Height for age Z-score F-test: 16.54 ($p<.001$), Weight for height Z-score F-test: 2.02 ($p=.09$)
Don Yang was the reference camp

What is the Contribution of Maternal and Child Characteristics to the Nutritional Status of the Burmese Refugee Children in Thailand?

Birth Weights of Children

Birth weights of 450 out of 540 total children were available; children born outside the camps were likely to have unrecorded birth weights. Children's weight at birth ranged from 1.1 to 5.0 kg. A low birth weight (< 2.5 kg) was found in 17% (N=77/450) of the babies born in camp. Tham Hin and Umpiem Mai had a higher prevalence of babies with a low birth weight (18% or 33/184 and 30/167 born in camp, respectively) than Don Yang (14% or 14/99 born in camp). The average HAZ of the 77 children born with a LBW was –2.16. Forty-four (57%) of these children were stunted and ten (13%) were wasted. A very low birthweight (<1.5 kg) was found in 1% (N=6) of the camps.

Birth weight was positively correlated with HAZ ($r=.254$, $p<.001$) and WHZ ($r=.178$, $p<.001$). Low birth weight was associated with low HAZ ($X^2=9.48$, $p=.002$) and WHZ ($X^2=13.1$, $p<.001$). When adjusted for age, gender and camp location, birth weight was a positive predictor of HAZ (Table 3.15.). No variables remained significant predictors of WHZ ($F= 1.61$, Adjusted $R^2= .006$, $p=.15$).

Table 3.15. Multiple Regression (Enter Procedure) of Birth Weight to Height for Age Z-score in Tham Hin, Don Yang and Umpiem Mai Refugee Camps in Thailand

	B	SE	T-value	P-value	Adjusted R^2
Height for Age Z-score					.153
Age in months	–.022	.004	–5.93	<.001	
Female gender	.293	.105	2.8	.005	
Tham Hin	.156	.138	1.13	.26	
Umpiem Mai	–.174	.141	–1.24	.22	
Birth Weight (kilograms)	.555	.091	6.09	<.001	

Don Yang was the reference camp
Height for age Z-score F-test: 17.03 (p<.001)

Maternal Anthropometrics

Maternal Height

Four hundred and twenty-five non-pregnant mothers were measured for heights and weights. There were fewer mothers than children because other family members accompanied some of the children and several mothers were pregnant. Maternal height was positively correlated with infant's weight at birth (r=.164, p<.001). Maternal height was also a positive predictor of child's HAZ and WHZ when adjusted for the child's age, gender and camp location (Table 3.16.).

Table 3.16. Multiple Regression (Enter Procedure) of Maternal Height to HAZ And WHZ* in Tham Hin, Don Yang and Umpiem Mai Refugee Camps in Thailand

	B	SE	T-value	P-value	Adjusted R^2
Height for Age Z-score					.144
Age in months	–.026	.004	– 6.8	<.001	
Female gender	.133	.109	1.22	.22	
Tham Hin	.238	.136	1.76	.08	
Umpiem Mai	–.166	.138	–1.2	.23	
Maternal height in meters	4.74	1.03	4.6	<.001	
Weight for Height Z-score					.027
Age in months	–.0004	.003	–.15	.88	
Female gender	–.05	.087	–.62	.53	
Tham Hin	–.029	.109	–.26	.79	
Umpiem Mai	.093	.111	.84	.40	
Maternal height in meters	2.65	.827	3.2	.002	

Don Yang was the reference camp
*HAZ=Height for age Z-score WHZ= Weight for height Z-score
HAZ F-test: 15.04 (p<.001), WHZ F-test: 2.56. (p=.03)

Maternal BMI

Maternal body mass index (BMI) ranged from 16.3 to 36.6 kg/m². The mean was within the normal range at 22.2 ± 3.1 kg/m²; 7% (N=31) were considered underweight with a BMI of less than 18.5 kg/m² and 17% (N=72) were considered overweight with a BMI of greater than 25. Mothers in Don Yang camp had an average 1.5 kg/m² lower body mass index (about 3.5 kg less weight for height) than in the other two camps.

When maternal BMI was categorized, maternal underweight was associated with greater frequency of low HAZ (X^2=8.4, p=.02) in their children. Maternal BMI was also positively correlated with their infant's weight at birth (r= .211, p<.001). Maternal BMI was significantly, positively associated with HAZ and WHZ when adjusted for age, gender and camp location by linear regression analysis (Table 3.17.).

Table 3.17. Multiple Regression (Enter Procedure) of Maternal Body Mass Index to HAZ and WHZ* in Tham Hin, Don Yang and Umpiem Mai Refugee Camps in Thailand

	B	SE	T-value	P-value	Adjusted R²
Height for Age Z-score					.129
Age in months	–.025	.004	–6.53	<.001	
Female gender	.145	.109	1.33	.18	
Tham Hin	.141	.14	1.01	.32	
Umpiem Mai	–.199	.14	–1.42	.16	
Maternal BMI** (kg/m²)	.068	.018	3.77	<.001	
Weight for Height Z-score					.031
Age in months	–.0002	.003	–.05	1.0	
Female gender	–.058	.086	–.67	.51	
Tham Hin	–.121	.11	–1.09	.28	
Umpiem Mai	.057	.011	.38	.7	
Maternal BMI (kg/m²)	.057	.014	3.97	<.001	

Don Yang was the reference camp
*HAZ=Height for age Z-score, WHZ= Weight for height Z-score
HAZ F-test: 13.48 (p<.001), WHZ F-test: 3.66 (p=.003)
** BMI=Body Mass Index

Child Illness

One hundred and sixty three children (30%) were ill within the month before the survey, 82 (50%) of them were severely ill. The children considered ill had fever, pain, or a cold. Those considered severely ill had diarrhea for more than 10 days and/or went to the clinic and took medication for an ailment, such as pneumonia or malaria.

Wasting was associated with presence of illness (WHZ X^2=4.29, p=.04) and severe illness (WHZ X^2=6.35, p=.01). In linear regression analysis on anthropometric indicators adjusted for age, gender and camp location, illness and severe illness were significant predictors of WHZ, but not HAZ (Tables 3.18. and 3.19.).

Age in months was negatively correlated with illness (r= –.128, p=.003) and severe illness (r= –.100, p=.04). The average age of the children who were ill and severely ill was 27.5 and 26.6 months, respectively. Gender was not a predictor of illness (F= .645, Adjusted R^2= –.001, p=.42).

Table 3.18. Multiple Regression (Enter Procedure) of Illness to HAZ and WHZ* in Tham Hin, Don Yang and Umpiem Mai Refugee Camps in Thailand

	B	SE	T-value	P-value	Adjusted R^2
Height for Age Z-score					.099
Age in months	–.023	.003	–6.73	<.001	
Female gender	.130	.098	1.33	.18	
Tham Hin	.336	.124	2.72	.007	
Umpiem Mai	.017	.125	.13	.89	
Illness present	–.174	.109	–1.60	.11	
Weight for Height Z-score					.026
Age in months	.001	.003	.51	.61	
Female gender	.032	.076	.42	.68	
Tham Hin	.014	.096	.14	.89	
Umpiem Mai	.239	.096	2.49	.01	
Illness present	–.281	.084	–3.35	<.001	

Don Yang was the reference camp
* HAZ = Height for age Z-score, WHZ= Weight for height Z-score
HAZ F-test: 12.43 (p<.001), WHZ F-test: 3.78 (p=.002)

Table 3.19. Multiple Regression (Enter Procedure) of Severe Illness to WHZ* in Tham Hin, Don Yang and Umpiem Mai Refugee Camps in Thailand

	B	SE	T-value	P-value	Adjusted R^2
Height for Age Z-score					.074
Age in months	–.020	.004	–.5.38	<.001	
Female gender	.112	.105	1.07	.29	
Tham Hin	.272	.140	1.94	.05	
Umpiem Mai	.012	.128	.10	.92	
Severe illness present	–.170	.138	–1.24	.22	
Weight for Height Z-score					.028
Age in months	.0007	.003	.23	.82	
Female gender	.059	.084	.7	.48	
Tham Hin	–.1	.111	–.9	.37	
Umpiem Mai	.228	.101	2.24	.03	
Severe illness present	–.31	.109	–2.83	.005	

Don Yang was the reference camp
* HAZ = Height for age Z-score, WHZ= Weight for height Z-score
HAZ F-test: 7.88 (p<.001), WHZ F-test: 3.52 (p=.004)

What is the Contribution of the Behavioral Feeding Practices to the Nutritional Status of the Burmese Refugee Children in Thailand?

Breastfeeding

Mean duration of months breastfeeding among the 288 children no longer breastfed, was 19.6 ± 10.1 months (1 to 51 months). Eleven percent of children were breastfed for less than one year and 8% (24/306) were exclusively breastfed until four months of age.

Breastfeeding until 6 to 11.9 months was associated with low prevalence of stunting (HAZ X^2=12.28 p<.01). When adjusted for age, gender and camp location, longer duration of breastfeeding was a negative predictor of WHZ (Table 3.20.).

Sixty-seven percent (16/24) of the wasted children were still being breastfed at the time of the survey, compared to 46% (224/489) of non-wasted camp children. Still breastfeeding was negatively correlated with number of meals a child ate per day (r= –.199, p<.001). Children who were breastfed at the time of the survey ate fewer meals per day than weaned children.

Table 3.20. Multiple Regression (Enter Procedure) of Duration of Breastfeeding to HAZ and WHZ* in Tham Hin, Don Yang and Umpiem Mai Refugee Camps in Thailand

	B	SE	T-value	P-value	Adjusted R^2
Height for Age Z-score					.107
Age in months	–.023	.004	–6.11	<.001	
Female gender	.141	.099	1.42	.16	
Tham Hin	.370	.125	2.96	.003	
Umpiem Mai	–.011	.124	–.09	.93	
Duration of breastfeeding in months	–.002	.006	–.39	.70	
Weight for Height Z-score					.016
Age in months	.006	.003	1.94	.05	
Female gender	.047	.078	.61	.55	
Tham Hin	–.016	.100	–.16	.87	
Umpiem Mai	.143	.100	1.47	.14	
Duration of breastfeeding in months	–.012	.004	–2.72	.007	

Don Yang was the reference camp
* HAZ = Height for age Z-score, WHZ= Weight for height Z-score
HAZ F-test: 13.24 (p<.001), WHZ F-test: 2.67 (p=.02)

Number of Meals per Day

The mean number of meals a child ate in the refugee camp was 2.3 ± .7 SD per day (0 to 4 meals per day). Children ate more meals per day if they were eating complementary food (2.4 meals per day) than if they were still breastfeeding (2.2 meals per day).

Number of meals a child consumed per day was negatively correlated with HAZ (r = –1.04, p=.02). When adjusted for age, gender and camp location, consuming more meals a day was a negative predictor of WHZ (Table 3.21.). When consuming three to four meals a day was tested, consuming more meals a day remained a significant negative predictor of WHZ (B=-.381, SE=1.77, t = -2.156, p=.03), but not HAZ (p>.05).

Over 90% (21/23) of the children receiving four meals a day were from Don Yang camp. The average WHZ of the children who consumed four meals a day was –.99 and the border wide average was –.59. The average HAZ of these children was –2.13 and the border wide average was –1.85.

Table 3.21. Multiple Regression (Enter Procedure) of Number of Meals per Day to HAZ and WHZ* in Tham Hin, Don Yang and Umpiem Mai Refugee Camps in Thailand

	B	SE	T-value	P-value	Adjusted R^2
Height for Age Z-score					.103
Age in months	–.024	.004	–6.76	<.001	
Female gender	.170	.098	1.74	.08	
Tham Hin	.306	.140	2.20	.03	
Umpiem Mai	–.044	.131	–.33	.73	
Number of meals per day	.019	.084	.23	.82	
Weight for Height Z-score					.02
Age in months	.004	.002	1.62	.11	
Female gender	.046	.075	.61	.55	
Tham Hin	–.165	.107	–1.53	.13	
Umpiem Mai	.067	.101	.66	.51	
Number of meals per day	–.166	.065	–2.56	.01	

Don Yang was the reference camp
* HAZ = Height for age Z-score, WHZ= Weight for height Z-score
HAZ F-test: 13.13 (p<.001), WHZ F-test: 2.72 (.02)

Age Received Rations

The average age in months that children first received rations was 3.9 ± 3.2 months (1 to 36 months). Age children received rations was negatively correlated with anthropometric indicators for HAZ (r= –.154, p=.004). When adjusted for age, gender and camp location, age that children received rations was a negative predictor of HAZ (Table 3.22.). No variables remained significant predictors of WHZ (F= 1.65, Adjusted R^2= .006, p=.15).

Table 3.22. Multiple Regression (Enter Procedure) of Age Child Received Rations to HAZ * in Tham Hin, Don Yang and Umpiem Mai Refugee Camps in Thailand

	B	SE	T-value	P-value	Adjusted R^2
Height for Age Z-score					.03
Age in months	–024	.003	–6.86	<.001	
Female gender	.146	.1	1.48	.14	
Tham Hin	.144	.14	1.02	.31	
Umpiem Mai	–.175	.13	–1.3	.19	
Age in months received rations	–.037	.02	–2.04	.04	

Don Yang was the reference camp
* HAZ=Height for age Z-score, HAZ F-test: 14.67 (<.001)

Age of Onset of Complementary Foods

The average age in months at which children started to eat complementary food was 4.6 ± 3.5 months (<1 to 30 months). Forty-eight percent (N=258) of children started complementary food before four months of age and 32% started after six months (N=175). Age of onset of complementary food was not associated with differences in anthropometric indicators (p>.05).

When adjusted for age, gender and camp location, age of onset of complementary food was a negative predictor of HAZ (Table 3.23.). No variables remained significant predictors of WHZ (F= 2.08, Adjusted R^2= .011, p=.07).

Table 3.23. Multiple Regression (Enter Procedure) of Age of Onset of Complementary Food to HAZ* in Tham Hin, Don Yang and Umpiem Mai Refugee Camps in Thailand

	B	SE	T-value	P-value	Adjusted R^2
Height for Age Z-score					.10
Age in months	–.022	.003	–6.31	<.001	
Female gender	.213	.099	2.16	.03	
Tham Hin	.249	.124	2.01	<.05	
Umpiem Mai	–.056	.124	–.45	.65	
Age in months started complementary food	–.016	.006	2.66	.008	

Don Yang was the reference camp
* HAZ=Height for age Z-score, HAZ F-test: 14.67 (<.001)

Stepwise Regression of Significant Independent Variables on Growth Indicators

Stepwise Regression of all significant independent variables on growth indicators was performed. The variables entered for height for age Z-score were: age, female gender, camp location, presence of iron deficiency (both pale eyelids and pale nailbeds together), birth weight, maternal height and BMI, still breastfeeding, age child first received rations and complementary food, and child ate rice. The significant positive variables retained in the model were birth weight, maternal height, child ate rice and female gender. Significant negative variables retained in the model were age of child, living in Umpiem Mai camp and iron deficiency. The final model explained 25.6% (Unadjusted R^2) of variation of HAZ (Table 3.24.).

The variables entered for weight for height Z-score were: age, female gender, camp location, total clinical signs of nutrient deficiency, birth weight, maternal height and BMI, whether child was ill or severely ill the month prior to the survey, breastfeeding duration and number of meals a child ate per day. Significant positive variables retained in the model were maternal height and birth weight; significant negative variables were illness, number of meals eaten, breastfeeding duration and age. The final model explained 12.9% (Unadjusted R^2) of variation of WHZ (Table 3.24.).

Table 3.24. Multiple Regression Analysis (Stepwise Procedure) of Nutritional Status of 540 Burmese Refugee Children in Thailand

	B	SE	T-value	P-value
Height for Age Z-score				
Birth weight in kilograms	.564	.097	5.79	<.001
Maternal height in meters	4.023	1.085	3.71	<.001
Age in months	–.026	.004	–6.32	<.001
Iron deficiency present (0=no, 1=yes)	–.677	.266	–2.54	.01
Female gender (0=male, 1=female)	.298	.110	2.70	.007
Umpiem Mai (0=no, 1=yes)	–.304	.115	–2.64	.009
Eat rice (0=no, 1=yes)	.434	.197	2.21	.03
Weight for Height Z-score				
Birth weight in kilograms	.198	.091	2.18	.03
Maternal height in meters	3.129	1.023	3.06	.002
Age in months	–.010	.005	–1.98	<.05
Illness present (0=no, 1=yes)	–.353	.109	–3.24	.001
Duration of breastfeeding in months	–.005	.002	–2.81	.005
Number of meals per day	–.244	.079	–3.09	.002

Height for age Z-score F-test: 16.337(p<.001), Adjusted R^2=0.241
Weight for height Z-score F-test: 6.977 (p<.001), Adjusted R^2=0.111

CHAPTER 4
DISCUSSION

High rates of malnutrition are positively correlated with high rates of mortality in children; malnutrition is linked to almost half of all preschool deaths today (Fernandez et al. 2002). Stunting, wasting and micronutrient deficiencies are matters of concern, as they reflect chronic and acute malnutrition in children. In refugee camp settings, where refugees are dependent on outside aid, international organizations are responsible for preventing malnutrition. Outside aid provides health care, shelter and food rations to refugees.

The type and quantity of food rations are dependent upon nutritional needs of refugees, available resources of aid organizations, and permission of host country authorities. Additional factors are to provide food on a regular basis that is culturally acceptable and logistically feasible. Rapid nutrition assessments serve to prioritize nutrition and health needs with resources in a refugee camp. This study was a follow-up on previous studies, which indicated a high prevalence of chronic malnutrition and micronutrient deficiencies in refugee camps on the Thailand-Burma border.

Analysis of results and discussion answer the original research question concerning the etiology of malnutrition in 6 to 59 month old children in Burmese refugee camps on the Thailand-Burma border. Rates of malnutrition in this survey confirmed a stunting prevalence of approximately 45% and a wasting prevalence of approximately 5% seen in a previous study by Kemmer et al. (2003) in the same camps. Clinical examination in this study revealed minimal prevalence of riboflavin and iron deficiency in under-five year old Burmese refugee children.

The final regression model in this study tested the strength of the results by adjusting for all associated variables. The model confirmed the interconnected nature of malnutrition suggested by the operational framework in the introduction. In the final model of malnutrition, significant positive predictors of height for age and weight for height Z-scores were weight at birth, height of mother, female gender and child ate rice. Significant negative predictors were age of child, presence of indicators of iron deficiency, illness, consuming more meals per day, longer breast feeding duration, and living in Umpiem Mai camp.

This discussion will address the question posed in the introduction, "What are the contributing factors to the nutritional status of the 6 to 59 months old Burmese refugee children in Thailand?" by discussing the significant variables from the final regression model (Table 3.24.) and relating them to the operational framework in the introduction, as well as discussing other significant variables from the results.

Research Question: What are the Contributing Factors to the Nutritional Status of the 6 to 59 Month Old Burmese Refugee Children in Thailand?

Demographic Contribution to Malnutrition

Age of Child

Stunting and wasting were predicted by older age of children. Stunting was worse in Umpiem Mai camp, where there were proportionately more children over the age of three compared to Tham Hin and Don Yang camps. Over time, stunting increases in chronic deficit, and typically presents as short stature for age in older children. Stunting can also be evidence of past acute malnutrition (de Onis and Habicht 1996) or repeated infection (Fernandez et al. 2002).

Stunting and wasting increased from the 6 to 11.9 month age group to the 12 to 23.9 month age group. This is around the same time that the children started complementary feeding, which may account for decreased nutritional status.

Wasting in older children can also be attributed to lack of adequate nutrition from the ration diet. Older children require more energy than younger ones (DRI 2002, UNHCR/WFP 2004), however they receive the same food rations. The seven to 12 month old infants met 150% of their energy needs with the ration diet and most of them were also breastfed. However, the four year olds only met approximately 75% of their energy needs from the food basket, if they ate their entire portion of the shared ration.

Gender of Child

This study confirmed that stunting was higher in males. Kemmer et al. (2003) also found higher malnutrition in males in the same Burmese refugee camps as this study. In their study, iron deficiency anemia was predicted by males. Boys require more energy than girls (DRI 2002, UNHCR/WFP 2004). In the refugee camps, however, all of the children under-five receive the same amount of energy from rations. This may be one of the reasons why the boys are more stunted than the girls.

Camp Location

Living in Umpiem Mai camp was a predictor of stunting. In this camp, children also had a higher prevalence of wasting (6.7%) than Tham Hin (3.7%) and Don Yang (2.6%) and there were more children who were ill and severely ill. The refugee children did not receive extra kilocalories in times of illness; a chronic shortage of nutrients together with illness may explain the increased malnutrition in Umpiem Mai camp. The connection with camp location, illness and malnutrition is diagramed in the operational framework (Figure 1.3.), and explained in-depth in "Maternal and Child Characteristics; Illness."

In zone 2e of Don Yang camp, three quarters of the children were stunted. Of these stunted children, most were not born in camp. Children were considered not born in camp if their birth weights were unknown; however, this may be a proxy for mothers who are unaware of their children's health or nutrition, and did not keep health records.

The mean height for age Z-score was highest in Tham Hin camp. Tham Hin camp receives a slightly bigger food basket, than the other two camps because it is harder for the refugees to leave the camp to supplement the rations. This may have contributed to the better Z-scores.

Maternal and Child Characteristics

Maternal Anthropometrics and Birth Weight

This research indicated that childhood stunting and wasting were predicted by a shorter stature of mothers and low birth weights (LBW). Low maternal height may also be a result of stunting as children. Malnutrition in mothers can continue to be reflected in child's nutritional status (Rahman et al. 1993); it is not unusual for stunted mothers to have stunted babies (Moren 1995). Low maternal body mass index was also a significant predictor of malnutrition and may indicate limited uterine size, which can also lead to babies with LBW (Adair and Prentice 2004).

Tham Hin and Umpiem Mai had a higher prevalence of babies with LBW than Don Yang. Pregnant mothers in Tham Hin received 300 extra kilocalories a day in the form of mung beans and eggs, and pregnant mothers at Don Yang and Umpiem Mai received 850 extra kilocalories a day as eggs, oil, and peanuts. Karen women prefer small babies for easier delivery, this may mean that they do not eat the extra rations and may contribute to babies born with low birth weights (personal correspondence with Menefee A., Nutritionist, BBC 2002-2005).

Mothers were reportedly having more children per capita in the camps, than when they lived in Burma (personal correspondence with Menefee A., Nutritionist, BBC 2002-2005). This may indicate that mothers are having multiple pregnancies with short birth spacing. Low birth weight is attributed to short birth spacing and multiple pregnancies (Kramer 2003).

Child Illness

Presence of illness was a predictor of wasting in this study. Illness may have contributed to wasting if the children were too sick to eat. Brief periods of nutritional deficiencies may also lead to wasting (Allen and Gillespie 2001). In addition, diets normally adequate for healthy children might be insufficient for children who are ill or malnourished; children require more Calories when they have a fever or infection. Children also require energy dense food for catch up growth after having diarrhea or infections (Prentice and Paul 2000). The complementary foods in the camp were lower in fat and kilocalories than breastmilk, and may not have provided adequate energy or micronutrients for an ill or malnourished child for optimal health. A previous study showed that illness was a predictor of iron deficiency in these refugee camps (Kemmer et al. 2003).

The percentage of ill and wasted children was greatest in Umpiem Mai camp. The weather may be one reason why there were more ill children in Umpiem Mai. Umpiem Mai has a lot of rain and is located at an altitude of 1,200 meters; it is colder than the other two camps and cold temperatures increase energy requirements. Perhaps it was harder to give more children individual medical attention at this camp, than in the other two camps. Yet another reason may be sanitation. Houses are on hilly terrain, resulting in possible septic leakage down the hills.

Age was correlated with illness. The average age of children who were ill and severely ill was about 27 months. Most children walk by two years old, leading to increased exposure to infection from greater contact with other children and the environment. This is also around the age that children were no longer breastfeeding; this may have contributed to increased consumption of contaminated food or water and decreased protective factors from disease (Michaelsen et al. 2003).

Behavioral Feeding Practices

Breastfeeding

Longer duration of breastfeeding was a significant predictor of wasting, and breastfeeding after 24 months was associated with greater prevalence of stunting (HAZ $X^2=12.28$ $p<.01$). It is possible that infants who were breastfeeding longer were doing so due to lack of sufficient complementary food; perhaps the older family members were eating the children's food and therefore they kept breastfeeding. Or maybe the children were on a cycle of illness where they would not eat and would only breastfeed. Minerals such as zinc (Umeta et al. 2003) and iron (Michaelsen et al. 2003) are insufficient for infant growth after six months of lactation.

In the Burmese refugee camps, two-thirds of the wasted children were still being breastfed at the time of the survey, compared to less than half of all camp children. This may be because concerned mothers continued breastfeeding children who appeared malnourished, rather than breastfeeding led to wasting. Simondon et al. (2001) also has reported a higher prevalence of malnutrition in children who were breastfed for a longer duration. They attributed the longer duration of breastfeeding to the child's small size; complementary feeding was delayed because the mothers thought that their children were too small and weak (Simondon et al. 2001).

In the Burmese refugee camps, less than ten percent of children were exclusively breastfed until four months of age. Infants are recommended to exclusively breastfeed until at least four months for optimal growth and development. About one-third of infants are exclusively breastfed until they are four months old, worldwide (WHO 2002b).

In the refugee camps, the adult ration foods did not meet recommended amounts of vitamins A, B1, B2 and other micronutrients (Banjong et al. 2003). Maternal micronutrient deficiencies of these vitamins are reflected in breastmilk, and can contribute to inadequate infant growth (Michaelsen et al. 2003).

<u>Age of Onset of Complementary Food</u>

Late onset of complementary food and prolonged breastfeeding were both predictors of stunting. Early or late onset of complementary food can lead to malnutrition (Tontisirin and Yamborisut 1995). Over 20% of stunted children started complementary food after seven months of age; malnutrition and growth faltering can be caused by late onset of complementary food (Michaelsen et al. 2003) or extended exclusive breastfeeding (Tontisirin and Yamborisut 1995). Infants are less susceptible to stunting if they start complementary foods at six months of age (Onyango et al.1998).

In the camps, almost half of the children started complementary food before four months of age. In Burma, complementary food is typically started in the fourth month (personal correspondence with Byrd, M.W. January 2005). Children have difficulty swallowing and digesting solid food before they are four months old. It is recommended to start complementary food at 26 weeks or six months of age (Michaelsen et al. 2003). Infants who receive complementary food early are at increased risk of food allergies, diarrhea (Underwood and Hofvander 1982), and possibly iron deficiency; vegetables or cereals could interfere with breastmilk iron absorption (Tontisirin and Yamborisut 1995).

Rice and rice soup were common complementary foods in the refugee camps. Onyango et al. (1998) reported possible long term harmful consequences of early introduction of cereal food. Other complementary foods in the camp are beans and eggs. Appropriate complementary foods are high in kilocalories, vitamin A, vitamin D, iron, zinc, and are sufficient in protein, i.e., a mixture of rice, mung beans and seeds or nuts (Tontisirin and Yamborisut 1995).

Number of Meals per Day

In the Burmese refugee camps, increased number of meals was a predictor of wasting. These 'meals' were defined as containing rice which is not nutrient dense enough, alone, for preschool children's nutritional status. The wasted children were supposed to get supplementary feeding, according to camp guidelines, but the children eating four meals per day were not getting supplementary feeding. Almost all of the children who ate four meals per day lived in Don Yang camp.

Rations

Individual Foods

Eating rice was a positive predictor of height for age Z-score in this study. Children may have replaced other nutrient dense foods, necessary for growth, with rice, including protein-rich meat. Four year old children ate approximately 600 to 900 grams of cooked rice per day, compared to the Thai Food Guide recommendation of 480 grams per day (Banjong et al. 2003). However, only 92% of children ate rice at the time of the survey; therefore, rice may be a proxy representation of food security.

Iron

Iron deficiency was both a predictor and an outcome of malnutrition. Kemmer et al. (2003) found a much higher prevalence (85%) of iron deficiency than this study (5%), presumably because they measured blood samples for zinc protoporphyrin heme. When iron is insufficient in red blood cells, zinc protoporphyrin builds up and can be measured as a ratio to heme (ZPP/H) (Griffin et al. 2002). However, zinc protoporphyrin may be inflated due to infection as well as zinc deficiency, leading to false positives.

When vitamin C is consumed together with iron, vitamin C boosts non-heme iron absorption (DRI 2000a, Singh 2004). Vitamin C is not provided by the ration foods, and almost 50% of children in the Burmese refugee camps ate an iron inhibitor food daily, such as tannins from tea (Kemmer et al. 2003).

This study confirmed a previous study by Banjong et al. (2003), approximately half of the iron in the refugee diet was provided by rice. The only highly bioavailable heme iron source supplied by the ration foods was the fermented fish, which is usually not eaten by younger children (personal correspondence with Menefee A., Nutritionist, BBC 2002-2005). It is possible that fermented shrimp or fish paste contributes to the bioavailability of iron in rice, as heme iron sources help absorb non-heme iron (Kemmer et al. 2003). However, it remains to be investigated whether the iron in the shrimp or fish paste is from processing, and therefore not a heme source.

Dietary Diversity

Dietary diversity score (DDS) in this study revealed that the average number of foods consumed, including breastfeeding, was less than six. Kemmer (2001) reported a DDS of less than six different foods per week (excluding breastfeeding) was associated with anemia ($p<.001$), and iron deficiency ($p<.05$) in the Burmese camps. Some studies have associated stunting with lack of dietary variety (Ruel 2003), but DDS was not associated with malnutrition in this study. Onyango et al. (1998) reported that dietary diversity was more important than breastfeeding status in children over one year of age.

Supplemental Feeding

Wasted children should be receiving therapeutic supplementary feedings in the in-patient department of the camp. However, only one out of ten wasted children was receiving supplemental feedings at the time of this survey. This study confirmed results from another study in the same camps (Kemmer et al. 2003), that indicated health agencies were not adequately identifying children in need of supplemental feeding.

Adequacy of the Ration Diet

This study analyzed the ration foods and confirmed results from other studies; the ration was short in several nutrients essential for growth and development (Banjong et al. 2003, Kemmer et al. 2003, McGready et al. 2001). Children are susceptible to nutrient deficiencies with the current food basket.

The one to three year old children consumed an average of 2.2 meals with rice per day (180 grams), or about 68% of their ration (Food Systems 2001). Subtracting 32% of rice and all the fish paste (because the one to three year olds only consumed 68% of rice and no fish paste) from the nutrient analysis of the rations reduced the amount of energy (340 kcal), protein (7 g), calcium (235 mg) and iron (3g) consumed from the analysis. Breastmilk compensated for some of the nutrients missing in the analysis; however it is difficult to know the amount that the children consumed.

Rice accounted for 80% of the energy and 68% of the protein in the rations. The fermented fish accounted for eight percent of the protein in the rations, and was the only animal source of protein. The amino acid score indicated that only 71% of protein from the ration diet was met. Therefore, amino acids were being used as kilocalories and protein was not sufficient for proper growth and development in children. The amino acid score may actually be lower, as the children did not eat the fermented fish. Banjong et al. (2003) also found that protein was not adequate in the rations.

Vitamin and mineral deficiencies are associated with malnutrition, especially in children in developing countries (Mason et al. 2001). Micronutrients such as riboflavin, vitamin A, calcium and iron are especially important to proper growth and health (Neumann et al. 2003).

Riboflavin deficiency was found in four percent (N=24) of the children in the clinical examination. Children received 38% to 58% of recommended intake for riboflavin from the refugee rations. Foraged or purchased foods accounted for another 40% of riboflavin intake among the refugees (Banjong et al. 2003).

Ration dietary vitamin A was found primarily in the legumes or in the chilies. Since the amount of vitamin A in the diet does not meet the DRI, and it is one of the most common vitamin deficiencies in children throughout the developing world, children received supplementary vitamin A in capsule form by mouth. However, even with supplementation, the refugee children only meet about 50% of the Dietary Reference Intakes for vitamin A.

Banjong et al. (2003) reported that vitamins A and C in the refugee diet were mostly from non-ration foods. The researchers reported that the refugees purchased vegetables approximately four times a month and that 70% of the refugees grew fruits and vegetables such as cassava, pumpkin, green peas or papaya. Seventy-four percent of the refugees foraged for bamboo shoots, mushrooms, potatoes and wild fruits. These outside foods accounted for 98% of the vitamin C intake among the refugees (Banjong et al. 2003).

Calcium in the refugee diet is mostly from the fermented fish, which is confirmed in a study by Banjong et al. (2003). Fish bones are a source of calcium and part of the fermented fish; however bones can be difficult for children to eat (Banjong et al. 2003), and the camp children reportedly do not eat a lot of the fermented fish.

Over 50% of the thiamin in the rations was from highly polished broken white rice. Another study confirmed thiamin deficiency in women from these same refugee camps due to the polished rice. The authors of this study used erythrocyte transketolase activity, which assays enzymatic production of glyceraldehyde 3-phosphate in hemolysates (McGready et al. 2001).

Ration foods are available as soon as a newborn is registered. However, parents typically registered their children from one to six months of age and therefore did not receive rations for their child as early as possible (personal correspondence with Menefee A., Nutritionist, BBC 2002-2005). In Don Yang camp, none of the families received rations for their children before six months of age. Infant rations benefit the whole family as they are added to the family food basket. Infants benefit through improved mother's milk production or in proportion to their access to family food.

The Sphere project minimum standard for food is 2,100 kilocalories per person per day; adults received 2,400 kilocalories (children under-five received about 1,200 kilocalories) in the BBC daily food basket. According to Sphere, food aid should be adjusted according to accessibility to outside foods and refugee needs (Sphere 2004).

Although the Burmese refugees have access to outside food, malnutrition rates in the children reflect the need to fortify the food basket with more nutrients.

Blended wheat/soy flour is currently being evaluated for addition to the rations. It provides the following nutrients per 100 grams: 500 RE vitamin A, 0.128 mg vitamin B1, 0.448 mg vitamin B2, 4.8 mg vitamin B3, 120 µg folic acid, 48 mg vitamin C, 1.2 µg vitamin B12, 16 mg iron, 100 mg calcium, 5 mg zinc. This blended flour would help alleviate micronutrient deficiencies of the ration diet. Once implemented, the amount of rice in the diet would be reduced from 266 grams to 225 grams for the children under-five and 50 grams of the blended food will be added (personal correspondence with Menefee A., Nutritionist, BBC 2002-2005).

Study Limitations

The assumptions of the NCHS/WHO international growth reference curves are that growth patterns of healthy and well-fed preschool children throughout the world are similar to those of healthy and well-fed American children (de Onis and Blössner 1997). High rates of stunting, such as those found in the Burmese refugee camps in Thailand, are indicative of a whole population at risk, not just the individual children below the cutoff point of –2 Z-scores. These growth curves are suggested for comparison and monitoring purposes in a population, and not specifically for different ethnic groups; therefore, new reference data are being collected from diverse ethnic groups throughout the world to establish international normative data (de Onis and Habicht 1997).

Two different height measurement methods were used, but not recorded, in this survey. Recumbent lengths were intended to be taken until children were two years old, and standing heights of children who were two years of age and older. It is possible that a child who was younger than two years was measured standing up, or more likely, recumbent length was measured in a child older than two years. Although the Centers for Disease Control (CDC) adjusted the growth charts to be equal in length and height, there remains a slight difference; a 24 month old child who is 87 centimeters in recumbent length is just above the 50^{th} percentile of the mean. However, the same child is just below the 50^{th} percentile of the mean, when standing height is taken (CDC 2000). In this study, stunting appeared to start around 20 months of age; however, the difference may have been due to measurement method.

A rapid clinical survey helps detect typical indicators of nutrient deficiencies. All or some body parts such as hair, face, eyes, mouth, thyroid gland, skin and skeleton can be examined to identify signs of nutrient deficiencies (Jelliffe 1966). Several nutrient deficiencies have similar characteristic signs. For example, dry, rough skin can be protein, niacin, biotin, vitamin A, vitamin B6, omega 6 fatty acids or zinc deficiency. This makes it difficult to interpret the condition upon examination and draw conclusions from the results. Biochemical tests could improve the diagnosis, but may be impractical or inappropriate.

The children were averse to having their mouths examined; therefore mouth examinations were left out. However, different conditions of the mouth are characteristic of different nutrient deficiencies. For example, a scarlet tongue is characteristic of niacin deficiency, swollen gums are characteristic of vitamin C deficiency and teeth can be examined for fluoride deficiency. It might have been beneficial to coax the children to stick their tongues out and look in their mouths.

A lower prevalence of iron deficiency was found, using a clinical evaluation of nail and conjunctiva pallor, compared to Kemmer et al. (2003), who used blood values.

However, factors contributing to iron deficiency were similar. A limitation of the clinical examination was short training period prior to the first camp. This may have been the reason that no clinical signs of iron deficiency were detected in the first camp.

There were some inconsistencies in the reported data that made analysis confusing. For example, it was reported that one child was breastfed until three months, but started to eat food at six months, and a 31 month old child was reported to have breastfed until 40 months. Such inconsistencies may be due to data collection; perhaps a personal digital assistant (PDA) with prodigy for inconsistencies would have been practical to avoid some human error (Selanikio et al. 2002). Also, the percentage of children surveyed at each camp was uneven (14% Tham Hin, 26% Don Yang and 9% Umpiem Mai). This may have given an uneven representation of the individual camps.

Children whose birth weights were unknown were considered not born in camp. It might have been judicious to ask whether the child was born in camp, and if not, how long the child lived in camp in order to compare malnutrition rates. Other unasked questions were whether the child had any siblings, how far apart in age they were and how old the mother was when she had the baby. This information would have been useful to determine birth spacing influence on birth weights and malnutrition. It may also have been helpful to ask if the children were exclusively breastfed and for how long to see the influence of exclusive breastfeeding on malnutrition.

In the rapid nutrition survey, Question 7.1 asked what foods the children usually ate "more than four times a week". Although foods are limited in the camps, perhaps a clearer phrasing of the question could have been in a food frequency format, i.e., "How often does the child eat fish, in what amount, how is it prepared and what is the source of the food?" in order to further analyze the foods eaten. However, this would have added more time to the survey and may have been culturally inappropriate.

In regards to illness (question 9.0) and severity of illness (question 9.1), the illness itself was not recorded on all of the surveys, so it was difficult to assess whether the illness was malaria or diarrhea, etc. It would have been useful to determine maternal health and nutritional status during pregnancy to see the influence on birth weight, nutritional status and illness of the children. Perhaps a few extra minutes on the survey would have yielded a lower number of children surveyed, but more detailed results.

Conclusion

The prevalence of stunting malnutrition in the Burmese refugee children is high, according to results in this thesis, as well as by Kemmer et al. (2003) and Banjong et al. (2003). Under-five malnutrition, as measured by height for age and weight for height, in the camps is mostly accounted for by maternal malnutrition leading to babies with low birth weight, illness and possibly nutrient deficiencies in the rations due to governmental, logistical and financial limitations. Micronutrient fortification, improved maternal health and education and increased funding could help resolve some malnutrition. Increased funding could lead to an increase in quantity and quality of familiar, nutritious and fortified ration foods and provide human resources to educate women and children on nutrition and health. This would lead to a decrease in the malnutrition rates in the under-five year olds, and ultimately to a better quality of life when they reach adulthood.

Further Studies

Border Wide

A longitudinal study on the duration of breastfeeding and child growth would help to determine the effects of breastfeeding on nutritional status. A longitudinal study, including a clinical examination, of the fortified flour intervention would help to see the effects of micronutrient fortification on children's nutritional status.

Individual Camps

It would be interesting to further investigate the causes of illness and low birth weights in Umpiem Mai camp. Further studies in Don Yang camp might help to explain the causes of stunting in zone 2e, as well as why none of the children received rations before six months of age, why four meals per day were consumed almost exclusively at Don Yang camp, and why there was lower average maternal weight in Don Yang camp compared to the other camps.

Recommendations

Education:

- Health risks associated with low birth weight babies.
- Timing of introduction and appropriate complementary foods.
- Mora and Nestel (2000) support the recommendation to improve perinatal nutrition with a life-cycle approach that begins with girls in early childhood.

Nutrition:

- Exclusive breastfeeding until four to six months of age.
- Iron-fortified complementary foods that the rest of the family would not eat, such as iron-fortified baby rice cereal.
- More fat and micronutrients in rations, such as a high energy micronutrient dense spread (Lopez de Romana and Gross 2003) or high energy biscuits for wasted children.
- More kilocalories for ill children.
- Substituting part of the ration's rice for sardines to add protein, iron, vitamin C and calcium (USDA 2003) and nutrition education of changes in the rations to prevent trading for more rice.

Health:

- Biannual rapid nutrition surveys to monitor malnutrition.
- Review of supplemental feeding program to include more children.

Logistics:

- Gardening space to grow vegetables, herbs and fruit trees.
- Environmental/sanitation check of septic system at Umpiem Mai camp.

APPENDIX A
DEFINITIONS

Anthropometry:

Anthropometry is used to gauge the health and nutritional status of individuals or populations (de Onis and Habicht 1996, FANTA 2003). Anthropometry is based on four inexpensive and non-invasive indices; age, sex, weight and height (FANTA 2003).

Anthropometric Indices:

Anthropometric indices are used to screen children at risk of malnutrition over the short term, as well as to assess population changes over the long term (FANTA 2003). The anthropometric indices most frequently used when assessing infants and children are height for age (stunting), weight for age (underweight) and weight for height (wasting) (Allen and Gillespie 2001, Gorstein et al. 1994, WHO 1995). Mid-upper arm circumference (MUAC) is a valuable anthropometric indicator to predict immediate mortality risk in under-five year old children (FANTA 2003, Vella et al. 1993). It is assumed that arm size does not change much from 12 to 59 months, therefore a cut-off classification for malnutrition is used for children under-five; less than 12.5 cm is considered severe malnutrition and less than 11.0 cm is considered acute and severe malnutrition (Moren 1995).

The "Shakir *strip*" is a quick alternative method that uses color coded bracelets to determine malnutrition by comparing arm circumferences. If the green bracelet fits the children they have mild malnutrition, if the yellow bracelet fits, they have moderate malnutrition, and if the red bracelet fits, they have severe malnutrition (Nogueira de Almeida et al. 1999).

Another simple anthropometric measure is the fat fold, which is conducted using skin fold calipers. Body fat is calculated and used to gauge energy reserves (Jelliffe 1966). This helps determine malnutrition prevalence, although it is used more frequently to detect obesity (Seoane and Latham 1971).

Depending on the nutritional goal, different indices are recommended (WHO 1995). This paper focused on height for age and weight for height nutritional indices. These indices are used for growth monitoring to prevent malnutrition in young children in the developing world (Ruel et al. 1991).

Malnutrition Classification System:

Research suggests that all children have the potential to grow at the same rate if under the same nutritional environmental conditions until they are ten years of age (FANTA 2003). Therefore, reference standards to compare anthropometric indices worldwide were developed by the US National Center for Health Statistics and suggested for use by the World Health Organization (FANTA 2003). When reporting malnutrition, anthropometric indices are generally expressed as 1) percentiles, 2) percentage of the median, 3) Z-scores (FANTA 2003, Gorstein et al. 1994).

1. Percentiles specify at what percent of the reference population an individual ranks. Percentiles do not catch distribution extremes, and cannot be reported in means or standard deviations (Gorstein et al. 1994, WHO 1995).
2. Percent of the median is a ratio of observed value of the child compared to the median value of the reference population (FANTA 2003). It is used when the reference population distribution is unknown (Gorstein et al. 1994). Mild, moderate and severe malnutrition are classified as approximately 90%, 80% and 70% of the median weight for age (FANTA 2003).

3. Z-scores show the number of standard deviations above or below the reference median or mean value (Fernandez et al. 2002). Z-scores have more significance than percent of the median (Moren 1995). The Z-score will identify more malnourished children than the reference median, i.e., a minus 2 Z-scores is approximately 82.5% median weight for height (Menefee 2002). Mild, moderate and severe malnutrition are classified as –1, –2 and –3 Z-scores, respectively, below the median (FANTA 2003).

Z-score is the favored way to convey malnutrition rates when surveying acute and chronic malnutrition (FANTA 2003) and is the best system for analysis and presentation of population growth data (Allen and Gillespie 2001, de Onis and Blössner 1997) because it normalizes the population variance of each anthropometric measure. Global malnutrition rates are calculated by adding the number of children with minus 2 Z-scores and minus 3 Z-scores.

Stunting:

Children are stunted when they are 2 Z-scores below the NCHS/WHO international growth reference median value for height for age (Allen and Gillespie 2001, Peck et al. 1981). Height for age Z-score is abbreviated as HAZ in the results of this paper. A statistical description of stunting, wasting and underweight is in Table A1.1., based on research by Allen and Gillespie (2001), de Onis and Blössner (2003) and Gorstein et al. (1994).

Wasting:

Children are wasted when they are 2 Z-scores below the NCHS/WHO international growth reference median value for weight for height (Allen and Gillespie, 2001, Peck et al. 1981). Wasting can be used to track weight changes in children of unknown age (Gorstein et al. 1994). Weight for height Z-score is abbreviated as WHZ in the results of this paper.

Underweight:

Children are underweight when they are 2 Z-scores below the NCHS/WHO international growth reference median value for weight for age (Allen and Gillespie 2001). Underweight is the result of short stature, thinness, or both (Gorstein et al. 1994).

Table A1.1. Description of Z-Score Prevalence in Measures of Malnutrition in Children Under-five

Measure/ Prevalence	**Low** Population below –2 Z-scores	**Medium** Population below –2 Z-scores	**High** Population below –2 Z-scores	**Very high** Population below –2 Z-scores
Stunting	<20%	20-29%	30-39%	>40%
Wasting	<5%	5-9%	10-14%	>15%
Underweight	<10%	10-19%	20-29%	>30%

Allen and Gillespie (2001), de Onis and Blössner (2003) and Gorstein et al. (1994)

Low Birth Weight Baby:

A low birth weight baby is defined by the World Health Organization as born weighing less than 2.5 kg (UNS/SCN 2004).

Intrauterine Growth Retardation:

A full term baby born with a low birth weight (less than 2.5 kg) intrauterine growth retardation (IUGR) (Kiely et al. 2003).

Kwashiorkor:

Kwashiorkor is acute protein malnutrition distinguished by edema (Trowell 1954).

Etiology of kwashiorkor was not well understood when it was discovered and was thought to be a combination of pellagra and nutritional edema; therefore it has been cited in literature as infantile pellagra, as well as approximately forty other terms (Golden 2002, Trowell 1954).

The Swahili translation for kwashiorkor describes the child with red tinged hair easily plucked due to inadequate protein in the diet. The child with kwashiorkor also has muscle wasting detected by thin arm circumference, lethargic affect and failure to thrive. Other symptoms include a rash; culebrilla ("snakeskin") describes the rash on children with kwashiorkor. *Syndrome dépigmentation oedème* describes children with kwashiorkor who lose pigmentation and have edema (Jelliffe 1966).

Marasmus:

Marasmus is Greek for "to waste away". Marasmus is characterized by a lack of dietary energy from starvation (Jelliffe 1966). In the developing world marasmus is commonly due to mothers who choose to feed their babies from a bottle, have insufficient milk production, or are separated from their children and cannot breast feed them (El Lozy et al. 1980). Children with marasmus show at least one of these signs: "old man face" or "saggy bottom" due to lack of fat or severe muscle wasting (Van Loon et al. 1987).

Protein-Energy Malnutrition:

Protein-energy malnutrition (PEM) is severe acute undernutrition (Toole 1993b). PEM is caused by food scarcity, famine, inappropriate complementary foods or infection (MSF 2004). Severe PEM includes both kwashiorkor and marasmus. Formerly it was referred to as Protein-Calorie Malnutrition (PCM).

Rapid Nutrition Assessment Survey:

A rapid nutrition assessment survey, specifically a cross-sectional point prevalence survey, is a single assessment of the sample population at one point in time conducted over a few days. Rapid nutrition assessment measurements include age, sex, weight and height. Other components of the survey can include questionnaires and interviews on a child's diet and illness (Scrimshaw and Hurtado 1987). A rapid nutrition assessment survey may also include a physical examination.

APPENDIX B
SOCIO-POLITICAL CONSIDERATIONS

Refugee Definition

Refugees are people who have had to flee their countries due to war or political unrest. Refugees are often unable to return to their own countries for fear of persecution due to their race, religion, or political view. Refugees are protected by law through the United Nations High Commissioner for Refugees (UNHCR 1946).

In 1990, there were about 30 million refugees and internally displaced people who needed international assistance. By 1993, this number increased to over 43 million (Toole and Waldman 1993). Today there are about 17 million refugees (UNHCR 2004) and 25 million internally displaced people (Global IDP 2005), including 5.5 million children (WHO 2002b).

A typical ration or food basket provided by an aid agency to a refugee population should consist of foods that are high in nutritional value and in accordance with the religious and cultural traditions of the populations. It must also consider foods that are taboo for pregnant or lactating mothers (Sphere 2004).

Burmese Refugees in Thailand

In Thailand, 10,000 Burmese refugees arrived in 1984, and the Thai government allowed them to set up housing. The Thai government contacted humanitarian agencies to provide assistance to the refugees.

The Burmese Border Consortium (BBC) is a consortium of humanitarian agencies who came together to help the Burmese refugees in 1984. The BBC provides food, water, shelter, blankets, cooking and cleaning supplies. Their goal is: "To alleviate malnutrition and food insecurity brought about by the ongoing conflict in Burma and provide the basic human needs of displaced persons along the Thailand/Burma border" (BBC 2003).

In the 1990s there were 34 refugee camps. The Thai government reduced the number to ten in 1997. Of the ten remaining camps the three most northern are Karenni; Ban Kwai, Ban Mai Bai Soi and Ban Mae Surin. Approximately 22,000 people live in these camps that border the Karenni state of Burma (BBC 2003).

There are seven camps where predominantly Karen refugees live, directly across the border of the Karen and Mon states in Burma; Mae Kong Kha, Mae Ra Ma Luang, Mae La, Umpiem Mai, Nu Po, Ban Dong Yang, and Tham Hin. There are approximately 115,000 people living in these camps (BBC 2003).

The total number of refugees in the ten camps dependent on the BBC for food rations is approximately 125,000. Including resettlement camps on the Burmese side of the border, an unregistered site in Thailand, and a student center, the number of people at least partially dependent on BBC food baskets totals over 138,000 (BBC 2003) (Figure 2.1.).

It is estimated that 1,000 new refugees enter Thailand from Burma every month (BBC 2003). In 2000, the Thai government restricted admission to Burmese fleeing conflict, not those fleeing human rights violations (USCR 2001).

Between May 1999 and December 2002, the United Nations High Commissioner on Refugees counted 29,067 Burmese who applied for permission to live in Thailand. Of that number, only 41% were admitted and 24% are waiting for consideration. The 10,448 people who were turned away had valid worries of being arrested back in Burma. Concern was heightened for these people who were of Karen origin but were being returned to a Mon cease-fire area (BBC 2003).

Food Scarcity/Human Rights Abuse in Burma

An Asian Human Rights Commission (AHRC) statement claims the hunger situation in Burma has not changed in 100 years (AHRC 1999). AHRC alleges that there is evidence that millions of people in Burma are hungry. It has identified seven factors that cause hunger, even outside of the civil war areas, including forced labor and paddy quotas (AHRC 1999).

The government forces rice farmers to sell rice to the army at a discounted price from the market price, called a "rice tax". The amount of rice to be sold to the government is not calculated on the farmer's harvest, but on arable land. If a farmer's crop does not yield a complete crop, or if some of the land has poor quality soil, he/she still has to provide the government with the same amount of rice. If farmers produce insufficient rice, they have to go to the market, pay full price for rice and then sell it to the military for half the market price. When rice farmers have a bad crop, they risk being tortured by the police for missing their quota. If there is resistance, the military capture, torture, rape and use forced labor (AHRC 1999).

An informant from the Karen state reported that the military came into his village and ate their pigs and chickens. Whatever they could not eat, they killed and whatever rice they could not carry, they set afire. The rationale for destroying the food is that it would be used to feed traitors. The informant said that his children had malaria and diarrhea. He is now in a refugee camp and feels that he would have died of starvation or disease if had he stayed in his village (AHRC 1999).

A Burmese villager reported that some people in the countryside are eating only porridge, others sweet potatoes or bamboo shoots, and still others just the water skimmed off boiled rice. Some people eat nothing so that their children can eat. These children are suffering from diarrhea, sore stomachs, and death (AHRC 1999).

Burmese Diet

Rice accounts for about half of the agricultural output in Burma. Other crops are corn, peanuts, beans, and sugarcane. Approximately 60% of the population works in agriculture and forestry (CIA 2001).

When the Burmese first arrived in Thailand in 1984, the BBC asked what foods the refugees needed to get them through the winter months. They replied, “Rice.” When they were asked what else they needed, they said, “More rice.” They had to leave Burma in a hurry and they could not take enough of their main staple, rice (personal correspondence with Dunford, J., Director, BBC 2002).

APPENDIX C
APPROVAL PROCESS

In November 2001, contact was first made with a Registered Dietitian (RD), Andrea Menefee, MPH, at a non-governmental organization, the Burmese Border Consortium (BBC) in Bangkok, Thailand. Approval for the author to intern from the University of Hawai'i to participate in a rapid nutrition survey was granted by the BBC in December 2001. Two months before the survey, the refugee camp entry visa application process began. Five weeks before the survey, Andrea Menefee sent letters to camp leaders, non-governmental agencies responsible for camps, and Thailand's Ministry of Interior. The letters described the survey and requested permission to conduct it. Since the study was non-invasive, no further approval was needed from any Thai institution regarding human studies in Thailand.

APPENDIX D
RAPID NUTRITION SURVEY QUESTIONNAIRE

Burmese Border Consortium 2002

OK TO SURVEY: ☐ 0. No တနၢ်ဘၣ်. ☐ 1. Yes နၢ်ဘၣ်.

Questionnaire for Children 6 – 59 months
တၢ်သံကွၢ်လၢဖိသၣ်(၆)လါတုၤ(၅၉)နံၣ်အဂီၢ်

ID Number နီၣ်ဂံၢ်____________ **Camp** ခဲတြီ____________

1. Child's name ဖိသၣ်အမံၤ________________________
   Zone/section ဒိၣ်–ကဝီၤ____________ House number ဟံၣ်နီၣ်ဂံၢ်____________

2. Child's sex ဖိသၣ်မုၣ်.ခွါ ( ) 1. male ခွါ ( ) 2. female မုၣ်

   Age သးနံၣ်________ years နံၣ် ________ months လါ total age in months ________

   Date of Birth အိၣ်ဖျဲၣ်မုၢ်နံၤ________ day သီ ________ month လါ ________ year နံၣ်
   ( ) 9. don't know တသ့ၣ်ညါဘၣ်.

3. Birth-weight အိၣ်ဖျဲၣ်သိစါအတယၢၢ်တၢ________ kg ဂရမ် ( ) 9. don't know တသ့ၣ်ညါဘၣ်.

4. Age (months) when first received ration foods သးနံၣ်ဖဲမၤနၢ်တၢ်အီၣ်စကူသးနံၣ်အလါ
   ____________ months လါ ( ) 9. *not yet started* တနၢ်ဘၣ်ဒံဘၣ်.

5. Age (months) when child first started eating any type of food ဖိသၣ်အသးနံၣ်ဖဲစးထိၣ်အီၣ်တၢ်အီၣ်တမံၤမံၤအဂီၢ်
   ____________ months လါ ( ) 9. not yet started တစးထိၣ်ဒံဘၣ်.

6. Age when child stopped breastfeeding completely ဖိသၣ်အသးနံၣ်ဖဲပတှၣ်ကွံၣ်အီၣ်မိၢ်နၢ်ထံ
   ____________ months လါ ( ) 9. still breastfeeding အီၣ်နၢ်အဖၢမုၢ်

7. Number of meals (not snacks) normally eaten/day ညီနုၢ်အီၣ်တၢ်အီၣ်လၢတနံၤတီၢ်ပူၤ.(တၢ်အီၣ်ဆံးကိာ်)

   ☐ 0 ☐ 1 ၁ ☐ 2 ၂ ☐ 3 ၃ ☐ 4 or more ၄ မ့တမ့ၢ်အါန့ၢ်

7.1 Foods child usually eats (can be more than one) တၢ်အီၣ်လၢဖိသၣ်အီၣ်ညီနုၢ်(ကအါန့ၢ်တခါ)

   ☐ rice မ့ၤ ☐ rice soup မ့ၤချံ ☐ beans ဝဲ ☐ fruit တၢ်သ့တၢ်သၣ်
   ☐ vegetable တၢ်ဒိးတၢ်လဲၣ် ☐ eggs ဆီဒံၣ် ☐ meat/fish တၢ်ဖံးတၢ်ညၣ်,ညၣ် ☐ oil သိ
   ☐ other (like milk...) တၢ်အဂၤ(တၢ်နၢ်ထံ)____________

8. Does child receive supplementary food? မ့ၢ်ဖိသၣ်နၢ်ဘၣ်တၢ်အီၣ်အဂၤလၢတၢ်ဆါဟံၣ်တမံၤမံၤဓါ.

   ☐ 0. No တနၢ်ဘၣ်. ☐ 1. Yes နၢ်ဘၣ်.

9. Within this month, has child been ill? တလါအံၤအတီၢ်ပူၤဖိသၣ်ဆါကွဲအိၣ်ဓါ.

   ☐ 0. No တဆါကွဲဘၣ်. ☐ 1. Yes ဆါကွဲ.

   9.1 If yes, was the illness serious? (eg malaria, acute diarrhea, pneumonia, had to go to clinic...)
   ဖဲ၉.၂မ့ၢ်ဆါကွဲနၣ်မ့ၢ်အဆါကဖးနးညါဓါ. (အဒိ,တၢ်ညဉ်ဂီၢ်,တၢ်ဟာဖၢလူပသိၣ်တၢ်ဖှၣ်ဘၣ်,ဘၣ်လဲၤလၢတၢ်ဆါဟံၣ်.....)

   ☐ 0. No တအိၣ်ဘၣ်. ☐ 1. Yes အိၣ်.

ID Number နီၣ်ဂံၢ်________________ **Camp** ဒၢကဝီၤ____________

10. Physical Examination ဂ့ၢ်ဒိတၢ်မၤကွၢ်	**0 - Normal** ဝ့ ဘၣ်ဂီၢ်	**Abnormal** တဘၣ်ဂီၢ်
10.1 general appearance တၢ်အိၣ်ဆူၣ်အိၣ်ချ့အတၢ်အိၣ်ဖျါ		( ) 1. overweight ဘီၣ်တလၢ ( ) 2. thin ဃဲၤတလၢ
10.2 hair ခိၣ်သူ		( ) 1. red, dry ဂီၤ,ဃ့ထီ ( ) 2. thin, falls easily ဘ့,လီၤထဲးညီ
10.3 eyes မဲာ်ချံ		( ) 1. Bitot's spots ဘံထီးခံအဖျၢၣ်ဒိ ( ) 2. other ခဲဘူးခဲကၤ,အဂၤ__________
10.4 eyelid (bottom) မဲာ်ချံဖံးဒိလာ်		( ) 1. pale လီၤဝါ
10.5 mouth ကိာ်ပူၤ		( ) 1. wound on both sides ပူၤလိၢ်အိၣ်ခံကပၤလာ် ( ) 2. scar on both sides အစီးဘိၣ်လိၢ်အိၣ်ခံကပၤလိာ်
10.6 nails စုမှၣ်ခီၣ်မှၣ်		( ) 1. pale လီၤဝါ
10.7 skin ဖံးဘ့ၣ်		( ) 1. dry, rough ဃထို,သွဲး ( ) 2. dry, flaky ဃ့,အဖံးလီၤအီး ( ) 3. infection ဘၣ်ကူဘၣ်က်
10.8 edema in arms, legs စုခီၣ်ကဘု		( ) 1. visible signs (refer to clinic) ထံၣ်တၢ်ပနီၣ်သ့,ဆှၢဆူတၢ်ဆါဟံၣ်

11. other အဂၤတဖၣ် ____

NOTE: DO NOT TAKE WEIGHT AND HEIGHT OF MOTHER IF PREGNANT
တၢ်နီၣ်– တဘၣ်ဒိးထွဲထိၣ်ထွဲပှၤမိၢ်ဒၢအတယၢၢ်ဃၤဒီးအထီတဂ့ၤ

HEIGHT အထီ

Ask the mother and child to remove shoes. မိၢ်ဒီးဖိသၣ်ဘ့ၣ်လီၤခီၣ်ဖံး

16. Height of child ဖိသၣ်အထီ________________________cm

17. Height of mother မိၢ်အထီ________________________cm

WEIGHT အတယၢၢ်ဃၤ

Ask mother and child to remove shoes and any extra clothing (bag, belt, hat, etc.)
မၤမိၢ်ဒီးဖိသၣ်လီၤခီၣ်ဖံးတၢ်ကူတၢ်ကၤတဖၣ်(ထၢၣ်,ယီၢ်တကွီၤ,ခိၣ်ဖြိၣ်,အဂၤတဖၣ်)

Scale number စဲၤထိၢ်နီၣ်ဂံၢ် ☐ 1 ☐ 2

12. Weight of child ဖိသၣ်အတယၢၢ်ဃၤ______________Kg scale error စဲၤထိၢ်ကမၣ်____________

13. Weight of mother မိၢ်အတယၢၢ်ဃၤ______________Kg scale error စဲၤထိၢ်ကမၣ်____________

14. Weight of mother/other adult + child ____________Kg scale error စဲၤထိၢ်ကမၣ်____________
 မိၢ်မ့တမ့ၢ်ပှၤသးပှၢ်ဒီးဖိသၣ်အတယၢၢ်ဃၤ

15. Weight of other adult ______________________Kg scale error စဲၤထိၢ်ကမၣ်____________
 (mother not present) ပှၤသးပှၢ်အတယၢၢ်ဃၤ(မိၢ်တဟဲ,တအိၣ်ကတီၢ်)

REFERENCES

Adair, L.S. & Prentice, A.M. (2004) A critical evaluation of the fetal origins hypothesis and its implications for developing countries. J. Nutr. 134:191-193.

Allen, L.H. (2003) Interventions for micronutrient deficiency control in developing countries: past, present and future. J. Nutr. 133:3875S-3878S.

Allen, L.H. & Gillespie, S.R. (2001) Improving child growth: What Works? A Review of the Efficacy and Effectiveness of Nutrition Interventions, United Nations Administrative Committee on Coordination Sub-Committee on Nutrition ACC/SCN: Geneva in collaboration with the Asian Development Bank, Manila pp.1-123.

American Dietetic Association Nutrition Fact Sheets (ADA). (1998) Kid's nutrition needs; breastfeeding and beyond. Accessed on March 14, 2004 at http://www.eatright.org/Public/NutritionInformation/8474_nfs85.cfm?CFID=3784386&CFTOKEN=5462822

Anonymous. Journal of the American Dietetic Association. (2003) Position of the American Dietetic Association: addressing world hunger, malnutrition, and food insecurity. J. Am. Diet. Assoc. 103:8:1046-1057.

Asian Human Rights Commission (AHRC). (1999) People's Tribunal on Food Scarcity and Militarization in Burma. Edited version of Voice of the Hungry Nation, Asian Human Rights Commission (AHRC). Accessed May 2003 at: http://www.foodjustice.net/modules.php?name=Content&pa=showpage&pid=8&cid=5

Banjong, O., Menefee, A., Sranacharoenpong, K., Chittchang, U., Eg-kantrong, P., Bonnpradern, A. & Tamchitipong, S. (2003) Dietary assessment of refugees living in camps: a case study of Mae La Camp, Thailand. UNU Food Nutr. Bull.: 24(4):360-367. Accessed on July 9, 2004 at http://www.unu.edu/unupress/food/fnb24-4-3.pd

Bhaskaram, P. (2002) Micronutrient malnutrition, infection and immunity: an overview. Nutr. Rev. 60: S40-S45.

Black, M.M. (2003) Micronutrient deficiencies and cognitive functioning. J. Nutr. 133: 3927S-3931S.

Blanck, H.M., Bowman, B.A., Serdula, M.K., Khan, L.K., Kohn, W., Woodruff, B.A. & the Bhutanese Refugee Investigation Group. (2002) Angular stomatitis and riboflavin status among adolescent Bhutanese refugees living in southeastern Nepal. Am. J. Clin. Nutr. 76:430-435.

Burmese Border Consortium (BBC). (2001) Camp Rations Summary (updated May 2001). Burmese Border Consortium, Bangkok Thailand.

Burmese Border Consortium (BBC). (2002) Tham Hin (22/04/02), Don Yang (22/04/02) and Umpiem Mai (20/10/02) Fact sheets. Burmese Border Consortium, Bangkok Thailand.

Burmese Border Consortium (BBC). (2003) Burmese Border Consortium Relief Programme January to June 2003. Bangkok Thailand.

Byrd, M.W. (2005) Personal Correspondence; Burmese-American MBA student.

Campbell, D.I. Elia, M. & Lunn, P.G. (2003) Growth faltering in rural Gambian infants is associated with impaired small intestinal barrier function, leading to endotoxemia and systemic inflammation. J. Nutr. 133:1332-1338.

Carvajal, F.D., Alfaro, C.T. & Monge-Rojas, R. (2003) Vitamin A deficiency among preschool children: a re-emerging problem in Costa Rica? Arch. Latin. Nutr. 53(3):267-70 (abs).

Caulfield, L.E., de Onis, M., Blössner, M. & Black, R.E. (2004a) Undernutrition as an underlying cause of child deaths associated with diarrhea, pneumonia, malaria, and measles. Am. J. Clin. Nutr. 80:193-198.

Caulfield, L.E., Richard, S.A & Black, R.E. (2004b) Undernutrition as an underlying cause of malaria morbidity and mortality in children less than five years old. Am. J. Trop. Med. Hyg. 71: 55-63.

Committee for the Coordination of Services to Displaced Persons in Thailand (CCSDPT). (2001) Comparison of malaria and beri beri morbidity rates by camp/month: Annual Health Statistic Report, p. 55 and 61. Bangkok Thailand.

Centers for Disease Control (CDC) National Center for Health Statistics (NCHS) Clinical Growth Charts Set 1 and 2. (2000) Accessed on January 3, 2005 at http://www.cdc.gov/nchs/about/major/nhanes/growthcharts/clinical_charts.htm

Centers for Disease Control and Prevention (CDC). (2004) BMI - Body Mass Index: BMI Calculator. Accessed on April 2, 2005 at http://www.cdc.gov/nccdphp/dnpa/bmi/calc-bmi.htm

Chakravarty, I. & Sinha, R.L. (2002) Prevalence of micronutrient deficiency based on results obtained from the national pilot program on control of micronutrient malnutrition. Nutr. Rev. 60: S53-S58.

CIA World Fact Book. (2001) Burma Government. Accessed on May 27 2003 at http://www.workmall.com/wfb2001/burma/burma_government.html

Coulombier, M., Ducos, M., Henkens, B., Pecoul, M., Philips, M., Rigal, H., Sondorp, E., Spielman, M.-P., Van Dorpe, H. & Zaccharias, R. (1995) Sampling methods and treatment in supplementary feeding programmes: Nutrition Guidelines 1st edition (Arbelot, A., ed.), pp. 49-95. Médecins Sans Frontières, Paris France.

de Onis, M. & Blössner, M. (1997) The international reference population; The World Health Organization Global Database on Child Growth and Malnutrition. WHO/NUT/97.4. World Health Organization, Geneva Switzerland.

de Onis, M. & Blössner, M. (2003) The World Health Organization global database on child growth and malnutrition: methodology and applications. Int. J. Epi. 32:518-526.

de Onis, M., Blössner, M. & Villar, J. (1998) Levels and patterns of intrauterine growth retardation in developing countries. Eur. J. Clin. Nutr. 52: S1.

de Onis, M., Frongillo, E.A. & Blössner, M. (2000) Is malnutrition declining? An analysis of changes in levels of child malnutrition since 1980. Bull. WHO 78:1222-1233. Accessed July 7 2004 at http://www.who.int/nutgrowthdb/00-0688.pdf

de Onis, M. & Habicht, J.P. (1996) Anthropometric reference data for international use: recommendations from a World Health Organization Expert Committee Am. J. Clin. Nutr.; 64: 650 - 658.

de Onis, M., Garza, C. & Habicht, J.P. (1997) Time for a New Growth Reference. Pediatrics 100:e8. Accessed on January 10, 2005 at http://pediatrics.aappublications.org/cgi/content/full/100/5/e8

Delange, F., de Benoist, B., Burgi ,H. & the ICCIDD Working Group. (2002) Determining median urinary iodine concentration that indicates adequate iodine intake at population level. Intl. J. Pub. Health 80:633-6.

Dietary Reference Intakes (DRI). (1997) Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride, pp. 71-145. National Academies Press, National Academy of Sciences, Washington DC.

Dietary Reference Intakes (DRI). (1998) Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline, pp. 199. National Academies Press, National Academy of Sciences, Washington DC.

Dietary Reference Intakes (DRI). (2000a) Vitamin C, Vitamin E, Selenium, and Carotenoids, pp. 95-185. National Academies Press, National Academy of Sciences, Washington DC.

Dietary Reference Intakes (DRI). (2000b) Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc, pp. 82-161 & 207-432. National Academies Press, National Academy of Sciences, Washington DC.

Dietary Reference Intakes (DRI). (2002) Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients), pp. 58, 82-161, 90, 93-206, 519-525. National Academies Press, National Academy of Sciences, Washington DC.

Dunford, J. (2002) Personal correspondence; Director, Burmese Border Consortium. Bangkok Thailand.

El Lozy, M., Herrera, G., Latham, M.C., Mc Gandy, R.B., McCann, M.B. & Stare, F.J. (1980) Nutrition, pp. 27-32. The Upjohn Company, Kalamazoo MI.

Food and Nutrition Technical Assistance (FANTA) Project. (2003) Anthropometric evaluation and annual monitoring indicators and Comparison of anthropometric data to reference standards: Anthropometric Indicators Measurement Guide (2003 revised edition), pp. 10-13 and 39-42. Accessed January 13, 2004 at:http://www.fantaproject.org

Fernandez, I.D., Himes, J.H., & de Onis, M. (2002) Prevalence of nutritional wasting in populations: building explanatory models using secondary data. Bull. WHO: (4) 282-291 Accessed on May 16 2003 at http://www.scielosp.org/scielo.php?script=sci_arttext&pid=S0042-96862002000400006&lng=en&nrm=iso&tlng=en

Fidler, M.C., Davidsson, L., Walczyk, T. & Hurrell, R.F. (2003) Iron absorption from fish sauce and soy sauce fortified with sodium iron EDTA. Am. J. Clin. Nutr. 78:274-278.

Food Systems of Refugees Living in Camps: A case study of refugees from Burma; Mae La Camp, Mae Sot District, Tak Province, Thailand. (2001) Institute of Nutrition at Mahidol University and Burmese Border Consortium, Bangkok Thailand.

Frongillo E.A. Jr., de Onis, M. & Hanson, K.M.P. (1997) Socioeconomic and demographic factors are associated with worldwide patterns of stunting and wasting of children. J. Nutr. 127: 2302-2309.

Global IDP Project (2005). Internal Displacement: A Global Overview of Trends and Developments in 2003; Global Overview. Accessed on March 12, 2005 at http://www.idpproject.org/global_overview.htm

Golden, M.H.N. & Briend, A. (1993) Treatment of malnutrition in refugee camps. Lancet 342(8867):360-362.

Golden, M.H.N. (2002) The development of concepts of malnutrition. J. Nutr. 132:2117S-2122S.

Gopalan, C. (1975) Protein versus calories in the treatment of protein-calorie malnutrition: metabolic and population studies in India. In Protein-Calorie Malnutrition, Nutrition Foundation Monograph series (Olson, RE., ed), pp. 330-341. Academic Press, New York NY.

Gorstein, J., Sullivan, K., Yip, R., de Onis, M., Trowbridge, F., Fajans, P., & Clugston, G. (1994) Issues in the assessment of nutritional status using anthropometry Bull. WHO 72: 273-283.

Griffin, I.J., Reid, M.M., McCormick, K.P.B. & Cooke, R.J. (2002) Zinc protoporphyrin/haem ratio and plasma ferritin in preterm infants. Arch. Dis. Child. Fetal and Neonatal Ed. 87:F49-F51. Accessed on January 15, 2004, at http://adc.bmjjournals.com/cgi/content/full/fetalneonatal%3b87/1/F49

Grillenberger, M., Neumann, C.G., Murphy, S., Bwibi, N.O., van't Veer, P., Hautvast, J.G.A.J. & West, C.E. (2003) Food Supplements have a positive impact on weight gain and the addition of animal source foods increases lean body mass of Kenyan schoolchildren. J. Nutr. 133:3957S-3964S.

Grubesic, R.B. & Selwyn, B.J. (2003) Vitamin A supplementation and health outcomes for children in Nepal. J. Nurs. Scholar. 35(1):15-20 (abs).

Hayes, K.C. & Hegsted, D.M. (1973) Toxicity of the vitamins. In Toxicants Occurring Naturally in Foods, pp. 258. National Academy of Sciences, Washington DC.

Jelliffe, D.B. (1966) Special problems in different groups: The Assessment of the Nutritional Status of the Community (with special reference to field surveys in developing regions of the world), WHO Monograph Ser. #53, pp. 176-218. World Health Organization, Geneva Switzerland.

Jones, G., Steketee, R.W., Black, R.E., Bhutta, Z.A., Morris, S.S. & the Bellagio Child Survival Study Group. (2003) How many child deaths can we prevent this year? Lancet 362: 65-71.

Kemmer, T. M., Bovill, M.M., Kongsomboon, W., Hansch, S. J., Geisler, K.L., Cheney, C., Shell-Duncan, B. K. & Drewnowski, A. (2003) Iron deficiency is unacceptably high in refugee children from Burma. J. Nutr. 133: 4143-4149.

Kemmer, T.M. (2001) Report from the Thai Red Cross Society and the University of Washington Collaborative Nutrition Assessment Study.

Keys, A., Brozek, J., Henshchel, A., Mickelson, O. & Taylor, H.L. (1950) Human Starvation volume I - II, pp. 1-1065. North Central Publishing Company, St. Paul MS.

Kiely, J.L., Brett, K.M., Yu, S. & Rowley, D.L. (2003) From Data to Action, CDC's public health surveillance for women, infants, and children; birth outcomes, pp. 185-202. Accessed on July 26, 2004 at www.CDC.gov/nccdphp/drh/dotoact/pdf/birouts3.pdf

Kramer, M.S. (2003) The epidemiology of adverse pregnancy outcomes: an overview. J. Nutr. 133:1592S-1596S.

Kurpad, A.V., Regan, M.M., Nazareth, D., Nagaraj, S., Gnanou, J. & Young, V.R. (2003) Intestinal parasites increase the dietary lysine requirement in chronically undernourished Indian men. Am. J. Clin. Nutr. 78:1145-1151.

Kurpad, A.V., Regan, M.M., Varalkshmi, S., Gnanou, J. & Young, V.R. (2004) Daily requirement for total sulfur amino acids of chronically undernourished Indian men. Am. J. Clin. Nutr. 80:95-100.

Lee, R.D. & Nieman, D.C. (1993) Nutritional Assessment, second edition, pp. 1-485. McGraw-Hill Companies, Boston MA.

Lopez de Romana, G. & Gross, R. (2003) IRIS. III: proposal of a multicenter efficacy study using a high-energy, micronutrient-dense spread. Food. Nutr. Bull. 24: S39-41 (abs). Accessed October 21 2004 at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=14564943&dopt=Abstract

Louwman, M.W.J., van Dusseldorp, M., van de Vijver, .FJ.R., Thomas, C.M.G., Schneede, J., Ueland, P.M., Refsum, H., & van Staveren, W.A. (2000) Signs of impaired cognitive function in adolescents with marginal cobalamin status. Am. J. Clin. Nutr. 72:762-769.

Lozoff, B., Jimenez, E., Hagen, J., Mollen, E. & Wolf, A W. (2000) Poorer behavioral and developmental outcome more than 10 years after treatment for iron deficiency in infancy. Pediatrics 105:4 pp.e51. Accessed on April 18, 2004 at www.pediatrics.aappublications.org/

Luxemburger, C., White, N.J., ter Kuile, F., Singh, H.M., Allier-Frachon, I., Ohn, M., Chongsuphajaisiddhi. T. & Nosten, F. (2003) Beri-beri: the major cause of infant mortality in Karen refugees. Trans. R. Soc. Trop. Med. Hyg. 97(2):251-5.

Mason, J.B. (2002) Lessons on Nutrition of Displaced People. J. Nutr. 132:2096S-2103S.

Mason, J.B., Lotfi, M., Dalmiya, N., Sethuraman, K. & Deitchler, M. (2001) Current progress and trends in the control of vitamin A, iodine and iron deficiencies: The Micronutrient Report, pp.1-68. Micronutrient Initiative, Ottawa Canada. Accessed September 4, 2003 at http://www.micronutrient.org/frame_HTML/resource_text/publications/mn_report.pdf

McGready, R., Simpson, J.A., Cho, T., Dubowitz, L., Changbumrung, S., Böhm, V., Munger, R.G., Sauberlich, H.E., White, N.J. & Nosten, F. (2001) Postpartum thiamine deficiency in a Karen displaced population. Am. J. Clin. Nutr. 74:808-813.

Medecins Sans Frontiers (MSF). (2004) Learn more about nutrition. Accessed on January 10, 2005 at http://www.msf.ca/refugeecamp/learnmore/nutrition/index.htm

Menefee, A. (2002) Acute malnutrition rates from survey and supplementary feeding. Statistics report for Tham Hin, Don Yang and Umpiem Mai camps.

Menefee, A. (2002-2005) Personal Correspondence; Nutritionist, Burmese Border Consortium. Bangkok Thailand.

Michaelsen, K.F., Weaver, L., Branca, F., & Robertson, A. (2003) Breastfeeding and alternatives, complementary feeding; Feeding and Nutrition of Infants and Young

Children, Guidelines for the WHO European Region, with emphasis on the former Soviet countries, pp. 140-167 and 181-210. WHO Reg. Pub., Eur. Ser. No. 87.

Mora, J.O. & Nestel, P.S. (2000) Improving prenatal nutrition in developing countries: strategies, prospects, and challenges. Am. J. Clin. Nutr. 71:1353S-1363S.

Moren, A. (1995) Health and nutrition information systems among refugees and displaced persons. Workshop Report on Refugees' Nutrition background document #5 Information Systems, pp. 119-128. EPICENTRE, Paris France.

Moungsookjareoun, A. (2002-2004) Personal Correspondence; Public Health, Burmese Border Consortium. Bangkok Thailand.

Murphy, S.P. & Allen, L.H. (2003) Nutritional importance of animal source foods. J. Nutr. 133: 3932S-3935S.

Neggers, Y. & Goldenberg, R.L. (2003) Some thoughts on body mass index, micronutrient intakes and pregnancy outcome J. Nutr. 133:1737S-1740S.

Neumann, C.G., Bwibo, N.O., Murphy, S.P., Sigman, M., Whaley, S., Allen, L.H., Guthrie, D., Weiss, R.E. & Demment, M. W. (2003) Animal Source Foods Improve Dietary Quality, Micronutrient Status, Growth and Cognitive Function in Kenyan School Children: Background, Study Design and Baseline Findings. J. Nutr. 133:3941S-3949S.

Nogueira de Almeida, C.A., Ricco, R.G., Nogueira, M.P.C., Del Ciampo, L.A. & Mucillo, G. (1999) Comparison of four anthropometric methods of nutritional assessment and evaluation of the agreement between two reference populations. J. Trop. Ped. 45: 345-350.

Onyango, A., Koski, G. & Tucker, K.L. (1998) Food diversity versus breastfeeding choice in determining anthropometric status in rural Kenyan toddlers International Int. J. Epi. 27 (3):484-9.

Peck, R.E., Chuang, M., Robbins, G.E. & Nichman, M.Z. (1981) Nutritional status of Southeast Asian refugee children. Am. J. Pub. Health 71(10):1144-1148.

Pelletier, D.L. & Frongillo, E.A. (2002) Changes in child survival are strongly associated with changes in malnutrition in developing countries. J. Nutr. 133:107-119.

Pelletier, D.L., Frongillo, E.A. Jr., Schroeder, D.G., & Habicht, J-P. (1995) The effects of malnutrition on child mortality in developing countries. Bull. WHO 73:443-448. Accessed on July 8, 2004 at http://whqlibdoc.who.int/bulletin/1995/Vol73-No4/bulletin_1995_73 (4)_443-448.pdf

Peterson, E.A., Roberts, L., Toole, M.J. & Peterson, D.E. (1998) The effect of soap distribution on diarrhoea: Nyamithuthu Refugee Camp. Int. J. Epi. 27(3):520-4.

Prentice, A.M., & Paul, A.A. (2000). Fat and energy needs of children in developing countries. Am. J. Clin. Nutr. 72(5): 1253S-1265S.

Rahman, M., Roy, S.K., Ali, M., Mitra, A.K., Alam, A.N. & Akbar, M.S. (1993) Maternal nutritional status as a determinant of child health. J. Trop. Ped. 39(2):86-8 (abs). Accessed September 29, 2004 at Medline 8492369.

Ramakrishnan, U. (2002) Prevalence of micronutrient malnutrition worldwide. Nutr. Rev. 60: S46-S52.

Recommended Dietary Allowances (RDA). (1989) 10th Edition. Subcommittee on the Tenth Edition of the Recommended Dietary Allowances, Food and Nutrition Board, Commission on Life Sciences, National Research Council.

Riddoch, C.H., Mills, C.F. & Duthie, C.G. (1998) An evaluation of germinating beans as a source of vitamin C in refugee foods. Eur. J. Clin. Nutr. 52:115-118.

Rucker, R.B., Suttie, J.W., McCormick, D.B. & Machlin, LJ. (2001) Handbook of Vitamins, Third Edition, pp. 1-600. Marcel Dekker, Inc. New York NY.

Ruel, M. (2003) Operationalizing dietary diversity: a review of measurement issues and research priorities. J. Nutr. 133: 3911S-3926S.

Ruel, M.T., Pelletier, D.L., Habicht, J-P., Mason, J.B., Chobokoane, C.S. & Maruping, A.P. (1991) Comparison of two growth charts in Lesotho: Health Workers' Ability to understand and use them for action. Am. J. Pub. Health 81(5):610-616.

Scrimshaw, N.S. (2003) Symposium: Nutrition and Infection, Prologue and Progress since 1968: Historical concepts of interactions, synergism and antagonism between nutrition and infection. J. Nutr. 133:316S-321S.

Scrimshaw, N.S., Taylor, C.E. & Gordon, J.E. (1968) Interactions of Nutrition and Infection. World Health Organization Monograph Series No. 57, Belgium.

Scrimshaw, S. & Hurtado, E. (1987) Rapid Assessment Procedures for Nutrition and Primary Health Care; Anthropological Approaches to Improving Programme Effectiveness, pp. 1-70. UCLA Latin American Center Publications.

Selanikio, J.D., Kemmer, T.M., Bovill, M. & Geisler, K. (2002) Mobile computing in the Humanitarian Assistance Setting: An introduction and some first steps. J. Med. Sys. 26(2):113-25.

Seoane, N. & Latham, M.C. (1971) Nutritional Anthropometry in the identification of malnutrition in childhood. Env. Child Health 9:98-104.

Siekman, J.H., Allen, L.H., Bwibo, N.O., Demment, M.W., Murphy, S.P. & Neumann, C.G. (2003) Kenyan schoolchildren have multiple micronutrient deficiencies, but increased plasma vitamin B-12 is the only detectable micronutrient response to meat or milk supplementation. J. Nutr. 133:3972S-3980S.

Simondon, K.B., Simondon, F., Costes, R, Delaunay, V. & Diallo, A. (2001) Breast-feeding is associated with improved growth in length, but nor weight, in rural Senegalese toddlers. Am. J. Clin. Nutr. 73:959-967.

Singh, M. (2004) Role of micronutrients for physical growth and mental development. Ind. J. Ped. 71:59-62. Accessed on Apr 25 2004 at http://www.ijppediatricsindia.org/article.asp?issn=0019-5456;year=2004;volume=71;issue=1;spage=59;epage=62;aulast=Singh

Soares-Wynter, S.Y. & Walker, S.P. (1996) Resting metabolic rate and body composition in stunted and nonstunted children. Am. J. Clin. Nutr. 64:137-141.

Solomons, N.W. & Mazariegos, M. (1995) Body composition in MesoAmerica. Asia Pac. J. Clin. Nutr. 4:59-62.

Spiegel, P., Sheik, M., Gotway-Crawford, C., & Salama, P. (2002) Health programmes and policies associated with decreased mortality in displaced people in postemergency phase camps: a retrospective study. Lancet 360: 1927-33.

Sphere Project. (2004) Minimum standards in food security, nutrition and food aid: Humanitarian Charter and Minimum Standards in Disaster Response revised handbook, pp. 58-90, 138. Accessed May 16, 2003 at http://www.sphereproject.org/handbook/rev_index.htm

Steketee, R.W. (2003) Pregnancy, nutrition and parasitic disease. J. Nutr. 133:1661S-1667S.

Tontisirin, K., & Yamborisut, U. (1995) Appropriate weaning practices and foods to prevent protein-energy malnutrition: An Asian review: Human and Clinical Nutrition. United Nations University Press Food and Nutrition Bulletin16 (1). Accessed on December 21, 2004 at: http://media.payson.tulane.edu:8086/cgi-bin/gw?e=t1c11gsdl-mhl-1-T.6.B.137.1-500-50-00e&q=&d=T.6.B.137.5.1&a=t

Toole, M. (1993) Protecting Refugees' nutrition with food aid; ACC/SCN Statement on Nutrition, Refugees and Displaced Persons. Section IV. Nutrition of Refugees. Accessed on 7/28 at www.unsystems.org/scn/archives/npp12/ch6.htm

Toole, M. (1999) Public health consequences of inaction. In A Framework for Survival, Health, Human Rights and Humanitarian Assistance in Conflicts and Disasters, (Cahill, K., ed.), pp. 13-30. Routledge, London England.

Toole, M.J. (1992) Micronutrient deficiencies in refugees. Lancet 339:1214-1217.

Toole, M.J., Nieburg, P. & Waldman, R.J. (1988) The association between inadequate rations, undernutrition prevalence, and mortality in refugee camps: case studies of refugee populations in Eastern Thailand, 1979-1980, and Eastern Sudan, 1984-1985. J. Trop. Ped. 34:218-223.

Toole, M.J. & Waldman, R.J. (1990) Prevention of excess mortality in refugee and displaced populations in developing countries. J. Am. Med. Assoc. 263 24: 3296-3302.

Toole, M.J, & Waldman, R. (1993) Refugees and displaced persons war, hunger and public health. J. Am. Med. Assoc. 270(5):600-605.

Torlesse, H., Kiess, L. & Bloem, M.W. (2003) Association of household rice expenditure with child nutritional status indicates a role for macroeconomic food policy in combating malnutrition. J. Nutr. 133:1320-1325.

Trowell, H.C. (1954) Kwashiorkor. In Food Scientific American pp. 52-56. W.H. Freeman and Company, San Francisco CA.

Umeta, M., West, C.E., Verhoef, H., Haidar, J. & Hautvast, J.G.A.J. (2003) Factors Associated with Stunting in Infants Aged 5-11 Months in the Dodota-Sire District, Rural Ethiopia. J. Nutr. 133:1064-1069.

Underwood, B. & Hofvander Y. (1982) Appropriate timing for complementary feeding of the breast-fed infant. Acta. Paed. Scan. Supp. 294:1-32.

United Nations Children's Emergency Fund (UNICEF). (1998) The State of the World's Children 1998 Focus on Nutrition: the Silent Emergency. Accessed April 17, 2004 at http://www.unicef.org/sowc98/

United Nations Children's Emergency Fund (UNICEF). (2001) Child Malnutrition. Accessed on May 26, 2004 at http://www.unicef.org/specialsession/about/sgreportpdf/02_ChildMalnutrition_D7341Insert_English.pdf

United Nations Children's Emergency Fund (UNICEF). (2002) Information by country at a glance: Myanmar, Thailand and USA statistics. Accessed on February 4, 2004 at: http://www.unicef.org/infobycountry/

United Nations Children's Emergency Fund (UNICEF). (2004) Vitamin and Mineral Deficiency: A global progress report. Accessed on July 30 2004 at http://www.micronutrient.org/reports/reports/Full_.pdf, pp 1-43.

United Nations High Commissioner on Refugees (UNHCR). (2004) Basic Facts. Accessed on November 12, 2004 at http://www.unhcr.ch/cgi-bin/texis/vtx/basics

United Nations High Commissioner on Refugees (UNHCR). (1946) General Assembly resolutions: Refugees and Displaced Persons (A/RES/62(I)). Accessed on November 8, 2004 at http://www.unhcr.ch/cgi-bin/texis/vtx/home

United Nations High Commissioner on Refugees/World Food Programme (UNHCR/WFP). (2004) Planning a general ration: Joint Assessment Guidelines (with Tools and Resource Materials) First Edition, pp. 177-181. Accessed on November 6, 2004 at http://documents.wfp.org/stellent/groups/public/documents/ena/wfp038210.pdf

United Nations Population Division (UNPD). (2002) World Population Prospects: The 2002 Revision Population Database. Accessed on October 5, 2004 at: http://esa.un.org/unpp/p2k0data.asp

United Nations System Standing Committee on Nutrition (UNS/SCN). (2000) Nutrition throughout the Lifecycle: 4th Report on the World Nutrition Situation.

United Nations System Standing Committee on Nutrition (UNS/SCN). (2004) 5th report on the world nutrition situation. Nutrition for improved development outcomes, annex 7, pp. 1-120.

United States Department of Agriculture (USDA). (2003) National Nutrient Database for Standard Reference, Release 16. Accessed January 26, 2004 at http://www.nal.usda.gov/fnic/cgi-bin/nut_search.pl

US Committee for Refugees (USCR). (2001) Country report: Burma: Worldwide Refugee Information. Accessed on January 27, 2004 at http://www.refugees.org/world/countryrpt/easia_pacific/2001/burma.htm

Van Dusseldorp, M., Schneede, Refsum, H., Ueland, P.M., Thomas, C.M.G., de Boer, E. & van Staveren, W.A. (1999) Risk of persistent cobalamin deficiency in adolescents fed a macrobiotic diet in early life. Am. J. Clin. Nutr. 69:664-671.

Van Loon, H, Saverys, V., Vuylsteke, J.P., Vlietnck, R.F. & Van den Berghe, H. (1987) Screening for marasmus: a discriminant analysis as a guide to choose the anthropometric variables. Am. J. Clin. Nutr. 45:488-493.

Vella, V., Tomkin, A., Borghesi, A., Migliori, G.B., Ndiku, J. & Adriko, B.C. (1993) Anthropometry and childhood mortality in Northwest and Southwest Uganda. Am. J. Pub. Health 83:1616-1618.

Viteri, F.E. & Gonzalez, H. (2002) Adverse outcomes of poor micronutrient status in childhood and adolescence. Nutr. Rev. 60: S77-S83.

Waslien, C.I. & Stewart, L.K. (1994) Nutrition of the Asian adolescent girl. Asia Pac. J. Pub. Health: 31-33.

Waterlow, J.C. (1989) Energy-sparing mechanisms: reductions in body mass, BMR, and activity: their relative importance and priority in undernourished infants and children: Activity, Energy Expenditure and Energy Requirements of Infants and Children. Beat Schürch & Nevin S. Scrimshaw International Dietary Energy Consultancy Group UN ACC/SCN. Accessed on August 10, 2004 at http://www.unu.edu/unupress/food2/UID09E/uid09e00.htm#Contents

Williams, C.D. & Oxon, B.M. (1935) Kwashiorkor a nutritional disease of children associated with a maize diet. Lancet: 1151-1152. Accessed August 18, 2004 at www.scielosp.org/pdf/bwho/v81n12/v81n12a11.pdf

Wood, R. (2000) Assessment of marginal zinc status in humans. J. Nutr. 130:1350S-1354S.

World Food Programme (WFP). (2004) Facts and Figures on Child Hunger. Accessed on November 6, 2004 at http://www.wfp.org/index.asp?section=1who.int/nut/nutrition2.htm

World Health Organization (WHO). (1995) Physical status: the use and interpretation of anthropometry: report of WHO expert committee. WHO Tech. Rept. Ser. No. 854. Geneva Switzerland: WHO. Accessed on July 22, 2004 at http://whqlibdoc.who.int/trs/WHO_TRS_854_(chp5).pdf

World Health Organization (WHO). (2002a) Reducing risks, promoting healthy life: The World Health Report 2002, pp 1-13. World Health Organization, Geneva, Switzerland. Accessed on May 16 2003 at http://www.who.int/whr/2002/Overview_E.pdf

World Health Organization (WHO). (2002b) Global Strategy for Infant and Young Child Feeding. Geneva Switzerland, World Health Assembly. Accessed on January 7, 2005 at http://66.102.7.104/search?q=cache:5b8_hLSlebcJ:www.who.int/nut/documents/gs_infant_feeding_text_eng.pdf+Global+Strategy+on+infant&hl=en

World Health Organization (WHO). (2003) Nutrition. World Health Organization, Geneva, Switzerland. Accessed on July 13, 2004 at http://www.who.int/nut/nutrition2.htm

Yip, R. & Sharp, T.W. (1993) Acute malnutrition and high childhood mortality related to diarrhea; lesson from the 1991 Kurdish refugee crisis. J. Am. Med. Assoc. 270: 587-590.

Zimmerman, M.B. & Kohrle, J. (2002) The Impact of iron and selenium deficiencies on iodine and thyroid metabolism: biochemistry and relevance to public health. Thyroid 10: 867-878.