Reduction of Vitamin A Deficiency Among the Otomí Indians of the State of Querétaro

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Abstract

1995 clinical analysis of the four villages of the Otomí Indians in the State of Querétaro by Texas A&M University students and students of La Universidad Autónoma de Querétaro show that more than 40 percent of the children suffer from one or more clinical signs of vitamin A deficiency. Lack of dietary vitamin A is the most common micronutrient deficiency in Mexico. The primary cause of this deficiency is low dietary in take of vitamin A and reduced nutrient absorption due to measles, diarrhea, and parasitic infections. The most recognized sequelae of vitamin A deficiency is ocular deterioration, insufficient mucous production leading to reduced activity of the immune system, and stunted growth. Clinical assessment of vitamin A deficiency within the indigenous populations of Querétaro has been determined by dietary analysis, night blindness, skin examination and anthropometric measurements. The development of a vitamin A prophylaxis program for the indigenous populations in the State of Querétaro, Mexico, emphasizes the cultural factors influencing the ongoing micronutrient deficiencies in this region. The program aims to maintain long-term integration of vitamin A through dietary modification, nutritional education and short-term capsular supplementation.

for Dr. Bates, who has inspired me and many others to contribute to the global community in a meaningful way

Freedom for indigenous peoples wherever they are - this is my cause. It was not born out of something good; it was born out of wretchedness and bitterness. It has been radicalized by the poverty of my people, the malnutrition that I as an Indian have seen and experienced, the exploitation I have felt in my own flesh, and the oppression that prevents us from performing our sacred ceremonies, showing no respect for the way we are.

At the threshold of the twenty-first century, the struggle of indigenous peoples to gain respect for their rights, identities and aspirations is dynamic and increasingly widespread. It can no longer be denied or hidden by any of the groups seeking to perpetuate oppression or discrimination. The new millennium offers promise for those who have resisted for five hundred years in defense of their rights and their history.

Many people have said that indigenous peoples are myths of the past, ruins that have died. But the indigenous community is not a vestige of the past, nor it is a myth. It is full of vitality and has a course and a future. They have not killed us and they will not kill us now. We are stepping forth to say, "No, we are here. We live."

-Rigoberta Menchú

1992 Nobel Peace Prize Laureate

Foreword to the 1993 book entitled,

Endangered Peoples

by Art Davison

Millions of people suffer and many die from lack of minute traces of nutrients. Methods of prevention are cheap and simple. Their universal application could yield health and economic benefits comparable to those achieved by smallpox eradication

Dr. V Rmamalingaswani, Chair UNDP Task Force on Health
Ending Hunger Conference, Montreal, October 1991.

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Introduction to Vitamin A

History of Vitamin A

In 1913 vitamin A was discovered by McCollum and Davis and 83 years later it continues to be in the spotlight of nutritional and biochemical research around the world (Ross 1991). In 1935, vitamin A's role in vision was documented by George Wald and its relationship to xeropthalmia, commonly referred to as "night blindness," came to be understood. Since these early discoveries, research has shown a variety of ways in which vitamin A affects health.

A Global Perspective on Vitamin A

Unfortunately, vitamin A deficiency is the leading cause of blindness in children under five in the developing world. The World Health Organization estimates that as many as 228 million children are affected subclinically at a severe or moderate level by vitamin A deficiency, and that deficiency of this micronutrient is a problem in more than 75 countries (USAID 1993).

Meta analysis of seven studies completed in 1991 led USAID (United States Aid for International Development), the National Eye Institute, and the World Health Organization, to conclude that, on average, children receiving some form of vitamin A supplementation were 23 percent less likely to die than children not receiving vitamin A within the living conditions. In addition, vitamin A has been linked to decreased severity of illness episodes and lower rates of hospitalization (Beaton 1993).

The downside to vitamin A is the deterioration of the quality of life accompanied by deficiency but, on the other side, it is a preventable and curable health problem. The main challenge to fighting this lies in human hands.

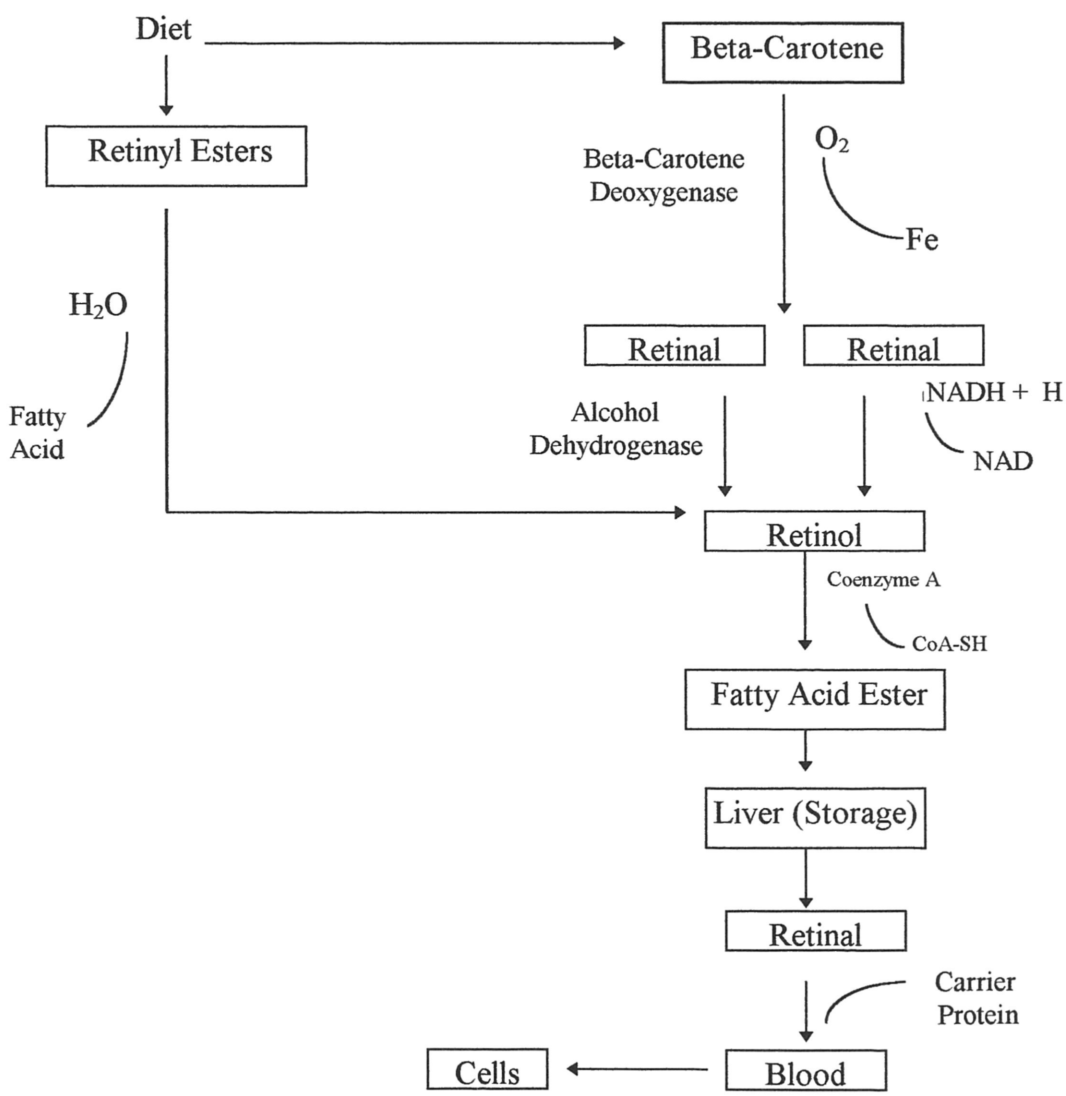
Chemical Properties of Vitamin A

The chemical name for vitamin A, "retinol," was derived from its function relating to the eye and light-dark adaptation. The chemical compound of retinol is a primary alcohol of high molecular weight of 286. It has the formula $C_{20}H_{29}OH$. Retinol is soluble in fat but since it is an organic molecule, it is insoluble in water. Its insolubility in water is related to the potential toxicity of vitamin A which will be discussed later.

The term "vitamin A" is used in reference to both "preformed vitamin A" which comes from animal sources and "provitamin A cartenoids" which come from plant sources. Preformed vitamin A, the biologically active form of retinol, is the only source of vitamin A which occurs naturally and does not need to be chemically converted upon entry into the body. Preformed vitamin A is found in animal sources usually associated with lipids such as eggs and red meat. Vitamin A compounds are deposited primarily in the liver as well as in small amounts in the kidneys, lungs, and adipose tissue as esters of huge chain saturated fatty acids.

The "provitamin A" form of vitamin A is found in the plant derivative known as cartenoids. The most common carotenoid source of retinol for humans is the beta-carotene ($C_{40}H_{56}$) cartenoid. Beta-carotene is one of the three (alpha, beta, and gamma) forms of carotene, all of which are converted into vitamin A upon entry into the body. Beta-carotene provides two thirds of the vitamin A integral to human nutrition and is found in deep green and yellow vegetables. Carotenoids, which refers to any plant sources containing carotene in either of its three forms, must be converted to the retinoid form if to be used as vitamin A which is explained below (Wardlaw and Insel 1993).

Figure 1. Conversion of dietary beta-carotene to retinol (vitamin A) for use by cells (Wardlaw and Insel 1993)



Common Sources of Vitamin A

Preformed vitamin A is found in animal sources. It is found in very high concentrations in vertebrate livers, fresh liver oils, and fish oils, and in moderate amounts in milk and eggs (Olson 1994).

In contrast, preformed vitamin A is found in a variety of fruits and vegetables, including carrots, leafy green vegetables, tomatoes, papayas, asparagus, cantaloupe, mangos, sweet potatoes, carrots, spinach, squash, broccoli, and apricots. Generally it is in all plants containing the deep yellow, green, or red pigments known as carotene.

Being a fat-soluble vitamin, vitamin A is generally less likely to be secreted or lost during different forms of food preparation. For example, the vitamin A content of boiled carrots will be comparable to raw carrots whereas water-soluble vitamins are affected by cooking practices such as boiling or frying (Wardlaw and Insel 1993).

Transport

Once absorbed, vitamin A travels from the lymphatic system to the bloodstream. In the bloodstream, vitamin A is carried by lipoproteins known as VLDLs (very low density lipids) and LDLs (low density lipids) to target cells. The lipoproteins are metabolized by cells lining the bloodstream and the undigested remnants are transported to the liver, where the majority of vitamin A is stored (Wardlaw and Insel 1993).

Cartenoids are absorbed with 40 percent efficiency whereas about half of that is seen for preformed vitamin A. About 30 percent of cartenoids are deposited into adipose cells giving the yellow-orange skin tone characteristic of people fond of carrot juice (Olson 1994).

Vitamin A Storage

The liver is the most efficient organ for vitamin A storage. The liver stores 90 percent of the body's vitamin A. Liver storage and absorption are influenced by age and nutritional status. Malnutrition and reduced immunization status can lead to premature depletion of vitamin A and preclude further decline in health. For example, infectious diseases such as measles and parasites contribute to severe reductions in vitamin A storage and absorption.

Age also plays a role in an individual's ability to maintain sufficient vitamin A storage. Infant to adult development is accompanied by a dramatic increase in the amount of vitamin A absorbed. Thus infants and children are at particularly high risk, in addition to environmental factors, of insufficient vitamin A storage (Wardlaw and Insel 1993).

Metabolism of Vitamin A

In retinoid target tissues, several binding proteins and enzymes mediate the reactions attributed to retinoic homeostasis. The recognition of the retinoid binding protein and retinoid plays a more important role in regulation than do the individual retinoid and binding protein subunits. The CRBP (cellular retinoic acid binding protein) delivers retinal from microsomes to the cytosol and the cellular retinoic acid binding protein (CRABP) retrieves retinoic acid and facilitates its metabolism. The cellular synthesis and transfer of retinoic acid cannot be unrestrictedly coupled - there are cells which do not coexpress the apocellular retinol-binding protein (CRBP) and the cellular retinoic acid binding protein. Synthetic retinoids which bind to the CRABP might increase the steady state concentration of free retinoic acid by displacing the free retinoic acids and interfering with its metabolism (Napoli 1993).

TOXICITY OF VITAMIN A

Since fat-soluble vitamins, such as Vitamin A and E, are not readily broken down by hydrolysis or they are not water soluble, a natural accumulation of vitamin A can occur, and at certain levels can be toxic. Toxicity of vitamin A is known as hypovitaminosis and can occur at three levels: acute, chronic, and tetatogenic which causes fetal deformities (Wardlaw and Insel 1993).

Of grave concern is the implication of excessive intake of preformed vitamin A by pregnant women leading to birth defects. According to a recent study by Rothman et. al. published by the New England Journal of Medicine, pregnant women taking more than 8000 IU of vitamin per day are at risk for fetal defects originating in the cranial nerve crest (Rothman 1995).

Currently the Recommended Daily Allowance (RDA) of vitamin A for women is 800 retinol equivalents or 2700 IU (international units) vitamin A per day (National Research Council 1994). Since preformed vitamin A is available from both micronutrient supplements and animal sources such as eggs and liver, capsular intake needs to be monitored. Eating habits and the frequency at which certain foods are consumed also need to be assessed before a woman is supplemented.

NOMENCLATURE AND EQUIVALENCIES

SI units (μmol/L), more than ever, are being utilized when appropriate in nutritional literature rather than other methods of expression such as the international unit

(IU) which denotes amounts in µg (Olson 1994). Yet it is still common to use weight measures such as µg of vitamin A or carotenoids per volume, often taken as 100 ml of plasma. Unfortunately, the variety of units used results in considerable confusion regarding the appropriate conversion of retinol and carotenoid equivalents to vitamin A equivalents in a nutritional context and vice versa. Plasma retinol concentrations of <10 µg/dL are usually associated with clinical signs of vitamin A deficiency. Concentrations of 10 to 20 µg/dL are associated with Bitot's spots.

Table 1. Common units and equivalent units used to express amounts of micronutrients (Newman 1994)

Unit	Equivalent Unit
1 retinol equivalent (RE)	1 µg all-trans retinol 6 µg all trans beta-carotene 12 µg other provitamin carotenoids 3.33 IU vitamin A activity from retinol 10 IU vitamin A activity from beta-carotene 5 IU vitamin A activity from a mixed diet (50% as retinol and 50% beta-carotene)
1 international unit (IU)	0.30 µg all-tran retinol 0.60 µg all-trans beta-carotene
1 µg retinol 1 µg beta-carotene 1 µg other provitamin A carotenoids	1.0 µg RE / 0.0035 µmol 0.167 µg RE / 0.0019 µmol 0.084 µg RE / 0.0019 µmol
1 µmol retinol 1 µmol beta -carotene 1 µmol other provitamin A carotenoids	286.44 µg retinol 536.85 µg beta-carotene 536.85 µg other provitamin A carotenoids

Table 2. Recommended dietary intakes of vitamin A in retinol equivalents (RE) according to the World Health Organization/ Farming Agriculture Organization (WHO/FAO) and the United States National Research Council (USNRC), 1993

Age (years)	WHO/FAO	
Infants/Children	Basal RE	Safe RE
0-0.5	180	350
0.5-1.0	180	350
1-3	200	400
4-6	200	400
7-10	250	400
10-12	300	500
12-15	350	600
Women		
15-18	330	500
18+	270	500
Pregnant Lactating (mos)	370	600
0-6	400	850
7-11	450	850
12-23	450	850
>24	450	850

Table 3. Farming and Agriculture Organization (FAO) retinol levels indicating vitamin A status (1988)

Indicator of Vitamin A Status			
Vitamin A Status	Serum Retinol (μ g /L)	Serum RBP (mg/L)	Liver Retinol (μ g /g)
Preschool Children			
Deficient	<100	<22	<10
Marginal	100-200	22-26	10-20
Adequate	>200	>26	>20
Adults			
Deficient	<200	—	<10
Marginal	200-300	—	10-20
Adequate	>300	>26	>20

VITAMIN A AND HEALTH

VISION

Ocular deterioration is the most common indicator of vitamin A deficiency. Night blindness, a primary symptom, occurs at the early stages of vitamin A deficiency and is characterized by poor adaptation to the dark. Lack of vitamin A results in insufficient production of rhodopsin in the rods of the retina of the eye which regulates adaptation to light variances.

As the mircronutrient deficiency becomes more severe, abnormal cell growth in the conjunctiva epithelium of the eye causes the small glands of the eye tissues to lose their secretion action and subsequently, dry out. The early signs of the drying of the cornea is referred to as xerosis.

The onset of corneal xerosis often leads to drying, wrinkling, and roughness of the conjunctiva and consequently, infection. Dry, lackluster patches with a triangular, whitish, foamy appearance seen on the conjunctiva at this point in deterioration are known as Bitot spots.

If the deficiency is not treated once Bitot's spots are present, irreparable damage can occur. The Bitot's spots spread over the whole eye and the cornea loses its sensitivity to light and takes on a cloudy appearance vulnerable to the formation of ulcers and permanent scarring of the tissue. The subsequent softening of the cornea is known as keratomalacia and results in total blindness. The process of vitamin A deficiency leading to blindness in its entirety is referred to as xeropthalmia(Wardlaw and Insel 1993).

VITAMIN A AND EPITHELIUM

Vitamin A is essential for maintaining the function of mucous-forming cells which serve as a primary immuno-defense mechanism. Mucous-forming cells play an active role in the lining of the lungs, eyes, gastrointestinal tract, vagina, kidney, urinary tract, and teeth - all epithelial linings by protecting the tissues from foreign substances in two ways: by creating a physical barrier and secreting lysozymes which digest foreign material. Without sufficient vitamin A, epithelia cells become dry and flat and gradually harden to form keratin, a dry, scale-like tissue.

Table 4. Sequelae of Vitamin A Deficiency in Epithelial Systems (Wardlaw and Insel 1993)

Biological System	Physical Manifestation	Subsequent Clinical Conditions
Gastrointestinal Tract	tissues slough off, leaving few villi	vomiting, weight loss from inability to retain food, diarrhea, abdominal pain
Respiratory Tract	nasal passage dries out, cilia are lost, salivary glands dry out, and mouth becomes vulnerable to infection	barrier to infection is removed and respiratory infections occur
Genitourinary Tract	epithelia tissue breaks down resulting in the loss of mucous linings	more inclined to urinary tract infections, vaginal infections, and kidney stones
Teeth	ameloblasts which form the enamel structure of the tooth fail to fully develop	teething process is hindered; later in life can lead to mouth pain, difficulty in eating, and tooth loss
Skin	skin becomes dry and scaly; small, hard, pigmented lumps or pustules of keratin form at hair follicles	*phrynoderma* or "toad's skin" results, the condition affects the skin of the arms, hands, thighs, abdomen and back

VITAMIN A AND IMMUNITY

Active metabolites of vitamin A appear to assist the body's immune response in three ways: maintain production of mucous secreting cells active in the linings of major organs, enhancement of antibody response, and reinforce cell-mediated immunity. As described earlier, vitamin A is essential for the differentiation of epithelial cells. It is the protective secretions of these cells that constitute primary role of vitamin A in the immune response.

Studies in vitamin A deficient humans indicate an abnormality in the production of T lymphocytes, the cells which regulate antibody production by B lymphocytes. Viral antigens which require T lymphocytes to induce a immune response, such as measles, thus are a greater threat to individuals lacking in vitamin A.

In addition to immunity via epithelial linings and antibody response, vitamin A also boosts the cell-mediated inflammatory response to invading antigens. Studies in animals have shown vitamin A to stimulate "nonspecific immunity," the immunity characterized by an increase of the phagocytic activity of the cells involved in the immune response (Nowak 1993).

Vitamin A has an active role in the body's resistance to infectious agents. This fact in itself makes the distribution and availability of vitamin A key to reduction of childhood infections and unnecessary deaths.

Morbidity caused by disease

Mortality the ratio of deaths to population; death rate

as defined by the 1995 Webster's New World Dictionary

AFFECT OF VITAMIN A ON CHILDHOOD MORBIDITY AND MORTALITY

In the past quarter of a century, long-term clinical supplementation programs conducted around the world are exposing the link between childhood morbidity and mortality and vitamin A deficiency. According to Sommer et al., vitamin A deficiency is taking its toll on childhood resistance to infections even before being severe enough to cause xeropthalmia, the major physical symptom linked with diagnosing vitamin A deficiency (1994). With this in mind, the need to treat marginal vitamin A deficiency as well as "at risk" populations becomes a critical role in reducing childhood morbidity and mortality.

According to seven separate clinical trials conducted from 1982 to 1992, vitamin A supplementation can reduce preschool-age child mortality by 19 to 54 percent. A prospective, longitudinal study of 4000 rural preschool children in Indonesia set precedent in 1979 by associating childhood mortality with increasing severity of xeropthalmia. The study estimated that 16 - 20 percent of all preschool deaths were related to vitamin A deficiency in which xeropthalmia was present (Sommer 1994). A subsequent community-based supplementation trial in Indonesia reduced mortality by 34 - 41 percent when all the children who died during the trial were counted regardless if they had received vitamin A or not (Nowak 1993). Prospective analysis suggests the decrease in childhood mortality could be higher than 50 percent if every deficient child had been supplemented. The following table gives an overview of the relation of eight community based trials on preschool mortality.

Vitamin A supplementation and its association with the prevention of death due to diarrhea and measles have been key factors in the contribution to decreased childhood mortality. Meta analysis of randomized controlled trials indicate that supplementation of children with complicated measles with 2000 to 20000 IU daily for two to twenty days can reduce mortality by 60 percent overall and by 90 percent in infants below 1 year old as well as lessen the duration and severity of measles (Nowak 1993). An analysis of dietary vitamin A intake and the incidence of diarrhea and respiratory infection of 28,753

Sudanese children of 6 months to 6 years, a strong inverse relationship was found **(Fawzi, 1211).**

Table 5. Trials investigating the impact of vitamin A supplementation on the death rate of malnourished children adapted from W.W. Fawzi et al. 1993.

Location of trial and Yr. Publish.	Experiment Regimen	Treatment Unit No.	Mortality Rate
Tanzania, 1988	400,000 IU; half on admission, half next day	186 individuals	declined
Cape Town, South Africa, 1990	400,000 IU; half on admission, half next day	189 individuals	declined
Durban, South Africa, 1991	200,000 IU on admission, day 2, and day 8	60 individuals	declined
Aceh, Indonesia, 1986	200,000 IU vitamin A, 40 IU vitamin E per 6 mos.	450 villages	declined
Java, Indonesia, 1988	about 2700 IU vitamin A per g MSG	2 areas	declined
Tamil Nadu, India, 1990	8,333 IU vitamin A, 20 mg vitamin E in peanut oil per wk.	206 clusters	declined
Hyderabad, India, 1990	200,000 IU vitamin A in peanut oil per 6 mos.	84 villages	declined
Sarlahi, Nepal, 1991	200,000 IU vitamin A, 40 IU vitamin E per 4 mos.	261 wards	declined
Jumla, Nepal, 1991	200,000 IU vitamin A once	16 districts	declined
Bombay, India, 1991	200,000 IU vitamin A once	2 slums	declined
Northern Sudan, 1992	200,000 IU vitamin A, 40 IU vitamin E per 6 mos.	16,789 households	declined
Kassena-Nankana, Ghana, 1993	200,000 IU vitamin A once, 40 IU vitamin E per 4 mos	1,455 individuals	declined

Table 6. Likely Impact of Vitamin A Mortality Rate with Respect to Age according to a meta-analysis by Beaton et. al. in 1993

Age (months)	Mortality rate per 1000	Lives saved per 1000 covered
6-11	27.8	6.2
12-23	25.0	5.8
24-35	12.0	2.8
36-47	4.8	1.1
48-59	4.1	0.9

VITAMIN A AND MATERNAL AND CHILD HEALTH

After reviewing a number of past clinical research programs in underdeveloped countries, the combined status of the mother-infant unit in relation to vitamin A took on a new meaning. The mother's role in infant health is the most important factor influencing vitamin A status in the child's first two years of life and can impact the rest of one's quality of life thereafter. The following paragraphs describe the scientific symbiosis of the mother-infant dyad with regards to vitamin A and in chapter three, the maternal and child health trends in four Otomí villages are reviewed.

VITAMIN A FROM MOTHER TO INFANT

Vitamin A is transferred from mother to infant in two ways: via the placenta during gestation and via breastmilk during lactation. Of these two routes, the majority of the vitamin A stored by an infant is transferred via breastmilk. According to Rebecca J. Stoltzfus, PhD., Division of Human Nutrition, School of Hygiene and Public Health at Johns Hopkins University, approximately 60 times more vitamin A is transferred during the first six months of lactation than is absorbed by the fetus during the entire pregnancy (1994).

The fetus requires a limited amount of vitamin A for development of vital organ systems, such as the lungs. As mentioned earlier, large amounts of vitamin A during pregnancy have been shown to be teratogenic in amounts greater than 8000 IU per day. The placenta is self-regulating and unless an exceedingly large dose of vitamin A is consumed, the placenta successfully passes only small, necessary amounts to the fetus. For example, normal weight American infants were found to have liver concentrations of 0.038 umol/g vitamin A. In contrast, infants breastfed were shown to have an estimated intake of 310 umol/g during the first six months of lactation. The placenta is precise and well-regulated with regards to vitamin A transmission (Stoltzfus 1994).

Like the placenta, the mammary glands also play a controlled and vital role in the vitamin A status of an infant. Colostrum, the first fluid secreted by the mammary glands following birth, is particularly abundant in vitamin A, contains approximately 7 umol/L vitamin A and the mature breastmilk of a healthy woman is about 2.3 umol/L vitamin A. The minimal vitamin A concentration suitable for infant nutrient requirements is about 1 umol/L whereas 1.75 umol/L is usually the recommended amount (Stoltzfus 1994). Also, vitamin A of breastmilk is absorbed more readily than external sources due to the digestive enzyme, lipase, found in breastmilk.

Recent research in Indonesia by Stoltzfus et al. 1993 showed children *not* breastfed have a six to eight times greater risk for xeropthalmia. In Bangladesh a study of 2,687 children six months to three years old, breast feeding was shown to confer a 74%

reduction of risk of vitamin A deficiency on the average for children under three years of age (IVACG 1993).

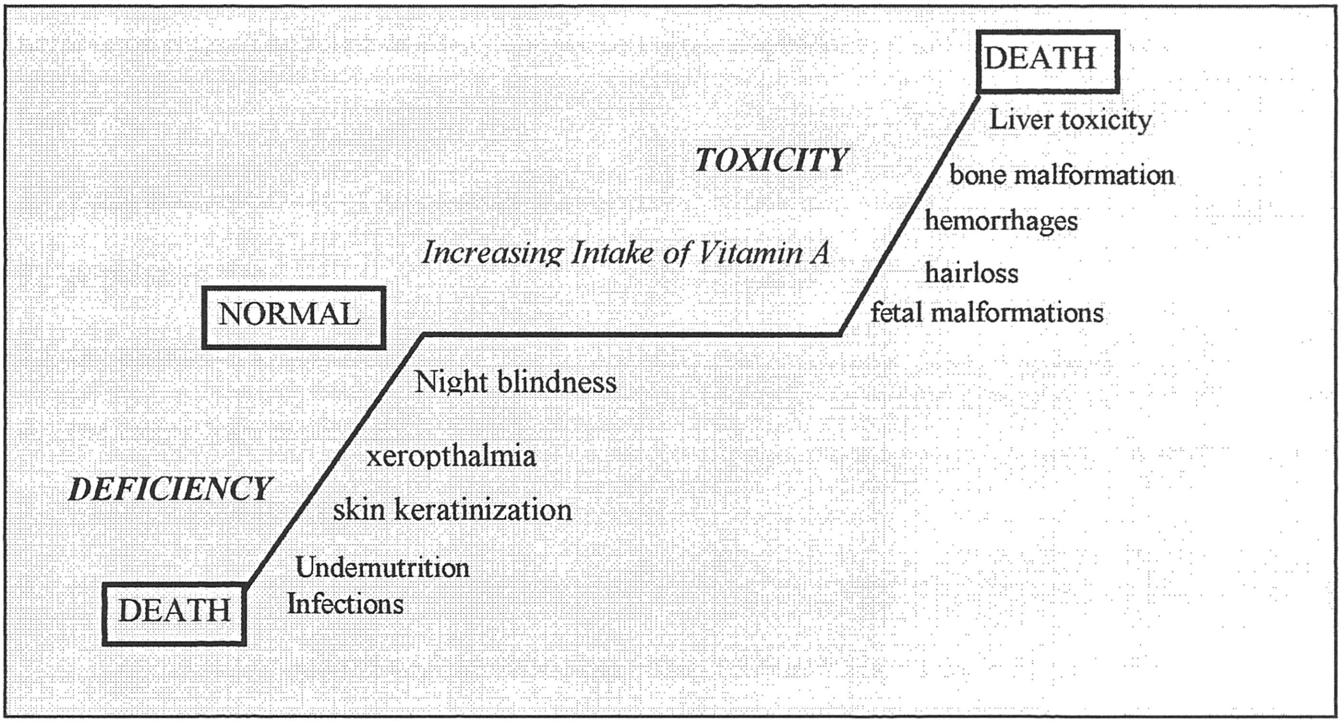
MATERNAL VITAMIN A STATUS

The nutritional status of the mother determines whether the fetus or infant is supplied with an ample amount of vitamin A during gestation and subsequently, lactation.

Animal studies suggest that vitamin A deficient mothers during pregnancy are more likely to give birth to infants with low vitamin A fetal reserves. Human research regarding the consequences of low fetal vitamin A reserves is limited and must be expanded before any solid conclusions can be made. However, studies have shown in both animals and humans that fetal weight gain and insufficient vitamin A reserves are strongly associated. Fortunately, low fetal reserves of vitamin A can be compensated for by a few days of breastfeeeding even under less than optimal nutriture conditions (Stoltzfus 1994). But, if the mother is not breastfeeding, or only breastfeeding for a short time, this becomes an invalid means of compensation as well as a public health concern.

The vitamin A status of the mother determines the content of the breastmilk. An undernourished mother will usually have breastmilk with half the vitamin A content of that of a healthy woman. The observed mean ranges of vitamin A content in breastmilk are 0.4 umol/L to 1.80 umol/L, where about 1 umol/L, as mentioned above, is considered low. The main public health strategy aimed at immediate reduction of the incidence of undernourished mothers giving birth to high-risk infants is vitamin A supplementation of about 5,000 IU daily during pregnancy and postpartum. In the Program Development section, this strategy is further developed.

ASSESSMENT OF VITAMIN A STATUS



The above chart maps out the sequelae of too much vitamin A to too little vitamin A. Five states of vitamin A nutriture exist: deficient, marginal, satisfactory, excessive, and toxic. The deficient and toxic states are clearly defined by clinical signs whereas both the marginal and clinical states show no clinical signs, although such individuals are at greater risk for deficiency or toxicity, respectively.

Clinical, behavioral, biochemical, and dietary indicators have been developed to assess vitamin A status. Recent developments have emphasized differentiating between the marginal and satisfactory threshold of vitamin A status due to recent studies showing the dramatic increase in childhood mortality and morbidity as a result of marginal vitamin A status (Sommer 1994) .

Assessment of vitamin A deficiency within a particular population can be done in a number of ways. The route one may choose to follow depends on a multitude of factors, including,

1. goals and objectives of assessment
2. population size
3. the resources available
4. the technology available
5. willingness of the respondents
6. ethics

Invasive procedures such as collecting serum retinol levels are expensive, timely, and require skilled phlabotomists, whereas the dietary and behavioral analysis is less expensive and more easily administered.

Behavioral Analysis

Behavioral analysis is the easiest way to assess vitamin A status because it does not require technology and it is not invasive (no blood needs to be drawn). For the collection of data regarding the nutritional status of the Otomí Indians of Querétaro, Mexico, during the summer of 1995, behavioral and clinical methods were used. The most revealing of the behavioral methods with respect to overall population is the dietary analysis. Listed below are some common methods for assessing vitamin A status without using serum samples.

A. History of Night blindness A history of night blindness is obtained from the mother or the child. In cultures where vitamin A inadequacy is common, there is often a colloquial term for "night blindness." Deciphering idiomatic language used to describe this condition plays a key role in the visit when working in foreign countries.

B. Vision Restoration Time: The retina is bleached with strong light and the time required for the children to identify letters or objects is assessed.

C. Rapid Dark Adaptation Time After bleaching the retina with strong white light, the time required for individuals to sort objects according to color or locate objects in a darkened room is assessed. The time required for the child to achieve the task is then compared to the time it took for a similar age child with normal dark adaptation to complete the task (Olson 1994).

D. Health History History of past illnesses is taken from child's mother. Specific information regarding parasites, diarrhea, and acute respiratory infections is recorded.

E. Dietary Analysis There are five general types of dietary assessment surveys described by Frances E. Thompson and Tim Byers in the 1994 supplement of the Journal of Nutriton which have been summarized below. According to the survey goals and population needs, one or two of the survey methods described could be used.

1. Dietary Record Method

For the dietary record method, the amounts of beverages and foods consumed over a period of three to four consecutive days are recorded. Consumption is recorded by interviewees around each eating time so as to collect accurate data. The amounts consumed can be indicated with illustrations or reference to common quantities such as a bowl or cup (refer to illustrations on page). The data recorded would include recipes, amounts eaten by each family member, names of each food (brand names if possible), and preparation methods. The data collected can be recorded in a number of ways, i.e. a Dictaphone, questionnaires in open-ended or "checklist" format. The advantages of this method are accuracy and a comprehensive analysis. For this reason, food records are described as the "gold standard" against which other dietary methods are compared. Further, the measurement of foods and food amounts are much more accurate than when the family or individual must recall the foods eaten and in what amount over a few days. On the other hand, this method is time-consuming and relies on the participation of the respondent who must record the information. Thus, in populations with low literacy and lack of motivation to participate, the validity of the information can be questionable. Also, once the data is collected with this method, it must be formatted and organized for analysis which can be time consuming.

2. The 24-Hour Dietary Recall

In the 24-Hour Dietary Recall Method, the respondent is asked to remember and report all the foods and beverages consumed within the household over the past 24-hours. The recall is recorded by the interviewer who should be well-trained in standardized diet assessment as well as familiar with the language, regional foods, and food preparation techniques of the target population. The interviewer plays a strong role in the collection of accurate information and improves accuracy of data by *probing*. Probing refers to extensive questioning in regards to food amounts, preparation, and allocation of foods to each family member. Interviewers must be trained to probe in a standardized and structured manner so as not to be misleading.

An advantage to the 24-hour dietary assessment method is that respondents are not required to be literate and are not provided with written information. Since this method focuses on only the past 24 hours, the recall interview is usually short. The interviewer can control the amount of detail recorded, for example, if vitamin A is the focus, then the interviewer can focus the recall towards vitamin A containing foods.

Disadvantages include the fact that diet varies day to day and only a 24-hour period is used to characterize an individual's diet. Past comparisons between the 24-hour recall method and dietary record method show mixed results, some showing similar estimates of dietary intake and others showing disparity.

3. Food Frequency Method

The food frequency method asks respondents to report their usual frequency of consumption of each food from a list of foods for a specific period (refer to questionnaire in Appendix A). Usually only frequency of food consumption is collected, not quantity nor method of preparation. Overall nutrient intake estimates are derived by summing over the products of reported frequency of each food by the amount of nutrient in a specified serving of that food.

The food frequency method allows one to gather an overall picture of the respondent's usual intake of foods. The method relies heavily on the ideology that the usual intake outweighs the amount of intake. There are computer programs which have made food frequency a quick and inexpensive method for estimating usual dietary intake.

The limitations of the food frequency method include lack of information regarding quantities consumed. And results can often be misleading if there are inaccuracies in the listing of foods or overrepresentation of certain foods. The validity of food frequency results should be regarded as approximations or estimates. The results give a much more accurate overview of food intake and nutrient intake rather than the *levels* of intake. A food frequency list should be comprehensive and applicable to the population being surveyed.

4. Brief Assessment Methods

Brief dietary assessment methods are quick methods useful for measuring dietary intake of specific sub-populations of an overall target population. This method may be a simplified food frequency survey or may focus on eating behaviors other than frequency of intake. Surveys are often simplified, only demanding a "yes" or "no" reply from the interviewee. For example, children under the age of 6 with symptoms of night-blindness could be assessed quickly by a food-frequency survey focusing on the dietary intake of foods high in vitamin A.

This method is quick and cost-effective allowing for quick assessment and subsequent implementation of an intervention program. On the other hand, these brief assessments have brief half-lives which do not represent the given population for a long period of time - they are very of the moment.

5. Diet History Method

The diet history method refers to the collection of information regarding not only the frequency of uptake and amount of food intake but also details regarding the make-up of meals and food preparation. The Burke diet history (Burke being the individual who coined the term "diet history") includes three elements: detailed interview of usual eating patterns, a food list asking amount and frequency usually eaten, and a 3-day diet record. The detailed interview is the central feature of the Burke diet history, with a food frequency checklist and the 3-day diet record used as cross checks of the history.

The major strength of the diet history method is its assessment of the usual meal patterns and details of food intake rather than intakes for a short period of time or only frequency of food consumption. Also details about how the foods are prepared provide for better assessment of nutrient intake (e.g. frying vs. baking), and the joint effects of foods eaten together.

The disadvantage to this method is that respondents are asked to make many judgments about the usual foods and the amounts of these foods eaten. The need for accurate information requires an interviewer trained in dietary nutrition.

When choosing a method of dietary analysis, one must focus on the primary research question and the issues of secondary interest influencing the principal concern. In this case, the primary goal of carrying out a dietary assessment of the indigenous populations of the State of Querétaro, Mexico, is to assess the vitamin A intake and vitamin A status of children below the age of 12 and women within reproductive age. The secondary diet issues which influence vitamin A status are the eating behaviors and food sources of the indigenous populations.

Clinical Indicators

Clinical assessment involves documenting the presence or absence of functional signs of vitamin A deficiency. Early clinical signs of lack of vitamin A include loss of appetite, stunted growth, and impaired immune response with a decreased resistance to infections. Night blindness develops when liver reserves of vitamin A are almost exhausted. Ocular deterioration such as abnormal dryness of the conjunctiva, corneal xerosis, Bitot's spots, and irreversible keratomalacia, are all symptoms of "night blindness" or xeropthalmia.

Clinical assessment is a "hands on" assessment of vitamin A status which does not require intensive training nor serum samples. On the other hand, clinical methods do not necessarily reveal which individuals are of marginal vitamin A status and not yet showing visible symptoms of deficiency. Below three methods of clinical assessment are briefly described.

1. Detection of Xeropthalmia Both eyes are examined for dryness, lesions due to infections, and scarring of the eye (Sommer 1994).

2. Follicular Hyperkeratosis Dry skin with a rough, spiky appearance and altered pigmentation.

3. Physical Development: Height and weight combined with sex and age yield anthropometric indices revealing the stunting and malnutrition. Teeth and cranial bone development.

SERUM RELATED INDICATORS

Serum levels of vitamin A are the most common used biochemical technique to measure vitamin A status, even though the results are highly regulated by each individual physiologically. Unfortunately, serum levels are predicative of only critically low or highly toxic levels of vitamin A reserves. But, serum distribution curves of random serum levels can be used to compare the status of populations in regards to the probability of the occurrence of vitamin A deficiency. Values less than 20ug/100 (0.70 umol/L) ml are considered low and below 10ug/100ml (0.35 umol/L) are considered deficient. Generally, when a total of 15% of the population is in the low range or 5% is in the deficient range, a serious public health concern exists. However, one must keep in mind the criteria for vitamin A status varies with age and gender and the above criteria is not definitive, only generalized (Olson 1993).

Serum levels of vitamin A tend to be more indicative of an individual's status when two serum levels are obtained before and after vitamin A supplementation. This way, the attainment of an individual's homeostatic level is indicated by the second serum sample. From an ethical perspective, this protocol allows vitamin A intervention programs to assess their "success."

Two alternate biochemical methods known as the relative-dose response and the modified relative dose response have proven more useful in determining marginal vitamin A status. The relative dose-response (RDR) Blood samples are obtained before and after a 3.5 *u*mol (450-1000 ug) oral dose of retinol. The first blood level is taken after x hours of fasting. The second blood test is taken five hours after dosing and following a meal with minimal vitamin A. The blood samples are analyzed for vitamin A and the RDR is calculated using the formula:

$$RDR = \frac{\text{vit } A_5 - \text{vit } A_o \times 100\%}{\text{vit } A_5}$$

where vit A_5 is the serum vitamin A level after five hours and vit A_o is the serum vitamin A level initially. An RDR greater than 20% is indicative of a "positive" RDR or, in other words, inadequate hepatic vitamin A denoting marginal vitamin A status. A positive RDR occurs when hepatic levels of vitamin A are less than 20 ug/g or 0.07 umol/g (Underwood 1990)

As liver reserves of vitamin A become depleted due to low dietary intake of vitamin A, a build up of retinol binding proteins (RBP) occurs. The accumulation of free RBP is proportional to the scarcity of dietary vitamin A in the body. Exogenous vitamin A in the form of oral retinol, binds free retinol binding proteins in an amount of time relative to the amount of free RBP. Thus, before and after serum vitamin A tests provide a dynamic and precise manner in which to determine serum vitamin A status (Underwood 1990).

The modified relative dose response (MRDR) is a modified version of the RDR, as the name indicates. This evaluation uses dehydroretinol and only requires one blood test five hours after dosing. For the MRDR, a high-performance liquid chromatography is required and dehydroretinol is less accessible commercially (Underwood 1990).

A fairly new technique described by the INCEPO 1988 training manual in vitamin A assessment by impression cytology was developed to diagnose vitamin A status via the eye. This method is known as the conjunctiva impression cytology (CIC) test. The underlying principle of this method is to evaluate the morphology of the epithelial cells of the conjunctiva which are affected by inadequate vitamin A nurtriture. A strip of cellulose filter paper is touched to the conjunctiva of each eye, removed, fixed, stained, and evaluated for "normal histology" on a standardized and graded scale. The CIC method measures the decrease in goblet cells and the derangement of epithelia on the conjunctiva of the eye (Underwood 1990).

In order to obtain useful histological evaluations of vitamin A status in terms of conjunctiva impression cytology, an adequate number of cells must be obtained from the conjunctiva. This can prove difficult in children under three years of age as well as in populations already suffering from conjunctiva infections (Underwood 1990). The CIC method is an invasive procedure in which skilled health care workers and laboratory equipment are required and useful for a limited population.

Other Serum Assessment Procedures

The isotope dilution method is used to estimate the total body reserves of vitamin A. As described by Furre et al in a 1989 protocol write up, an isotope-labeled vitamin A is administered and mixes with the body stores of vitamin A. Then the amount of the labeled vitamin A in the blood, relative to the amount administered, is used to calculate the total body amount of vitamin A, assuming a constant proportion is stored in the liver. This method is expensive and requires the difficult to obtain isotopes as well as high-cost instruments such as high power liquid chromatography (HPLC) and mass spectrometry (Underwood 1990).

An extreme method, liver biopsy, would only be recommended when concurrent biopsies are needed for diagnostic purposes. Since the liver stores approximately 90% of the total body reserve of vitamin A, biopsy may be used to estimate vitamin A status (). Ethical reasons make this a less viable alternative method (Newman 1994).

THE NUTRIONAL STATUS OF THE OTOMI INDIANS

History of the Otomi Indians in Mexico

The Otomí people are only one view of the kaleidoscope of indigenous culture of Mexico. The Otomí, located primarily in the mountainous region of central Mexico, carry on their traditional lifestyle and language which originated hundreds of years prior to the Spanish conquest of the Spanish in 1519.

Unlike the indigenous peoples of Chiapas and the Yucátan, which are situated in tropical regions, the Otomí Indians live in a mountainous, isolated region of Mexico where the soil is arid and rainfall is minimal. Refer to Appendix G to see a map of Querétaro. The agricultural potential of the land is limited to maize and beans and few, if any, vegetables and fruits. The geographic location of the Otomí also inhibits their access to fresh water. Water is obtained through long journeys on foot and is quite scarce. The poor agricultural conditions and location not only limit the diet of the inhabitants but inhibits their ability to expand economically.

Introduction to Data Collection

The 1995 Texas A&M Study Abroad Group led by Dr. George Bates and a group of students from La Universidad Autónoma de Querétaro conducted an extensive anthropometric and nutrition analysis of Otomí children during the 1995 summer weeks of May 17th until June 30. The data the students collected and compiled is the first of its kind in this area of Mexico. Without the hard work and diligence of these students, there would be little literature regarding the nutritional status of the Otomí people.

ANTHROPOMETRY

Height and weight measurements of children from Otomí communities were analyzed using the Waterflow and Gomez Classification Systems. The Waterflow classification system evaluates height for age, and weight for height, whereas the Gomez classification system evaluates weight for age. The basis for cutoff standards is based on the National Center for Health Statistics (NCHS) in Bethesda, Maryland.

Table 7. Levels of Malnutrition: Percent Median Cutoffs for Classification Systems

Waterflow	
Height for Age	Classification
> 95%	normal
90-95%	mild stunting
85-90%	moderate stunting
<85%	severe stunting

Gomez	
Weight for Age	Classification
> 95%	normal
90-95%	mild wasting
85-90%	moderate wasting
<85%	severe wasting

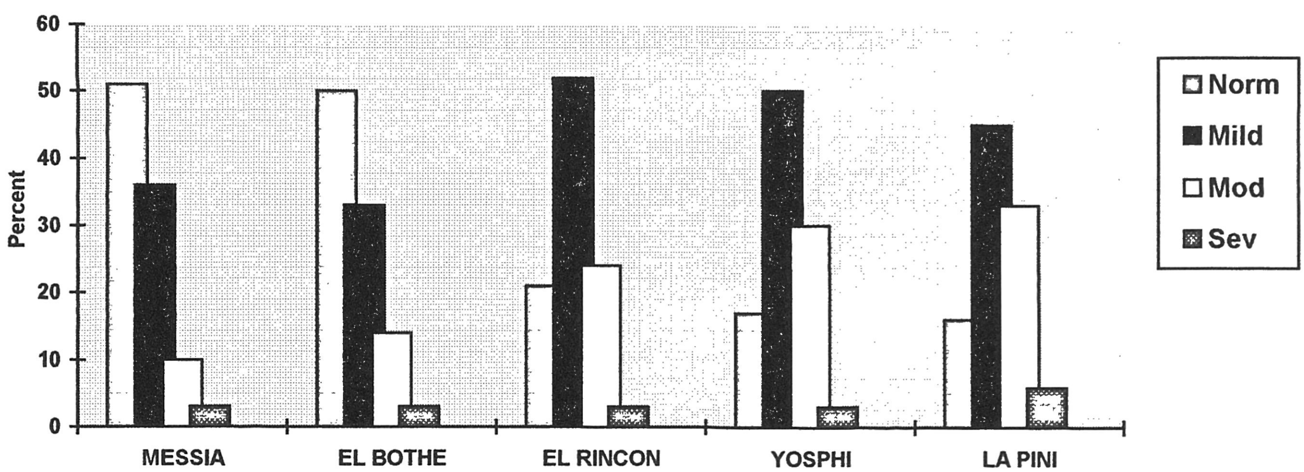
Insufficient height for age is often indicative of chronic protein energy malnutrition (stunting) whereas low weight for age indicates acute energy malnutrition (wasting). Normally, stunting is more difficult to reverse than wasting.

The anthropometric data collected in the Otomí villages was age, height, and weight of children under five years old. A bathroom scale or infantometer was used to measure weight, and a measuring tape was used to determine height. Age was determined by school records or birth certificate when available or by mother's recall. If the birth date was not available, it was assumed that the child's birthday was that day. As hard as it is to believe within American culture, there actually were children with not only approximated birth dates, but approximated ages.

The data from these measurements was analyzed using Epi 6.1, epidemiological computer analysis software developed by the World Health Organization and distributed in the United States by the Centers for Disease Control (CDC). Refer to Appendix A to see the anthropometry survey sheet used.

Two hundred and thity children were weighed and measured in five Otomí communities, Mesilla, El Bothe, El Rincon, Yosphi, and La Pini. Overall, 4 percent of the children suffered from severe stunting and 21 percent suffered from moderate stunting. The prevalence of severe stunting was highest in La Pini with 6 percent, whereas the other four communities each averaged 3 percent stunting. The results are presented below.

Figure 2. Prevalence of Stunting in Mesilla, El Bothe, El Rincon, Yosphi, La Pini, according to the NCHS Standard and the Waterflow Classification.



The purpose of collecting and analyzing anthropometrical data when determining nutritional status is to gauge the prevalence and severity of malnutrition. For example, dietary analysis may provide an estimation of the dietary intake, but cannot be used to predict if the children are growing. Of the anthropometric data collected, the fact that three of the five Otomí communities had less than 25 percent of the children measure at the normal height for their age is shocking. This data in itself indicates the existence of malnutrition and the next three methods employed to assess the nutritional status of the Otomí provide information with respect to vitamin A deficiency.

DIETARY ANALYSIS

The diets of the Otomí children under five years of age of El Bothe, El Rincón, La Mesilla, and La Pini, were assessed with a survey processed by a diet analysis computer software. The survey used to summarize daily eating habits was modeled after a questionnaire developed by the National Institute of Nutrition in Valle de Solis, Mexico. The survey contains a list of foods and vocabulary common to the Otomí. The survey was administered in Spanish to the child's mother and is given in both Spanish and English in Appendix B. A list of the %RDA value of foods eaten by the Otomí can be found in Appendix H.

The survey results were analyzed using a dietary analysis program to determine the approximate percent Recommended Daily Allowance (%RDA) of vitamin A. Also a score measuring vitamin A deficiency or potential development of deficiency was given to each child according to the answers to five questions regarding vitamin A consumption. The scores are ranked according to: 0-40 high risk, 41-100 moderate risk, and >100 low risk.

Review of the dietary survey showed the average diet of the Otomí consisted of corn tortillas, beans, tomatoes, limes, and chiles. Meat, mainly poultry, and milk were consumed on a weekly basis, and fruits and vegetables were eaten about once a month. Analysis of the surveys for micronutrient intake showed vitamin A and iron intake to be low. The graphs below give a nutrition breakdown in relation to the percent Recommended Dietary Allowance and the vitamin A deficiency scoring results for each community surveyed.

Figure 3. Percent Recommended Dietary Allowance (%RDA) of Vitamin A in the diet of Otomi children (RDA is 450 RE

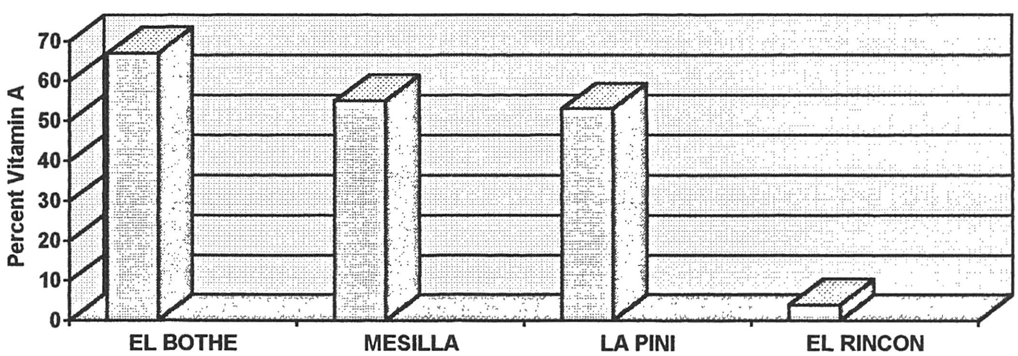
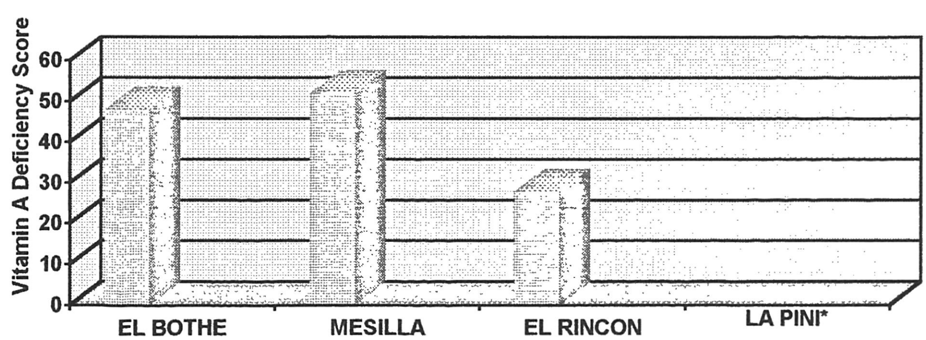


Figure 4. Vitamin A Deficiency Scores for Otomi Villages where 0-40 is high risk, 41-100 is moderate risk, and >100 is low risk of deficiency. Note: Data for La Pini was not collected.



Maternal and Child Health of the Otomi

Maternal and child health was assessed by the Texas A&M University Study Abroad Program and the students of La Universidad Autónoma de Querétaro in the Otomí villages of La Bothe, Mesilla, La Piní, and Yosphi. The questionnaire found in Appendix C was administered to 51 Otomí mothers, 3 of La Piní, 4 of El Bothe, 21 of Mesilla, and 23 of Yosphi. The survey was designed to be simple and brief. Unfortunately, due to the wording of some of the questions, the amount of information and degree of detail varied.

Within rural populations in Mexico, it is not uncommon for adolescent girls to quickly marry and begin a family. The results of the survey showed the average age for the first pregnancy for mothers in villages was between 16 and 20 years old. In the village of El Bothe, all of the four mothers had had their first child between the age of 11 and 15 years old. Not only do mothers begin bearing children young, they are often pregnant the majority of their reproductive years. The mothers of the these four Otomí villages averaged four to seven pregnancies in a lifetime, given not all pregnancies are carried out unto completion or that each child survived once born.

Unlike women in urban areas, the women of the Otomí villages lack access to clinics and doctors for prenatal care and pregnancy services. Of the women surveyed, none visited a doctor on a regular basis and the majority of babies were delivered at home rather than in clinics. Actually, for these women their "prenatal care" was not lifting heavy objects during pregnancy. Many women from this area see a doctor only if a complication associated with their pregnancy arises. These women are isolated culturally as well as geographically from modern health care.

From the nutrition perspective, the diet of a pregnant woman is vital to the livelihood of her children. From the data collected and past investigations in rural Mexico, the diet of pregnant mothers did not significantly change from when she was not pregnant. Although the 1995 survey in Otomí villages was somewhat inconclusive about increases in caloric intake, a 1982 publication by the National Institute of Nutrition in Mexico reports that women from rural areas in Mexico increase their caloric intake on average by 230 calories during pregnancy and by 310 calories during lactation (Chavez and Martinez 1982).

Additional information regarding maternal and child health, such as spontaneous or induced abortion, premature births, and birth weight, was harder to come by since babies were usually not born under medical supervision.

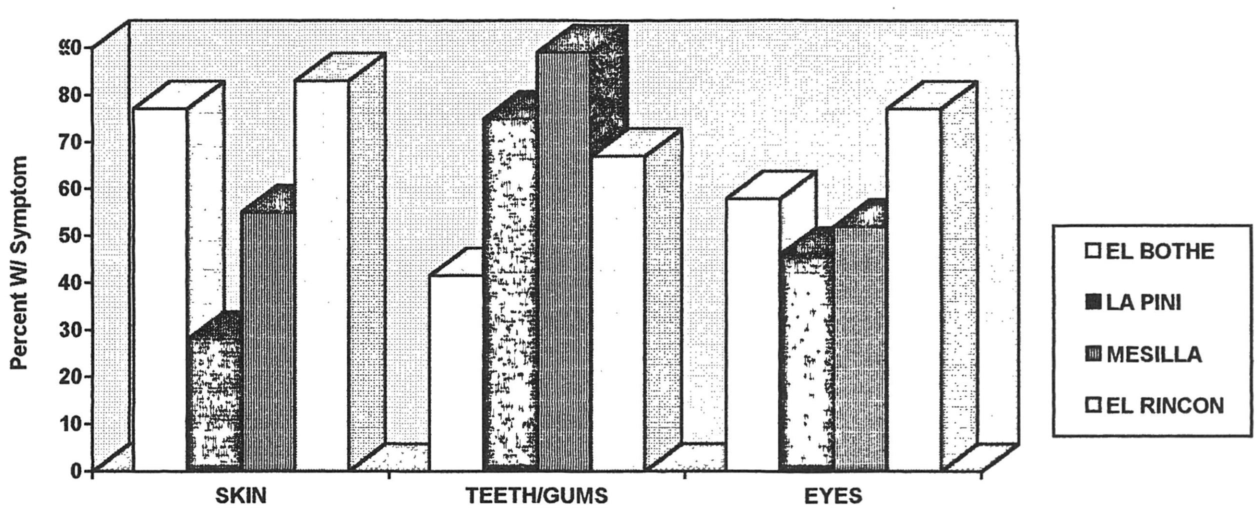
Another area which was emphasized in the survey was lactational habits of Otomí mothers. An average of 51 precent of the mothers in Mesilla, Yosphi, and La Pini, said they beastfed their child(ren) for 12 to 15 months. Although it was not specified, it was assumed that it was *exclusive* breastfeeding. Unfortunately in the last ten years the trend towards formula has made headway in urban as well as rural areas of Mexico (Margen, 1991). Tea and/or water was often introduced while the infant was breastfeeding. In areas, such as these potable water is scarce and the risk of infection in infants increases when unclean water is used in formula.

The information collected by the 1995 Study Abroad and the Mexican students was valuable and a great beginning to assessing the state of the mother infant dyad in rural Otomí villages. Unfortunately language barriers, small sample size, and ambiguous questions in the survey left unanswered questions as well as new ones.

CLINICAL ANALYSIS

The Otomí people of the El Mesilla, El Bothe, El Rincon, and La Pini, were observed for physical signs of vitamin A deficiency. The main physical symptoms used to assess vitamin A deficiency were Bitot's spots (triangular, gray spots on the eyes), kerantinization of skin (horny, dry texture), and cracked and/or decayed teeth. The clinical assessment sheet used can be found in Appendix D and the new clinical assessment sheet subject to approval can be found in Appendix E.

Figure 5. Summary of Clinical Findings in Four Otomi Vilages where Percentages Indicate Number of Children With Symptoms



Overall, the results indicate the most prevalent symptom of vitamin A deficiency was visible in the eyes during examination. The survey classifies any "spots, redness, pale membranes, palpebral fissures, infections on roots of eyelashes" as a symptom of malnutrition. Most often, such symptoms are attributable to lack of vitamin A.

La Pini seems to be the village with the lowest clinical indication of vitamin A deficiency whereas in El Rincon, between 60 to 80 percent of all the children reviewed had clinical symptoms of malnutrition.

The survey designed for the 1996 Study Abroad in Mexico is precise and detailed about specific micronutrient deficiencies and clinical symptoms whereas the 1995 clinical assessment survey was quite vague. The 1996 survey will provide data which can be analyzed in a more comprehensive and valid manner.

The data collected by the 1995 Texas A&M Study Abroad Program and the students of La Universidad Autónoma de Querétaro under the leadership of Dr. George Bates and Faculty of the National Institute of Nutrition in Mexico City and Valle de Solis is an essential part of identifying and eliminating vitamin A deficiency. Fortunately, the involvement of such motivated and educated students in developing and carrying out this research will influence careers in eliminating micronutrient problems such as the one they diagnosed.

REDUCTION OF VITAMIN A DEFICIENCY IN THE STATE OF QUERÉTARO, MEXICO

Introduction to Vitamin A Program

Originally when developing the proposal for my undergraduate thesis, vitamin A supplementation was the main focus. Since long-term assimilation of vitamin A into the day-to-day lives of the Otomí Indians was my main goal, the emphasis on nutrient prophylaxis proved contradictory. After a few months of research and my trip to Mexico, I came to the realization that supplementation was only a facet of a multi-step process to eliminate endemic vitamin A deficiency. In fact, the project I have designed involves dietary modification, breastfeeding promotion, public health intervention, and nutritional education, in addition to capsular supplementation.

The design of a program to effectively eliminate vitamin A deficiency, as mentioned above, requires combining a number of intervention methods. Deciding on which methods are best for a target group depends on numerous factors regarding the populations and the resources available. For example, the extent of deficiency may require immediate supplementation and clinical health care followed by programs with less than instant results, such as home-gardens and dietary modification. Among the Otomí people of Querétaro a 40 percent incidence of marginal vitamin A deficiency was determined during the summer of 1995 by Texas A&M University students and students from La Universidad Autónoma de Querétaro. The age groups most effected are children under 6 years and women of reproductive age. The most common deficiency symptoms of this group were dry skin and mild xeropthalmia indicating that the more severe symptoms of subclinical vitamin A deficiency were, fortunately, not prevalent. Thus, the program developed is not an “emergency” aid program, but one comprehensive and multifaceted in its approach.

The first chapter of my program designed to combat vitamin A deficiency tackles the ever important theme of supplementation. Supplementation has many ethical implications and depends highly on intervention, funding, and the willingness of the participants. In developing a program specific for the target group, the Otomí Indians, short-term supplementation has been emphasized in order to reduce intervention dependency and safeguard self-sustenance. My program design has been heavily influenced by past programs and publications regarding past failures and successes as well as the personal needs of the Otomí community.

PART I SUPPLEMENTATION

UNIVERSAL VERSUS TARGET SUPLEMENTATION

There are two main types of supplementation which need to be defined: universal coverage and targeted coverage. Universal coverage refers to distribution of large-doses of vitamin A to designated groups of a certain geographic region according to an established time schedule. Target delivery refers to the distribution of large amounts of vitamin A via a liaison between high-risk individuals and the existing health care services of the area, i.e. community based nutrition/health programs or periodic mass immunization campaigns (Underwood 1990). Target programs can include treating specific age groups through existing health service infrastructure or targeting specific diseases, i.e. xeropthalmia or chronic diarrhea or both.

Target supplementation is generally considered more efficient, cost-effective, and sustainable than universal supplementation programs (AGN 1993). An example of a universal program would be a group of nutritional experts from the United States distributing large doses of vitamin A in southeast Asia without utilizing the region's health care services as the primary middle-man. As a result, universal programs tend to face the challenge of inadequate population coverage due to lack of familiarity with the region and/or target population and the task of adopting and training health care workers of the region to assist in the distribution. Past universal programs have noted the following complications: transport problems, inefficient distributors, lack of long-term administrative support and political motivation, beneficiary disinterest, and poor information-education-communication (AGN 1993).

The program design for supplementation of the Otomí is a target program emphasizing, although not limited to, children below six years old and women of reproductive age. The state of Querétaro has a number of strong national intervention programs organized by La Universidad Autónoma de Querétaro, and programs developed and funded by the National Institution of Nutrition, Salvador Zubirán. It would be unethical to implement a universal supplementation program to a group of people that are striving to maintain their traditional lifestyle and are weary of urban influences.

Supplementing Children

The recommended dose for children over one year in age is 200,000 IU twice a year or every six months. For an infant between 6 and 12 months, the recommended dose is 100,000 IU twice a year. The duration of coverage varies with respect to factors such as parasitic infection, diarrhea, and protein-energy malnutrition of the individual. Under these circumstances absorption can be reduced by 20 percent, indicating the need to assess deficiency prior to developing the supplementation program. Populations with severe deficiency linked to malabsorption due to infections may need prophylaxis more often than less deficient populations (refer to table on next page). Capsules in fractional amounts such as 50,000 IU may prove more useful when varied amounts are being distributed among a population (WHO 1988).

Maternal Vitamin A Supplementation

Since the goal for lactation is to maintain the highest, safest vitamin A concentration of the breast milk, the maternal vitamin A status is crucial. When a woman enters the lactational state with inadequate vitamin A reserves and it is not possible to ensure improvement of her dietary intake, WHO and UNICEF recommend a daily oral dose of 2700 IU or 800 RE of retinol for two weeks. Considering it is unlikely the Otomí will have day-to-day contact with health providers, large doses of retinol (200,000 to 300,000 IU, 60,000-90,000 RE) may be given at parturition or within the first prenatal month. This dosage should maintain normal levels of vitamin A for at least three months. As is the case with supplementation, providers should probe the mother to confirm she is not receiving other high doses of vitamin A from other sources, i.e. fortified foods prior to dosage. As mentioned on page 7, vitamin A is teratogenic. Also postpartum dosing of women should be maintained at relative low levels since the Otomí mothers usually exert little control over birth spacing (Newman 1984).

Table 2. Summary of vitamin A supplementation protocol according to 1988 guidelines of the WHO UNICEF IVACG Task Force.

Age Group	Amount Vitamin A	How Often
Infants; 6 to 12 months of age	100,000 IU	Twice a year
Children above >12 months	200,000 IU	Twice a year
Children suffering from parasites, diarrhea, or respiratory infection	200,000 IU	At time of first contact with health worker for ea. episode of illness
Children 1 to 6 years of age with xeropthalmia	200,000 IU	Once upon diagnosis, once the next day, and once 4 weeks later
Pregnant Mothers	2700 IU	per day for 2 weeks
Lactating Mothers	200,000 IU	Once upon delivery or during the next 2 mos.

Operational Matters

A vitamin A prophylaxis program requires strict concern for "operational matters," such as the shelf-life and chemical form of the supplement. Vitamin A preparations are generally labeled as "IU" or international units, but ever increasing amounts are being listed as milligrams (mg) and micrograms (μ g). Refer to page 8 for a complete listing of amounts and equivalents. Preparations for vitamin A supplementation may be supplied as retinol palmitate or retinol acetate. In these two forms, vitamin A is usually diluted in high quality peanut oil with vitamin E as an antioxidant to stabilize the vitamin A and enhance the absorption and storage of vitamin A by the body. The chemical and biological activity of vitamin A is affected by temperature and sunlight but cold storage is not required. The shelf-life of an oily solution of vitamin A properly stored in an opaque container is at least 2 years (WHO 1988).

Cost of Supplementation

The cost of vitamin A supplementation is minimal compared to the benefits. Although very few companies manufacture high-dose vitamin A capsules, UNICEF supplies 200,000 IU capsules at approximately $0.02 each (WHO 1988). Also, some international organizations, such as Hoffman-La Rouche SIGHT AND LIFE, provide capsules free of charge. The capsules used by TAMU Study Abroad were provided by this Swiss-based program.

In conclusion, vitamin A supplementation of the Otomí people of Querétaro should ideally be short term, but most importantly it should have long term side effects. Thus, a time limit should not be imposed on supplementation, and as long as the population is willing and the vitamin A supplements are available, the program should continue. The supplements should be supplied under the jurisdiction of a skilled health care worker or nutritionist. Tetragenicity of vitamin A is of utmost concern and pregnant mothers should have their vitamin A intake evaluated before more is given.

Part II. Dietary Analysis

Food Frequency Survey

Since the dietary assessment of indigenous populations in Querétaro will be used to give an overview of the dietary habits in this region of Mexico with regards to specific nutrient intake (i.e. vitamin A), the survey will be "cross-sectional." A cross-sectional dietary analysis gives a snapshot of the dietary practices of a particular population at a specific point in time. Most commonly, food frequencies are used to estimate the population's diet in a survey form. This method allows for quantitative accuracy in estimating average daily food and nutrient intake in the population studied.

For the dietary assessment of this specific program, the 24-hour recall method may not give enough detail regarding the average diet, and the diet history method would be too time consuming and idiomatically demanding.

Challenges of Administering the Food Frequency Survey

Two main challenges of conducting the dietary analysis of the women and children of the indigenous population of Querétaro, Mexico, are the ethnic barriers and the collection of information regarding the dietary habits of infants and young children. Since most young children are unable to give a comprehensive overview of their dietary intake, the child's primary guardian (usually the mother) will be responsible for providing the child's or children's dietary information. Unfortunately, the child is not always under the supervision of the mother during all feeding times. In situations such as these, it is important that the interviewer is trained to probe and question the validity and completeness of the dietary information given by the respondent.

A second barrier is language and culture which could easily inhibit interaction between outsiders and the Otomí peoples of Querétaro For example, ethnic foods have localized names unfamiliar to the interviewer and the respondent may negate the consumption of a particular food because the word referring to the food is not understood. Such challenges can be overcome by having interviewers work closely with members of the target population when devising a food list and conducting the interviews. Also, developing the survey food list in both English and Spanish would contribute to eliminate language barriers.

The Summer 1995 Study Abroad Group conducted a food frequency survey which is given in Appendix B in both Spanish and English. Language barriers and lack of formal training are two factors which may influence the validity of the results. The survey was developed according to a model survey of the National Institute of Nutrition in Valle de Solis.

Part III. Nutrition Education

Dietary Modification

Within the Otomí villages surveyed during the summer of 1995 there are a range of factors influencing the foods they do and do not eat. The main one is availability. The foods rich in vitamin A, such as green leafy vegetables and fresh fruits, are expensive and difficult to cultivate in this area. Other factors influencing the consumption of such foods are: seasonality of certain foods, attitudes regarding what foods children are fed, geography, and socio-economic status of the families and the women within these families.

As far as availability is concerned, increased access to vitamin A rich foods could be brought about in a few ways: home gardens, economic/food policies which affect the availability, price, and demand for such foods, and nutrition education to improve practices related to the consumption of vitamin A rich foods.

Home gardens have often been regarded as the light in the dark when micronutrient deficiencies take their toll on vulnerable populations. Unfortunately, this is unrealistic for the benefits of a home garden often do not outweigh the money, effort, time, and skill, required to establish and maintain one. As for the region of the State of Querétaro where the Otomí Indians live, a home garden is limited to producing a few vegetables within season and takes a good deal of care and time. If a home garden was to be agreed upon, tomatoes and one or two other green vegetables common to the diet of the Otomí would be ideal for production. The garden and the work required to maintain it could be shared by the community or just one or two families and women could be taught to collect and store seeds for the next planting. The home garden would require horticultural instruction, seeds, and fertilizer.

Promotion of policies increasing the supply of outside food sources accessible economically and geographically to the Otomí communities is another important way in which vitamin A rich foods can be made more readily available to the Otomí communities. Desarrollo Integral de la Familia (DIF) or Integral Development of the Family has provided milk free and/or at a lower cost to the Otomí. This milk could be fortified with vitamin A and then given to the communities. Geographically isolated communities could be mapped out for a food delivery service to be carried out monthly or weekly by the intervention programs sponsored by La Universidad Autónoma de Querétaro, Mexico.

Nutrition education to improve the consumption of vitamin A rich foods involves providing information on basic and child nutrition, food preparation, and sanitation. The area of nutrition education is broad and crucial to the impact intervention could potentially have. If the target population understands the importance of micronutrients and certain foods, they will work to make change, whereas if the intervention fails to tailor a culturally sensitive program to the needs and interest of the people, outside efforts may be completely disregarded. For the Otomí population, I feel it would be best to have community leaders (i.e. Otomí women) and other Mexicans working long-term as nutrition educators.

Long-term participation is important because a familiar face becomes someone who can be trusted and relied upon. Community participation along with a long term commitment is ideal because this instructor is living within the community, is available upon demand, and has an ever growing wealth of nutrition knowledge. Community based leadership would most likely require an outside source for instruction and teaching materials. This could be provided by the joint TAMU and Universidad Autónoma de Querétaro programs in the summer and the Universidad Autónoma de Querétaro program within the academic year. Teaching materials, such as posters and illustrated pamphlets, are available through a number of organizations listed in the last section of this chapter.

REPRODUCTIVE HEALTH

Birth spacing and fertility awareness are nothing new to women of the western world. But within the Otomí communities, knowledge of reproductive health is limited to experience and superstition. Although it would not be ethical to bring in the western definition of fertility control (contraception) into these communities, it would be wise to provide some type of counseling or educational instruction on reproductive health.

Of course, such counseling should be performed by a doctor or skilled health care worker and should be conducted on a one-to-one basis to insure confidentiality. It would even be wise to make sure the health care provider is someone accepted and trusted within the particular community. For example, Dr. Ericka Oliver of Querétaro has been working within the Otomí communities for two years now and has formed a strong relationship with the people as well as a deep respect for their traditional lifestyle.

BREASTFEEDING PROMOTION

Beastfeeding plays a very positive and beneficial role in the overall health of an infant. With regards to vitamin A, breastfeeding is the most important factor determining the vitamin A status of infants below six months of age (WHO 24). Although the concentration of vitamin A in colostrum depends on the nutritional status of the mother, vitamin A deficiency is not common in breastfed infants, even in undeveloped areas where deficiency is endemic (Newman 1994). The data collected during 1995 which was presented in the preceding chapter, shows that a majority of Otomí mothers breastfed their infant(s) for approximately one year. In order to maximize the benefits of breastfeeding:

1. All Otomí women should be informed of the benefits and management of breastfeeding
2. Otomí mothers and future mothers should be taught how to "happily" breastfeed. There could be a demonstration with a doll by a fellow Otomí mother who invites each woman to take part in active learning.
3. Encourage initiation of breastfeeding within the first half-hour of birth.
4. Explain how lactation can be maintained even when the mother is separated from child.
5. Encourage breastfeeding upon demand.
6. Emphasize exclusive breastfeeding of one infant.
7. Explain the importance of long term breastfeeding, but also note if necessary shorter terms are better than no breastfeeding.

FUNDING AND SUPPORT FOR ELIMINATING MICRONUTRIENT DEFICIENCIES

A number of strong and active national organizations in Mexico and a few international organizations could provide substantial support for the program developed for the Otomí people. Mexico is a country which has not been open to a great deal of outside intervention, so the number of international organizations intervening (besides TAMU) would be few to none.

A few organization and addresses are listed in Appendix F as well as the addresses of international organizations on the World Wide Web. Many international development organizations like Unicef and SIGHT AND LIFE provide vitamin A supplements in capsular and liquid form for a very small fee or none at all.

CONCLUSION

A strong and successful micronutrient program in any part of the world needs leaders within the community and near the community to oversee and stand behind it. After attending the XVII International Vitamin A Consultative Group Convention in Guatemala City, Guatemala, during March 1996, I learned the desire to improve global health is tied to purse strings and a multitude of political issues. After the opening address of the conference on eliminating vitamin A deficiency globally, the health of the developing world's children was not mentioned again. The majority of the conference revolved around funding and limitations placed on micronutrient programs because of financial constraints.

Fortunately in Querétaro, where I spent part of my 1995-1996 winter break, there are groups actively working to improve the health of the Otomí and other indigenous peoples of the area. The state university, La Universidad Autónoma de Querétaro, had a number of programs available for students to become involved with the rural communities and a number of local doctors, like Dr. Ericka Oliver and Dr. Rocío Arellano, volunteered weekly to provide health care to the Otomí. I even met a theater arts student who spent his vacation time teaching within the rural communities.

For this reason, I think there is the potential for great success in improving the micronutrient status of the Otomí. The program I have developed is to be utilized by individuals working for the communities already and the students who shall become involved with the communities in the future.

AFTERWORD

This thesis took me to rural Mexico, the remote villages of Guatemala, and the homes of many wonderful and dedicated people such as the Oliver family in Querétaro, the Mejía family in Querétaro, and the Sywulka family in Guatemala. I have learned much more than what is written on these pages.

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Appendix A: Anthropometry Survey Sheet

Nombre____________________Sexo___ #______

Nombre del Padre_________________________ Comunidad___________

Fecha __/__/__. Fecha de nacimiento __/__/__. Edad________

Talla _____cm Peso ____kg

Clase de Desnutrición

	Normal	Ligero	Moderato	Severo
Talla/Edad	______	______	_______	______
Peso/Talla	______	______	_______	______
Peso/Edad	______	______	_______	______

Recomendaciones

Normal - Está bien.

Ligero - El niño necesita más alimentos como pollo, leche, huevo, carne de res (proteína) y tortilla, frijoles, sopa de pasta, frutas, verduras, y pan (carbohidratos).

Moderato o Severo - Es muy importante que él coma esos alimentos. También, revisión médica.

Appendix B: Dietary Questionnaire

Dietary Evaluation

Name of Father_______________________ Community_____________________

Name of Child________________________ Age __________________________

Sex_________ Date of Birth _____________ Today's Date___________________

Grains	Times Per Week
rice	______________
tortillas	______________
chickpea	______________
lentels	______________
soy	______________
bread	______________
beans	______________

Fruits and Vegetables

squash	______________
pear	______________
banana	______________
melon	______________
papaya	______________
guava	______________
mandarin	______________
peach	______________
watermelon	______________
plum	______________
Capulin	______________
Swiss chard	______________
spinach	______________
carrots	______________
lime	______________
orange	______________
lemon	______________
grapefruit	______________
cabbage	______________
cauliflower	______________
tomato	______________
chiles	______________

Foods	Times Per Week
beef	______________
chicken	______________
liver	______________
fish	______________
milk	______________
eggs	______________

Sugars and Oils

soda	______________
oil	______________
butter	______________
sweets	______________

Do your children have trouble seeing at night? yes no

Does your child frequently get diarrhea? yes no

Does your child frequently cough?

EVALUACION DIETETICA

NOMBRE DEL PADRE:____________________ COMUNIDAD:____________________

NOMBRE DEL NINO:____________________ EDAD:____________________

SEXO:__________ FECHA NAC:__________ FECHA EST:__________

GR ANOS:	VECES POR SEMANA	ALIMENTOS ANIMALES:	VECES POR SEMANA:
arroz	________	carne de res	________
tortillas	________	pollo	________
garbanzo	________	higado	________
lentejas	________	gueso	________
soya	________	leche	________
pan	________	huevos	________
papas	________		
frijoles	________		

FRUTAS Y VEGETABLES:

chicharro fresco	________
calabacita	________
nopales	________
platano	________
papaya	________
melon	________
guayaba	________
mandarina	________
durazno	________
sandia	________
ciruela amarilla	________
capulin	________
acelgas	________
espinicas	________
zanahorias	________
lima	________
naranja	________
limon	________
toronja	________
col	________
coliflor	________
tomate	________
chiles	________
mango	________

ACEITES Y AZUCAR:

refrescos	________
aceite	________
manteca	________
dulce	________

Tiene hijos que no pueden ver en la noche?	Si______	No______
Su hijo sufre de diarrea frecuentamente?	Si______	No______
Tiene frecuentemente su hijo tos?	Si______	No______

OBSERVATIONS:

conjunctivitis	Si______	No______
xerophthalmia or Bito's Spots	Si______	No______
Spoon Shaped Nails	Si______	No______
Bleeding Gums	Si______	No______

RDA:

Energy__________ Protein__________

Vitamin A__________ Iron__________

Vitamin C__________

Appendix C: Maternal Questionnaire

Maternal Questionnaire

NUTRITIONAL EVALUATION OF THE MOTHER

Evaluator________________Date____________________Community_______________

Last Name_______________Mother's Name___________________________________

Mother:

Age:__________________

Height:_________________ Less than 145 cm? y n

Weight:_________________ Less than 45 kg? y n

BMI:___________________ Less than 19.5? y n

Ideal Weight:_____________

INFORMATION REGARDING PREGNANCY:

1. Age of last pregnancy
2. Number of times pregnant
3. Date of last birth
4. When you are pregnant, do you drink alcohol? y n How much?

   Do you smoke?
5. Have you received prenatal care?
6. Of your children, how many were born in a clinic?
7. Did you take iron supplements during your pregnancy?
8. Did you take or were you given anything else (vitamins, minerals, etc.)?
9. What changes were made in your food consumption during pregnancy?
10. Have you had babies which were born underweight?
11. Have you had babies which were premature?
12. Have you had an abortion (natural or induced) or have you had any stillborn babies?

LACTATION:

13. At what age did you stop breastfeeding your child?

14. A what age did you begin to breastfeed your child?

15. A what age did you begin to feed your child solid foods?

What foods did you give your child?

Did your babies get exposure to natural sunlight?

Did you give any other liquids besides breast milk to your children?

Maternal Questionnaire

Evaluacion Nutricional de la Madre

Evaluador:________________ Fecha:_________ Cominidad:_____________

Nombre (Padre):________________ Nombre (Madre):_______________

Madre:

Edad:_____			
Estatura:______	Menos de 145cm?	Si	No
Peso:_____	Menos de 45kg?	Si	No
BMI: (kg/m^2)_______	Menos de 19.5?	Si	No
Peso ideal:___________			

INFORMACION DE EMBARAZO:

1. Edad a la que tuvo su 1er ebarazo:

2. Número de embarazos:

3. Fecha de nacimiento del bebé más pequeño:

4. Cuando estaba embarazada, tomó alcohol (cerveza, etc)?

   Cantidad?

   Fumó?

5. Tuvo algún tipo de cuidado prenatal?

   Qué tipo de cuidad tuvo?

6. De sus niños, Cuántos nacieron en la clínica?

7. Tomó hierro durante el embarazo?

8. Le han recetado algo más (vitaminas, minarales, etc)?

9. Durante su embarazo, Qué cambios ha hecho en su alimentación?

10. Ha tenido bebés que nazcan con bajo peso?

11. Ha tenido bebés que nazcan prematuros?

12. Ha tenido abortos o muerte del bebé recién nacido?

LACTANCIA:

13. A qué edad le dejó de dar pecho a sus hijos?

0 3 6 9 12 15 18 24 meses

14. A qué edad empezó a dar pecho a su bebé (calostro)?

15. A qué edad empezó a darle alimentos sólidos a su bebé?

*Qué comidas le empezó a dar? (Hierro)

*Sacó a sus niños al sol?

*Le dio liquidos a su niño además de la leche materna?

Appendix D: Clinical Assesment Survey

CLINICAL ASSESSMENT

GENERAL INFORMATION

Name of Child______________________________ DOB___/___/___ Sex___ #___
Father's name____________________________Mother's name_____________________
Community_________________________________ Address_________________________
Surveyor__________________________________ Date___/___/___

ANTHROPOMETRY

Height_______________ Weight______________ Head Cir.___________
H/A__________________ W/H_________________ W/A_________________

PHYSICAL FINDINGS

Body System	Acceptable Findings	Malnutrition Findings
Hair	shiny, firm in the scalp, normal color	dull, brittle, dry, loose, abnormal color

Observation:____
____

Body System	Acceptable Findings	Malnutrition Findings
Eyes	bright, clear pink membranes that adj. easily to light	pale membranes, spots, redness, adj. slowly to light, palpebral fissures, infections on roots of eyelashes

Observation:____
____

Body System	Acceptable Findings	Malnutrition Findings
Teeth and Gums	no pain or carries gums firm, teeth bright	missing, discolored, or decayed teeth; gums bleed easily and are swollen/spongy, bad misalignment

Observation:____
____

Body System	Acceptable Findings	Malnutrition Findings
Face	clear complexion wo/ dryness or scaliness, normal looking features	off-color, scaly, flaky, cracked skin; long, flat filtrum, underdeveloped mid-face, thin upper lip

Observation:____
____

Body System	Acceptable Findings	Malnutrition Findings
Glands	no lumps	swollen at front of neck, cheeks

Observation:____
____

Tongue	red, bumpy, rough	sore, smooth, purplish, swollen

Observation:____

____

Skin	smooth, firm, good color	dry, rough, spotty; "sandpaper" feel or sores; lack of fat under skin, edema

Observation:____

____

Nails	firm, pink	spoon-shaped, brittle, rigid
Muscles,Bones, and Joints	muscle tone, posture long bone development appropriate for age	"wasted" appearance of muscles; swollen bumps on skull or end bones; bowed legs or knock-knees; stiff or underdeveloped joints

Observation:____

____

DIAGNOSIS

____

____

____

____

____

If fetal alcohol effects are present, ask the following questions.

1. How many glasses of pulque (or alcohol) do you drink a day?
   Cuantos vasos de pulque (o alcohol) toma al dia?

____

2. Did your drinking patterns change during pregnancy?
   Su habito de tomar alcohol cambian durante el embarazo?

____

3. Does your child experience learning difficulties?
   Su nino tiene dificultad para aprender?

____

Appendix E: Clinical Assessment Survey to be Approved

CLINICAL ASSESSMENT

GENERAL INFORMATION

Name of child:____________________ DOB:___/___/___ Sex:___ #:___

Name of father:____________________ Name of mother:____________________

Community:____________________ Address:____________________

Surveyor:____________________ Date:___/___/___

ANTHROPOMETRY

Height:____________ Weight:____________
H/A:____________ W/H:____________ W/A:____________

PHYSICAL FINDINGS

Body Sys.	**Physical Symptoms**	**V**	**Deficiencies**
Hair	Hairloss		Biotin
			Zinc
			Vitamin C
Face	Seborrheic dermatitis (seen predominantly in nasolabial folds)		Riboflavin
			Vitamin B6
	Dermatitis lesions that may resemble sunburn		Niacin
	Acneiform rash		Vitamin B6
Eyes	Inflamed eyelids		Riboflavin
	Sensitivity to light		Riboflavin
	Corneal vascularization (reddening of cornea)		Riboflavin
	Night blindness		Vitamin A
			Zinc
	Hyperkeratinization (changes in epithelial tissue)		Vitamin A
	Xerosis (drying)		Vitamin A*
			Vitamin C
	Bitot's spots (triangular gray spots on eye)		Vitamin A**
	Keratomalacia (irreversible drying)		Vitamin A**
	Corneal degeneration (blindness)		Vitamin A***
	Ocular hemorrhages seen in the bulbar conjunctivae		Vitamin C
	Blue sclera		Iron
	Pale eye membranes		Iron
Mouth, Teeth, and Gums	Cheilosis (formation of painful cracks on the upper and lower mouth)		Riboflavin
			Vitamin B6
	Angular Stomatitis (fissures radiating from the corners of the mouth)		Riboflavin
			Folic Acid
			Vitamin B6
	Scurvy lesions (hyperkeratotic follicle surrounded by a red, hemorrhagic halo)		Vitamin C
	Dryness		Vitamin C
	Loose teeth and fillings		Vitamin C
	Cracks in teeth		Vitamin A
	Slow eruption of teeth		Vitamin D
	Malformed teeth		Vitamin D
	Decay prone teeth		Vitamin D
			Vitamin A
			Fluoride

Tongue	Glossitis ("magenta tongue", i.e. purplish-red tongue)		Riboflavin
			Niacin
			Vitamin B6
			Folic Acid
	Smooth tongue		Niacin
			Vitamin B6
			Folate
			Vitamin B12
	Inflamed, swollen tongue		Niacin
Skin	Skin rash		Riboflavin
	Scrotal (or vulval) dermatitis		Riboflavin
	Bilaterally symmetrical dermatitis, especially on areas exposed to sun (Casal's necklace)		Niacin
	Dry and scaly dermatitis		Niacin
			Biotin
	Fissures on dermatitis		Niacin
	Irritation of sweat glands		Vitamin B6
	Rough skin		Vitamin C
			Zinc
	Blotchy bruises		Vitamin C
	Hyperkeratosis (plugging of hair follicles with keratin, forming white lumps)		Vitamin C
	Dry		Zinc
			Vitamin C
	Pruritic skin		Vitamin C
	Pale palm creases		Iron
	Itching		Iron
	Pitting Edema		Vitamin C**
Nails	Pail nailbeds		Iron
	Concave nails		Iron
Muscles and Bones	Muscle twitching		Vitamin B6
			Vitamin D
	Convulsions		Vitamin B6
			Magnesium
	Muscle degeneration		Vitamin C
			Vitamin E
	Joint pain		Vitamin C
			Vitamin A
	Rickets		Vitamin D
	Lax muscles (protrusion of abdomen)		Vitamin D
	Muscle spasms		Vitamin D
	Muscular weakness		Vitamin E
			Potassium
			Folic Acid
			Magnesium
			Vitamin C**
			Iron
			Pantothenic acid
	Severe pain in calf muscles		Vitamin E
	Muscle cramps		Sodium
			Pantothenic acid
	Bizarre muscle movements (especially of eye and face muscles)		Magnesium
	Difficulty in swallowing		Magnesium
FAS	Long flat philtrum		
	Underdeveloped midface		
	Thin upper lip		

Appendix F: Webb Sites and Addresses

Web Sites

The Micronutrient Initiative (MI)
http:/www.idrc.ca/mi/index.html

National Library of Medicine
http://www.nlm.nih.gov/welcome.html

The World Bank
http://www.worldbank.org/html/hcovp/hdd/contents.html

World Health Organization (WHO)
http://www.who.ch/

United States Agency for International Development (USAID)
http://www.info.usaid.gov

Addresses

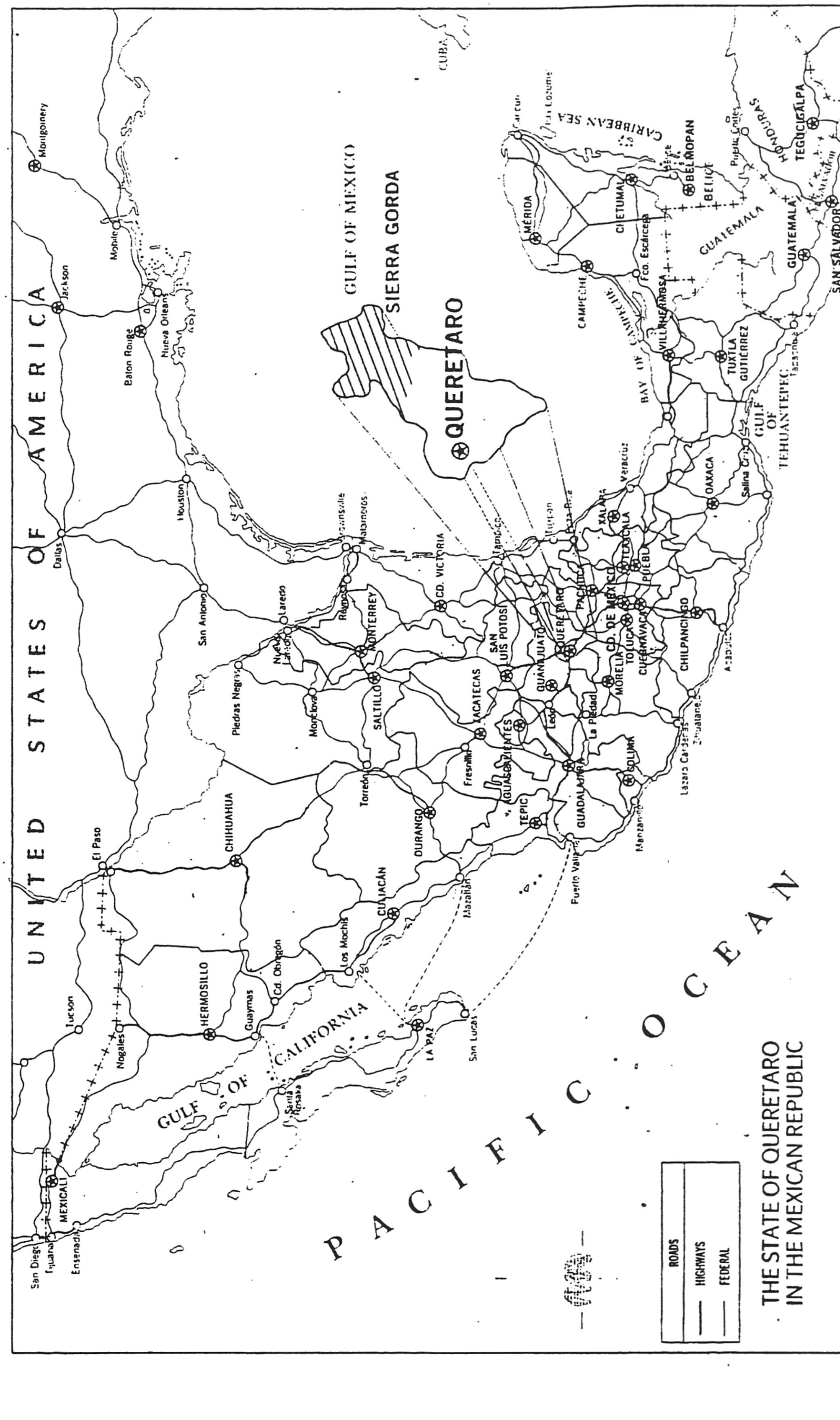
Task Force SIGHT AND LIFE
Post Box 2116
Basel 4070
Switzerland
Tel: 41-61-691-2253

Helen Keller International
Av. Zarco #2630
Chihuahua, Chih. 31020

Instituto Nacional de Nutrición, Salvador Zubirán
Vasco de quiroga No. 15, Tlalplan
14000
Mexico, DF, Mexico

Appendix G: Map of Mexico

Map of Mexico



Appendix H: List of %RDA in Common Foods

Food Description	Serving Size	RE	% RDA /Serv
banana	1 whole	9	2
beef liver	3oz	9123	2,027
black beans	1/2c	1	0
butternut squash	1c baked	1435	319
cantalope	1/2 melon	860	191
carrot	1 whole fresh	2024	450
cheese, cheddar	1 inch cube	51	11
chicken breast	1 c cooked	22	5
chicken liver	3 oz	928	206
corn	1c cooked	45	10
egg	1 ea cooked	95	21
green pepper	1 whole fresh	50	11
lentils	1/2 c cooked	5	1
mango	1 whole	805	179
milk, whole	1 c	76	17
nopal	100g	220	49
onion	1/2 c cooked	0	0
orange	1 whole	27	6
papaya	1 whole store ripened	90	20
papaya	1 whole sun ripened	615	137
peach	1 medium	47	10
peas	1/2c	2	0
potato	1 whole, baked	0	0
pumpkin	1c	5424	1205
spinach	1c cooked from frozen	1474	328
sweet potato	1whole, baked	2484	552
tomato	1 whole, fresh	76	17
tortilla, corn	1 ea	8	2
tuna in oil	3 oz	20	4
winter squash	1 c baked	850	189

Appendix I: Individuals Who Participated in Collecting Data on the Nutritional Status of the Otomí

Study Abroad Faculty

Dr. Rocío Arellano

Dr. George Bates

Dr. Adolfo Chávez

Maestra Maricarmen Diaz

Dr. Luis Mejia

Maestra Leticia Mercado

Dr. Homero Martinez

Dr. Ericka Oliver

Dr. Sergio Quesada

Dr. Enrique Rios

Universidad Autónoma de Querétaro Student Participants

Licenciatura en Nutricion

Rosalia Alarcon Espinosa

Martha Alejandre Villar

Rocio Flores Nuño

Claudia Paleta Guadarrama

Ester Ramirez Moreno

Evangelina Resendiz

Facultad de Medicina

Fanny Aguilar Cortes

Efren Espinoza Gutierrez

Magdalena Sierra Lück

Lucelli Yañez Gutierrez

Postgrado en Alimentos, Facultad de Quimica

Maricela Gonzalez Leal

Marcela Martinez Perez

Ma. Violeta Estela Martinez Resendia

Texas A&M University Student Participants

Sara Allison

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Jackson Bean

Jackie Brown

Michael Couvillon

Joanna Garza

Kathryn Hays

Seon Jones

Jeremy "Chad" Liggin

Daniel Ludwig

Heather L. Myrick

Bryan D. Parrent

Adri Peterson

Edna M. Sanchez

Anna "Katie" Schulte

Chris Spradley

Rebecca Turnbow