

**REPORT OF THE XXII
INTERNATIONAL VITAMIN A
CONSULTATIVE GROUP
MEETING**



**VITAMIN A AND
THE COMMON
AGENDA FOR
MICRONUTRIENTS**

**LIMA, PERU
15-17 NOVEMBER 2004**

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RAPPORTEUR: DR. CHRISTINE CLEWES

**ASSISTANT RAPPORTEURS:
PROF. DAVID THURNHAM
DR. MARJOLEINE DIJKHUIZEN**

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Front cover and title page:

The Amazonas river is the largest in the world and the source of life for the most varied linguistic cultures in the world. Renzo Uccelli/PromPeru

Gera's waterfall in the jungle of San Martin. Heinz Plenge/PromPeru

South American camelids. Source of virtual offering, they are an icon for the local communities, Cusco. Jorge Sarmiento/PromPeru

Danzaq, dancers from Paucartambo, Cusco. Mylene D'Auriol/PromPeru

Girls from Qeros, a quechua community. Mylene D'Auriol/PromPeru

Back cover:

The vicuña, a peaceful and graceful animal, lives in the high Andean plains between 3,500 and 5,000 masl. Alejandro Balaguer/PromPeru

The Andean Cock of the Rocks is considered the Peruvian national bird. With 1,701 species, Peru is the country with most bird species in the world. Alejandro Balaguer/PromPeru

The jaguar or otorongo is the largest and most formidable predator in the Amazon jungle. It can measure up to 3 meters long including the tail and can weigh up to 150 kilos. Alejandro Balaguer/PromPeru

The Colca Canyon is one of the deepest in the world, Arequipa. Heinz Plenge/PromPeru

Sloth in Manu's National Park. With 84 of the 104 known life zones on the planet, Peru ranks among the first in biodiversity. Heinz Plenge/PromPeru

Additional copies of this and other IVACG publications are available free of charge to developing countries and for US \$3.50 to developed countries. Copies can be ordered from the IVACG Secretariat:

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This report is the summary of the presentations and discussions that took place at the IVACG Meeting and does not necessarily reflect the scientific recommendations or views of IVACG, the U.S. Agency for International Development, or the International Life Sciences Institute.

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The XXII IVACG Meeting was co-hosted by IVACG and the Local Organizing Committee of the Peruvian Ministry of Health and representatives of United Nations technical agencies, the private sector, multilateral agencies, and nongovernmental organizations in Peru, with funding from the Government of Peru. The Office of Health, Infectious Diseases and Nutrition, Global Health Bureau, U.S. Agency for International Development, and the Peruvian Ministry of Health assumed major responsibility for organizing the meeting. Special thanks are given to Task Force SIGHT AND LIFE for their contributions to the publishing of this report.



The IVACG Secretariat and the Local Organizing Committee gratefully acknowledge the additional contributions of the following organizations:

The Micronutrient Initiative

Unilever Health Institute

Nestlé S.A.

H.J. Heinz Company

Local Organizing Committee in Peru



- Dr. Luis Enrique Podestá, Director General, Division of People's Health, Ministry of Health
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- Dr. Sandra Contreras, Project HOPE

About IVACG

Established in 1975, the International Vitamin A Consultative Group guides international activities for reducing vitamin A deficiency in the world. IVACG concentrates its efforts on stimulating and disseminating new knowledge, translating that new knowledge to enable its practical application, and providing authoritative policy statements and recommendations that others can use to develop appropriate prevention and control programs.

Publications List

Strategic Placement of IVACG in the Evolving Micronutrient Field (Revised 2004)

IVACG Statement: The Anney Accords to Assess and Control Vitamin A Deficiency: Summary of Recommendations and Clarifications (2002) (Available in English, French, Spanish, and Portuguese)

IVACG Statement on Maternal Night Blindness: A New Indicator of Vitamin A Deficiency (2002)

Conversion Factors for Vitamin A and Carotenoids (2002)

Delivery of Vitamin A Supplements with DPT/Polio and Measles Immunization (2000)

Status of the Studies on Vitamin A and Human Immunodeficiency Virus Infection (2000)

Combining Vitamin A Distribution with EPI Contacts (2000)

The Bioavailability of Dietary Carotenoids: Current Concepts (1999)

IVACG Statement on Vitamin A and Iron Interactions (1998)

IVACG Statement on Safe Doses of Vitamin A during Pregnancy and Lactation (1998)

IVACG Policy Statement on Vitamin A Status and Childhood Mortality (1997)

IVACG Statement on Clustering of Xerophthalmia and Vitamin A Deficiency Within Communities and Families (1996)

IVACG Policy Statement on Vitamin A, Diarrhea, and Measles (1996)

A Brief Guide to Current Methods of Assessing Vitamin A Status (1993)

Nutrition Communications in Vitamin A Programs: A Resource Book (1992)

Vitamin A Supplements: A Guide to Their Use in the Treatment and Prevention of Vitamin A Deficiency and Xerophthalmia (Published by the World Health Organization in conjunction with IVACG and UNICEF, 1988; second edition 1997)

The Safe Use of Vitamin A by Women During the Reproductive Years (1986) (Available in English and French)

The Symptoms and Signs of Vitamin A Deficiency and Their Relationship to Applied Nutrition (1983) (Available in Spanish only)

Biochemical Methodology for the Assessment of Vitamin A Status, and Reprints of Selected Methods for the Analysis of Vitamin A and Carotenoids in Nutrition Surveys (1982) (2 BOOK SET)

The Safe Use of Vitamin A (1980) (Available in English and French)



Acknowledgements



Many individuals and organizations contributed to the success of the XXII IVACG Meeting. The U.S. Agency for International Development, through the Micronutrient Global Leadership cooperative agreement provided the primary support for the XXII IVACG Meeting. The Peruvian Ministry of Health, through the Local Organizing Committee, collaborated in planning the meeting, and also helped organize the national micronutrient symposium that preceded the XXII IVACG Meeting. The Local Organizing Committee also planned the study tours, providing participants an opportunity to learn about micronutrient deficiency control programs in Peru.

The IVACG Secretariat gratefully acknowledges additional contributions from The Micronutrient Initiative, Unilever Health Institute, Nestlé S.A., and H.J. Heinz Company for the XXII IVACG Meeting. Special thanks are given to Task Force SIGHT AND LIFE for their contributions to the meeting through travel grants, simultaneous translation at the meeting, and the publication of this report. The IVACG Steering Committee members at the time of the meeting: Mr. David Alnwick; Dr. Zulfiqar Bhutta; Dr. Omar Dary; Dr. Frances R. Davidson, IVACG Secretary; Dr. Chewe Luo; Dr. Suttalak Smitasiri; Dr. Alfred Sommer, IVACG Steering Committee Chair; Dr. Kraissid Tontisirin; and Dr. Keith P. West, Jr., together with invited experts: Dr. Sean Lynch, Dr. Robert Black, and Dr. Mahmoud Fathalla worked diligently to develop the meeting program. Their expertise in selecting timely topics was apparent in the high level of interest and discussion during the meeting's sessions.

IVACG extends a special thanks to the overall rapporteur for the meeting, Dr. Christine Clewes and the assistant rapporteurs, Prof. David Thurnham and Dr. Marjoleine Dijkhuizen. The rapporteurs did a superb job at cohesively summarizing the meeting's presentations and discussions into this report.

IVACG thanks the many presenters that shared their invaluable work with a broad audience. The secretariat is also grateful to the chairs of the scientific sessions for their role in guiding the discussions. Finally, the meeting would not have been successful without the dedication of the meeting attendees. We hope that the meeting provided the vitamin A community with new information and revitalized energy to continue improving and expanding micronutrient deficiency control programs.

The Micronutrient Global Leadership project is a cooperative agreement of the Office of Health, Infectious Diseases and Nutrition, Global Health Bureau, U.S. Agency for International Development with the International Life Sciences Institute (ILSI) Research Foundation. The ILSI Research Foundation's Human Nutrition Institute serves as the IVACG Secretariat.

Summary

The theme “Vitamin A and the Common Agenda for Micronutrients” provided the scientific direction and program context for the 22nd meeting of the International Vitamin A Consultative Group (IVACG), which was held in Lima, Peru on 15–17 November 2004. The goals were to advance the prevention of vitamin A and other micronutrient deficiencies, especially those of iron and zinc; to better understand the diversity of nutrient-nutrient and nutrient-disease interactions; and to consider how knowledge of such effects can be used to enhance the effectiveness and safety of micronutrient interventions. These issues were examined in over 45 oral and 100 poster presentations during the 5-day meeting, which was attended by approximately 800 delegates from 71 countries throughout the world. Building on the momentum of the 21st IVACG meeting in Morocco in 2003 to integrate micronutrient strategies through invited participation of INACG and IZiNCG, the Peru theme and program established the IVACG meeting as the largest forum in the world dedicated to improving the health, development, and survival of children and women through the prevention of multiple micronutrient deficiencies. This report summarizes proceedings of the first three days of deliberation and the formal “IVACG Meeting,” which addressed vitamin A and the common micronutrient agenda and was dedicated to the memory and contributions of Dr. Clive West.

Inaugural addresses drew immediate attention to the co-existence of poverty and “hidden hunger” (micronutrient deficiencies) among children and women in Latin America. These talks focused on Peru, which has been working hard to reduce vitamin A, iron, and iodine deficiencies in recent years, as exemplified by a 32% decline in the prevalence of childhood vitamin A deficiency from 1997 to 2001. The keynote address by Dr. Gerald Keusch, of Boston University, USA, placed the “common agenda” into context, noting that the promotion of adequate breast and complementary feeding, vitamin A supplementation, and zinc treatment for diarrhea are examples of affordable and effective interventions that can be implemented with the cooperation of governments, academia, and a committed non-governmental and donor community.

Presentations on food-based strategies to control vitamin A deficiency began with a report from Bangladesh, where a pilot program by Helen Keller International that initially distributed poultry, a milking cow, or fish stock sustainably increased income, target group animal food intake, and other facets of food security in several hundred households. In rural Tanzania, the World Vegetable Center observed an 80% uptake of vegetable gardening practices in households that received seeds, home garden training, on-site demonstration plots, and instruction on food preservation and recipes. These and other poster presentations emphasized that poor communities can increase food production and diversify their diets with the right program inputs. Improving vitamin A status using local produce, however, requires attention to the carotenoid mix of vegetables and fruits, food storage and meal preparation methods, frequencies of intake, and other dietary and health factors.





There were many reports of progress in developing, testing, and cross-culturally expanding the acceptability and use of varieties of beta-carotene-rich orange-fleshed sweet potatoes, especially throughout sub-Saharan Africa. An update by Professor Ingo Potrykus, of the Humanitarian Golden Rice Project and Network, Switzerland, on the evolving potential of genetically modified, beta-carotene-fortified “Golden Rice” to prevent vitamin A deficiency gave a glimpse of how biofortification of staple foods may help to achieve future dietary micronutrient goals. However, the highly variable and often low bioefficacy of carotenoids remains an obstacle in improving vitamin A status with plant foods. Conventional food fortification with multiple nutrients offers a viable and expanding set of options for deficiency control, especially where production can be centralized to reduce costs of monitoring and enforcement. For example, improved salt fortification techniques may make it feasible to address multiple deficiencies, such as those of vitamin A and iron, while preventing iodine deficiency. For the foreseeable future, however, vitamin A supplementation remains the mainstay of prevention for most countries.

Progress in micronutrient deficiency control requires ever-improving methods to assess status and response to interventions. In this regard, the latest thinking was given on strengths and limitations of existing methods to assess vitamin A status. These include the modified relative dose response and the measurement of serum, dried blood spots, retinol binding protein, acute phase reactants, stable isotopes, and dark adaptation. There is still concern

about the complex influences of intensity and duration of infection on absorption, mobilization, utilization, and excretion of vitamin A, which can alter serum retinol independent of body vitamin A stores. This could lead to misinterpretation of circulating levels of vitamin A in assessing population status and prevalence of vitamin A deficiency. New insights were shared by Dr. Christine Clewes, of the Centers for Disease Control and Prevention, USA, on how acute phase reactant data may be useful in interpreting associations between serum retinol and infection.

There is much to learn about responses to micronutrient supplementation in varying disease states. In Zimbabwe, complex responses to vitamin A were reported in HIV-infected mothers and their newborns, including blunted biochemical changes (e.g., in serum retinol and hemoglobin). Although there was no overall mortality effect, there were diverse subgroup effects on a range of outcomes. Protracted inflammation in HIV may mask potential biochemical responses to micronutrient supplementation, as was also reported from a trial in Kenya. It is becoming apparent that the same micronutrients may exert varied effects on outcome depending on context.

In the NNIPS-3 trial in Nepal, a multiple antenatal micronutrient supplement improved birth weight across the entire distribution and lowered symptoms of premature rupture of membranes, but it also increased the risk of dysfunctional labor (possibly related to increased birth size). Folic acid and iron supplementation, on the other hand, reduced the risk of both low birth weight and hemorrhage. In

a second trial among Nepalese pregnant women consuming vitamin A-fortified rice, riboflavin supplementation improved iron stores and decreased risk of anemia. These and other reports discussed at the meeting helped to reveal the complexity and potential utility of understanding both the interactive and independent effects of micronutrients. As pointed out by Dr. Robert Black, of the Johns Hopkins Bloomberg School of Public Health, USA, some micronutrients may have non-interfering effects. For example, vitamin A is effective against measles morbidity, while zinc is not; zinc may be effective against pneumonia, while vitamin A is not; zinc interferes with iron in treating anemia, while vitamin A enhances the effects of iron. Therefore, methods to determine the need for micronutrient supplement use and formulation were a focus of the meeting.

Once efficacy and safety of micronutrient interventions are determined, the public health challenge is to scale up and keep the interventions effective. Vitamin A supplement coverage—along with child survival overall—benefited greatly by being added to the global National Immunization Day (NIDs) campaigns. Now, in the post-NIDs era, countries and agencies throughout the world have worked to sustain the momentum, and high vitamin A coverage through carefully planned and orchestrated campaigns have achieved remarkable success. Examples

reported during the meeting include National Child Health Weeks in Zambia, National Nutrition Weeks in Mali, National Health Worker Days in Rwanda, National Micronutrient Days in Niger, National Vitamin A Plus Campaigns in Bangladesh, and the Preschoolers Health Week in the Philippines.

In Ghana, emphasis has been placed on effectively integrating vitamin A supplementation into routine health services; in Uganda, on implementing a new Minimum Health Care Package that includes vitamin A supplementation and efforts to increase vitamin A-rich food consumption. The reward of sustaining program activity is evident from Nepal, where Mr. Ram Shrestha, of Nepal's National Vitamin A Program, reported that consistently achieving a semi-annual coverage of 85% or more of children with high-potency vitamin A has prevented an estimated one-quarter million child deaths since the program began in 1993.

These and other reports of policy and program initiatives discussed during the XXII IVACG Meeting can serve to inform, illustrate, guide, and motivate an increasingly expanded agenda to control micronutrient deficiencies in the developing world.

This summary was prepared by Dr. Keith P. West, Jr.



PROGRAM AT A GLANCE

XXII IVACG Meeting

Sunday 14 November	1500–1900 Registration	
Monday, 15 November	Tuesday, 16 November	Wednesday, 17 November
0800 Registration Open	0800 Registration/Exhibits Open	0800 Registration/Exhibits Open
0900–1010 Inauguration	0830–1030 Assessment	0830–0920 Alternative Size Supplements
1010–1040 Break	1030–1130 Poster Session and Break	0920–1000 Supplementation: Post-NIDs
1040–1100 Status of Vitamin A in Peru	1130–1230 Infection	1100–1230 Supplementation: Country Experiences and Policy Implications
1100–1145 Keynote Address: Micronutrients within a Global Context		
1145–1150 Tribute to Dr. Clive E. West		
1150–1230 Food-Based Approaches for Controlling Vitamin A Deficiency Available Foods		
1230–1430 Lunch	1230–1430 Lunch	1230–1430 Lunch
1430–1545 Food-Based Approaches for Controlling Vitamin A Deficiency (continued) Bioavailability Biofortification	1430–1530 Maternal and Newborn Outcomes	1430–1545 Programs
1545–1630 Poster Session and Break	1530–1600 Poster Session and Break	1545–1600 Concluding Remarks
1630–1730 Food-Based Approaches for Controlling Vitamin A Deficiency (continued) Food Fortification	1600–1700 Multiple Micronutrients	1600 Closing Ceremony
1730 Meeting Adjourns	1700 Meeting Adjourns	1630 End of IVACG's formal sessions
1900 Welcoming Reception	1730–1900 Evening Session 1: Science and Policy: Bridging the Gap (IVACG)	1730–1900 Evening Session 1: Discovery to Development: Nutrition Sets the Breeding Agenda for Biofortified Foods (HarvestPlus)
	1900–2030 Evening Session 2: How Do We Achieve High VA Protection without Polio NIDs?: Lessons from a 20-VAS Country Program Assessment (UNICEF/The Micronutrient Initiative)	1900–2030 Evening Session 2: Stable Isotope Techniques in Nutrition: Focus on Iron and Vitamin A (International Atomic Energy Agency)

XXII IVACG Meeting

15–17 November 2004

Sunday, 14 November 2004

1500–1900 Registration

Monday, 15 November 2004

0800 Registration open

0900 **Inauguration of the XXII IVACG Meeting**

0900 Welcome Message from the Chair of the Local Organizing Committee
Dr. Luis Enrique Podestá, Director of the Office of People's Health,
Ministry of Health, Peru

0910 Welcome Message from the Chair of IVACG
Dr. Alfred Sommer, Dean, Johns Hopkins Bloomberg School of Public
Health

0920 Welcome Message from the United Nations Children's Fund
Dr. Andres Franco, UNICEF Representative for Peru

0930 Welcome Message from the Food and Agriculture Organization of the
United Nations
Dr. Luis Castello, FAO Representative for Peru

0940 Welcome Message from the Pan American Health Organization/World
Health Organization
Dr. Manuel Peña, PAHO Representative for Peru

0950 Welcome Message from the United States Government
Dr. Richard Martin, Director, Office of Health, USAID/Peru

1000 Welcome Message from the Government of Peru
Dr. Pilar Mazzetti Soler, Minister of Health of Peru

1010 Break

1040 **Status of Vitamin A in Peru**
Dr. Cesar Náquira

1100 **Keynote Address: Micronutrients within a Global Context**
Dr. Gerald Keusch

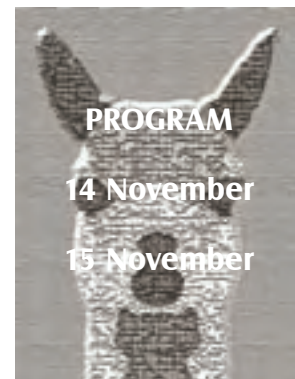
1130 Open Discussion

1145 **Tribute to Dr. Clive E. West**
Dr. Alfred Sommer

1150 **Food-Based Approaches for Controlling Vitamin A Deficiency**
Chair: Dr. Alfred Sommer
Co-Chair: Dr. Sutilak Smitasiri

1150 Introduction
Dr. Alfred Sommer

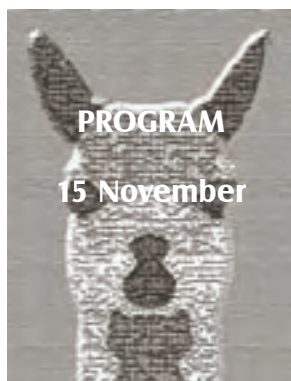
1155 **M40*** **Available Foods**
Homestead Food Production Contributes to Improving Household Food and
Nutrition Security
Ms. Gudrun Stallkamp



** Readers can use the codes next to presentation titles to locate abstracts of the presentations beginning on page 61.*

Monday, 15 November 2004 (continued)

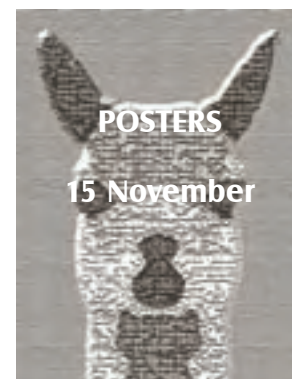
- 1205 **M41** Promotion of Production and Consumption of African Indigenous Vegetables to Improve Intake of Vitamin A and Other Micronutrients in Tanzania
Dr. Deborah Ash
- 1215 Open Discussion
-
- 1230 Lunch
-
- Bioavailability**
- 1430 **M42** Beta-Carotene Conversion to Vitamin A: Regulation in Humans
Ms. Nuttaporn Wongsiriroj
- Biofortification**
- 1440 **M43** Beta-Carotene-Rich Orange-Fleshed Sweet Potato Improves Vitamin A Status of Primary School Children in South Africa
Dr. Paul Van Jaarsveld
- 1450 **M44** Bioengineered Provitamin A-Enriched Tropical Rice
Dr. Karabi Datta
- 1500 Provitamin A Content in Golden Rice
Dr. Ingo Potrykus
- 1515 **M45** Increasing Vitamin A by Consuming Chicken Eggs Produced from Hens Fed *Spirulina*
Dr. Wiranda Piliang
- 1525 Open Discussion
-
- 1545 Poster Session and Break
-
- 1630 **Food-Based Approaches for Controlling Vitamin A Deficiency (continued)**
Chair: Dr. Omar Dary
Co-Chair: Ms. Gabriela Lock
- Food Fortification**
- 1630 Introduction
Dr. Omar Dary
- 1635 **M46** Effect of Different Cooking Methods on Vitamin A Stability of Foods in Developing Countries
Dr. Varghese Abraham
- 1645 **M47** Chapatti Fortified with Micronutrients in Improving Vitamin A and Iron Status in School-Age Children in Rural Bangladesh
Dr. Ahmed Rahman
- 1655 **M48** Triple Fortification of Salt with Microencapsulated Iodine, Iron and Vitamin A: A Randomized, Double-Blind Trial
Dr. Michael Zimmermann
- 1705 Beyond Nutritional Efficacy
Dr. Omar Dary
- 1715 Open Discussion
- 1730 End of day's formal sessions
- 1900 Welcoming Reception



Monday Posters

Posters on Dietary Diversification

- M1** Perception of Availability of Vitamin A-Rich Foods by Mothers: An Indirect Indicator for Evaluating Food Diversification Programs
Dr. Mohamed Ag Bendeck
- M2** Low Access to Beta-Carotene, Lutein and Zeaxanthin in Households of Brazil's Urban Areas
Dr. Jaime Amaya-Farfan
- M3** Institutional Strengthening and Intersectoral Linkages Set the Stage for Successful National Food-Based Program in Ghana
Ms. Esi Foriwa Amoaful
- M4** Content and In Vitro Accessibility of Beta-Carotene in Cooked Green Leafy Vegetables from Sri Lanka
Ms. Udumalagala Gamage Chandrika
- M5** Dietary Vitamin A Intake and Factors Influencing It among Micronesian Children and Caretakers
Dr. Lois Englberger
- M6** Micronesian Carotenoid-Rich Bananas and Other Foods: Successes and Lessons Learned for Preventing Vitamin A Deficiency
Dr. Lois Englberger
- M7** Seasonal Availability of Locally Produced Beta-Carotene-Rich Vegetables in a Rural Setting in South Africa
Dr. Mieke Faber
- M8** Updated Brazilian Database of Food Carotenoids
Prof. Delia Rodriguez-Amaya
- M9** Carotenoid Content in Totai Fruit (*Acrocomia totai* Mart.) by LC-DAD-MS
Dr. Maria Isabel Magne
- M10** Knowledge, Attitudes and Practices of Yellow Maize Consumption in Zimbabwe
Dr. Lucie Malaba
- M11** Momordica Powder and Oil from Gac Fruit, the Highest Content in Beta-Carotene, Lycopene and Vitamin E
Prof. Bui Minh Duc
- M12** The Issue of Vitamin-A-Rich Food Consumption by Preschool Children and Related Factors in a Rural Area
Mrs. Constance Nana
- M13** Effect of Baobab Leaf (*Adansonia digitata* L.) Diet on Vitamin A and Iron Status of Nigerian Children
Dr. Ngozika Nnam



Monday Posters (continued)



- M14** Sorrel (*Hibiscus sabdariffa*) Calyx as a Promising Source of Beta-Carotene to Control Vitamin A Deficiency
Dr. Ngozika Nnam
- M15** Delivery of Postprandial Retinol for Incorporation into Milk in Wild-Type and Retinol-Binding Protein Knockout Mice (RBP^{-/-})
Ms. Sheila M. O'Byrne
- M16** Using *Spirulina platensis* to Reduce Vitamin A Deficiency in Malagasy Children
Dr. Berthine Razafiarisoa
- M17** The Adequacy of Vitamin A Intake in the Diet of Nepalese Women and Children in the Annarpurna District of Nepal
Dr. Alison Rigby
- M18** Varietal Differences in the Carotenoid Composition of Squashes and Pumpkin and Retention During Dehydration
Dr. Mieko Kimura
- M19** Challenges Facing Food-Based Interventions in Addressing Vitamin A Deficiency and Possible Solutions
Ms. Generose Mulokozi
- M20** Carotenoid Composition of Processed Carrots Commercialized in Brazil
Dr. Mieko Kimura
- M21** A Red Palm Oil-Based Bread Spread to Alleviate Vitamin A Deficiency in Primary School Children
Dr. Martha E. Van Stuijvenberg
- M22** Moving with Red Palm Oil towards Dietary Diversification Strategy for Controlling Vitamin A Deficiency in Burkina Faso
Dr. Noël Marie Zagre
- M23** Potential Contribution of Mangoes to Vitamin A Intake in Rural Burkina Faso
Dr. Noël Marie Zagre

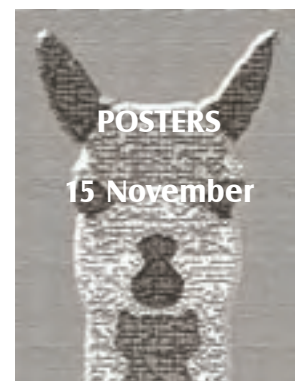
Posters on Bioavailability

- M24** Vitamin A Equivalency of Beta-Carotene in Oil in Healthy Dutch Adults Measured Using Specifically ¹³C-Labeled Beta-Carotene and Retinol
Ms. Carolien Bouwman
- M25** Human Carotenoid Metabolism Assessed with Radioisotope Techniques
Dr. Betty Jane Burri
- M26** Daily Consumption of Indian Spinach (*Basella alba*) or Sweet Potatoes Has a Positive Impact on Total Body Vitamin A Pool Size in Bangladeshi Men
Dr. Marjorie Haskell

Monday Posters (continued)

Posters on Biofortification

- M27** Carotenoid Content of Ten Varieties of Orange-Fleshed Sweet Potatoes Promoted in Burkina Faso
Dr. Mohamed Ag Bendeck
- M28** Vitamin A Partnership for Africa: A Food-Based Approach to Combat Vitamin A Deficiency through Increased Utilization of Orange-Fleshed Sweet Potato
Dr. Regina Kapinga
- M29** Beta-Carotene Content of Sun-Dried and Oven-Dried Chips of Orange-Fleshed Sweet Potato
Dr. Paul Van Jaarsveld
- M30** Changes in Beta-Carotene Content of Sweet Potatoes Kept in the Field and During Post-Harvest Stage at Room Temperature
Dr. Paul Van Jaarsveld
- M31** Introduction of Orange-Fleshed Sweet Potatoes in Gourma Province, Burkina Faso
Mr. Olivier Vebamba



Posters on Food Fortification

- M32** Comparison of the Carr-Price Colorimetric Method to the HPLC Technique for Vitamin A Determination in Fortified Oils
Prof. Hassan Aguentaou
- M33** Stability of Vitamin A-Fortified Table Sugar in Simulated Market Conditions ('Takal' System) in the Philippines
Dr. Mario Capanzana
- M34** Stability of Salt Triple Fortified with Iodine, Iron and Vitamin A
Prof. Levente Diosady
- M35** Human Milk Response to One Year of Sugar Fortification with Vitamin A in the Republic of Nicaragua
Ms. Yadira Medrano
- M36** Carotenes in Oil: Approaches to Incorporating a Safe and Effective Dietary Vitamin A Fortificant/Supplement into Regional Cuisines: A Guatemalan Experience
Ms. Monica Orozco
- M37** Micronutrient Intake, Anemia, and Vitamin A Deficiency in PANFAR and PACFO Beneficiary Peruvian Children
Prof. Carlos Rojas Dávila
- M38** Role of Temperature in Fortification of Sugar with Vitamin A
Mr. Surendra Sirohi

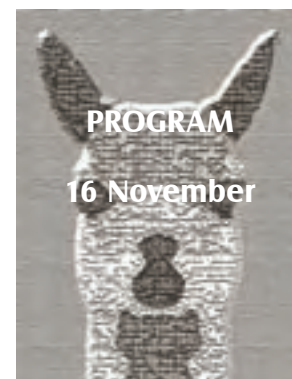
Monday Posters (continued)

- M39** The Effect of Salt Fortified With Iron, Iodine, Vitamin A and B Complex Vitamins on the Health of Children
Mrs. Malavika Vinod Kumar



Tuesday, 16 November 2004

- 0800 Registration/Exhibits Open
- 0830 **Assessment**
Chair: Dr. Keith P. West, Jr.
Co-Chair: Dr. Daniel Lopez de Romaña
- 0830 **T36** State-of-the-Art Vitamin A Assessment Methodologies: Report of a Joint IAEA and USAID Expert Consultancy
Dr. Sherry Tanumihardjo
- 0850 **T37** Rapid, Field-Based Assessment of Vitamin A Deficiency among Populations Using Retinol Binding Protein
Mr. John Hix
- 0900 **T38** Combined Measurement of RBP, sTfR and CRP in One Dried Blood Spot (DBS) – A Simple and Inexpensive Evaluation of Vitamin A, Iron and Infectious Status
Dr. Juergen Erhardt
- 0910 **T39** Validity of Blood Spot in Assessing Vitamin A Deficiency in Pregnant Nepalese Women
Dr. Rolf Klemm
- 0920 Open Discussion
- 0940 **T40** Impact of C-Reactive Protein on Retinol Concentrations of Zambian Children
Dr. Christine Clewes
- 0950 **T41** Pregnancy Affects Plasma Concentrations of Retinol and Acute Phase Proteins
Dr. Marjoleine Dijkhuizen
- 1000 Closing Remarks
Dr. Keith P. West, Jr.
- 1010 Open Discussion
- 1025 Dark Adaptometry Demonstration
Mr. Alain Labrique
-
- 1030 Poster Session and Break
-
- 1130 **Infection**
Chair: Dr. Claudio Lanata
Co-Chair: Dr. Susan Thollaug
- 1130 **T42** Complex Interactions with Infection and Diet May Explain Seasonal Growth Responses to Vitamin A in Preschool Children
Dr. Keith P. West, Jr.
- 1140 **T43** Impact of Neonatal and Maternal Vitamin A Supplementation on Anemia among Infants Born to HIV-Positive and HIV-Negative Mothers in Zimbabwe
Dr. Melissa Miller
- 1150 **T44** Impact of Postpartum VAS of HIV-Positive and HIV-Negative Women and their Infants on Serum Retinol Concentration and Morbidity
Dr. Melissa Miller



Tuesday, 16 November 2004 (continued)

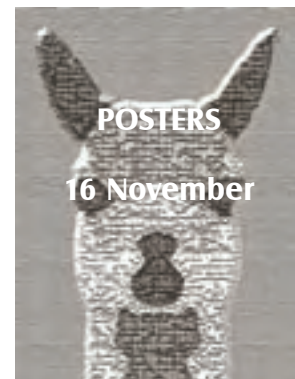
1200	Open Discussion
1230	Lunch
1430	Maternal and Newborn Outcomes Chair: Dr. Nelly Zavaleta Co-Chair: Dr. Jose Mora
1430	Overview Dr. Nelly Zavaleta
1445 T45	Impact of Antenatal Micronutrient Supplementation on Self-Reported Labor and Delivery Complications and Puerperal Morbidity Dr. Parul Christian
1500 T46	Treatment Effects of Maternal Micronutrient Supplementation Vary by Percentiles of the Birth Weight Distribution in Nepal Dr. Joanne Katz
1510 T47	Different Communication Strategies Can Increase Women's Awareness about Vitamin A-Rich Foods in Indonesia Ms. Sri Sukotjo
1520	Open Discussion
1530	Poster Session and Break
1600	Multiple Micronutrients Chair: Dr. Robert Black Co-Chair: Dr. Zulfiqar Bhutta
1600	Overview Dr. Robert Black
1615 T48	Iron Status is Associated with Pupillary Reaction Time and Predicts Greater Dark Adaptation Response to Iron and Riboflavin Supplements in Pregnant Nepali Women Provided with Ultra-Rice Dr. Lindsay Allen
1625 T49	Iron, Zinc and Vitamin A Supplementation in Infants: Interactions and Effects on Iron and Zinc Status Dr. Frank Wieringa
1635 T50	Vitamin A Supplementation Improves Iodine Efficacy in Goitrous, Vitamin A-Deficient Children Receiving Iodized Salt Dr. Michael Zimmermann
1645	Open Discussion
1700	End of day's formal sessions
1730–1900	Evening Session 1: Science and Policy: Bridging the Gap IVACG
1900–2030	Evening Session 2: How Do We Achieve High VA Protection without Polio NIDS?: Lessons from a 20-VAS Country Program Assessment UNICEF/The Micronutrient Initiative



Tuesday Posters

Posters on Assessment

- T1** Comparison of Indicators of Vitamin A Status in Thai Children
Dr. Neal Craft
- T2** Use of the CRAFTi Portable Fluorometer to Measure Vitamin A in Fortified Foods and Blood
Dr. Neal Craft
- T3** Infection and Inflammation May Influence Multiple Micronutrient Status in Pregnant Women: Findings From Nepal
Dr. Tianan Jiang
- T4** Development of Screening Indicators for Ranking Areas at Risk of Vitamin A Deficiency in Thailand
Dr. Kandavasee Maleevong
- T5** Higher Concentrations of Holo-Retinol Binding Protein in Vitamin A-Sufficient Compared to -Deficient Nepalese Women in the Last Trimester of Pregnancy
Mrs. Sandhya Sankaranarayanan
- T6** HPLC Methods for Vitamin A in Serum and Carotenoid Analysis: Results of a Validation Procedure
Dr. Touridomon Issa Some
- T7** Validation of the Modified Relative Dose Response Test against Liver Vitamin A for Application in Infants and Women Using a Swine Model
Dr. Sherry Tanumihardjo
- T8** Estimation of Vitamin A Deficiency in Infants
Dr. Frank Wieringa



Posters on Infection

- T9** Is There an Association between Vitamin A Status and Severity of Acute Respiratory Infection in Children?
Dr. Mahmoud El-Mougi
- T10** Sequestration of Vitamin A (VA) May Justify the General Use of VA Supplements to Treat Measles Infection
Mr. Sin Gieng
- T11** Serum Values of Interleukin 10 Appear Diminished in Children with Vitamin A Deficiency Disorders
Dr. Jorymar Leal
- T12** Effects of Multiple Micronutrient Supplements and Food Ration Interventions among Adult Men and Non-Pregnant and Non-Lactating Women Living with HIV/AIDS on Micronutrient Status
Prof. David Thurnham

Tuesday Posters (continued)

- T13** Serological Responses to Hepatitis B and *Haemophilus influenza* B Vaccines in Infants Receiving Vitamin A in Ghana
Dr. Samuel Newton
- T14** Serum Retinol, Infection and Intestinal Parasites in Vitamin A-Supplemented Children in Niger
Mr. Mamadou Ndiaye
- T15** Effect of Red Palm Oil on Respiratory Tract Infection among Adolescent Schoolgirls
Dr. Nigar Sultana



Posters on Maternal and Newborn Outcomes

- T16** Maternal Vitamin A Status and Levels of Vitamin A in Breast Milk: A Study Conducted in a Semi-Urban Community of Pakistan
Dr. Rakhshanda Bilal
- T17** Low Breast Milk Vitamin A and Associated Risk Factors among Lactating Women of the Karen Tribe in Northern Thailand
Dr. Uraiporn Chittchang
- T18** Effects of Vitamin A Supplementation on Immunity in Pregnant and Lactating Ghanaian Women
Dr. Sharon Cox
- T19** The Role of Grandmothers 'Muso Koroba' in Strengthening Postpartum Vitamin A Supplementation in Mali: A Qualitative Analysis
Mrs. Lina Mahy
- T20** Vitamin A Deficiency and Transplacental Vitamin A Delivery
Dr. Loredana Quadro
- T21** Strengthening Vitamin A Supplementation Programs through Effective Monitoring: Experiences from India, South Africa and Uganda
Ms. Ruth Harvey
- T22** Monitoring of Vitamin A Supplementation in Uttar Pradesh Reflects Challenges, Need for Capacity Building
Dr. Rajiv Tandon

Posters on Multiple Micronutrients

- T23** Effect of Vitamin A and Zinc Supplementation on Immune Response in Indonesian Preschool Children
Ms. Martha Irene Kartasurya

Posters on Determinants of Vitamin A Deficiency

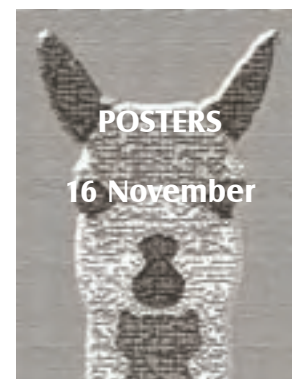
- T24** Seasonal Influences on Vitamin A Intake and Pregnancy Outcome in Women from Urban Slums of Delhi
Dr. Santosh Jain Passi

Tuesday Posters (continued)

- T25** Risk Factors for Night Blindness among Non-Pregnant Women in Indonesia
Mrs. Mayang Sari
- T26** Risk Factors for Xerophthalmia among Mothers and their Children and for Mother-Child Pairs with Xerophthalmia in Cambodia
Dr. Richard Semba

Posters on Recent Surveys

- T27** Daily Vitamin A Intake and Nutritional Disorders in Preschool Children: Case of the Northwest Area of Morocco
Prof. Hassan Aguentaou
- T28** Vitamin A Deficiency Disorders in Preschool Children of Eritrea
Dr. Zemui Alemu
- T29** Subclinical Vitamin A Deficiency in Israeli-Bedouin Toddlers
Dr. Christian Coles
- T30** Discrepancy Between Vitamin A and Iron and Zinc Status in 6- to 71-Month-Old Children in the Northern Cape Province, South Africa
Dr. Muhammad Ali Dhansay
- T31** Co-Existence of Micro- and Macronutrient Deficiencies among Children 24–84 Months Old in Maracaibo, Venezuela
Dr. Jorymar Leal
- T32** Vitamin A Status of Children Under 5 in Nigeria: Results of the Nigeria Food Consumption and Nutrition Survey
Dr. Busie Maziya-Dixon
- T33** High Prevalence of Anemia, Zinc and Subclinical Vitamin A Deficiency in Infants From 5 to 8 Months of Age in a District in the Northern Mountainous Area of Vietnam
Dr. Nguyen Xuan Ninh
- T34** Maternal Vitamin A Status and Iron Status vis-a-vis Growth, Development and Health of Infants from the Lower SES
Ms. Kajali Paintal
- T35** Venezuelan National Survey on Vitamin A Deficiency in Children from 6 to 59 Months Old
Dr. Liseti Solano



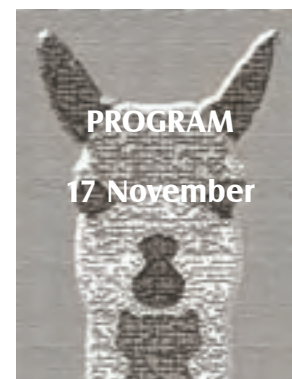
Wednesday, 17 November 2004



- 0800 Registration/Exhibits Open
- 0830 **Alternative Size Supplements**
Chair: Dr. Samuel Newton
Co-Chair: Dr. Carlos Rojas
- 0830 Overview
Dr. Lindsay Allen
- 0840 **W34** Anterior Fontanelle Bulging after Vitamin A Supplementation Given with DPT, Polio and Measles Vaccines in the First Year of Life
Dr. Mary Penny
- 0850 **W35** The Safety and Efficacy of Vitamin A Supplementation Alongside Routine Vaccinations: a Randomized Controlled Trial in Tanzania
Dr. Boniphace Idindili
- 0855 **W36** Randomized Trial of a Newly Proposed Regime for Vitamin A Supplementation of Young Infants Linked to the EPI in Ghana
Dr. Samuel Newton
- 0900 **W37** Milk Retinol and Oligosaccharide Concentrations in Gambian Women Following Two Doses of 200,000 IU Retinyl Palmitate Postpartum
Dr. David Thurnham
- 0905 Open Discussion
- 0915 Closing Remarks
Dr. Samuel Newton
- 0920 **Supplementation: Post-NIDs**
Chair: Dr. Ian Darnton-Hill
Co-Chair: Mrs. Rosanna Agble
- 0920 Introduction
Dr. Ian Darnton-Hill
- 0930 **W38** Sustaining the Gains of Vitamin A Supplementation: Innovative Ways of Integrating Vitamin A Supplementation into Child Health Services in Ghana
Ms. Esi Amoaful
- 0935 **W39** Vitamin A Capsule Distribution in Mali through National Nutrition Weeks: Reaching and Maintaining High Vitamin A Supplementation Coverage
Dr. Fatimata Ouattara
- 0940 **W40** Implementation of VAD Program: 2003–2010 Post-NIDs Experience of Rwanda
Mr. Aphrodis Ndagiymfura
- 0945 Open Discussion
-
- 1000 Poster Session and Break
-
- 1100 **Supplementation: Country Experiences and Policy Implications**
Chair: Dr. Frances R. Davidson
Co-Chair: Dr. Lucila Sierra
- 1100 **W41** Vitamin A Deficiency Is Virtually under Control in Nicaragua
Dr. Jose Mora

Wednesday, 17 November 2004 (continued)

- 1110 **W42** Building a Multisectoral Vitamin A Program in Uganda: Establishing Sustainable Roles
Ms. Louise Sserunjogi
- 1120 **W43** The Status of Vitamin A Supplementation for Young Children and Postpartum Women
Mr. Joseph Mugyabuso
- 1130 **W44** Vitamin A Distribution Enhances Vaccine Coverage within Routine Immunization
Dr. Geeta Verma
- 1140 **W45** Scaling-Up Child Health Services: A Decade's Experience of the Nepal National Vitamin A Program (NVAP)
Mr. Ram Shrestha
- 1150 Open Discussion
- 1220 Closing Remarks: Lessons Learned
Dr. Frances R. Davidson
-
- 1230 Lunch
-
- 1430 **Programs**
Chair: Dr. Chewe Luo
Co-Chair: Mr. Shawn Baker
- 1430 Overview
Dr. Chewe Luo
- 1435 **W46** The Nicaragua National Integrated Nutrition Monitoring and Evaluation System (SIVIN)
Dr. Josefina Bonilla
- 1445 **W47** Empirical Evaluation of the Impact of a Large-Scale Vitamin A Supplementation Program in Northern Ghana
Dr. Patricia David
- 1455 **W48** Comparison of Vitamin A Coverage According to Administrative versus Survey Data
Ms. Heather Gardner
- 1505 **W49** Can UNICEF VAC Coverage Rates Be Used to Indicate which Countries Require Additional Assistance to Eliminate VADD?
Ms. Julie Mateer
- 1515 Open Discussion
- 1535 Closing Remarks
Dr. Chewe Luo
- 1545 **Concluding Remarks**
Dr. Alfred Sommer
- 1600 **Closing Ceremony**
- 1630 End of IVACG's formal sessions



Wednesday, 17 November 2004 (continued)

- 1730–1900 Evening Session 1: Discovery to Development: Nutrition Sets the Breeding Agenda for Biofortified Foods
HarvestPlus
- 1900–2030 Evening Session 2: Stable Isotope Techniques in Nutrition: Focus on Iron and Vitamin A
International Atomic Energy Agency (IAEA)



Wednesday Posters

Posters on Alternative Size Supplements

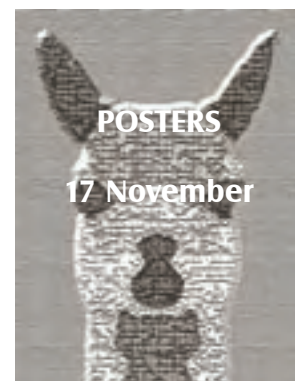
- W1** Randomized Study of the Impact of Different Doses of Vitamin A on Childhood Morbidity and Mortality
Dr. Christine Stabell Benn

Posters on Supplementation

- W2** Vitamin A Capsule Coverage among Bangladeshi Children 6 to 11 Months of Age: The Need for Improvement
Ms. Gudrun Stallkamp
- W3** Postpartum Vitamin A Capsule Coverage in Bangladesh
Ms. Taskeen Chowdhury
- W4** Vitamin A Intake among Children Who Received and Did Not Receive a Vitamin A Capsule in the Urban Slums of Jakarta and in Rural West Java, Indonesia
Ms. Siti Halati
- W5** Sustaining Vitamin A Supplementation: Testing a Community-Directed, Integrated Approach in Cameroon
Ms. Nancy Haselow
- W6** Low Vitamin A Capsule Coverage Rates among Postpartum Women in Central Java, Indonesia. What Are the Limiting Factors?
Ms. Elviyanti Martini
- W7** Evaluation of the Newly Proposed Vitamin A Supplementation Regimen for Postpartum Mothers Using Stable Carbon Isotopes
Mr. Samuel Tchum
- W8** Successful Vitamin A Distribution Campaigns in Madagascar
Dr. Simon Rakotonirina

Posters on Supplementation: Post-NIDs

- W9** Community-Based Vitamin A Supplementation Even in Emergency Situations
Ms. Micheline Ntiru
- W10** Postpartum Vitamin A Supplementation: Integrated, Routine Health Center Delivery in Cote D'Ivoire
Ms. Micheline Ntiru
- W11** Sustaining High VAC Coverage Beyond NIDs in the Philippines
Ms. Emerita Barquilla
- W12** The National Vitamin A Plus Campaign: A Success Story for Vitamin A Program in Bangladesh
Dr. Harriet Torlesse



Wednesday Posters (continued)



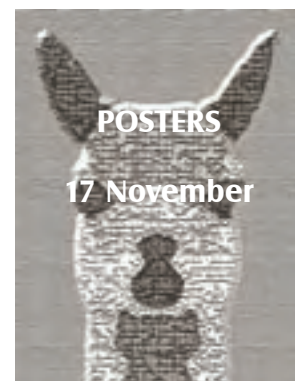
- W13** Distribution of Vitamin A Capsules Coupled with the Measles Vaccination Campaign: The Guinea Experience
Dr. Gil-Won Cusack
- W14** High Vitamin A Supplementation Coverage in Niger: The Challenges of Maintaining Success Six Years Later
Mrs. Aissa Mamadoultaiou
- W15** Addressing the Second-Generation Challenges in Vitamin A Supplementation in Tanzania
Ms. Bertha Mlay
- W16** Sustaining High VAC Supplementation Coverage in a Decentralized Setup: A Local Government Experience in the Philippines
Ms. Eva Concordia Puertollano

Posters on Programs

- W17** Effects of the Child Survival Program on the Reduction of Serum Retinol Deficiency in Children Under Five Years of Age, Project HOPE, Peru
Ms. Sandra Contreras
- W18** Health Worker Training and Multimedia Strategies Are Keys to Success for Zambia's Child Health Weeks
Dr. Ward Siamusantu
- W19** Do's and Don'ts: Convincing the Private Sector to Support Fortification Activities in Mali
Dr. Amenatou Cissé
- W20** Community Volunteers: An Excellent Channel for Postpartum Vitamin A Supplementation in Dinguiraye, Guinea
Dr. Gil Cusack
- W21** Evaluation of Iron/Folate and Vitamin A Supplementation Programs in Guinea
Dr. Gil Cusack
- W22** Large Scale-Up of VAC Distribution Pilot Project in Cambodia through Coordinated Efforts among Partner Agencies and Effective Use of Available Resources
Ms. Jutta Diekhans
- W23** Community and Non-Governmental Organizations' Roles in Accelerating Vitamin A Supplementation: A Southern Province Perspective
Mr. Bernard Kasawa
- W24** Evaluation of a Pilot Program for Postpartum Vitamin A Supplementation in Maputo City, Mozambique
Mrs. Sonia Khan

Wednesday Posters (continued)

- W25** Evaluation of the National Vitamin A Supplementation Program in Schoolchildren in a Rural Area of Sri Lanka
Mr. Sanath Mahawithanage
- W26** Impact of Vitamin A Supplementation on Health Status and Absenteeism of Schoolchildren in Sri Lanka
Mr. Sanath Mahawithanage
- W27** Institutionalizing the Distribution of Vitamin A in the Decentralized Health System of Zambia
Mr. Freddie Mubanga
- W28** Using Vitamin A Strategy to Boost Routine Immunization in Bihar
Dr. Geeta Verma
- W29** National Vitamin A Promotion Campaigns Increase Vitamin A Capsule Coverage Rates among 6- to 59-Month-Old Children in Indonesia
Dr. Amy Rice
- W30** Success Stories from West Africa: Nutrition Networking through the ECOWAS Nutrition Forum
Dr. Ismaila Thiam
- W31** A Rapid Assessment of the Management of the Vitamin A Supplementation Program in the Eastern Cape, South Africa
Ms. Chantell B. Witten
- W32** Developing an Information, Education and Communication (IEC) Strategy For Xhosa-Speaking Child Caregivers to Support the Routine Vitamin A Supplementation Program in the Eastern Cape, South Africa
Ms. Chantell B. Witten
- W33** Continuing Partnerships for Sustainable Prevention of Vitamin A Deficiency in Cambodia
Dr. Yaren Yim



Report on Presentations

The XXII International Vitamin A Consultative Group (IVACG) meeting was held in Lima, Peru 15–17 November 2004, and was attended by approximately 800 delegates from 71 countries. The overall theme of the meeting, “Vitamin A and the Common Agenda for Micronutrients,” highlighted the need for a better understanding of the interactions among micronutrients such as vitamin A, iron, and zinc. Over 45 oral presentations were given in themed sessions, and more than 100 posters were presented over the 3-day period.

Inauguration

The meeting began on Monday with a welcome message from Dr. Luis Enrique Podestá, director of the Office of People’s Health in Lima, Peru, and chair of the Local Organizing Committee for the meeting. Dr. Alfred Sommer, chair of the IVACG Steering Committee, added his own welcoming remarks and thanked the Local Organizing Committee for their hard work in preparing for the IVACG meeting.

Representatives from the United Nations Children’s Fund (UNICEF), the Food and Agriculture Organization of the United Nations (FAO), the Pan American Health Organization/World Health Organization (PAHO/WHO), the United States Agency for International Development (USAID), and the Ministry of Health for Peru also extended their welcome. Dr. Andres Franco, UNICEF representative for Peru, presented data on malnutrition, anemia, and vitamin A deficiency in children and stressed the importance of the need for work to continue on micronutrient deficiencies. Dr. Luis Castello, FAO representative for Peru, said that the theme of the IVACG meeting was of great importance to FAO. He saw the IVACG meeting as an opportunity to strengthen linkages among local, national, and international initiatives and between different sectors for the elimination of vitamin A deficiency. He presented statistics on vitamin A deficiency, iron

deficiency anemia, and iodine deficiency disorders in Peru, and reminded delegates of the formidable challenges still ahead. Dr. Manuel Peña, PAHO representative for Peru, while reaffirming the micronutrient problems, emphasized that other factors such as poverty, hunger, and disease also have to be taken into account. Dr. Richard Martin, Chief of the Office of Health, USAID/Peru, was happy that USAID had been associated with and sponsored the IVACG meetings for the last 25 years. He said that Peru is a country with 28 million people, of which 54% live in poverty, and through meetings such as IVACG, the problems of vitamin A deficiency, iron deficiency anemia, and iodine deficiency disorders are highlighted and addressed. The final speaker in the inaugural ceremony was Dr. Pilar Mazzetti Soler, Minister of Health for Peru, who spoke of the problems of “hidden hunger” in her country; in contrast, advances in reducing micronutrient deficiencies have resulted in a 32% drop in vitamin A deficiency in Peru between 1997 and 2001.

Dr. Cesar Náquira, of the National Institute of Health, in Lima, Peru, began the scientific sessions and gave the delegates an overview of the vitamin A status of Peru. The most recent subclinical vitamin A deficiency surveys, the National Monitoring of Nutritional Indicators, were carried out by the Centro Nacional de Alimentación y Nutrición (CENAN) in 1998, 1999, 2000, and 2001 in children 6 to 59 months of age and women 15 to 49 years of age. The sample was identified using information provided by the National Institute of Statistics and Information, and was then divided into six regions; 360 households from each region were selected. The data collected in 2001 showed that there was a 32% reduction in vitamin A deficiency between 1997 and 2001, and that intake of vitamin A-rich foods was low but varied among regions. Vitamin A supplementation has been carried out in Peru since 1999, but is focused on selected regions of the country based on ecological indicators. Postpartum women and children 6 to 11 and 12 to 23 months of age are targeted for vitamin A supplementation. There are no large-scale

All contents and ideas presented in this report are the work of the authors and do not necessarily reflect those of IVACG, USAID, or the International Life Sciences Institute.

or national programs, but margarine and milk are fortified. There is also a food distribution program that gives breakfast to 500,000 schoolchildren in six regions.

Keynote Address: Micronutrients within a Global Context

Dr. Gerald Keusch, of Boston University, in Boston, Massachusetts, USA, gave the keynote address. He began by reviewing some disturbing world statistics: 1.2 billion people are living in poverty on less than US\$1/day, with a further 2.8 billion living on less than US\$2/day. One-sixth of the world is chronically hungry. The population is growing daily and there are already more than 6 billion people in the world. The environment is deteriorating due to human actions. Civil society is in disarray, with increases in civil and foreign wars, genocide, etc., resulting in families being displaced and increasing the number of refugees. Health is essential for economic development, political and social structures, and, most important of all, personal growth and development. Life expectancy in the richest countries in the world has been increasing since 1991, but in five African countries is now less than 40 years. Gains in many other countries have been wiped out because of AIDS, tuberculosis, and malaria. Ninety-five percent of the disease burden is in developing countries, and HIV, tuberculosis, and malaria are rapidly increasing. Lack of good nutrition is a conditioning factor for infectious disease mortality. Effective nutritional and other interventions such as combined breastfeeding, complementary feeding, and vitamin A and zinc interventions are estimated to reduce child mortality by more than 25%. It is projected that global distribution of mortality from infectious disease may be halved by 2020; however, such forecasts may be optimistic. Infectious disease has an "unfinished agenda," and although new rapid detection methods are being developed in industrialized countries, such tests are not available in many developing nations. In the United States, the health expenditure is 15% of the gross national product for all aspects of health, with disproportionate amounts spent on

the smallest (richest) sections of society. In addition, over 90% of health research is focused on diseases affecting less than 10% of the world's population. Furthermore, although new infectious agents continue to emerge and spread globally, the money for research and development is dwindling.

Using the example of vitamin A, Dr. Keusch showed that it took more than 20 years from the discovery that children given vitamin A supplements have a reduced risk of mortality to the implementation of vertical supplementation programs. Why did it take so long? Had science been supported at the appropriate level, would that have made a difference? Dr. Keusch stated that clinical research should be more closely linked to field studies, scientists should target underlying mechanisms using modern techniques, and there should be a greater focus on biological interactions with other risk factors using integrated approaches. However, none of this can be achieved without good leadership from government, academia, civil society, and committed donors to finance the work.

Tribute to Clive West

Dr. Sommer gave a moving tribute to Dr. Clive West and his contribution to the field of nutrition. Dr. West died of Kahler's disease, a multiple myeloma bone marrow disease, on 27 August 2004. Throughout his career, Dr. West carried out substantial work on the importance of vitamin A and other micronutrients. His work on the bioavailability of β -carotene established that the amount of vitamin A available from plant foods had been overestimated. Many people in the nutrition field have benefited from Dr. West's drive to understand better the factors that determine micronutrient bioavailability, interactions, and malnutrition. He was attentive to laboratory accuracy and helped colleagues in developing nations improve the quality of their analyses. All in the nutrition world will miss him, perhaps most of all his colleagues from IVACG, who knew him well. All delegates stood in silence as a mark of respect.

Scientific Presentations

Food-Based Approaches for Controlling Vitamin A Deficiency

Fruits, vegetables, large and small livestock, poultry, and fish are all good sources of micronutrients, but in many populations diets do not include many of these nutritious foods. A number of approaches have emerged to encourage diversification and to increase nutritional benefit from the foods eaten. These include home gardening, food fortification, genetic engineering, nutrition education, and increased bioavailability of food components. In this session, talks on methods to increase the home production of vitamin A-rich foods, improved methods of preparing foods to make carotenoids more bioavailable, genetic engineering to produce golden rice, the costs of monitoring foods fortified with vitamin A, and the stability of fortified foods were presented.

The session was introduced by Dr. Sommer, who gave an overview of the progress made in estimating the bioavailability of plant vitamin A. It is now suggested the β -carotene:retinol ratio for fruits and vegetables is 12:1 and 26:1, respectively. Using these values, a 70 g serving of dark-green leafy vegetables will only meet 20% of the recommended dietary allowance (RDA) for vitamin A in children 4 to 8 years old. Therefore, in order to meet the RDA a child would have to eat 350 g of dark-green leafy vegetables per day. Only people in Europe and North America would receive enough vitamin A in the food supply to meet the RDA. Using this background, Dr. Sommer introduced an extra speaker, Professor Emeritus Ingo Potrykus, of the Humanitarian Golden Rice Project and Network, in Zurich, Switzerland, who was later going to speak on engineering the β -carotene biosynthetic pathway into rice endosperm to enhance the vitamin A content.

Available Foods

The first speaker in the session, Ms. Gudrun Stallkamp, of Helen Keller International, in Dhaka, Bangladesh,

updated the audience with recent data on homestead food production and its effects on food and nutrition security in Bangladesh (M40*). The pilot project in two rural districts encouraged home gardening and animal husbandry. Poultry was given to 600 households, 160 households received fish or a milking cow, and 20 received both fish and a milking cow. Longitudinal data on 400 target and 300 control households were collected between April 2002 and 2003. The program significantly improved animal food production and consumption in the target group; for example, 94% of households in the target group had consumed eggs in the last 7 days compared with 46% of households in the control group. The household income from selling poultry in the target group was 250 BDT (Bangladeshi Takka) compared with 52 BDT in the control group, enabling the families in the intervention group to purchase extra food. The speaker concluded that as a result of the intervention, there was greater dietary diversity, increased consumption of micronutrient-rich animal foods, and more income was generated to be spent on other food, thereby contributing to improved household food and nutrition security.

The second speaker Dr. Deborah Ash, of the Muhimbili School of Public Health, in Dar es Salaam, Tanzania, described work to improve vegetable production and consumption in Tanzania using indigenous species (M41). Supported by the World Vegetable Centre, the following priority crops were identified: amaranth, African eggplant, African nightshade, Ethiopian kale, jute mallow, okra, and spider plants. Germ plasm was obtained for each plant. A baseline survey revealed that only one-quarter of households practiced home gardening, and the production of vegetables was hindered by several factors, including: lack of access to seed stock, lack of agricultural services, lack of knowledge, low rainfall, limited food preservation techniques, and lack of access to markets. It was not surprising that consumption of vegetables was low and only nine vegetables were commonly consumed (spinach, cabbage, cowpea and cassava leaves, onions, and tomatoes). No

* Readers can use the codes next to presentation descriptions to locate abstracts of the presentations beginning on page 61.

leguminous vegetables were eaten and fruit was consumed seasonally. An intervention program to promote dietary diversification recruited 1500 households from ecologically diverse livelihoods, e.g. subsistence farmers, pastoralists, and the fishing community. Interventions included: training in home-gardening techniques, provision of seeds, on-site demonstration plots, teaching food preservation techniques, and recipe demonstrations. There was an 80% uptake rate and the intervention successfully improved food availability, quality, and security. Programs to promote food-based strategies in Tanzania are virtually non-existent. It would be possible to scale up such a program to other parts of the country.

There was a large group of posters related to dietary diversification. In particular, many authors reported on the use of a wide variety of plant foods and their effectiveness in improving the status of vitamin A and other micronutrients. Fruits studied ranged from the well-known, such as bananas (M6) and mangos (M23), to the less-familiar totai fruit (M9) and gac fruit (M11). Vegetables studied ranged from squash, pumpkin (M18), carrots (M20), and other commonly used vegetables (M7, M10) to many different varieties of green leafy vegetables (M4), including some lesser-known ones such as baobab leaves (M13) and sorrel (M14). Different uses of red palm oil (M21, M22) were reported, as well as the use of β -carotene-rich *Spirulina* algae (M16, see also oral presentation M45). Furthermore, several assessments of programs, approaches, and challenges (M3, M19) for dietary diversification were presented, as well as assessments of populations and their dietary habits and dietary risks (M1, M2, M12, M17). The poster from Ghana was a good example of new approaches being made to increase food security and nutrition, as it described attempts made to prevent duplication of effort by the agriculture and health sectors and combined resources in a common agenda (M3). More technical posters included information on food composition data (M8), analyses of different food processing methods, and even mechanisms to deliver retinol to mice (M15).

Posters dealing with the theme of dietary diversification carried several important messages. It is clear that carotenoid content varies widely in plant foods, not only among species, but also with different processing and preparation methods. Many plant foods have the potential to improve vitamin A status when included in the diet, but results from Tanzania and Micronesia show that it is crucial to choose varieties with high carotenoid contents that are eaten regularly and are cooked to make the carotenoids most bioavailable (M6, M19). The latter point was also illustrated by the poster from Sri Lanka showing improved β -carotene bioavailability when oil or coconut milk was added during cooking (M4). Seasonal availability and deterioration of β -carotene during storage (M7, M23) are also factors to be considered. New foods and food preparations were shown to be acceptable and effective, as in the case of a bread spread made from red palm oil in Burkino Faso (M22) and South Africa (M21). Intervention studies show that the inclusion of specific plant foods chosen for their high carotenoid content and bioavailability can effectively improve vitamin A status, but that nutritional education, communication, and accessibility are crucial for success. Interestingly, the perceived availability of vitamin A-rich foods was found to correlate well with improvements in night-blindness in a home gardening study in Burkino Faso (M1). In conclusion, new plant foods and uses, processing methods, and intervention approaches are being developed to optimize the role of dietary diversification as a long-term and sustainable approach to combat vitamin A deficiency.

Bioavailability

Ms. Nataporn Wongsiriroj, doctoral student at Columbia University, in New York, USA, began the afternoon session and asked the question, do cellular vitamin A concentrations influence the conversion of provitamin A carotenoids to vitamin A (M42)? The conversion of β -carotene takes place in three steps: 1) cleavage of β -carotene by the carotene cleavage enzyme, 2) reduction of retinal to retinol by retinal reductase, and 3) esterification of retinol to retinyl ester by lecithin:retinol

acyltransferase. Cellular retinol-binding proteins (RBPs) are important sensors of cellular and tissue vitamin A levels, and when vitamin A levels are sufficient, they are bound to retinol as holo-cellular RBPs. When vitamin A levels are deficient, the proteins are present as apo-cellular RBPs. Cellular RBP type I (RBP-I) is widely distributed in the tissues, especially in the liver, kidney, testes, and lung, and in smaller amounts in other tissues. Cellular RBP-I is not found in the small intestine, where cellular RBP-II is found exclusively. Data were presented to show that apo-cellular RBP-I markedly stimulated the carotene cleavage enzyme, and the stimulation was concentration dependent, suggesting that apo-cellular RBP-I could stimulate the conversion of pro-vitamin A to retinol and regulate the conversion. However, changes in the concentrations of either apo- or holo-cellular RBP-II appeared to have no effect on the conversion of β -carotene to retinol, so regulation of carotene cleavage enzyme activity in the gut via cellular RBP activity would not appear to be sensitive to vitamin A status.

There were three posters in the section on bioavailability. Two presented detailed data on β -carotene uptake, metabolism, and impact on vitamin A status in different study populations of healthy western adults (M24, M25) and one in Bangladeshi men (M26). All used different methodologies to measure ^{13}C - (M24), ^{14}C - (M25), and deuterium-labeled (M26) β -carotene and its metabolites. Results were generally in agreement with existing estimates. There is a striking difference between the results obtained from test doses in oil, which are overall quite consistent, and those obtained when β -carotene is given in test meals or as part of a diet, which vary much more. The machinery to measure isotopic compounds is being improved constantly, and the development of more precise and practical methods will allow future studies to measure β -carotene bioavailability and metabolism very precisely in different populations under a wide range of circumstances (M24, M25). At present, available methodologies give a good estimate of the effect of dietary β -carotene on vitamin A status in a population at risk

of vitamin A deficiency, therefore enabling the interpretation of interventions (M26).

Biofortification

The objective of the study presented by Dr. Paul van Jaarsveld, of the Medical Research Council, in Tygerberg, South Africa, was to determine the efficacy of daily consumption of boiled and mashed, β -carotene-rich orange-fleshed sweet potato to improve vitamin A status (M43). Primary school children 5 to 10 years old in a controlled, unmasked school-feeding program in Kwa-Zulu Natal Province, South Africa, were dewormed, stratified by classroom and gender, and randomly assigned to receive orange-fleshed sweet potato ($n = 90$) or white-fleshed sweet potato (controls; $n = 90$). At baseline, weight and height were measured, a modified relative dose-response (MRDR) test was performed to determine adequacy of liver vitamin A stores, and serum ferritin and zinc concentrations were measured. Children were fed sweet potato 5 days a week for a total of 53 days over 10.6 weeks, and a normal school meal was served after the sweet potato was eaten. Following a 10-day washout period, the baseline tests were repeated. The proportion of children with low liver vitamin A reserves fell significantly from 22% to 14%, but there was no effect on plasma retinol concentrations. Orange-fleshed sweet potato was shown to have good acceptability among the children. The authors concluded that the high- β -carotene orange-fleshed sweet potato varieties have the potential to reduce vitamin A deficiency in developing countries. Therefore, food diversification through the production of yellow-orange β -carotene-rich vegetables is a viable long-term strategy to complement supplementation and fortification programs.

The next section of the session concentrated on bioengineered, provitamin A-enriched rice. Dr. Karabi Datta, of the International Rice Research Institute, in Manila, Philippines, began by saying that up to 72% of energy intake in Asian countries can be from rice, and so enrichment of rice with vitamin A has the potential to increase vitamin A intake (M44). Their research began by screening existing rice varieties

for those already containing provitamin A. Once identified, enrichment was begun by introducing two genes, *psy* and *crt1*, into the endosperm. Stable integration and inheritance of the transgenes were confirmed through molecular analyses. The β -carotene content of the enriched rice ranged from 0.79 to 1.40 $\mu\text{g/g}$ dry rice seed.

Dr. Potrykus continued the theme of biofortification with a talk on the provitamin A content of golden rice, which contains the genes required to activate the biochemical pathway leading to β -carotene. The speaker suggested that the vitamin A contribution from golden rice will provide 50% of the RDA, and this is sufficient to prevent vitamin A deficiency based on estimations by the International Food Policy Research Institute. However, questions still remain regarding bioavailability, loss during cooking, stability during storage, acceptance by consumers, and adoption by farmers.

Dr. Potrykus suggested that a farmer can benefit from this technology with only one seed. One seed will produce one plant, which in turn can produce 1000 seeds, and some of these seeds may be used for the next sowing. In an ideal, metaphorical world, where all seeds successfully become new plants, Dr. Potrykus suggested, assuming 2 harvests/year, that in two years, each seed has the potential to produce sufficient food for 100,000 people and carries the technology to reduce vitamin A malnutrition in a cost-effective and sustained manner. No additional agrochemicals or pesticides, novel farming systems, or new seed are required. The technology is free up to a yearly rice-generated income of US\$10,000 per farmer or local trader. The speaker suggested that once regulatory issues are solved, biofortification of rice with iron, zinc, lutein, and other micronutrients will be possible. He also said that research into enhancing other potential staple foods (e.g., cassava and sorghum) is under way.

The final talk of this session was by Dr. Wiranda Piliang, of Bogor Agricultural University, in West Java, Indonesia, who had looked at a novel way of increasing

the vitamin A content of eggs by feeding hens *Spirulina*, a blue-green algae that contains a high content of β -carotene and xanthophylls (M45). One-hundred-eighty hens were divided into four treatment groups with three replications comprising nine hens in each replicate. Four levels (0%, 0.5%, 1.0%, and 1.5%) of ground *Spirulina* were added to each treatment diet. Egg production, egg yolk color, cholesterol, and carotenoid and xanthophyll content in the egg yolk were monitored. The highest level of *Spirulina* in the diet (1.5%) gave the lowest cholesterol (133 mg/10 g fresh egg yolk) and the highest retinol content (0.266 mg retinol/100 g egg yolk), while the highest cholesterol content resulted from the control diet (178 mg/10 g fresh egg yolk). The retinol content resulting from the high-*Spirulina* diet was 2.4 times that present in commercial chicken eggs: equivalent to 266 retinol equivalents and contributing 48% of the infant RDA.

The theme of biofortification was addressed in five posters on the sweet potato. Studies ranged from technical studies (M27, M29) to implementation-oriented studies (M30) to operational research (M28, M31). The more technical papers compared the carotenoid content of different varieties of orange-fleshed sweet potato in Burkino Faso, and recommended the "Jewel" variety based on its high β -carotene content and good cultural acceptability (M27). Research in South Africa showed that β -carotene losses in orange-fleshed sweet potato can be greatly reduced by optimizing the drying process by using thicker slices and avoiding direct sun exposure (M29). It was also reported that the β -carotene content actually increased if the potatoes were left in the ground and only harvested when needed, and that synthesis continued during room storage for up to 18 weeks (M30). On a larger scale, programs in several sub-Saharan African countries in the Vitamin A for Africa Partnership (M28) and in Burkino Faso (M31) reported that orange-fleshed sweet potato showed potential as a crop that could be included in the diet, although promotion, education, and marketing potential were identified as key factors for success.

Food Fortification

Dr. Omar Dary, of MOST, The USAID Micronutrient Program, in Washington, DC, USA, said that the most cost-effective dietary intervention is food fortification, but results depend on the dosage. For example, 10 to 15 mg vitamin A/kg sugar can increase plasma retinol concentrations from 0.72 to 1.06 $\mu\text{mol/L}$. However, the program viability depends on the cost of the food vehicle per family. For example, the cost per person per year for fortified sugar is US\$0.086, about 1.8% of the price of non-fortified sugar, compared with fortified monosodium glutamate, for which the cost is US\$0.07 per person per year, but which is 16% of the price of non-fortified monosodium glutamate. Enforcement of fortification regulations has to be done to ensure reliability, and cost can depend on the size of the factory. Thus, if enforcement requires two visits and the analysis of 10 samples per site per year, then for 10 medium-sized factories the cost is \$3000/year. At the village level, which might have only 2% of the capacity of factories, costs rise to \$150,000/year (Table 1).

Finally, the industry has to pay for equipment, quality control, and external control, the costs for which can range from 0.11% of the year's sales for a medium-sized factory to 0.34% for an artisanal system. Therefore, economic viability depends on the fortificant producing only a small increment in the price of the vehicle with oil and flour resulting in a smaller price increment than sugar, and sugar less than salt and MSG.

The next presentation addressed the question of stability of vitamin A in

fortified vegetable oils. Dr. Varghese Abraham, of Champion Foods, in Brampton, Ontario, Canada, described experiments with five oils—soybean, sunflower, peanut, mustard, and vanaspati ghee—that were fortified with four different concentrations of vitamin A (25, 100, 200, and 300 IU/g) at five different temperatures (25°C, 28°C, 32°C, 36°C, and 40°C), in dark and light, in closed and open containers, air- and nitrogen-blanketed, with and without antioxidants (M46). Samples were analyzed every 4 weeks for 6 months. The fortified oils were then used for cooking using different methods: pan frying, gravy making, steam cooking, pressure cooking, or shallow frying. In addition, a packaging study was carried out using clear glass bottles, polyvinyl chloride (PVC), high-density polyethylene, brown PVC, brown high-density polyethylene, and metal tins. Results to date suggested that all six oils followed the same decomposition pattern, and the presence of antioxidants made only a slight difference. The level of vitamin A in the oil did not have much influence on its stability. Pressure cooking retained more vitamin A than boiling or pan frying, but overall, 65% to 85% of the vitamin was retained with all cooking methods. The selection of packaging material is important because sunlight destroys vitamin A; opaque containers such as tins retain almost 100% of vitamin A.

Dr. Ahmed Rahman, of the International Center for Diarrhoeal Disease Research in Dhaka, Bangladesh, described studies to detect improvements in vitamin A and iron status in schoolchildren consuming chapatti (an unleavened Indian bread) made from fortified wheat flour (M47). In rural Bangladesh, 22% of preschool and school-

Table 1: Reliability depends on enforcement

	Industry		
	Medium	Small	Artisanal
Number of factories	10	50	500
Inspections/year	20	100	1,000
Analyses/year	100	500	5,000
Cost in US\$	3,000	15,000	150,000

Medium industry = 50 to 250 metric tons (MT)/d; small industry = 20 to 50 MT/d; artisanal industry = 1 to 5 MT/d.

age children are vitamin A deficient (serum retinol $<0.7 \mu\text{mol/L}$). Food fortification has been identified as a cost-effective and sustainable strategy to prevent or correct micronutrient deficiencies. The study was a double-blind, controlled trial in a rural area. A 700 g packet of flour contained enough to make chapattis for seven people, and each bag was coded to indicate whether it was fortified. After 6 months, the mean serum retinol concentrations of children eating fortified chapattis had risen from 0.96 to 1.06 $\mu\text{mol/L}$, but there was no change in the control group: 0.98 compared with 0.94 $\mu\text{mol/L}$. There was no impact on iron status.

Last in this session, Dr. Michael Zimmerman, of the Swiss Federal Institute of Technology, in Zurich, Switzerland, spoke about the challenges of triple fortification of salt with iron, vitamin A, and iodine (M48). He said that this type of fortification could be highly effective due to the beneficial interactions of iron, iodine, and vitamin A in metabolism. Furthermore, the addition of all three micronutrients into a single foodstuff might reduce costs compared with separate fortification programs. However, soluble iron compounds, which are the most bioavailable, react with moisture and impurities in salt and cause unacceptable changes in the color. Also, in the presence of ferrous iron and moisture, losses of iodine and vitamin A are high. To overcome the problem, Dr. Zimmerman suggested micro-encapsulating the iron with hydrogenated oil. The encapsulation reduced the iron-mediated color change of the salt, increased the stability of iodine, and stabilized/delayed the oxidation of the vitamin A.

To test the effectiveness of the triple salt fortification, a 10-month, double-blind, randomized controlled trial was carried out in children 6 to 14 years old ($n = 159$) in Morocco. Group 1 was given iodized salt and group 2 was given triple-fortified salt. After 10 months, serum retinol had increased from 0.93 to 1.18 $\mu\text{mol/L}$, and mean hemoglobin had increased from 114 to 129 g/L in the triple-fortified salt group,

with no change in the iodized salt group. In both groups, urinary iodine and thyroid volume improved. In conclusion, Dr. Zimmerman said that low-grade African salt fortified with microcapsules containing iodine, iron, and vitamin A is nearly indistinguishable from iodized salt and is well accepted. All three nutrients in triple-fortified salt were stable during storage and showed good bioavailability. However, for triple salt fortification to be a useful strategy, the issue of the large price increase of fortified salt remains to be resolved.

Cooking oil was featured in two posters. The first was from Morocco, where colorimetric methods were recommended to small-scale industry as low-cost alternatives to HPLC analysis for quality control of vitamin A-fortified oil (M32). The second poster, from Guatemala, showed that while the carotenoid content of standard red palm oil was too low to make a meaningful contribution to dietary vitamin A when used in a condiment sauce, using an oil with a higher carotenoid content could provide a palatable and safe dietary source of vitamin A (M36). Two posters focused on vitamin A-fortified sugar. In the Philippines (M33), the practice of repacking fortified sugar into transparent plastic bags for the retail market resulted in a 50% to 60% loss of vitamin A under different lighting conditions (within a month in some cases), although there were no significant changes in color. Fortunately, turnover is rapid, but the study highlighted the need to monitor vitamin A at all levels in the marketing chain to assess the amount received by the consumer. In Nicaragua, a 19% improvement in breast milk vitamin A concentration was seen after one year of sugar fortification, but the number of samples was small and the increase only occurred in some of the regions, probably because of differences in sugar consumption (M35).

Two posters featured studies on salt fortified with iodine, iron, and vitamin A. An experimental study to measure stability through the distribution system in Kenya and Nigeria found minimal losses of iron and iodine, but the vitamin

A component fell 40% to 80% (M34). However, because no special precautions were taken to exclude light, the authors felt that the results could be improved. Use of a similarly fortified salt in a controlled study in schoolchildren in India showed small improvements in the status of all three components after a one-year intervention (M39). Results from a study in Peru showed that mothers and children in areas with high levels of poverty and undernutrition who received a vitamin A and iron-fortified instant porridge distributed by the government program Programa de Complementación Alimentaria para Grupos de Mayor Riesgo (PACFO) significantly improved their dietary intake of these nutrients. However, when a second program, Programa de Alimentación y Nutrición para Familias en Alto Riesgo (PANFAR), supplied a similar level of energy and protein to the PACFO supplement but no extra micronutrients, there was no impact on vitamin A or iron status (M37).

Assessment

The gold standard for the biochemical assessment of vitamin A deficiency in populations is currently the measurement of serum retinol by HPLC. However, serum retinol concentrations are influenced by external factors such as infection and subclinical inflammation, and therefore may not give an accurate picture of the true vitamin A status of the population. In recent years, many new techniques to assess vitamin A status have been developed; these include stable isotope methodologies, isotope dilution techniques, and tracer studies. In addition, the development of field-friendly techniques has become essential to assess vitamin A status in populations where access to electricity may be limited and the centrifugation of samples and a cold chain may be impossible. The session on assessment gave an overview of these new techniques, discussed some experiences in using them, and discussed some of the problems of interpreting serum retinol.

Dr. Sherry Tanumihardjo, of the University of Wisconsin, in Madison, Wisconsin, USA, presented an overview of a report of a joint USAID and International Atomic Energy Association (IAEA) consultancy on state-of-the-art methodologies to assess vitamin A (T36). She described the MRDR test, stable isotope methodology, isotope dilution techniques, and tracer studies. The MRDR test is more sensitive to changes in liver reserves than serum retinol. For example, Indonesian children given 200,000 IU of vitamin A showed no change in serum retinol, but the MRDR test showed that the ratio of 3,4-didehydroretinyl acetate to retinol was significantly reduced. The MRDR gives a qualitative response, but is not a direct estimate of body reserves; however, it is less expensive than using stable isotopes and analysis by HPLC is routine and can be carried out in many countries. The cutoffs for the 3,4-didehydroretinyl acetate to serum retinol ratio are: vitamin A deficiency > 0.060, marginal status or unknown = 0.030 to 0.060, and adequate liver reserves < 0.030.

In the past decade, the use of stable isotope methodology using deuterated and ^{13}C forms of retinol has increased. Isotope dilution involves administering a dose of tracer, waiting for the dose to mix with the body pool of the subject (approximately 17 days), and then taking a blood sample. The amount of dilution is measured by gas chromatography-mass spectrometry. Studies in Bangladeshi surgical patients have shown that this technique gives an accurate measure of liver stores compared with a direct measurement from a liver sample.

Dilution techniques are also emerging as a way to measure bioequivalence of vitamin A content of different foods; for example, the ability of vegetables such as sweet potato to maintain or improve vitamin A status in children and adults. Conversion factors for β -carotene:retinol of 10:1 and 13:1 were calculated by this method for the bioavailability of β -carotene in spinach and sweet potato in Bangladeshi men. Recent research on this technique suggests that blood samples drawn at 3 days after consumption may offer enough

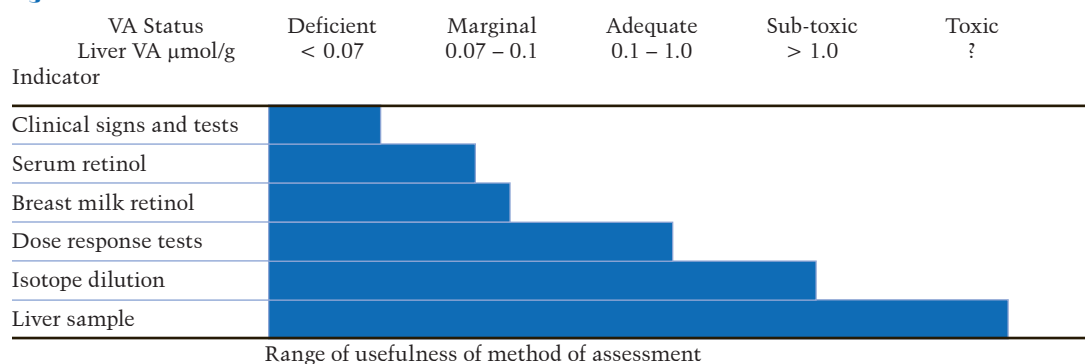
information to estimate total body stores, but appropriate equations still need to be derived. The usefulness of isotope dilution to show potential differences in the body pool of vitamin A was illustrated by reference to a 4-fold difference between Philipino and Guatemalan elderly people and a 50% increase following vitamin A supplementation in studies in Guatemalan elders. In both examples, serum retinol concentrations did not reflect the vast differences in the vitamin A pool size. The speaker also suggested that tracer techniques might be used in surveys.

In an attempt to improve isotope dilution methods, $^{13}\text{C}_4$ -retinyl acetate was synthesized and a more sensitive analytical method, gas chromatography-combustion-isotope ratio-mass spectrometry, was used to measure enrichment. A healthy female ingested 17.5 μmol of $^{13}\text{C}_4$ -retinyl acetate and blood samples were taken (over 4 years to date). The ^{13}C was well absorbed and the enrichment began to plateau at 8 days. The calculated liver stores on day 24 were 0.29 $\mu\text{mol/g}$ (normal). Thus, if the baseline stable: normal carbon isotope ratio ($^{13}\text{C}:^{12}\text{C}$) is known, a single blood sample 8 to 24 days after the oral dose will indicate the liver vitamin A concentrations. The speaker pointed out that the carbon isotope ratio ($^{13}\text{C}:^{12}\text{C}$) varies very little within population groups eating a similar diet. For example, in Malawian women ($n = 8$) the mean (SD) $^{13}\text{C}:^{12}\text{C}$ was 0.010931 (0.000019) which represents a coefficient of variation (CV) of a mere 0.2% in the baseline measurement. Therefore, if this method was used for surveys, a baseline measure would only need to be obtained for a few individuals.

The sophistication of methods to determine vitamin A status has greatly improved in the past decade. However, when looking at the continuum of indicators to vitamin A status, it is useful to remember the advantages and constraints of the methods as applied to populations (Figure 1). The method of choice will be dictated by resources available and access to analytical techniques.

The next speaker, Mr. John Hix, of Program for Appropriate Technology in Health, in Seattle, Washington, USA, addressed the topic of rapid, field-based assessment techniques (T37). RBP has been established as a surrogate indicator of vitamin A status, and two methods of RBP analysis were described: an enzyme immunoassay, a low-cost tool for quantitative vitamin A assessment, and an immuno-chromatographic strip test, which provides semi-quantitative estimates of RBP. The enzyme immunoassay technique gave good agreement with serum retinol concentrations ($r^2 = 0.67$), but using a cutoff of 0.7 $\mu\text{mol/L}$ for RBP only gave 60% sensitivity and 98% specificity. Raising the RBP cutoff to 0.775 $\mu\text{mol/L}$ increased sensitivity (80%) with little change in specificity (95%). Laboratory validation of the RBP immuno-chromatographic strip technique using 200 serum samples from Nicaragua found that the results correlated well with serum retinol, with a sensitivity of 73% and a specificity of 93%. The screening efficiency of the method for determining vitamin A deficiency was >91%. Using dried blood spots to collect and analyze blood by the two methods also showed promise. In conclusion, the

Figure 1: Vitamin A Status Continuum



preliminary evaluation shows that both the RBP enzyme immunoassay and the immuno-chromatographic strip test appear to demonstrate opportunities for simplifying the assessment of vitamin A status in populations.

The next presentation extended the discussions on the potential usefulness of dried blood spots. Dr. Juergen Erhardt, of the University of Indonesia, in Jakarta, Indonesia, described a combined measurement of RBP, serum transferrin receptors, and C-reactive protein from one dried blood spot (T38). He pointed out that under field conditions venous blood samples are usually difficult to collect, store, and transport. Capillary blood samples may be more feasible to collect, but centrifugation and freezing are still necessary. Dried blood spots are easy to collect and once dried can be transported and stored at room temperature (<25°C). Dried blood spots can then provide samples for RBP to measure vitamin A status, serum transferrin receptors for iron status, and can also be used to measure the inflammatory proteins C-reactive protein and α -1 acidglycoprotein by simple and inexpensive ELISA methods. Since the ELISA technique is very sensitive, a 10- μ L whole-blood spot is enough to measure all of the analytes. The cost of the chemicals is less than 20 cents per measurement, compared with a cost of US\$5 to US\$10 with a commercial kit. Dr. Erhardt made duplicate measurements in different positions on the ELISA plates and used certified dried blood spots for quantification. Comparison of whole blood on a filter paper with the same sample frozen resulted in nearly 100% recovery for RBP, 85% for serum transferrin receptors, and <70% for C-reactive protein. The lower recovery of serum transferrin receptors and C-reactive protein was consistent, so it can be corrected automatically by using certified dried blood spots treated in the same way as the samples. Variations in dried blood spot measurements are slightly higher than for plasma, and there is a risk of small systematic errors that can be corrected by measuring a subsample of matching plasma samples or using the sodium content of the dried blood spot extract to estimate the

dilution. More work is under way to validate this method, which has great promise.

Further work to refine retinol analysis from dried blood spots to overcome the problems of blood processing and the cold chain in the field was described by Dr. Rolf Klemm, of the Johns Hopkins Bloomberg School of Public Health, in Baltimore, Maryland, USA (T39). In this method, drops of blood obtained from finger punctures were spotted directly onto filter-paper cards, dried, and placed in an envelope at environmental temperature, then shipped for later analysis. Developmental work using various storage temperatures and times showed a high correlation between plasma retinol and dried blood spot retinol ($r^2 = 0.90$) from venous blood samples, and between capillary dried blood spots and venous serum retinol ($r^2 = 0.88$) in small groups of healthy, non-vitamin A-deficient adults. Further refinements to correct dilution volumes of dried blood spot extracts based on sodium recovery were also investigated. Using samples from 146 pregnant Nepalese woman enrolled in a community-based maternal vitamin A and β -carotene supplementation trial, Dr. Klemm described how dried blood spot retinol correctly identified 18 of 20 subjects whose serum retinol was <0.70 μ mol/L (90% sensitivity) and 126 pregnant women who were not deficient (100% specificity).

Dried blood spot retinol measurements alone explained 69% of the variation in serum retinol where concentrations were in the range of 0.20 to 2.52 μ mol/L, and both dried blood spot and serum retinol concentrations were able to show a significant treatment response to vitamin A supplementation, but not to β -carotene supplementation. Dried blood spot samples were obtained from venous blood in the study described, but strong associations between finger-prick dried blood spots and venous dried blood spots have been shown. In conclusion, dried blood spot retinol concentrations are subject to the same limitations as those of serum retinol, and the feasibility of the analytic procedure used to measure dried blood spot retinol in developing country laboratories needs to be determined.

Dr. Christine Clewes, of the Centers for Disease Control and Prevention, in Atlanta, Georgia, USA, reported some interesting results from a national vitamin A survey in Zambia (T40). Vitamin A deficiency is known to be a problem in Zambia, and the government is addressing the problem principally through supporting the supplementation of postpartum women and children 6 to 59 months of age, fortification of sugar, and dietary improvement. Supplementation of children is done through child health weeks. Sugar has been fortified with vitamin A at a concentration of 10 mg/kg sugar since 1998. To evaluate the impact of the vitamin A interventions, a two-part, non-stratified national cluster survey was carried out in 2003. The first part was in July right after a child health week, and the second part was in November, just before the next child health week. One randomly chosen, apparently healthy child, 6 to 59 months of age, was selected from each household visited. Capillary blood was taken and processed in the field and later analyzed by HPLC for retinol and C-reactive protein in a subsample by nephelometry. Approximately 86% of children reportedly received a vitamin A capsule in June. The mean retinol concentration in July and November 2003 was 0.72 $\mu\text{mol/L}$ compared with 0.64 $\mu\text{mol/L}$ in 1997 before the interventions. In the subsample in which C-reactive protein concentrations were measured, 75% of children with retinol values < 0.7 $\mu\text{mol/L}$ had elevated C-reactive protein values (≥ 5 mg/L) in July.

It was previously shown (Lancet 2003; 362:2052) that it is possible to correct depressed retinol concentrations for the presence of a subclinical acute phase response. Where there is an elevated C-reactive protein value, the apparently equivalent retinol concentration can be obtained by multiplying by 1.25. The correction makes it possible to potentially adjust what the retinol concentration would have been in healthy children, and suggests the proportion of the deficiency due to subclinical inflammation. Children who were healthy (C-reactive protein < 5 mg/L), had mean retinol concentrations

of 0.87 and 0.80 $\mu\text{mol/L}$; those children with an acute phase response had mean retinol concentrations of 0.60 and 0.61 $\mu\text{mol/L}$ in July and November, respectively. The correction factor suggests that mean retinol concentrations of children with a raised C-reactive protein were 0.75 $\mu\text{mol/L}$ at both time points. Dr. Clewes concluded her talk by putting forward four possible interpretations: an elevated acute phase response may a) prevent absorption, b) increase excretion, c) increase utilization, or d) prevent mobilization of a high-dose supplement, or it may be a combination of all the possibilities. Current evidence suggests that inflammation impairs mobilization of liver vitamin A, but further work is required to confirm this.

Dr. Marjoleine Dijkhuizen, of the University of Nijmegen, in Nijmegen, The Netherlands, presented data on how pregnancy affects plasma concentrations of retinol and acute phase proteins (T41). There are few normal values and cutoffs for acute phase proteins during pregnancy, which may result in an underreporting of the prevalence of subclinical infection in pregnant women. In addition, serum retinol concentrations are affected both by pregnancy and by the acute phase response. Using data from an intervention study in pregnant women, Dr. Dijkhuizen reported that a decrease in mean retinol concentrations (0.30 $\mu\text{mol/L}$) between the first and third trimesters was caused by hemodilution and a real decrease in vitamin A status. Concentrations of C-reactive protein were significantly higher during pregnancy than 6 months postpartum, with the highest concentrations in the third trimester. In contrast, α -1 acidglycoprotein concentrations were significantly lower during pregnancy, with the lowest concentrations in the third trimester.

During pregnancy, the prevalence of women with raised C-reactive protein concentration was higher than the prevalence of women with raised α -1 acidglycoprotein concentrations, whereas normally the opposite is true. If the prevalence of subclinical infection during pregnancy is the same as that at 6 months postpartum,

cutoffs for C-reactive protein during the first and third trimester should be 11.2 and 12.0 mg/L, respectively, to correspond with a C-reactive protein of 5 mg/L outside pregnancy. For α -1 acidglycoprotein (normal cutoff 1 g/L), the cutoffs should be 0.69 and 0.49 mg/L, respectively. In conclusion, before the prevalence of vitamin A deficiency in pregnancy can be accurately estimated, more data are needed on plasma retinol, C-reactive protein, and α -1 acidglycoprotein concentrations during pregnancy. The cutoffs for C-reactive protein and α -1 acidglycoprotein need to be revised. Likewise, the threshold for plasma retinol indicating vitamin A deficiency might be too high in the presence of hemodilution.

After the closing remarks by Dr. Keith West, of the Johns Hopkins Bloomberg School of Public Health, in Baltimore, Maryland, USA, on the assessment session, Dr. Alain Labrique of the same institution gave a demonstration of a dark adaptometry device to detect pre-clinical vitamin A deficiency and night blindness. The instrument comprised a pair of opaque swimmer's goggles and a "base station." The goggles are placed on the subject's eyes, providing a completely dark environment. The left eye of the goggles contains a miniature high-resolution infrared night-vision camera focused on the subject's iris. The right eye-piece contains a source of yellow-white incandescent light and a sensitive photometer measuring light intensity (in lux). The goggles are connected to the base unit, which has a 4-inch monitor on which the left eye can be observed. A trigger on the base unit is used to flash-bleach both eyes before a timed 10-minute period of dark adaptation begins. During the testing phase, the observer slowly increases the intensity of a flash of light to which the right iris is exposed at a constant rate. A response causes a contraction in both irises and the observer records the reading of the left eye on the lux meter. A three-stage pupillary response was seen in most subjects. Preliminary field tests have shown the machine to be acceptable and portable, but in areas with no electricity a small generator is needed.

The theme of assessment was covered by posters presenting methodological innovations, improvements, and validation. Examples include: the CRAFTi portable fluorometer to measure vitamin A in fortified foods and blood samples, a field-friendly tool that provides results comparable to standard methods (T2); a validation of the MRDR against liver vitamin A using a swine model, which showed the validity of current cutoffs and the feasibility of reducing sample volume by more than half (T7); and a validation study of HPLC methods for vitamin A and carotenoid analysis done in Burkina Faso (T6). The other posters focused on indicators and definitions of deficiency. RBP and dried blood spot methodology were compared with retinol and serum samples in a study in Thailand and showed good comparability, but unfortunately represented only a narrow range of (almost normal) vitamin A states (T1). RBP concentrations in pregnancy were investigated in Nepal, and the results indicated that in vitamin A deficiency, transplacental transport of retinol may be impaired, as indicated by low levels of holo-RBP in the last trimester. Therefore, the authors suggested vitamin A supplementation during the last trimester for vitamin A-deficient women (T5). Questions were raised concerning the determination of status and definitions of deficiency in pregnancy in a poster from Nepal indicating that infection and inflammation can influence concentrations of vitamins A, E, and B6, as well as the carotenoids, with consequences for the validity of cutoff values presently used (T3).

The appropriate cutoff values in pregnancy of the acute phase proteins C-reactive protein and α -1 acidglycoprotein was the subject of the talk by Dr. Dijkhuizen (T41). Cutoff values for deficient plasma retinol concentrations in Indonesian infants were also questioned in poster T8. Comparing the prevalence of deficiency (retinol <0.7 $\mu\text{mol/L}$) in mothers supplemented during pregnancy and their offspring, the authors showed a possible overestimation of deficiency in infants and suggested that a retinol concentration <0.5 $\mu\text{mol/L}$ might

be a more appropriate cutoff (T8). An innovative approach towards surveillance was presented in a poster from Thailand, in which a set of cost-effective and non-invasive proxy indicators were suggested. These ranged from land ownership and socioeconomic status indicators to nutritional status and the presence of certain infections as a screening tool for ranking areas at risk of endemic vitamin A deficiency (T4).

Infection

It is an accepted fact that vitamin A plays a role in infection. One of the earliest effects of infection is a reduction in the plasma/serum retinol concentration, which is probably a protective response to reduce vitamin A losses. The benefit obtained is dependent on the nutritional status of vitamin A before the onset of infection and on the length of exposure to the infection. If the infection resolves quickly and circulating retinol returns to the pre-infection concentration, then no long-term harm is done. However, if the infection is protracted, then access to vitamin A in the body may become critical, resulting in clinical signs of vitamin A deficiency. The outstanding success of vitamin A supplements in overcoming shortfalls in vitamin A supply and reducing morbidity and mortality in infancy has been amazing. In this session on infection, the presenters focused on a number of different outcomes following the administration of vitamin A supplements in the presence of infection, as well as on the effects of vitamin A deficiency on infection and immune function.

The first paper of this session was prepared by Dr. Haman Hadi, of the University of Gadjah Mada, in Yogyakarta, Indonesia, and presented by Dr. West (T42). The data shown were from a randomized, placebo-controlled trial of Javanese preschool children that examined whether levels of respiratory infections and seasonal differences in vitamin A intakes influence the effects of vitamin A supplementation on child growth. Treatments were given

every 4 months. Children 12 months of age or older received 200,000 IU; children under 12 months received 100,000 IU or a placebo. Randomization was done at an individual level. Weight was measured every month, recumbent length/standing height was measured every 4 months, morbidity data were collected every other day, and vitamin A intakes were collected using food frequency questionnaires. Vitamin A intakes varied by season. The proportion of children with no days of respiratory illness or diarrhea was highest from August to December. There was no significant difference in height increments between children stratified by combinations of season, burden of respiratory infections, and vitamin A intake. The effect of vitamin A supplementation on linear growth was modified by season, burden of respiratory infections, and vitamin A intake. The highest weight increment was found during April to July, while the lowest weight gain was found from August to December. The ponderal growth response to vitamin A supplementation was not different by season and burden of respiratory infections, or season, burden of respiratory infections, and vitamin A intake. In conclusion, the effect of vitamin A supplementation on growth is dependent on season and respiratory infections, and vitamin A intake is another important factor underlying the seasonal effect.

In the next presentation, Dr. Melissa Miller, postdoctoral fellow at the National Cancer Institute, in Bethesda, Maryland, USA, examined the impact of vitamin A supplementation of infants and mothers at birth on hemoglobin concentration in Zimbabwean infants at 8 to 14 months, and the determinants of postnatal anemia by HIV status (T43). The research team recruited singleton babies (>1500 g birth weight) at 96 hours and followed them for 8 to 14 months: 225 babies were born to HIV-negative mothers, and of the babies born to HIV-positive mothers 210 became infected, while 742 remained uninfected. Mothers and babies were randomized to treatment groups and the table below shows the number recruited and the smaller number indicates those who had Hb measured:

Infant	Mother	
	Placebo	400,000 IU vitamin A at delivery
Placebo	705→392 (Pp)	721→391 (Ap)
50,000 IU vitamin A at delivery	708→399 (Pa)	697→410 (Aa)

There was a significant interaction between infant and maternal vitamin A supplementation on anemia ($P = 0.01$) after adjusting for other determinants of anemia. At follow-up, hemoglobin was greater in infants from the Ap group (approximately 105 g/L) than in all of the other groups (103 to 104 g/L). Anemia was more common in HIV-positive infants (75%) than in HIV-negative babies of HIV-positive (39%) and HIV-negative (43%) mothers. Infant HIV infection independently increased the risk of anemia 6-fold after adjusting for other determinants of anemia. The predictors of anemia among HIV-negative were: male sex, lower total body iron at birth, exclusive breastfeeding for less than 6 weeks and a 6 month plasma ferritin <12 ng/L. In HIV-positive infants, the risk of anemia was strongly increased with early infection (<6 weeks), maternal CD4+ lymphocyte count (<400) at delivery, morbidity at >25% of visits, male sex and exclusive breast feeding for less than 6 weeks. The authors also showed that a single high dose of vitamin A given either to mother or baby at delivery significantly improved erythropoietin response to low hemoglobin concentration at 6 months among babies born to HIV-negative mothers, but had no significant effect on infant hemoglobin concentration or risk of anemia at 12 months of age, probably because iron, not vitamin A, was the limiting factor in hematopoiesis.

The same speaker presented the next talk on behalf of Dr. Jean Humphrey, of the Zimbabwe Vitamin A for Mothers and Babies project in Harare, Zimbabwe, as the data were derived from the same population group as above (T44). In this study, there were 7058 mothers in the treatment group (400,000 IU vitamin A) and 7052 in the placebo group. In the subset analyzed for serum retinol, 700 were HIV-positive and

400 HIV-negative. Among HIV-negative women, the mean change in serum retinol between baseline and 6 weeks was greater in the treatment group ($P = 0.02$), but the distribution of concentrations in both groups after supplementation was similar to a well-nourished population; mean retinol concentrations for the placebo and treatment groups were 1.6 and 1.7 $\mu\text{mol/L}$, respectively. Among HIV-positive women, the changes at 6 weeks were non-significant; mean concentrations of retinol were 1.25 and 1.30 $\mu\text{mol/L}$ for the placebo and treatment groups, respectively. A treatment effect was observed only among the HIV-positive women, whose baseline CD4 counts were less than 200 cells $\times 10^6/\text{L}$, where mean retinol concentrations increased and the proportion of low values (<1.05 $\mu\text{mol/L}$) was halved from 60% to 30%. Of women given a vitamin A supplement, HIV-negative women had a serum retinol distribution 35% higher than those who were HIV-positive, which was interpreted to indicate that hyporetinolemia of HIV is not responsive to vitamin A supplementation and may result from a chronic response to HIV (and only secondarily to opportunistic infections).

Vitamin A supplementation did not affect mortality, but may have had a beneficial effect on severe morbidity. Mortality rate in HIV-negative women was 0.3% at 12 months and 0.4% at 24 months. Mortality rate in HIV-positive women was 3.6% at 12 months and 7.7% at 24 months. A Cox model for mortality at 12 months showed increase risk if CD4 counts were < 200, hemoglobin was <7 g/dL, mid-upper arm circumference (MUAC) was <23, or the mother's age was >20 years. The author concluded that when retinol is measured in vitamin A surveys, there should be a concurrent measurement of acute phase proteins. However, she also suggested that for HIV endemic populations, simultaneous HIV testing would be simpler, cheaper, and more informative in interpreting retinol than acute phase proteins in identifying the proportion of the population likely to respond to supplementation, although no data were shown to support this proposition.

The theme of infection was addressed by several posters focusing on the effects of vitamin A deficiency on infection and immune function. A report from Egypt suggested that low and marginal serum vitamin A concentrations and depleted liver stores, as measured by the MRDR test, were found to be associated with acute respiratory infection and especially pneumonia (T9). However, these measurements were done in children with acute severe infection, and the effects of the acute phase response on the indicators measured makes the interpretation of these results less straightforward. In Niger, 60% of children 24 to 36 months of age were found to have intestinal parasites, primarily protozoa (*Giardia intestinalis* and *Entamoeba histolytica*), and the prevalence of vitamin A deficiency (40% $<0.7 \mu\text{mol/L}$) was only slightly changed 3 months after vitamin A supplementation (34%). In the follow-up survey, however, the authors found better vitamin A status associated with health-related variables (e.g., latrines in the home and running water) (T14). A study in Venezuela found lower levels of circulating interleukin-10 but not of other cytokines (IL-4, IL-2, and IFN γ) in children with abnormal conjunctival impression cytology (T11). The authors suggested that diminution of IL-10 would be related to an inflammatory response in respiratory and/or intestinal epithelia.

On a more mechanistic level, sequestration of vitamin A in the liver during inflammation was demonstrated using a rat model (T10). The authors modeled inflammation by continuous infusion of IL-6 for up to 7 days. Plasma α -1 acidglycoprotein was significantly raised after 21 hours, plasma retinol was lower (49%) after 44 hours, and liver retinol was increased by 68% at 7 days. The effects of supplementation on infection were presented in several papers. In Bangladesh, red palm oil supplements given for 90 days lowered the incidence of respiratory tract infections by half (38% to 17%) and also improved length growth in adolescent girls (T15). In Ghana, the authors reported that the effects of the new high-dose vitamin A supplements given to infants were being studied in combination with

the new pentavalent vaccines recently introduced in the Ghanaian Expanded Programme on Immunization (T13). A study in Kenya evaluated the effect of a multi-micronutrient supplement including β -carotene in combination with a food supplement on indicators of micronutrient status in people living with HIV/AIDS. Although serum β -carotene concentrations improved after supplementation, micronutrient status indicators did not seem to improve, possibly because of the effects of protracted inflammation in HIV masking potential effects of supplementation (T12).

Maternal and Newborn Outcomes

In her overview, Dr. Nelly Zavaleta, of the Instituto de Investigación Nutricional in Lima, Peru, suggested that a number of factors affect women's health, including social, economic, cultural, biological, individual behavior, and health and nutrition services. Factors influencing maternal nutrition and newborn outcomes include nutrition, genetics, the environment, and access to adequate care. Maternal nutritional problems stem from inadequate food intake, macro- and micronutrient deficiencies, and infections.

In the first presentation of the session, Dr. Parul Christian, of the Johns Hopkins Bloomberg School of Public Health, in Baltimore, Maryland, USA, used data from the Nepal Nutrition Intervention Project Sarlahi (NNIPS-3) study to report the effects of alternative combinations of prenatal micronutrient supplements on self-reported labor and delivery complications, puerperal morbidity, birth weight, infant mortality, infant and maternal morbidity, and maternal micronutrient status (T45). The study was a double-masked, cluster-randomized, controlled trial where 426 communities were randomized to receive one of five supplements: control (vitamin A: 1000 retinol equivalents), vitamin A plus folic acid (400 μg), vitamin A plus folic acid plus iron (60 mg), vitamin A plus iron-folate plus zinc (30 mg), or multiple micronutrients. Of the 4926 pregnancies, 4020 women delivered live births and were interviewed at birth, and 3600 of these

were interviewed for up to 9 days after the birth. The morbidity definitions of labor were: dysfunctional labor (≥ 24 h), vacuum, forceps, episiotomy, or cesarean section. For delivery, the definitions were: "baby was stuck"; "water broke" before labor pains began; postpartum hemorrhage (excessive bleeding at delivery and unconsciousness within 24 h of birth); eclampsia defined as convulsions (non-epileptic) in first 48 h of delivery or placental retention (the placenta came out after 60 minutes). Morbidity definitions of puerperal infection were a temperature $\geq 100.4^\circ$ F on any 2 of the first 10 days (excluding day 1); temperature $\geq 100^\circ$ F (excluding day 1) and foul-smelling vaginal discharge; gastrointestinal tract infection defined as any symptom of diarrhea (≥ 4 watery stools) and/or dysentery (mucus/blood in stools).

The results showed an increased risk of dysfunctional labor associated with the multiple micronutrient supplement (relative risk = 1.22), which may be due to the increase in birth size of infants in the upper end of the birth weight distribution. However, the symptoms of premature rupture of the membrane in the same group were lower by 34%. Folic acid alone resulted in fewer reports of convulsions (relative risk = 0.52) and placental breakage, whereas folic acid plus iron reduced the risk of hemorrhage by 43%. The 9-day morbidity follow-up symptoms of poor appetite and gastrointestinal problems were lower in all micronutrient groups compared with the controls. The risk of infection in the puerperium was lowered with folic acid plus iron, folic acid plus iron plus zinc, and multiple micronutrients.

Dr. Joanne Katz, of the Johns Hopkins Bloomberg School of Public Health, in Baltimore, Maryland, USA, informed delegates about the treatment effects of maternal micronutrient supplementation on the birth weight distribution in Nepal (T46). Birth weight is an outcome measure of interventions during pregnancy, since it is a measure of intrauterine growth retardation and is a strong predictor of early infant survival. In the Sarlahi district of Nepal, 426 communities were randomized to one of five treatment groups and received

daily micronutrient supplements until 12 weeks postpartum (see above). Dr. Katz presented a series of graphs that estimated the treatment effects across the whole range of birth weights as a function of the respective percentiles of the birth weights in the vitamin A-only group (control). The treatment effect varied significantly across percentiles. Folic acid plus iron had the largest impact on birth weight (100 g) in babies with a birth weight less than 2800 g, but the effect began to decline in babies heavier than 2700 g. There was a positive impact of folic acid plus iron plus zinc on birth weight of about 50 g between 2400 and 2900 g. The multiple micronutrients appeared to have the most impact, increasing birth weight by about 100 g across the whole distribution. The analyses showed that different combinations of micronutrients affect different parts of the birth weight distribution, which may help explain why an average improvement in birth weight may not translate into improved infant survival. Increased survival at low ends of the distribution may be cancelled by decreased survival at the upper end of the distribution.

Ms. Sri Sukotjo, of Helen Keller International, in Jakarta, Indonesia, explored potential sources of information about vitamin A available to women in Indonesia, with the hope that this information could help program planners design communication strategies to strengthen nutrition programs to promote disease prevention (T47). Data were collected by the government of Indonesia and the Helen Keller International Nutrition and Health Surveillance from October 2002 until March 2003 from approximately 30,000 rural households in eight provinces of Indonesia. Data were analyzed to compare the sources of information that women had received about vitamin A-rich foods in the past and the sources of information that women received about vitamin A capsules from recent national mass media campaigns. Depending on region, between 41% and 70% of mothers reported that they had heard about vitamin A-rich foods through mass media, interpersonal communications, or their children's

schools. A national mass media campaign was started in 2001 to create awareness of the new blue vitamin A capsule (100,000 IU) for 6- to 11-month-old children. The vitamin A capsule campaign was advertised using television, television plus print media, or print media only, and results suggest that the success of the different communication strategies depended on the characteristic of the area and its population. In conclusion, the campaign provided insights regarding coverage by mass media as a communication strategy.

The theme of maternal and newborn outcomes included a poster from Pakistan showing inadequate breast milk vitamin A levels (0.44 $\mu\text{mol/L}$) but sufficient output (740 mL/day) in malnourished women (T16), and a poster from Thailand suggesting that low dietary fat intake, dry season, and mountain areas are risk factors for low breast milk vitamin A content (0.51 $\mu\text{mol/L}$ or 0.28 $\mu\text{mol/g}$ fat) in Karen women (in addition, low coverage of vitamin A capsule programs is a main constraint in this population) (T17). A study from Ghana showed clinically relevant effects of vitamin A supplementation on immune function and pro-/anti-inflammatory cytokine responses during pregnancy and postpartum (T18). Vitamin A status significantly increased ratios of the pro-inflammatory $\text{IFN}\gamma$ and $\text{TNF}\alpha$ to non-inflammatory IL-10, and the authors suggested that good vitamin A status may increase cell-mediated immunity to malaria in pregnancy to lower the prevalence of active infection at delivery. In a mouse model, maternal dietary (i.e., post-prandial) and RBP-bound vitamin A are both important for transplacental delivery of vitamin A. Both of these pathways can support fetal development, but RBP is crucial in severe maternal vitamin A deficiency to ensure the supply of vitamin A to the fetus (T20).

Three posters focused on implementation aspects of vitamin A supplementation programs. An innovative approach was reported from Mali, which involved grandmothers in the advocacy of vitamin A capsules for pregnant women (T19). Two posters highlighted the importance

of monitoring for program improvement and success, both in a comparative multi-country setting involving India, South Africa, and Uganda (T21), and in a more detailed, region-specific analysis in Uttar Pradesh, India (T22).

Multiple Micronutrients

Dr. Robert Black, of the Johns Hopkins Bloomberg School of Public Health, in Baltimore, Maryland, USA, gave an overview of some of the factors to consider before using multiple micronutrient supplements. He began by saying that the purpose of the session was to consider where vitamin A interacts with other micronutrients in regard to biochemical or clinical outcomes, and to discuss how vitamin A and other micronutrients can be best employed to improve human health. The rationale for considering multiple micronutrients is that the deficiency of one micronutrient may limit the benefits obtainable by correcting the deficiency of another. It is already known that in some circumstances dual micronutrient interventions may not have an added benefit over single micronutrient interventions. For example, vitamin A is effective for measles treatment and zinc is not; zinc is effective for pneumonia treatment but vitamin A is not. That is, they have independent effects, but apparently they do not interfere with each other's effect. However, zinc can interfere with iron in the treatment of anemia, whereas the effects of vitamin A with iron on anemia are additive or greater. Vitamin A and zinc also seem to have synergistic benefits for child mortality.

Considerations for interpreting the joint effects of micronutrients should include the severity of single nutrient deficiencies, nutritional deficiency concordance, the adequacy of diet, the presence of infectious agent exposure and treatment, dose/duration of supplements (or fortified food), the age group or target population, and the means of delivery (e.g., supplement or food-based). There are also important factors to consider in the use of multiple micronutrient supplements for pregnant women and children. For example, are

they more or less efficacious than single micronutrients for specific clinical outcomes? Do they have more or less acceptability or adverse events than single micronutrients? Does an effect on multiple outcomes, perhaps even with some additional adverse events or reduction in effect size compared with single micronutrients, justify their use? Some recent examples of nutrient interactions are described in rest of this session.

Dr. Lindsay Allen, of the University of California, in Davis, California, USA, described a study to assess whether iron plus riboflavin, in addition to vitamin A-fortified Ultra-Rice™, improved nutritional status and dark adaptation more than Ultra-Rice™ alone (T48). Night-blindness affects 16% to 52% of pregnant women in rural Nepal and the main cause is vitamin A deficiency, which is not all cured by vitamin A or vitamin A plus zinc. A secondary objective of the study was to determine if there is a relationship between the pupillary response threshold score and biochemical indicators of iron and riboflavin status. A pilot study confirmed 40% iron deficiency and 86% riboflavin deficiency among women in the study population. Women less than 8 months pregnant were concurrently recruited and assigned into two masked treatment groups in 8- to 10-week cycles: group 1 received iron (30 mg as FeSO₄) plus riboflavin (6 mg); group 2 received a placebo capsule.

Both groups received retinyl palmitate-fortified Ultra-Rice™ (0.85 mg retinol equivalents [2839 IU]) for one meal plus the supplement or placebo for 5 days/week for 6 weeks. Dark adaptation was assessed by weekly maternal reports and pupillary response threshold scores. From the 6645 women recruited, 8% (554) women had night-blindness and, of these, 424 were eligible. Blood samples were collected at baseline and after 6 weeks for hemoglobin, erythrocyte riboflavin, plasma ferritin, retinol, albumin, and C-reactive protein. Demographic, socioeconomic status, and 7-day food frequency data for riboflavin-rich animal source foods were collected. Results showed that animal food intake was low. There was a high prevalence of riboflavin

deficiency, 65% was found in women with night-blindness and significantly less, 40%, in women without. Iron deficiency (40%) and iron deficiency anemia (33%) were also common. Serum retinol was positively correlated with ferritin and negatively correlated with anemia. Pupillary response threshold was negatively, and as strongly, correlated with plasma ferritin as it was with retinol.

Compared with placebo, iron plus riboflavin caused significantly greater increases in plasma ferritin (+3.9 versus -0.7 µg/L), decreases in iron deficiency anemia (from 35% to 15%), significantly greater increases in erythrocyte riboflavin, decreases in riboflavin deficiency (from 60% to 6%), greater improvement in pupillary response threshold, and a reduction in the percentage who had an abnormal pupillary response threshold and were iron deficient at baseline. Pupillary response threshold improved in both groups due to Ultra-Rice™, and final pupillary response threshold values were not significantly different from reference women without night-blindness. Therefore, iron deficiency may also be a risk factor for night-blindness. In conclusion, iron deficiency was more strongly implicated in night-blindness than riboflavin deficiency, perhaps because the role of iron in night-blindness may be related to retinol ester dehydrogenase or some other interaction with vitamin A metabolism. Iron plus riboflavin treatment improved the pupillary response threshold more in those with lower serum retinol at baseline. Future research should test the benefits of iron (with vitamin A) to reduce night blindness.

In the next talk, Dr. Frank Wieringa, of the University of Nijmegen, in Nijmegen, The Netherlands, said that vitamin A, iron, and zinc deficiencies are prevalent worldwide, and large-scale supplementation programs are undertaken to combat them, but interactions between the micronutrients may have important consequences on outcome (T49). As part of the Southeast Asia Multi-country Trial on Iron and Zinc Supplementation in Infants, pooled data were used from a double-blind, placebo-controlled, multicountry trial from four

study sites (Thailand, Vietnam, and two sites in Indonesia). Infants (4–6 months old; n = 2458) were given either 10 mg of iron and/or 10 mg of zinc daily for 6 months. Higher hemoglobin concentrations were found in infants receiving iron or iron plus zinc. The highest hemoglobin concentrations were found in infants receiving only iron. Infants receiving iron plus zinc supplementation had slightly lower hemoglobin concentrations than infants receiving only iron. There was no statistically significant interaction between zinc and iron on hemoglobin concentrations, but there was strong interaction between zinc and iron on plasma zinc concentrations. Zinc given alone tended to depress ferritin and increase iron deficiency anemia, but neither of these effects was significant. Therefore, although it is safe to give iron alone, if zinc is given, iron should be added to avoid any potential adverse effects of zinc on iron status.

Other important determinants on the effect of supplementation were sex differences and background high-dose vitamin A supplementation. Male infants are more at risk for anemia, and there was a larger response to iron supplementation in boys than in girls, but the hemoglobin after supplementation was the same in boys and girls. Does this mean that male infants have higher iron requirements? Prior to the study, as part of ongoing national/regional programs, three of the four sites gave high-dose vitamin A supplements: one site gave 50,000 IU and the other two gave 100,000 IU. Lower hemoglobin concentrations were found in infants who received vitamin A, but not iron supplementation, perhaps because of increased utilization of iron after vitamin A supplementation. Therefore, providing high-dose vitamin A without iron supplementation might negatively affect iron status. Specifically designed studies are needed to investigate these dose-effect relationships.

The last talk of this session was given by Dr. Zimmerman (T50). He began by saying that vitamin A deficiency and iodine deficiency disorders often coexist in children in developing countries such as rural areas of west and north Africa, where

32% to 57% of children suffer from both vitamin A deficiency and goiter. In areas of endemic goiter, micronutrient status is an important determinant of iodine and thyroid metabolism, and selenium and iron deficiencies act in concert with iodine deficiency to impair thyroid metabolism and modify response to prophylactic iodine. The study question Dr. Zimmerman aimed to answer was, in areas of iodine deficiency disorders, could the vitamin A status of a child with goiter influence his/her risk for hypothyroidism?

Moroccan school children (n = 298) with severe iodine deficiency disorders and poor vitamin A status were enrolled in a baseline cross-sectional study. A randomized, double-blind trial was undertaken for 10 months, in which iodized salt (25 µg iodine/g salt) plus placebo or iodized salt plus oral vitamin A (200,000 IU as retinyl palmitate) were given at 0 and 5 months. Serum retinol, RBP, transthyretin, C-reactive protein, thyrotrophin, thyroxin, thyroid-binding globulin, thyroglobulin, ultrasonographic thyroid volume, and urinary iodine were measured at baseline and at 5 and 10 months. At baseline, the children were severely iodine deficient and the prevalence of goiter was 89%. The prevalence of vitamin A deficiency was 19% and transthyretin concentrations were normal. There was a strong correlation between serum retinol and RBP, and RBP was negatively correlated with log thyrotrophin, log ultrasonographic thyroid volume, log thyroglobulin, and thyroxin concentrations.

Following the efficacy trial, the iodized salt plus vitamin A group at 10 months showed a significant increase in mean serum retinol, RBP, and the RBP/transthyretin ratio; the percentage of children with vitamin A deficiency was reduced; and there was a significant decrease in mean ultrasonographic thyroid volume and goiter rate compared with iodized salt alone. There were no significant differences in median urinary iodine between the groups at any time. In both groups receiving iodine supplements, urinary iodine concentrations increased significantly. The median thyrotrophin and thyroglobulin decreased

significantly in the iodized salt plus vitamin A group compared with the iodized salt only group. There was no significant change in mean thyroxin, transthyretin, or thyroid-binding globulin in either group. In summary, vitamin A deficiency in severely iodine-deficient children increases risk for goiter but decreases risk for hypothyroidism. High-dose vitamin A supplementation reduces thyrotrophin hyperstimulation and improves the efficacy of iodized salt to control goiter in children with moderate vitamin A deficiency. These findings may be mediated through the effect of vitamin A status on the pituitary retinoid receptor and thyrotrophin secretion.

There was only one poster displayed in the multiple micronutrients section, which was a study of serum IgG or salivary IgA following vitamin A supplementation with or without zinc in Indonesian children 2 to 5 years of age. The study showed no effects on mean values, although there may have been modest effects on salivary IgA in those with low baseline levels (T23).

Determinants of Vitamin A Deficiency

Posters on the determinants of vitamin A deficiency included results from India showing that seasonal variations in maternal nutritional status influenced pregnancy outcome (T24), and a study in Indonesia showing that night-blindness in non-pregnant women was strongly related to night-blindness during the previous pregnancy. Other contributory risk factors were diarrhea, high parity, and low socioeconomic status (T25). In Cambodia, xerophthalmia was found to cluster among mothers and their children, and was associated with diarrheal disease, leading to the recommendation that interventions be aimed at the household level (T26).

Recent Surveys

In the poster session on recent surveys, many countries and regions were represented. In Africa, a Moroccan study showed that preschool children in the

northwest region were at high risk of low vitamin A intake (T27), and a nationwide survey in Nigeria showed a high prevalence of vitamin A deficiency in children under the age of 5 in all sectors and areas (T32). In South Africa, the prevalence of vitamin A deficiency in 1999 among preschool children in the northern Cape Province was similar to that found in 1994 (19 vs. 18.5%), while the prevalences of anemia and iron deficiency anemia had increased 2- to 3-fold and were 45% and 34%, respectively. The authors emphasized the importance of area-specific data and said that a multi-micronutrient supplementation or fortification approach was needed (T30). Two posters presented details on vitamin A status in Venezuela. One study showed a prevalence of vitamin A deficiency (22%) and anaemia (44%) in preschool children, but only 8% showed both signs (T31). In contrast, the second paper presented data from a national survey in 2001 to 2002 of 1393 children under the age of 5; 203 were subsequently excluded because of high C-reactive protein concentrations, the mean serum retinol concentrations of the remainder was 0.74 (SD = 0.41) $\mu\text{mol/L}$. The authors suggested that these data showed that vitamin A deficiency at this moment is not a public health problem in Venezuela, but that marginal vitamin A status was prevalent enough to warrant preventive measures (T35).

In Vietnam, the prevalence of anemia and zinc and vitamin A deficiency (77%, 39%, and 39%, respectively) was found to be high in infants in the northern mountainous area, especially in ethnic minorities (T33). In India, a longitudinal cohort study of deprived children from an urban slum ($n = 42$) and a rural area ($n = 45$) found that nutritional intake, including vitamin A intake, was inadequate in lactating mothers in the first 6 months postpartum (864 to 809 $\mu\text{g/day}$), although the mean concentration of retinol in the milk was 1.79 (SD = 1.18) $\mu\text{mol/L}$. Morbidity of the infants was associated with the volume and frequency of breastfeeding (T34). Finally, in Israeli-Bedouin toddlers, the prevalence of vitamin A deficiency was 15%, and was associated with male sex, stunting, and the

warm season, while maternal education was negatively associated (T29).

Alternative Size Vitamin A Supplements

Dr. Allen provided an overview of the rationale for testing the potential risks and benefits of high-dose supplementation. The earlier randomized trial to assess the benefits and safety of vitamin A supplementation linked to immunization in early infancy was carried out in 9424 mother-infant pairs from Ghana, India, and Peru. The randomized, controlled trial gave single high doses of retinyl palmitate (25,000 IU) or placebo to infants at 6, 10, and 14 weeks of age and 100,000 IU at 9 months with diphtheria, pertussis, tetanus (DPT) vaccines/polio immunization. Mothers were given 200,000 IU or placebo at <6 weeks postpartum. There was a small but significant decrease in vitamin A deficiency (serum retinol $\leq 0.7 \mu\text{mol/L}$) and increase in liver stores (as tested using MRDR) at 6 months, but not at 9 and 12 months. There was no effect on mortality, anthropometry, overall or severe morbidity, and less than 1% of infants had bulging fontanelles. The study "confirmed the safety of the intervention, but showed no sustained benefits in terms of vitamin A status beyond age 6 months or on infant morbidity."

Kinetic estimates of liver concentrations following the supplements showed little difference at 6 months and nothing at 8 months. Based on the small effect seen in previous trials and the kinetic analyses, the decision was made to test the safety and benefits of increasing the dose of vitamin A delivered to infants and mothers. In the new trials, mothers in Ghana and Tanzania were given two doses of 200,000 IU as soon as possible after birth but before 6 weeks postpartum, and infants were given 50,000 IU at 6, 10, and 14 weeks of age and 100,000 IU at 4 to 6 months and 6 to 11 months of age. Safety and morbidity were measured routinely, and serum retinol and an MRDR test were carried out on infants at 6 and 9 months. The new trials doubled the dose to mothers postpartum. If this

significantly increases breast milk retinol for months, this strategy has the most potential for improving infant vitamin A stores. If it does not, the new dosing regimen is unlikely to produce detectable differences between groups even at 6 months postpartum.

The first talk of the session by Dr. Mary Penny, of the Instituto de Investigación Nutricional, in Lima, Peru, discussed the side effects associated with immunization-linked vitamin A supplementation programs (W34). In three earlier studies in Bangladesh, high rates of bulging fontanelles (10%) were reported when oral vitamin A (25,000 or 50,000 IU) was given to Bangladeshi infants together with DPT and oral polio vaccine. However, in the earlier large, multisite trials in Ghana, India, and Peru described above, far lower rates were found. Fontanelle examination was carried out before dosing and at 24 and 48 hours afterwards. Any abnormal findings were verified by a supervisor. Bulging appeared in the first 24 hours and was more common in Ghana, where the highest reported rate was 1.9% in the supplemented group at the third dose. In 82% to 88% of cases this resolved within 48 hours. Very few bulging fontanelles were mentioned spontaneously by caretakers. Across countries the most consistent association with bulging was fever or feverish symptoms. In summary, when vitamin A supplements are given at the same time as routine vaccinations, there was an increased risk of bulging fontanelles, but the episodes were mild and transient and generated little maternal concern. In the study described, differences between countries were observed.

Dr. Boniphace Idindili, of the Ifakara Health Research and Development Centre, in Ifakara, Tanzania, spoke next on the safety and efficacy of the immunization-linked vitamin A supplementation trial in Ifakara, Tanzania (W35). In a two-arm, individually randomized, double-blind clinical trial, a total of 780 mother-infant pairs were enrolled and mothers allocated to receive 200,000 IU vitamin A or placebo within 24 hours of delivery and at one month postpartum. Their infants

received three doses of 50,000 or 25,000 IU of vitamin A at 1, 2, and 3 months of age at the times of routine immunization. Baseline characteristics and completeness of follow-up were similar in both arms and there was no increase in any signs/symptoms in the higher-dose regimen. Also at 6 months, there was no significant difference in MRDR (43%–47% > 0.06), serum retinol concentration, or prevalence of vitamin A deficiency (36%–41% < 0.7 µmol/L) between the two groups. In conclusion, the high-dose regimen was well tolerated by both mothers and infants, but was not better than the lower-dose regimen for vitamin A deficiency prevention, because the prevalence of vitamin A deficiency was still >40% at 6 months in both groups.

Dr. Samuel Newton, of the Kintampo Health Research Centre, in Kintampo, Ghana, presented the results from the Ghana leg of a multicenter trial carried out in Kintampo district, where the trial design was similar to that in Tanzania (W36). The results presented were on the vitamin A status of infants at 6 weeks and 9 months postpartum, the side effects of vitamin A administered with DPT/polio vaccines, and breast milk retinol concentrations at 6 weeks and 6 and 9 months postpartum. The trial found a small improvement in vitamin A status up to 6 months of age, which was not sustained to 9 months of age. There was no statistically significant difference in vitamin A status between treatment groups using the MRDR test at 6 weeks (8%–11% > 0.06) or at 9 months (29%–26% > 0.06) and status showed a similar deterioration in both groups. There was no difference between the groups in the percentage of women with severe/moderately low breast milk retinol concentrations at baseline (32%–35%), 6 months (40%–43%), or 9 months (42%–40% < 0.7 µmol/L). Approximately 30% of milk retinol concentrations were between 0.7 and 1.05 µmol/L at all time points and in both groups. Approximately 1% of infants had bulging fontanelles in both groups.

Dr. David Thurnham, of the University of Ulster, in Coleraine, United Kingdom,

presented data from a study in The Gambia, where the new dosing regime has been compared with the existing Gambian recommended dosing, namely that mothers should receive 200,000 IU of vitamin A immediately after birth and infants should receive 100,000 IU at 9 months of age and 200,000 IU from 12 months of age onward (W37). The study took place in six villages around Keneba. Two-hundred-and-twenty women with a child born weighing more than 2500 g were recruited, and both mother and infant were followed for 12 months. The purpose of the study was to determine if the extra vitamin A would increase the resistance of the mucosal barrier in the gut and respiratory tract to infection. Previous work has reported that by 9 months, 60% of infants will be infected with *Helicobacter pylori* and more than 80% will be colonized with *Streptococcus pneumoniae*. In this presentation only the results of the milk retinol and human milk oligosaccharide content were given. Six breast milk samples were collected at monthly intervals between months 1 and 7. One-hundred-ninety-nine mother-infant pairs completed the study, and at month 1, the milk retinol concentration was approximately 2.0 µmol/L. In both groups, the concentration of retinol decreased by about 25% over the 6-month period, but there was no difference in milk retinol concentrations between the women receiving 200,000 or 400,000 IU vitamin A at any time point, although there was a tendency for retinol and other fat-soluble micronutrients to be higher in the group receiving 400,000 IU.

In a separate study, Sudanese refugees were also given either 200,000 or 400,000 IU vitamin A postpartum, and a comparison was made between them and the Gambian women. Within 1 week of the dose, concentrations of milk retinol for both Sudanese groups were the same as those at month 1 in the Gambian women. However, concentrations decreased rapidly, and at months 1 and 2, they were one-half those present in the Gambian women. These results suggest that vitamin A status was probably satisfactory in the Gambian women but low to inadequate in the Sudanese women.

Human milk oligosaccharides form the third largest component in milk by weight and are made up of three to four sugar molecules in many combinations, some with proteins. More than 130 have been identified, and vitamin A may be involved in the assembly of human milk oligosaccharides, which have antibacterial properties and act as decoy receptors by binding pathogens. There was a significant decrease in most of the human milk oligosaccharides with time, but no significant differences between treatments. There was a tendency for levels of neutral human milk oligosaccharides to decrease less rapidly in the group receiving 400,000 IU of vitamin A. In conclusion, although no differences were found between women receiving the two treatments, the data will be linked to the changes occurring in infant gut integrity and rates of acquisition of mucosal infections, so differences may yet emerge.

The poster on alternative size supplements covered the non-specific effects of vaccines and their interaction with high-dose vitamin A supplementation. The data presented showed that in Guinea-Bissau, half of the recommended dose combined with oral polio vaccine was associated with significantly lower mortality than the recommended dose in girls but not in boys in 9 months of follow-up. These data suggest that the protective effect of vitamin A may not be mediated merely through prevention of vitamin A deficiency, and that optimal doses may differ for boys and girls. The authors suggest that new, and especially higher, dosing schedules should be investigated thoroughly for long-term and non-specific effects before general use (W1).

Supplementation: Post-National Immunization Days

Many countries with preschool children at risk of vitamin A deficiency chose to integrate the distribution of vitamin A capsules to children 6 to 59 months of age with National Immunization Days (NIDs). The result was high coverage of the at-risk population, with some countries reaching

more than 80% of children with at least one dose of vitamin A each year. However, as polio eradication has progressed, many countries have phased out NIDs. What are the possibilities of achieving similar vitamin A capsule coverage without NIDs? One option is to set up NIDs-like campaigns specifically for vitamin A, but this could be expensive. Zambia tackled the problem by implementing Child Health Weeks twice a year, during which vitamin A capsules are distributed alongside a battery of other child health interventions, such as deworming, growth monitoring, and bed-net distribution. A second option is to incorporate the distribution of capsules with the Expanded Program on Immunization (EPI) and other health services, which may be cheaper, but may have lower coverage. In this session, country experiences post-NIDs were shared with the participants.

Ms. Esi Amoafu, of the Ghana Health Service, in Accra, Ghana, outlined the need to integrate the distribution of vitamin A supplements into routine service delivery systems and to explore ways of sustaining the gains in high coverage and improved child survival (W38). The objective of her program was to reach at least 80% of children 6 to 59 months of age with two doses of vitamin A per year through improving outreach and facility-based routine services, instituting a number of sub-district activities designed to improve efficiency and quality of service delivery, and increasing utilization and improving coverage of several key child health services. Previously, the Ghana Health Service had been implementing twice yearly vitamin A supplementation through mass campaigns, which resulted in reaching over 90% of the target groups. The strategies outlined were to provide vitamin A supplementation at all contacts made for child health care, including static points, to extend outreach and community health planning service centers, to organize yearly child health promotion weeks, and to undertake comprehensive retraining to improve the knowledge and skills of health workers. In addition, intensive information and communication were provided to improve caregiver knowledge and generate

demand. There was sensitization of community leaders for mobilization and service utilization and joint planning and logistics. A detailed monitoring framework was used to determine the proportion of staff trained, quantities of commodities and information provided, and coverage.

Following the planning stages, a series of consensus-building sessions were held with program implementers at all levels. Routine vitamin A supplementation is now ongoing at service delivery points. Caregiver education has been undertaken through radio and community mobilization activities. Vitamin A coverage of about 55% to 85% in different districts has been achieved, along with nationwide bed-net promotion, re-treatment demonstrations, and birth registration. Child health promotion weeks have been institutionalized and incorporated into regional and district plans and budgets. May of each year is designated for the promotion of vitamin A and other preventive care services. Overall, the changes have resulted in improved efficiency through the combination of services, making them more attractive to caregivers. The institutionalization of child health weeks (including vitamin A supplementation) have provided an effective way to ensure long-term sustainability.

The next talk was by Dr. Fatimata Ouattara, of Helen Keller International, in Bamako, Mali, who gave the audience some statistics on the state of the health of the Malian population (W39). Mali is 174th out of 177 countries in the Human Development Index, with an infant mortality rate of 122/1000 and an under-5 mortality rate of 222/1000; 51% of child deaths are attributable to malnutrition and 47% of children 0 to 59 months of age are vitamin A deficient. From 1998 to 2002, vitamin A capsule distribution was linked to NIDs. In 2000, the Ministry of Health, with support from Helen Keller International and The Micronutrient Initiative, organized regional micronutrient days in one region. In 2001, five regions were covered, and in June 2003 the first national nutrition week, *Semaine d'Intensification des Activités*

de Nutrition (SIAN), was held. SIAN is organized twice yearly and is a component of the national supplementation strategy based on intensifying routine vitamin A supplementation activities during one week and/or organization of campaigns adapted to the local situation. A national rapid coverage survey was organized after SIAN II (April 2004) in each of the six regions. A health district was randomly selected and a nationally representative sample of mothers, fathers, caregivers, health staff, administrative, and community authorities were interviewed.

National coverage according to parents was 83% and national coverage according to the Ministry of Health was 96%. About 41% of health agents did not receive refresher training on vitamin A supplementation, yet they were knowledgeable on target groups (88%), advantages of supplementation (88%), dosage (98%), and frequency of administration (78%). Central and southern regions benefited from radio and/or television messages, but in the north, traditional channels were more effective for information dissemination. In Mali, each region implements its own "custom vitamin A capsule delivery recipe," and therefore SIAN allows more flexibility and adaptation to regional needs because of decentralized management. The transition from NID-supported supplementation to national nutrition weeks has had no negative effect on the capsule coverage, but has presented some challenges that are manageable .

Mr. Aphrodis Ndagiymfura, consultant for the World Food Program in Kigali, Rwanda, said that Rwanda has a significant vitamin A deficiency public health problem (W40). In 2000, rates of maternal (1071/100,000), infant (107/1000), and young child (196/1000) mortality were very high. From 1991 to 1997, vitamin A supplementation was part of the routine system, and coverage was about 20% of the target groups. To increase coverage, supplementation of vitamin A was linked to the NIDs from 1998 to 2003. Coverage was high during this period. At the end of NIDs, vitamin A supplementation was integrated to the World Health Week in April and National Health Worker Day in

October, and the program was projected to run from 2003 to 2006. The first campaign in November 2003 had high coverage for infants and children, and 48% for lactating women 6 weeks postpartum. Fortification of foods with vitamin A is also seen as a long-term intervention. Results of the campaign so far have shown a reduction in measles mortality, a reduction in the prevalence of chronic malnutrition, an overall reduction in mortality of infants and young children, and increases in birth weight.

A series of posters were presented that report on strategies to achieve sustainable coverage in a wide range of circumstances. Two posters from Cote d'Ivoire showed that training and community mobilization and involvement outside of NIDs and even in conflict areas allow good and cost-effective coverage for children and postpartum women (W9, W10). A series of posters from different countries presented approaches specifically targeting children under 5 years of age based on integrating vitamin A supplementation with other health services, such as with measles vaccination in Guinea (W13), National Micronutrient Days in Niger (W14), deworming in Tanzania (W15), a package of health services dubbed "Preschoolers Health Week" in the Philippines (W11), and the "National Vitamin A Plus Campaign" in Bangladesh (W12). These approaches have led to improved viability and sustainability, better coverage, and better cost effectiveness. Awareness campaigns, information, education, and communication (IEC) programs, and social mobilization were often key components. Furthermore, social mobilization and advocacy specifically targeted at local government structures led to structural budgetary support from the local government for vitamin A supplementation in the Philippines (W16).

Supplementation: Country Experiences and Policy Implications

The first talk of this session was a success story from Nicaragua. Dr. José Mora, of MOST, The USAID Micronutrient Program, in Arlington, Virginia, USA,

said that vitamin A deficiency had been a problem of public health significance in 1993 when 31% of children under 5 years of age had subclinical vitamin A deficiency and their vitamin A intake was only 208 µg of retinol equivalents, or 52% of the RDA (W41). In 1994, national health weeks were implemented in which vitamin A was distributed twice a year to children, with multiple preventive services included. A semiannual cycle of district activities was established. Each campaign was carefully planned, and social mobilization was used to sensitize the communities. The distribution was registered on the child card and tally sheets, together with immunizations. Coverage was estimated by round, district, municipality, and child's age, and evaluation meetings were held after each national health week.

Sugar in Nicaragua is centrally produced in five privately owned plants and is consumed by 99% of the population, who eat approximately 87 g/d (32 kg/person/year). After 4 years of negotiations, a formal government/industry partnership was reached and sugar fortification with retinol was initiated for the 1999-2000 harvest. The cost was transferred to the consumer (2% of the retail price). The recommended level of retinol in sugar is 12 to 15 mg/kg at production, which is over 3.5 µg/g at the household. Quality assurance/quality control is carried out by industry and regulatory (plants, stores) and evaluative (households) monitoring by the Ministry of Health. The national micronutrient survey in 2000 revealed a reduction in the prevalence of vitamin A deficiency in children 1 to 4 years of age from 31% in 1993 to 8.6% in 2000, with severe vitamin A deficiency dropping from 8% to 0.2%.

The decline in vitamin A deficiency has been attributed to the cumulative effect of persistently high supplementation coverage, deworming of children, and sugar fortification. The most recent vitamin A deficiency assessment in 2002-2003 as part of the Sistema Integrado de Vigilancia de las Intervenciones de Nutrición (SIVIN) showed that plasma retinol distribution was normal, with 0.3% of values less than 0.7 µmol/L. Nicaragua provides

an outstanding example of success in controlling vitamin A deficiency after 10 years of sequential implementation of public health interventions aimed at increasing intake and reducing the risks of deficiency. The multiple intervention approach was successful because of strong political commitment expressed in resource allocation and full program ownership, appropriate and key intervention programs, and an effective monitoring and evaluation system.

Ms. Louise Sserunjogi, of MOST, The USAID Micronutrient Program, in Kampala, Uganda, spoke about building a multisectoral vitamin A program in Uganda (W42). In 1999, a survey of the nutritional situation in one "typical" district found an under-5 mortality rate of more than 149, vitamin A deficiency to be a significant clinical problem, and the usual diet to be low in vitamin A. The survey highlighted the significance of micronutrient malnutrition, the lack of a strategy to address the problem, and limited involvement of the private sector in nutrition issues. The assessment coincided with the implementation of the new Uganda Health Policy Minimum Health Care Package, which included a nutrition health sector strategic plan for vitamin A supplementation and increased consumption of vitamin A-rich foods. Implementation was to be decentralized with an overall objective of building a comprehensive, sustainable, multisectoral program including supplementation, dietary diversity, and fortification.

In 1999, vitamin A was delivered with the 9-month measles vaccination and at NIDs. A micronutrient task force was formed, which reviewed policy and ensured that supplementation protocol was made consistent with WHO/IVACG recommendations. Communication and advocacy materials were developed for social mobilization, and implementation guidelines were introduced. The new delivery mechanism was piloted in one district before the Ministry of Health launched a national program in May 2002, with second rounds proposed for November. However, different delivery mechanisms for

vitamin A were used; for example, NIDs, polio/measles, and child health preventive packages, so coverage was difficult to estimate. The best estimate was 50% in 2002 and 60% in 2003. In May 2004, the new child day strategy was launched, which included immunizations, deworming, re-treating bed-nets, and growth monitoring, and coverage was estimated to be 76%. Consumption of vitamin A-rich foods was promoted through the agricultural sector, and a community-based organization working with women farmers was set up.

In communities where the sweet potato was the staple, capacity building provided guidance on issues such as the preparation and care of fields, planting, timely harvesting, traditional methods of pest control, processing, and storage, as well as appropriate food preparation. The interest and skill of the participants was maintained by promoting the orange-fleshed sweet potato after the project had ended. Investment in a public/private partnership to improve the nutritional quality of manufactured foods persuaded one oil company to add vitamin A and two flour companies to add multiple micronutrients. In conclusion, Uganda has found the following keys to creating sustainable roles for improved nutrition: government support, policy review, stakeholder participation, applied research, community involvement, critical donor support, and technical assistance.

Mr. Joseph Mugyabuso, of Helen Keller International, in Dar es Salaam, Tanzania, talked about the methods used to improve the vitamin A status of young children and postpartum women in Tanzania (W43). Vitamin A supplementation has been a major strategy to control vitamin A deficiency since 1987 by targeting disease (1987) and by establishing routine Expanded Programmes on Immunization (1997), NIDs (1999-2000), and mass interventions (beginning in 2001). A qualitative rapid assessment study of vitamin A supplementation systems was carried out in 2004 to determine the strengths, limitations, and gaps in the national vitamin A supplementation program and to suggest mechanisms for improvement.

The key findings were that Tanzania had a favorable policy environment in that there was a devolution of decision-making powers to district councils and communities, a mixture of social mobilization mechanisms, and integration of supplementation into comprehensive council health plans in over 50 out of 119 districts of mainland Tanzania (>42%).

The weaknesses in the vitamin A supplementation policy guidelines were: no review and no further training of health workers since 1997, no new methods of promotion, inadequate knowledge among mothers and community leaders, variability in color and shape of the capsules, inadequate communication materials and job aids, and limited utilization of program data for action, especially at the community level. Further limitations included no mention of vitamin A supplementation in supervisors' checklists in some districts, minimal utilization of community-owned resource persons such as community health workers as social mobilizers, and inequalities in the distribution system. Findings from a population-based assessment suggested that the national vitamin A supplementation coverage of children 6 to 59 months of age was 84.6%, the national coverage of postpartum women was only 29.4%, and 60% of health workers reported that there were "hard to reach groups" in their area of intervention. In conclusion, the gaps in policy, implementation, and monitoring and low knowledge should be addressed.

Dr. Geeta Verma, consultant for UNICEF, in Patna, India, reported that Jharkhand State, India became a state in the year 2000 (W44). At that time, 54% of children were undernourished, vitamin A deficiency in preschool children was 9 times the WHO cutoff, and vitamin A capsule coverage was about 8% and was confined to health centers. In early 2003, the government decided to increase coverage with routine immunization by having a fixed health day. The idea was successfully piloted in four districts prior to initiation in 18 other districts using a group called the District Link Persons, who had previous experience in fixed health days from the

pilot project. Microplanning based on the master templates used in the pilot project were started at the village level and worked through the health system to the district level, where they were formalized. Social mobilization was carried out by 23,000 frontline workers trained on vitamin A supplementation and routine immunization. The reports of the vitamin A distribution were collected on tally sheets and showed that 90% of children received a dose of vitamin A. Other findings suggested that 92% of staff attended orientations, were aware of the correct quantity of vitamin A to give, and correctly marked the child's card. The goals now are to provide capacity building to the frontline staff, to integrate vitamin A in routine immunization through a fixed health day, and to intensify efforts to increase vitamin A coverage every 6 months.

In the last talk in this session, Mr. Ram Shrestha, of the National Vitamin A Program (NVAP), in Kathmandu, Nepal, reported that the NVAP was established by their Ministry of Health in 1993 (W45). The program provides vitamin A to children 6 to 60 months of age and pregnant women within 6 weeks postpartum. The program uses female community health volunteers to give the capsules. The female community health volunteers are motivated through a cycle of activities to help develop ownership, and an endowment fund has been set up to be used for their welfare. Starting with eight districts in 1993, the program expanded to all 75 districts over the next 9 years. NVAP has maintained coverage rates above 85% and reduced the incidence of Bitot's spots to 0.3%. NVAP is cost-effective at just 21 cents per child. Cumulative data show that nearly 250,000 child deaths have been averted since the introduction of the program in 1993, and 41,422 female volunteers and 70,836 multisectoral people have been trained and mobilized. The program has increased awareness about vitamin A-rich foods and the usefulness of vitamin A in the fight against disease, and has strengthened the link between community and health programs through female community health volunteers. The program has been a success story, but there

are a few limitations, such as lack of trust, lack of patience, geographical constraints, some political instability, and funding insecurity. The lessons learned are that a multisectoral approach that builds on local infrastructure must be used, that leadership is important but trust must be built, that barriers should be taken as challenges and opportunities, that motivation should be sustained, and that the program should rely on minimum external support.

In the lively discussion that followed, one particularly important point was raised by Dr. Rebecca Stoltzfus, of Cornell University, in Ithaca, New York, USA, who questioned whether the supplementation program in Nicaragua should now be modified to just target children most at risk, i.e. children under 24 or 36 months of age, since sugar fortification has been so successful. Dr. Dary had concerns about overconsumption of sugar in Nicaragua and pointed out that although the addition of vitamin A to sugar does not change sugar intake, because sugar is a cheap source of calories, about 60 g per person is eaten per day. Richer people have good vitamin A intakes and the amount of vitamin A added to foods in Nicaragua may need to be regulated. Dr. Dary suggested that salt should be considered as a possible vehicle to reach other sections of society, but at the moment the cost of salt fortification is high. However, before changing the focus of the supplementation program, operational research is needed in Nicaragua, for example, to determine the normal diet of a 24-month-old child.

Dr. Frances Davidson, of USAID, Washington, DC, USA, began her summary of the session by first asking the question, what is a successful supplementation program? Most programs seem to start with exclusive supplementation then add other interventions that make them more popular with communities. Therefore, the program must be relevant to the needs of each country and also be flexible in reacting to its goals. Government support is essential in providing resources and regulation. Priorities have to be established and there must be equity in the treatment of all population groups. Financial support is required, but, unlike

other health interventions, vitamin A supplementation programs always try to do the distributions cheaply. However, it is important to consider the cost of vitamin A deficiency in a population and compare this with the cost of preventing vitamin A deficiency by supplementing at-risk groups. The benefits of supplementation should be stressed to planners. Social mobilization and consistency are always needed, for example, by always holding child health interventions at the same time each year. Logistics and operational support can make or break a program, so advance planning is essential for smooth running. Monitoring and feedback to the community and to government keeps people informed of the needs and successes of the intervention. Finally, the individuals who are the ultimate beneficiaries must be respected.

There were seven posters under the theme of supplementation. Posters from Bangladesh reported low vitamin A capsule coverage in infants (W2) and in postpartum women (W3), and attributed it to failures in the existing delivery systems for these vulnerable groups. Low vitamin A capsule coverage was also reported in postpartum women in Indonesia (W6). In Indonesian infants and children, dietary intakes of vitamin A were found to be lower than the RDA, especially in those in rural areas and those in urban areas who did not receive vitamin A capsules (W4). In Cameroon, a vitamin A capsule delivery linked to the onchocerciasis control program has been piloted. Very encouraging results were obtained in reaching children, but the coverage of postpartum women was only 26%. An adjusted design is now being scaled up to 15 health districts, which will hopefully be sustainable (W5). In Madagascar, progressive improvements in national vitamin A campaigns have led to 100% coverage (W8). Lastly, plans were described to use stable isotope techniques to determine the length of time mothers are protected from vitamin A depletion after being given 200,000 and 400,000 IU vitamin A postpartum (W7). The data produced will provide answers to public health questions concerning the outcomes of vitamin A supplementation programs.

There were several posters on that focused predominantly on strategic and policy development issues. The development of a successful partnership among the government, the private sector, and consumer organizations for vegetable oil fortification in Mali was described (W19). Two posters from Cambodia reported the importance of collaboration with other agencies already supporting outreach activities. The twice-yearly, routine immunization outreach through health centers was found to be a good channel for capsule distribution. By defining the roles and responsibilities of the various partners, the scaling-up of vitamin A distribution was successfully achieved in 13 out of 15 operational districts (W22). A similar approach was described in the second poster on developing sustainable community-based vitamin A deficiency and night-blindness prevention programs in Cambodia, and the authors reported that night-blindness rates were now below WHO problem levels in both mothers and children (W33).

In Zambia, the active participation and support of communities and non-governmental organizations initiated early activities to increase vitamin A awareness (W23), but more recently, health reforms were initiated to promote structural integration of vitamin A supplementation with other preventive health services. Vitamin A supplementation is now incorporated within child health services, leading to its inclusion within the National Child Health Week Program (see also W18), which also gives greater financial sustainability (W27). Finally, a poster outlined some of the activities of the Economic Community of West African States (ECOWAS), a forum for a group of 15 west-African states. Their nutrition forum provides a network combining technical expertise with regional political structures and support from other partners such as donors. This network, through regional advocacy, goal setting, exchange of knowledge and expertise, and public accountability, has led to concrete advancement of vitamin A programs in the region (W30).

Monitoring Vitamin A Deficiency Control Programs

The last session of the IVACG meeting was introduced by Dr. Chewe Luo, of UNICEF, in New York, USA. The focus of this session was to look at methodologies being used to monitor programs in order to highlight some of the challenges with regard to coverage data, impact assessments, and cost-effectiveness using different delivery models. The current indicator, the percentage of children under 5 years of age receiving two rounds of supplements (4–6 months apart), is being measured in different ways:

- UNICEF (annual questionnaire to field offices) collects data on NIDs and campaigns (administrative data)
- WHO/UNICEF (joint reporting form) integrated vitamin A in EPI monitoring to cover the first year of life
- Multiple Indicator Cluster Surveys (MICS)
- Demographic and Health Surveys (DHS)
- Other national surveys

The question “what is the impact of supplementation on vitamin A status?” needs to be answered, but are the current methodologies applicable at the population level? What is the impact on under-5 mortality, and how much of attributable mortality reduction is due to vitamin A supplements? There is also donor pressure to show impact: “how many lives are saved?” Finally, if the under-5 mortality rate decreases, how does one know when it is safe to discontinue vitamin A supplementation, since that might be the cause of the reduced mortality?

Dr. Josefina Bonilla, of the Federación Red Nicasalud, in Managua, Nicaragua, reported on the monitoring system set up in Nicaragua (W46). The objective of the system was to help improve the health and nutritional status of women and children by regularly gathering, processing, analyzing, and using the information from

the nutrition programs, and the trends in the biological indicators. A centralized, modular, and integrated monitoring and evaluation system for periodic decision-making, SIVIN, was set up. SIVIN uses data from health service statistics, program surveillance, and households. The first year of SIVIN, 2002-2003, produced key information, including relevant micronutrient data revealing that vitamin A and iodine deficiencies are virtually under control. High coverage rates (70%) of vitamin A supplementation in children were sustained in both rounds, and iron supplementation to pregnant women increased to 88% in 2003 from 70% in 2000. Sugar, wheat flour, and salt are all properly fortified with high coverage and quality. The distribution of serum retinol concentrations in children 12 to 59 months of age has normalized, and only 0.03% were vitamin A deficient compared with 31% in 1993. Anemia in women is down to 16% and in children it is 23%.

In addition to continuing and consolidating the national household survey, SIVIN's work is focused on four critical issues: strengthening and integrating other sources of information, establishing effective mechanisms for the systematic transfer and integrated analysis of the information obtained from other sources, developing a systematic way to use the information to make timely decisions about policies and programs, and strengthening SIVIN's long-term sustainability. The Ministry of Health has made a serious political commitment and has assigned well-trained and highly motivated, committed, and competent staff to sustain SIVIN's household survey. The capacity to assume the full cost of the system and the operating costs of the household survey and other components, as well as social sustainability, are currently being analyzed.

Dr. Patricia David, of John Snow, Inc., in Boston, Massachusetts, USA, spoke to delegates about the empirical evaluation of the impact of a large-scale vitamin A supplementation program in Northern Ghana (W47). The evaluation used a retrospective comparison of pre- and post-intervention data from existing sources.

Data were compiled from the national vitamin A program, key informant interviews were conducted with regional program officers, outpatient clinic morbidity data were analyzed, causes of hospital admissions and deaths were obtained, and coverage and mortality rates from household surveys were used. The findings showed that in the provision and uptake of services, although some records were missing about capsule distribution to regions, tally sheets indicated that increased numbers of children were reached in succeeding rounds. Refresher courses were held each round and there were minimal logistical problems, but maternal knowledge was low.

Program estimates showed that by November 1998 coverage was estimated at over 90%, which increased above 100%, indicating inaccurate population projections or miscounts of doses dispensed. Therefore, population-based coverage data are preferable. Trends in outpatient visits acted as a proxy for perceived severity of diarrhea and measles, and visits for diarrhea declined by two-thirds. Attendance for all other causes more than doubled. Trends in hospital admissions acted as proxies for severity of cases of diarrhea in 6- to 59-month-old children, and the odds of admission for diarrhea declined by 33%. However, there was no change for 0- to 5-month-olds and no reduction in case fatality rates for diarrhea and measles-associated deaths.

Trends in childhood mortality began to decline before the national vitamin A program started—in northern regions mortality declined rapidly—but the trend needs confirmation in future surveys. Data indicated a sharper decline in mortality among 1- to 4-year-olds than for children under 1 year of age, which supports the hypothesis that the national vitamin A program contributed to improved survival. In summary, the data revealed an increase in vitamin A capsule coverage of the target population. Service statistics indicated a decline in severe diarrhea, but other factors may also contribute to this decline. Child survival improved rapidly, with the most marked improvement among

the age group most likely to benefit from supplementation, but one needs to be cautious in attributing mortality decline solely to the vitamin A supplementation program.

Ms. Heather Gardner, of Emory University, in Atlanta, Georgia, USA, spoke on assessing the validity of coverage data (W48). Vitamin A is often distributed during biannual campaigns, usually in the context of NIDs. However, NIDs are being phased out as the preferred mode of delivery, and alternate channels are becoming more important. This transition may interfere with the distribution and measurement of coverage, which is the main outcome indicator to assess the effectiveness of vitamin A supplementation programs. In light of the forthcoming changes, it has become increasingly important to understand how and with what accuracy coverage is determined. Therefore, the goals of this study were to summarize existing literature on national estimates, review reports of the validity and of accuracy of using maternal recall, and compare campaign or administrative and cross-sectional survey estimates.

All relevant data from 1995 to 2004 were included and 21 countries were identified as having such data. Administrative estimates were systematically higher than those derived from cross-sectional surveys: 70% (range: Tanzania 21% to Nepal 97.8%) versus 46% (range: Tanzania 12% to Nepal 81%). On average, the relative difference between the two survey estimates was 66.4%; the latter was calculated for each data point by subtracting the cross-sectional survey estimate from the UNICEF estimate and dividing by the same cross-sectional survey estimate (% relative difference) and multiplying by 100. These findings were added together and divided by 18, the total number of estimates (average % relative difference). These differences may occur because administrative estimates may be biased if the number of children who received supplements is not accurate or if the population size is overestimated or underestimated. Although specific evidence documenting over- or underestimation effects was not identified, countries such

as Cambodia and Indonesia are beginning to address this issue by reviving target group multipliers and comparing counted and census data. Cross-sectional survey estimates may be biased depending on the accuracy of maternal recall, but the literature presents conflicting results as to the accuracy of maternal recall.

The final oral presentation of the meeting was given by Ms. Julie Mateer, of World Vision Canada, in Mississauga, Ontario, Canada, who began by saying that vitamin A capsule coverage rates are often cited by UNICEF as the benchmark for its effectiveness in eliminating vitamin A deficiency (W49). The organization World Vision undertook cross-sectional surveys in remote areas of Afghanistan, Chad, Tanzania, Zambia, and India to determine vitamin A capsule coverage rates and clinical signs of vitamin A deficiency in children under 5 years of age. Results were compared with UNICEF national coverage rates and served as baseline data for a 3-year program to increase supplementation rates and improve capacity of local delivery services. The World Vision data revealed lower coverage rates during a 12-month period than UNICEF national data in four of the five countries surveyed. In addition, UNICEF data indicate that vitamin A deficiency is unlikely to be a public health problem in four of the five countries, but World Vision data indicate the opposite. Specifically, World Vision found that in Afghanistan, Chad, and Tanzania, night-blindness is above the WHO cutoff levels, and in Afghanistan, Tanzania, Zambia, and India, Bitot's spots were found to be of public health significance. The implications are that further effort and resources are needed in each of those countries to eliminate vitamin A deficiency, in addition to the significant contributions already being made. Therefore, data given by UNICEF on vitamin A coverage for different countries should be treated cautiously until confirmed by other methods.

This session included a series of posters reporting the evaluation and impact of programs in a wide range of countries. In Peru in a resource-limited setting, a

healthy-behavior and nutrition education program reduced the prevalence of vitamin A deficiency (retinol $<0.7 \mu\text{mol/L}$) in young children (<3 years) from 68% in 1997 to 29% in 2003, and eventually to 12% when combined with vitamin A supplementation (W17). Assessment of programs in Guinea yielded discrepancies in estimates of vitamin A coverage between the official rate (93%) and that calculated in the study (67%). Good coverage was found for iron, folate, and chloroquine (80%–90%), but a high prevalence of anemia combined with a lack of awareness and knowledge on vitamin A deficiency, iron deficiency anemia, or of iron-rich foods remained (W21).

In Dinguiraye, one of the poorest areas of Guinea, increased vitamin A coverage in postpartum women led to an increase in vitamin A awareness and the unexpected consequence of an increase in the numbers of births registered by women wanting the supplements (W20). A successful pilot program for postpartum vitamin A supplementation in maternity wards was reported from Mozambique (W24). In India, efforts to strengthen the vitamin A supplementation program by holding outreach sessions in villages boosted health service coverage of routine vaccinations and immunizations (W28).

In South Africa, assessment of the vitamin A supplementation program in 27 clinics in the Eastern Cape identified a lack of time and materials available for information, education, and communication (IEC) activities by health staff due to workload and insufficient in-service training and supervision. In addition, many clinics were often out of stock of 100,000 IU capsules (W31). A second program in the Eastern Cape Province evaluated various communication strategies, including a 5-month radio campaign to Xhosa-speaking caregivers on the advantages of vitamin A supplements, and found a 4-fold increase in vitamin A coverage (W32). Media messages through television and radio were also used in Zambia to promote vitamin A supplementation at child health weeks. In the program evaluation, motivated health workers were considered an important

source of information about child health weeks, as were television and radio messages; folk and print media played a lesser role (W18). In Indonesia, workers also found improved vitamin A capsule coverage after exposure to health promotion campaign messages (W29). Lastly, a study in Sri Lanka assessed the impact of vitamin A supplementation on absenteeism due to ill health in schoolchildren (5–11 years of age). They found that vitamin A status improved, but hemoglobin, growth, and school absenteeism were not affected (W26).

Concluding Remarks

In his concluding remarks, Dr. Sommer highlighted two of the main themes that emerged from the presentations and discussion:

1. Poor, malnourished populations are usually deficient in multiple micronutrients, not just one, and the optimal ways to address this problem remain to be defined. We've always known that deficiencies in multiple micronutrients can result in physiologic disturbances and clinical disease not anticipated from single nutrient deficiencies. It now appears that simply combining micronutrients into single supplements may result in unexpected, potentially deleterious outcomes.
2. The impact of micronutrient deficiencies, and supplements meant to address them, may well vary between populations, based upon differences in other health conditions, co-morbidities (HIV, malaria, TB, etc.), anthropometric status, and the like. These, too, require careful delineation to achieve understanding.

As a result, the solution to multiple micronutrient deficiencies may be far less clear and more variable than for vitamin A deficiency alone. Carefully collected scientific evidence will be needed to guide future policy development, and such policies may need to differ from one population to another.

It was reassuring to learn that the existing recommendations for the use of vitamin A in children 5 months to 5 years of age appear to remain robust and appropriate, even in HIV-positive populations. A primary challenge before us now is in finding ways to provide inexpensive, effective, and sustainable interventions. We now know that the present food supply for the developing world does not contain enough vitamin A or pro-vitamin A carotenoids to meet population needs. If dietary changes are to meet these needs, then the world needs to produce a great deal more vitamin A-rich foods; simply educating people to eat more foods of this type when they are not available is self-deluding. New tools such as genetically engineered grains might one day help to solve this problem, but until then, vitamin A supplementation, as individual doses or as fortified dietary items, are necessary to save the sight and lives of over a million young children and mothers each year.

A real ray of optimism is the way in which many countries, anticipating the end of NIDs, have developed and implemented alternative, effective vitamin A delivery systems.

Dr. Sommer concluded by thanking the Local Organizing Committee, the IVACG Secretariat, interpreters, student volunteers, and presenters for their lucid talks and good slides, and everyone was thanked for their active participation. Finally, he thanked USAID and Dr. Frances Davidson for their continuing support.

The meeting was ended with the final thought, "the health of populations depends on us."

ABSTRACTS



*Abstracts that appear in this booklet were presented at the
XXII IVACG Meeting.*

- M1 PERCEPTION OF AVAILABILITY OF VITAMIN A-RICH FOODS BY MOTHERS: AN INDIRECT INDICATOR FOR EVALUATING FOOD DIVERSIFICATION PROGRAMS.** M Ag Bendech, A Tarini, O Vebamba, Z Sifri and SK Baker. Helen Keller International- Burkina Faso (MA, AT,OV) HKI-Africa Regional Office-Senegal (ZS, SKB).

Vitamin A deficiency is a public health problem in Burkina Faso. Food diversification programs represent one of the possible strategies to control vitamin A deficiency. It is often difficult to evaluate these types of programs in the field. UNICEF and HKI conducted and evaluated a School and Community Gardening Program where perception of the availability of the gardening products by mothers was used as one of the indicators of success. We have here his reliability referring to the practice of the gardening by the households and to the prevalence of night blindness in the mothers during their last pregnancy.

During the survey, 810 mothers of children under five years of age were interviewed. The proportion of mothers who judge the availability of vitamin A rich food favorably is significantly higher in the villages where more than 30% of the households practice gardening (61.8%) than in the villages where less than 30% of households have a garden (49.7%, $P < 0.01$). In the same way, night blindness prevalence during the last pregnancy is less important for mothers who say that the availability of vitamin A rich food is good or very good (14%) compared to those who estimate availability as poor or non-existent (21%, $P < 0.01$).

These results seem to indicate that the perception of the availability of vitamin A-rich foods by mothers is a simple indicator that is complementary to the prevalence of night blindness in pregnant women to evaluate programs promoting the production and consumption of vitamin A rich foods in the Sahel.

- M2 LOW ACCESS TO BETA-CAROTENE, LUTEIN AND ZEAXANTHIN IN HOUSEHOLDS OF BRAZIL'S URBAN AREAS.** RM Padovani, J Amaya-Farfan, Food & Nutr Dept. Faculdade de Engenharia de Alimentos, Universidade Estadual de Campinas, CP 6121 DEPAR, FEA, UNICAMP and Núcleo de Estudos e Pesquisas em alimentação (NEPA) Campinas, Brasil.

Aims: To assess the consumer accessibility to carotenoids and identify the major food sources in the eleven main Brazilian urban centers, using the National Household Budget Survey (POF, IBGE 95/96), which recorded food purchases of 16,013 households, ranked by revenue level. **Methods:** The Brazilian and the USDA-NCC Carotenoid Databases were used to determine the contents of foods and calculate amounts of nutrients purchased per household. **Results:** It was inferred that the prudent daily "intake" (US Institute of Medicine, 2000) of 3 to 6mg of beta-carotene, provitamins-A (5.2 to 6mg) or total carotenoids (9 to 18mg) may not have been achieved in the households of any of the urban centers, especially in the poorer households. The availability of carotenoids, however, rose with the level of income in all cities. Food purchases accounted for a provitamin A supply that varied from 0.24-2.22mg/d, in the NE, to 0.50-1.60mg/d for β -carotene, from 0.04-0.50mg/d for α -carotene and 0.04-0.55mg/d for lutein + zeaxanthin. The principal foods identified, which significantly contributed to the carotenoid supply were: (β -carotene) carrot, pumpkin, mango and tomato. In all cases, carrots were the, or one of the, predominant sources of provitamin A. It was also noticed that in spite of leafy vegetables being rich sources of β -carotene, their low levels of "consumption" made poor sources, like mango and even tomato, become prominent sources (up to 14.9%) of provitamin A in most metropolitan areas, particularly among poor families. Only in cities of Central, Southeastern and Southern regions did leafy vegetables rank among the four most important sources; feature that was also income-dependent. Similarly, typical "consumption" levels of lutein + zeaxanthin ranged from 60-260, in the NE, to 160-400 μ g/d in Center and South. To the supply of these nutrients, corn flour, kale, lettuce and orange were the main contributors. **Conclusion:** This indirect measure of food consumption strongly suggests that access of Brazilian urban families to carotenogenic foods is insufficient to meet prudent levels of intake and that the poor are most affected.

- M3 INSTITUTIONAL STRENGTHENING AND INTERSECTORAL LINKAGES SET THE STAGE FOR SUCCESSFUL NATIONAL FOOD BASED PROGRAM IN GHANA.** E Amoafu (1), R Agble (1), A Nyaku (2), 1. Nutrition Unit, Ghana Health Service, Ghana; 2. MOST, The USAID Micronutrient Program, Ghana.

Introduction: Ghana is implementing a project to strengthen agriculture, nutrition and gender linkages to reduce hunger and malnutrition. Studies have shown that key players in agriculture, nutrition and gender have not been working together resulting in difficulties in achieving lasting solutions to high levels of malnutrition. Thus strategies to strengthen linkages between key sectors have been identified. **Aim:** The aim is to establish a system for frequent interactions among key players emphasizing the needs, interests and contributions of women and men resulting in the utilization of improved food varieties and increased availability and consumption of micronutrient rich foods. **Strategy:** The interventions were to develop case studies of successful projects as advocacy tools; replicate successful projects; create information and resource sharing mechanisms; test diet diversification programs in selected districts; update curricula in training institutions to incorporate current issues in nutrition and gender; and create coordinating committees to guide implementation and learn from the interventions. **Results:** A forum has been established bringing together representatives from health, agriculture, local government, research institutions, universities and others for regular consensus building and information sharing. Roles for participating organizations, modalities and mechanisms for collaboration have been established. Composite plans of action to promote food based interventions have been developed at all levels. Lessons learnt from successful interventions have facilitated the application of best practices in food based projects in some districts. Advocacy programs have been put in place targeting politicians and policy makers. Gender analysis training has been provided for planners and implementers to facilitate gender mainstreaming and to educators for curriculum revision. Guidelines and behaviour change communication methods were developed for community based planning and action. Selected communities have adopted home and school gardens and demonstration farms to improve household access to micronutrient rich foods throughout the year. **Conclusion:** This project has demonstrated that integrated planning, information and resource sharing and strengthening of institutional bridges have a combined potential for successful large scale food based programs.

- M4 CONTENT AND IN VITRO ACCESSIBILITY OF BETA-CAROTENE IN COOKED GREEN LEAFY VEGETABLES FROM SRI LANKA.** UG Chandrika, U Svanberg and ER Jansz, Department of Biochemistry, Faculty of Medical Sciences, University of Sri Jayewardenepura, Sri Lanka and Department of Food Science, Chalmers University of Technology, Box 5401, SE-40229 Göteborg, Sweden.

Background: A recent national survey in Sri Lanka revealed that 36% of pre-school children have vitamin A deficiency (serum retinol $< 20\mu$ g/dl). Provitamin A carotenoids from green leafy vegetables provide most of the dietary vitamin A in Sri Lanka. **Aims:** To measure the content and *in vitro* accessibility of provitamin A in green leafy vegetables (GLV) prepared using traditional cooking methods in Sri Lanka. **Methods:** In the first study 4 types of GLV, katurumurunga (*Sesbania grandiflora*), mukunuwanna (*Alternanthera sessilis*), gotukola (*Centella asiatica*) and manioc (*Manihot esculenta*) were either cooked with scraped coconut (malluma) or fried with coconut oil. In the second study 3 types of GLV, sarana (*Triathema monogyna*), nivithi (*Spinacea oleracea*) and tampala (*Amaranthus caudatus*) were cooked with coconut milk or with water. The total β -carotene and *in vitro* accessibility of β -carotene were determined using HPLC. The *in vitro* method simulates the conditions in the human intestinal tract. **Results:** The all-trans- β -carotene content in fresh blanched GLV ranged from 149 μ g/g dry weight (DW) in leaves of mukunuwanna to 565 μ g/g DW in the tampala. Cooking of fresh leaves resulted in some losses of all-trans- β -carotene and retention ranging from 56 to 76% in the malluma and 27 to 73% in the fried preparation. Cooking with water or coconut milk resulted in retentions ranging from 36 to 88%. The *in vitro* accessibility of all-trans- β -carotene in cooked vegetables ranged from 14 to 43% in malluma, and from 12 to 36% in the fried preparation. In the GLV cooked with coconut milk the *in vitro* accessibility ranged from 12 to 26% compared with 4 to 8% when cooked with water. **Conclusions:** The β -carotene content, retention and *in vitro* accessibility varied widely between the different varieties of green leaves. The three types of traditional cooking procedures showed about the same retention. Preparations with oil, scraped coconut and coconut milk had improved *in vitro* β -carotene accessibility.

- M5** **DIETARY VITAMIN A INTAKE AND FACTORS INFLUENCING IT AMONG MICRONESIAN CHILDREN AND CARETAKERS.** L Englberger, GC Marks, MH Fitzgerald. University of Queensland, Brisbane, Australia, University of Sydney, Sydney, Australia.

Background: Understanding dietary vitamin A (VA) intake and factors influencing it is critical for dietary improvement programs to alleviate vitamin A deficiency (VAD). The 7-day Helen Keller International (HKI) food frequency questionnaire (FFQ) is widely used but assesses only child intake. **Aims:** To develop a tool to measure dietary intake in Kosrae, Micronesia; assess intake of dietary VA/related nutrients among children and caretakers; and investigate relationships between dietary intake and influencing factors. **Methods:** A study using two dietary assessment methods was carried out by trained interviewers among a random sample of Kosrae children/caretakers where a VAD problem had been identified. Ethnography was used to develop a modified FFQ tool; this was used to collect data on 267 children/267 caretakers. Selected foods were analyzed for VA/carotenoid content. A quantitative 24-hour recall for three non-consecutive days was administered among a sub-sample (65 children, 65 female caretakers). Banana/pandanus cultivars (yellow- versus white-fleshed) and maturity were specified. Data were analyzed using the Pacific database (adding foods and recipes) and SPSS. **Results:** Yellow-fleshed banana, taro, and pandanus cultivars were carotenoid-rich. Total VA intake was low. Protein intake was high. Fish liver was eaten more frequently among caretakers; *Taiwang* was the most commonly consumed carotenoid-rich banana, but caretakers revealed a belief that it causes worms. There were no statistically significant associations between VA intakes and gender, caretaker education, or socio-economic status. **Conclusions:** A broad-based intervention is needed to improve VA intake. Ethnography was critical for survey tool development, detecting caretaker-child differences, and perceptions on *Taiwang*. Specifying cultivars and maturity improved assessment. Aspects of this methodology may be relevant where similar foods, as yellow-fleshed banana, are eaten. (Acknowledgements: SIGHT AND LIFE, Thrasher Research Fund, Centers for Disease Control and Prevention for funding support.)

- M7** **SEASONAL AVAILABILITY OF LOCALLY PRODUCED BETA-CAROTENE-RICH VEGETABLES IN A RURAL SETTING IN SOUTH AFRICA.** M Faber, AJS Benadé. Nutritional Intervention Research Unit, Medical Research Council, Cape Town, South Africa.

Background: A home-garden project that was integrated with community-based growth monitoring, linked to nutritional education and focused on the production of dark-green leafy and yellow/orange-fleshed vegetables had a favourable effect on serum retinol concentrations, habitual intake of dark-green leafy and yellow/orange-fleshed vegetables, and maternal knowledge regarding vitamin A nutrition. This community (in KwaZulu-Natal province, South Africa) depends on local production for a continuous supply of beta-carotene-rich vegetables, as these vegetables are not available from the local shops. **Aim:** To determine the seasonal availability of beta-carotene-rich vegetables in this community. **Methods:** Planting, harvesting and frequency of dietary intake of beta-carotene-rich vegetables were recorded monthly by interviewing the caregivers of under 5-year-old children during 2003. **Results:** Availability of yellow/orange-fleshed vegetables was highest during the first quarter of the year, while availability of dark-green leafy vegetables was highest during the 3rd quarter of the year. For those months when a low intake was reported for a specific vegetable, unavailability of the vegetable was given as the main reason. **Conclusion:** Seasonality played a major role in the availability of locally produced beta-carotene-rich vegetables. This has implications for food diversification promotion campaigns, it highlights the importance for processing and post-harvest products, and strategies should be developed to overcome the periods of low availability. The initial study was carried out with the aid of a grant from Thrasher Research Fund and the assistance of the Agricultural Research Council-Roodeplaat, South Africa.

- M6** **MICRONESIAN CAROTENOID-RICH BANANAS AND OTHER FOODS: SUCCESSES AND LESSONS LEARNED FOR PREVENTING VITAMIN A DEFICIENCY.** L Englberger, GC Marks, MH Fitzgerald, E Johnson. University of Queensland, Brisbane, Australia, University of Sydney, Sydney, Australia, Pohnpei Department of Health, Kolonia, Micronesia.

Background: Locally grown, culturally acceptable foods rich in provitamin A carotenoids are important for a food-based vitamin A deficiency (VAD) prevention strategy. In Pohnpei, Micronesia, there is a serious problem of VAD, which is related to an increased consumption of rice and other imported foods, replacing traditional staple foods (breadfruit, banana, taro, pandanus). Agriculture and social conditions are still favorable for local food production. **Aims:** To identify and promote locally grown foods/cultivars with the potential to alleviate VAD and identify factors relating to a food-based VAD intervention. **Methods:** Ethnography was used to select foods potentially rich in provitamin A carotenoids and identify factors relating to a food-based intervention. Foods were analyzed for carotenoid content. An awareness campaign and horticulture were used to promote the local foods, focusing on carotenoid-rich Karat (a traditional weaning food that became rare due to neglect) and *Taiwang* (a common tasty banana, neglected due to an association with poverty and health/illness beliefs). **Results:** Carotenoid-rich banana, breadfruit, giant swamp taro, and pandanus cultivars were identified, all characterized by yellow flesh. Markets started selling Karat and *Taiwang* after the campaign (they were not sold previously). Local food cultivars vary by nutrient content; consumption level; cost, availability, status, convenience, transport, cooking, and organoleptic aspects. **Conclusions:** A systematic consideration of traditional foods, cultivar differences, their cultural context, nutrient content, and other factors are critical to a food-based VAD prevention strategy. Yellow-fleshed bananas eaten as staple foods show potential for VAD prevention strategies in the Pacific. Further research and program development are needed. Aspects of this approach may be valuable in developing VAD prevention strategies in other countries. (Acknowledgements: SIGHT AND LIFE, Secretariat of the Pacific Community, Australian Government)

- M8** **UPDATED BRAZILIAN DATABASE ON FOOD CAROTENOIDS.** DB Rodriguez-Amaya, M Kimura, and J Amaya-Farfan. Faculdade de Engenharia de Alimentos, Universidade Estadual de Campinas, Campinas, São Paulo, Brazil.

Background: A database on food carotenoids is needed as basic information for programs to alleviate vitamin A deficiency and promote overall health, epidemiological studies, dietary intake surveys, etc. It is also consulted by the food industry, consumers and public health workers. Brazil has a wide diversity of food sources of these important compounds. The extensive database on the carotenoid content of Brazilian foods is constantly augmented and updated. **Aim:** To give an updated version of the Brazilian database on food carotenoids. **Methods:** In a continuing effort to have a database that reflects the constantly changing and expanding Brazilian market, data on new products have been added to the database. Only analytical results based on at least three sample lots, obtained by reliable methods are included. Aside from the six carotenoids demonstrated to have beneficial effects on human health (β -carotene, α -carotene, β -cryptoxanthin, lycopene, lutein and zeaxanthin), violaxanthin was also included because it is the principal carotenoid of many foods and may be shown to have a role in human health in the future. **Results:** The updated database has 238 food items, comprising fruits (60), green vegetables (75), roots (16), fruit vegetables (25) and processed foods (62). Of these, only 33 are also found in the US database and 26 in the European database. The Brazilian database demonstrates variations due to variety, maturity, production technique, climate, type of processing and different brands. **Acknowledgment:** This study was financed by the Brazilian Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) through the Programa de Apoio a Núcleos de Excelência (PRONEX) project no. 66.2307/1996-8

- M9 CAROTENOIDS CONTENT IN TOTAL FRUIT (ACROCOMIA TOTAL, MART) BY LC-DAD-MS.** M. Pilar VAZQUEZ-TATO,* Julio A. SEIJAS,* M. Isabel MAGNE S.,*# and Erick ROJAS B.# *Organic Chemistry Department, Faculty of Sciences, SANTIAGO OF COMPOSTELA UNIVERSITY, P. O. Box 280, 27080, Lugo, Spain. #Research and Development Center of Food Technology, GABRIEL RENE MORENO UNIVERSITY, P. O. Box 2819, Santa Cruz, Bolivia.

Nowadays, there is an increasing interest on the incorporation of new plant species to human diet. Among these new alternatives the best candidates are those being part of traditional food.

Total fruit (*Acrocomia totai*, Mart) belongs to AREACEAE (PALMAE) family and is widely distributed in Amazonian region. This plant has attracted our attention by its potential use as Provitamins A supply, due to its yellow to orange pulp. This led us to study the carotenoids content of total fruit.

The detection of beta-carotene was realized by HPLC after extraction with organic solvents and/or further saponification. Two ripening levels in total fruit were considered: ripening and post-ripening. And their stability studied by addition of antioxidants at two temperatures: room and refrigerated temperature. The other carotenoids were studied in samples obtained by direct extraction (Sample A) or extraction-saponification (Sample B) using LC-DAD-MS(APCI).

Beta-carotene content (4.7 mg/100g), was quantified by HPLC in ripening total fruit using TBHQ, the better antioxidant for refrigerated conservation according to UV/Vis spectrophotometer analysis.

The identification of carotenoids showed 14 different compounds in sample A, 7 of them esterified with fatty acids. Sample B showed 9 carotenoids. All those structures are preliminary interpretations.

The carotenoids contained in total converts this fruit in a potential provitamin A supplement to fortify popular diets in developing countries where the plant is traditionally grown. This joined to its ethnobotanical use, will contribute to improve the human health.

- M10 KNOWLEDGE, ATTITUDES AND PRACTICES OF YELLOW MAIZE CONSUMPTION IN ZIMBABWE.** LC Malaba, T Muzhingi, M Banzinger and K Pixley, Division of Nutrition, University of Zimbabwe and CIMMYT Maize Research Station, Harare, Zimbabwe.

Vitamin A deficiency has now been established to be a public health problem in Zimbabwe and other Southern African states. The concurrent presence of high prevalence of HIV infection also exacerbates the problem. VAD does not only result in increased mortality and morbidity in vulnerable groups, it has also been found to be a high risk factor for mother to child HIV transmission. Vitamin A deficient women are four times more likely to transmit HIV to their foetuses and twenty times more likely to have HIV DNA in their breastmilk than their uninfected counterparts. This means that HIV infection and VAD together pose an irreparable threat to child survival in communities where they co-exist.

Strategies to prevent mother-to child HIV transmission should incorporate ways of minimising VAD. Among strategies to reduce VAD in Southern Africa, is the promotion of yellow maize consumption. While yellow maize is known to contain high levels of provitamin A carotenoids, it is, however, resisted as a staple food due to its traditional use as stockfeed. Other reasons have also been given for this resistance.

We are conducting a national survey to establish the different reasons why yellow maize meets the level of resistance it has in the population. Information is being collected on knowledge, attitudes and practices as regards yellow maize consumption and production in Zimbabwe. Alternative yellow maize-based products are also being identified. Preliminary results from a pilot study in one rural setting seem to suggest a gender difference in preferences. In both cases, however, attitudes shifted when the nutritional benefits of yellow maize were highlighted. This suggests that a communication strategy was indeed necessary to change attitudes favourably. The results of the main survey, which is currently in progress will be ready for presentation at the IVACG in November, 2004.

- M11 MOMORDICA POWDER AND OIL FROM GAC FRUIT, THE HIGHEST CONTENT IN BETA-CAROTENE, LYCOPENE AND VITAMIN E.** BM Duc, NC Khan, HA Dao, LH Dung, National Institute of Nutrition (NIN), LX Thanh, VT Trang, Institute of Biological and Food Technology Hanoi (HUT).

Background: Carotenoids including β -Carotene, Lycopene and Vitamin E play many roles in human health. They have been implicated for many biological processes as well as the role in disease prevention. *Gac* fruit (*Momordica Cochinchinensis*) is a very popular fruit vegetable in Vietnam, due to its perfect combination of natural red yellow colour and very high content of antioxidants β -carotene, lycopene and vitamin E. **Aims:** To determine nutrient contents and bioactive ingredients of dried red seed membrane (powder) and oil from the seed membrane. **Methods:** Fresh pulp and red seed membrane was detached and dried at 60-70°C until 6.7-7.5% of water content. *Gac* oil was obtained cold-pressed extraction. Nutrient contents and bioactive ingredients were analysed by AOAC method. **Results:** Dried red seed membrane was 7.36% in compared with whole fresh fruit. Nutrient contents (g per 100g): water 7.1, protein 9.0, carbohydrate 40.4, lipid 27.8, fiber 12.1 and ash 3.6. Micronutrient contents (mg per 100g): carotenoids 356; β carotene 26.5; α -tocopherol 490.5; γ -tocopherol 25.9; δ -tocopherol 12.6 and total tocopherol 529.0. Fatty acids composition: SFA, MUFA, PUFA are 32.42, 45.32 and 22.52% respectively. Antioxidative activity of carotenoids was 82% by thiocyanate method as compared with the standard. **Conclusion:** *Gac* powder and oil from fruit showed highest content in provitamin A, vitamin E and other micro nutrients for prevention deficiency of vitamin A. This fruit may be a good source for prevention and therapy of human cancer and HIV/AIDS. It is needed to establish international cooperation on expanse exploitation agriculture, analysis of bioactive substances, experiment on animal and human for the sustainable health and prevention of chronic diseases.

- M12 THE ISSUE OF VITAMIN A RICH-FOOD CONSUMPTION BY PRESCHOOL CHILDREN AND RELATED FACTORS IN RURAL AREA.** N Constance P (1), Z Noel Marie (2), B Inge (3) and T Alfred S (1). 1. Centre de Recherche en Sciences Biologiques, Alimentaires et Nutritionnelles CRSBAN) Unité de Formation et de Recherche en Sciences de la Vie et de la Terre, Université de Ouagadougou 03 BP 7021 Ouagadougou Burkina Faso; 2. Hellen Keller International, représentation au Niger, BP 11728 Niamey, Niger; 3. Division of Human Nutrition and Epidemiology Wageningen University, P.O. Box 8129 6700 EV Wageningen, The Netherlands.

Background: Vitamin A deficiency remains a public health problem in Burkina Faso. Dietary diversification might be a promising strategy to prevent and control vitamin A deficiency. However so little interest is put on it to explore the real potential of food based approaches. **Aim:** The objective of the study was to understand the issue of vitamin A-rich foods availability and consumption at household level by children 6 months to 3 years old. **Methods:** Two cross-sectional studies were conducted on wet season and dry season. They included 36 mother-child pairs. Data were collected through market survey, interviews and observation of food practices. Food consumption pattern was investigated through 24 hours recall method and food frequency questionnaire. Food attributes and food quality were assessed through key informant interview, pile sorting and focus group discussion. **Results:** We identified and selected 3 animal sources of vitamin A, 3 sources of yellow orange fruit and 11 sources of green leafy vegetable. The general picture of the food consumption patterns is a monotonous cereal-based diet. Only 10% of children consumed animal source of vitamin A once week. The consumption of green leafy vegetables was an average four times a week. Vitamin A-rich food's consumption was affected by lack of information and food habits. For instance, mangoes were consumed only 3 times a week despite their availability, accessibility and affordability from March to June. Food attribute, and perception of food quality, were a strong constraining factor to the consumption of mango and valuable pro vitamin-A rich vegetables such as amaranths leaves and *Moringa oleifera* leaves. **Conclusion:** The study showed that pro vitamin A rich foods' consumption by children was limited by social practices, economical constrains and food habits. Taking into account these cultural barriers to develop and implement food based approaches may result in a behavioral and food consumption pattern change.

- M13 EFFECT OF BAOBAB LEAF (*ADANSONIA DIGITATA* L.) DIET ON VITAMIN A AND IRON STATUS OF NIGERIAN CHILDREN.** *NM Nnam.* Department of Home Science and Nutrition, University of Nigeria, Nsukka.

Background: Vitamin A deficiency (VAD) and iron deficiency anemia (IDA) are severe public health problems in Nigeria, in spite of a wide variety of traditional food plants rich in micronutrients. There is need to tap the potentials of under exploited plant foods in the dietary diversification strategies to controlling malnutrition in Nigeria. Baobab leaf is rich in multiplicity of micronutrients, which interact with each other for their effective utilization (156.5µg/g, β-carotene). **Aim:** To determine the efficacy of a diet containing baobab leaf powder (BLP) in improving the vit. A and iron status of school children in Nigeria. **Methods:** One hundred and sixty children, randomly selected from a rural community primary school in Nsukka were dewormed and divided into test group (TG) and control group (CG) (n = 80). The TG was fed diet containing 50g BLP for 6 weeks. Serum retinol (SR) and β-carotene (BC), haemoglobin (HB), and serum ferritin (SF) levels of the subjects were determined before and after the dietary intervention. **Results:** The proportion of children with SR levels below 20µg/dl fell significantly from 21.25% to 10.0% in the TG, and their serum BC increased from 6.8µg/dl to 14.1µg/dl. The CG had no change in SR and serum BC levels. For children with HB<11.0g/dl there was a significantly higher rise of Hb in the TG compared to the CG. SF level increased 19µg/dl in the TG, with no increase in the CG. **Conclusion:** BLP improved vit. A and iron status of children in Nigeria. The leaf is readily available, inexpensive and rich in many micronutrients. Nutrition communication should be intensified for its increased rate of consumption to control micronutrient deficiency.

- M15 DELIVERY OF POSTPRANDIAL RETINOL FOR INCORPORATION INTO MILK IN WILD TYPE AND RETINOL-BINDING PROTEIN KNOCKOUT MICE (RBP-/-).** *Sheila M. O'Byrne,* Loredana Quadro, Debra J. Wolgemuth, Angela Christiano, Ira J. Goldberg and William S. Blaner. Institute of Human Nutrition, College of Physicians & Surgeons, Columbia University, New York.

Background: Breast feeding is the most important source of vitamin A for the developing infant. Vitamin A arrives in the milk from 2 sources: from hepatic stores bound to retinol-binding protein (RBP) and via chylomicrons which circulate in postprandial blood. Mouse models offer unique possibilities to study these mechanisms that are not possible in humans. **Aims:** To study the contribution of postprandial vitamin A to milk formation. **Methods:** Milk levels from wild type & mice lacking RBP were analyzed for lactating female mice placed on diets that provided either normal, excessive or no vitamin A. Additionally, labeled vitamin A was then given orally to the lactating mice and the time course of its incorporation into milk was followed. At weaning, pups were sacrificed & histological analysis performed to establish the effects of milk vitamin A levels of tissue health. **Results:** No difference in milk vitamin A levels was found between the groups receiving the control diet indicating that postprandial vitamin A is sufficient to allow for normal vitamin A incorporation into milk. Our data further indicate that the factors regulating vitamin A incorporation into milk reside within mammary tissue. For lactating wild type & RBP-deficient mice placed on either excess or deficient vitamin A diets, the diet of the mother had a very marked physiological impact on skin & testes development of the pups compared to the regular diet. **Conclusion:** Our studies indicate that mammary tissue is able to increase uptake of vitamin A from the circulation when it senses vitamin A deficiency. Moreover, mammary tissue is capable of taking up very higher concentrations of vitamin A when it is available in the postprandial circulation and it appears to have no mechanism to set an upper limit of vitamin A incorporated into milk. This can result in adverse physiological consequences for the postnatal development of the skin, testes & possibly other tissues.

- M14 SORREL (*HIBISCUS SABDARIFFA*) CALYX AS A PROMISING SOURCE OF BETA-CAROTENE TO CONTROL VITAMIN A DEFICIENCY.** *NM Nnam,* NG Onyke. Department of Home Science and Nutrition, University of Nigeria, Nsukka.

Background: Vitamin A deficiency (VAD) rates in children are higher than 16% in some regions of Nigeria especially in rural communities. If no effective action is taken to prevent and control VAD, over 300,000 Nigerian children will die between now and the year 2010 as a result of current VAD rates. **Aim:** To determine the β-carotene level of sorrel calyx, a locally available natural vegetable in Nsukka rural communities, and use the calyx as a dietary intervention strategy to control VAD in school children. **Methods:** Fresh sorrel calyces were harvested, cleaned and solar dried. The calyces were milled into fine flour and analyzed chemically for β-carotene, iron, zinc and ascorbate. One hundred and twenty school children in Nsukka rural community primary school, 5-10 years were the target subjects selected to test the effectiveness of sorrel calyx for its adequacy in vitamin A. The children were randomly selected and divided into test and control groups. During a 4-week dietary intervention, the test group was fed diet that provided 2.9 mg β-carotene daily based on sorrel calyx. The subjects had both physical and clinical examinations (eye lesion, serum retinol and haemoglobin (Hb) levels) before and after the dietary intervention. This served as base line data. **Results:** The sorrel calyx had high retinol (285.29 RE), iron (833.00 mg/100g) and ascorbate (53.00mg/100g). The test subjects had higher Hb and serum retinol levels and no VAD symptoms as against the control. **Conclusion:** Sorrel calyx is a good natural source of β-carotene, iron and ascorbate. It is locally available in Nsukka rural communities, however nutrition education is imperative for its increased rate of consumption and incorporation into the traditional diets.

- M16 USING SPIRULINA PLATENSIS TO REDUCE VITAMIN A DEFICIENCY IN MALAGASY CHILDREN.** *B Razafiarisoa,* E Ramaroson, D Ramampihirika. National Research Center for Environment and Halieutic and Sea Sciences Institute, Madagascar.

Background: Vitamin A Deficiency (VAD) is a significant problem in Madagascar. The prevalence of children less than six years old which had serum retinol values below 0.70 µmoles/l were 42% by 2000. Dietary interventions were planned for eliminating VAD. **Aims:** To use *Spirulina platensis* to reduce VAD in Malagasy children. **Methods:** A randomized study was conducted during 21 days. It concerned 90 under weighted children aged 4 to 5 years old. They were divided in three groups: (1) those who were given 200 000 UI of vitamin A (a control group), (2) those who were intaked daily fortified food with vitamin A (pumpy sauce), (3) those who were consumed daily *Spirulina platensis* in the diet. Dietary history (24-hours recall) was obtained. Serum retinol concentrations were determined by HPLC at the first and the last day. Anthropometrics index (Height and Weight) were measured every week. **Results:** Diets indicated a low consumption of animal proteins, fats and vitamin A. On the first day, the serum retinol levels of all children were "low": (1) 0.43 ± 0.04 µmoles/l, (2) 0.41 ± 0.05 µmoles/l, (3) 0.44 ± 0.06 µmoles/l. It was raised in each group 21 days later: (1): +10.68%; (2): +10.4%; (3): +12.71%. In addition, the prevalence of underweight (Weight/Age) had declined of 10.5% and the wasting had disappeared after 7 days only for the third group; the difference was statistically significant. According to these observations, *Spirulina platensis* reduces both Protein-Energy malnutrition (PEM) and Vitamin A Deficiency (VAD). **Conclusion:** *Spirulina platensis* is a food with high nutritive value. It can be used in a dietary intervention to reduce both PEM and VAD.

M17 THE ADEQUACY OF VITAMIN A INTAKE IN THE DIET OF NEPALESE WOMEN AND CHILDREN IN THE ANNARPURNA DISTRICT OF NEPAL. AJ Rigby, RK Shrestha. Stanford University School of Medicine, Palo Alto, California and Nepal Technical Assistance Group, Kathmandu, Nepal.

Nepalese women and their offspring have been shown to be at risk for several nutritional deficiencies. The National Vitamin A Program (NVAP) has been established to meet the need for supplementation of vitamin A to virtually all areas in Nepal. The objective of our study was to determine the intake of key micronutrients, including vitamin A from foods and supplemental sources in the diets of mothers and children <5 years living in the villages of the Annapurna mountain region. 15 mothers were randomly selected and interviewed about their nutritional intake and also of their children (n=24). Dietary sources of vitamin A were assessed for frequency within the diet. The age at which solid food was commenced and breast-feeding stopped were also factors in determining the adequacy of vitamin A intake in the young children's diets. Mid-arm muscle circumference was measured to identify risk of malnutrition in the cohort. Salt samples were measured for iodine content from 17 households. The mean duration of breast-feeding in this group was 6-7 months. The frequency of intake of green or orange fruit or vegetables ranged from none to 7 times/week and over half of the children were consuming liver. The majority of mothers were aware of the NVAP and vitamin A pills being distributed twice per year. The mean mid-arm muscle circumferences of the children were within normal range. All salt samples tested had adequate amounts of iodine (>30 ppm) to prevent iodine deficiency. The study showed that the diets of Nepalese women and their children were acceptable in this region. Our data concurs that the national vitamin A supplementation program and iodized salt promotion are making a huge impact on the health status of Nepalese children. This regional study allowed us to gain further insight into channels for nutrition education for this population.

M19 CHALLENGES FACING FOOD BASED INTERVENTIONS IN ADDRESSING VITAMIN A DEFICIENCY AND POSSIBLE SOLUTIONS. G. Mulokozi, B Österlind and U Svanberg. Tanzania Food and Nutrition Centre, Dar es Salaam, Tanzania. Department of Food Science, Chalmers University of Technology, Göteborg, Sweden.

Background: Vitamin A deficiency (VAD) afflicts people living in developing countries who derive most of their vitamin A from plant foods. The basic cause of VAD is attributed to diets containing little preformed vitamin A and plant foods with low content and bioavailability of provitamin A carotenoids. **Aim:** To assess the adequacy of preformed vitamin A and provitamin A carotenoids in foods consumed by young children, to establish the causes of low dietary intake of provitamin A carotenoids from plant foods and to suggest possible solutions with different varieties of yellow/orange fruits and orange-fleshed sweet potato subjected to optimal post-harvest handling and preparation methods. **Methods:** Food frequency questionnaire was used to assess the adequacy of preformed vitamin A and provitamin A carotenoids in foods consumed by preschool children in rural communities; information on acceptability of provitamin A-rich foods by children were obtained by interviewing mothers or care-takers; content and in vitro accessible provitamin A carotenoids in preparations of fruits and orange-fleshed sweet potatoes were quantified by HPLC method. **Results:** Provitamin A carotenoids constitute the main dietary source of vitamin A in studied communities. The colour and taste enhanced the preference of provitamin A carotenoid containing food by young children. There were significant variability in the content of all-trans- β -carotene and accessibility in yellow/orange fruits and orange-fleshed sweet potato prepared using different methods. Post-harvest handling and processing methods had major effect on retentions and in vitro accessibility of β -carotene content in processed products. **Conclusions:** Food intervention strategies have the potential of addressing vitamin A deficiency if food varieties with high content and accessible provitamin A carotenoids are consumed regularly and preparation methods that enhance the accessibility and bioavailability of provitamin A carotenoids are promoted.

M18 VARIETAL DIFFERENCES IN THE CAROTENOID COMPOSITION OF SQUASHES AND PUMPKIN AND RETENTION DURING DEHYDRATION. CC Garcia*, M Kimura*, MA Mauro*, CH Azevedo-Meleiro**, and DB Rodriguez-Amaya*. * UNESP-Universidade Estadual Paulista, São José do Rio Preto, São Paulo, Brazil; ** UNICAMP-Universidade Estadual de Campinas, Campinas, São Paulo, Brazil.

Background: Programs to alleviate vitamin A deficiency and to reduce risk for degenerative diseases must consider the inclusion of squashes and pumpkin among foods to be promoted. These vegetables are widely available around the world, are easy to produce, keep for months when stored intact at ambient temperature and have good acceptability. The carotenoid composition, however, varies markedly among the different varieties. For longer storage and to facilitate transport, dehydration can be carried out. **Aims:** To determine the carotenoid composition of five varieties of squashes and pumpkins and evaluate retention in dehydrated squash. **Methods:** The carotenoid composition was determined by HPLC. Due its high provitamin A content, *C. moschata* cv. "Menina Verde" was chosen as raw material for drying. Slices of 5 mm thickness were dehydrated in an airflow drier at 50 C for six hours. **Results:** Marked qualitative and quantitative differences in the carotenoid composition were observed in the varieties studied. *C. moschata* cv. "Menina Verde" and *C. moschata* cv. "Goianinha" had similar profile with β -carotene predominating (67 and 57 $\mu\text{g/g}$, respectively) followed by α -carotene (27 and 24 $\mu\text{g/g}$). The hybrid "Tetsukabuto", resembled the *C. pepo* cv. "Mogango", lutein (57 and 10 $\mu\text{g/g}$) and β -carotene (30 and 5 $\mu\text{g/g}$) were the principal carotenoids. *C. maxima* "Exposição" had the most different profile, with the predominance of violaxanthin (21 $\mu\text{g/g}$), followed by β -carotene (15 $\mu\text{g/g}$). Retention of α -carotene and β -carotene were 76% and 79%, respectively, the concentrations of these carotenoids in the dehydrated product being 307 $\mu\text{g/g}$ and 746 $\mu\text{g/g}$, respectively. **Conclusions:** The *C. moschata* cv. "Menina Verde" had the highest provitamin content among the five most commercialized Brazilian squashes and pumpkins. Drying this variety resulted in good retention of the carotenoids. **Acknowledgment:** This study was financed by the Brazilian Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) through the PRONEX project no. 66.2307/1996-8.

M20 CAROTENOID COMPOSITION OF PROCESSED CARROTS COMMERCIALIZED IN BRAZIL. N Tawata, and M Kimura. Depto. Engenharia e Tecnologia de Alimentos, UNESP, São José do Rio Preto, São Paulo, Brasil.

Background: The carrot, widely recognized as a good source of provitamin A carotenoids, has already been studied in Brazil, raw and cooked. Processed carrots, however, has not been investigated. Due to the increased commercialization and consumption of processed foods in Brazil, processed carrots need to be studied. **Aim:** To determine the carotenoid composition of frozen and canned carrots available in the Brazilian market. **Methods:** Three different lots of each product, each lot comprising three packages of frozen baby carrots (two brands), canned baby carrots (one brand), minimally processed baby carrots (two brands), frozen carrot cubes (one brand) and canned carrot cubes, purchased at supermarkets in São Paulo and Campinas, Brazil, were analyzed by HPLC, using monomeric C18, 3 μm , 4,6 x 150 mm column and acetonitrile:methanol:ethyl acetate (60:20:20) as mobile phase. **Results:** No significant differences were observed within the brands. The mean contents ($\mu\text{g}/100\text{g}$) of lutein, α -carotene e β -carotene were, respectively, 480, 3028 and 7724 for frozen baby carrots; 565, 3022 and 5596 for canned baby carrots; 248, 5200 and 5787 for minimally processed baby carrots; 543, 3641 and 4986 for frozen carrots cubes; and 543, 3164 and 6091 for canned carrots cubes. Although variations in carotenoid composition would be expected from varietal differences and processing effects, the qualitative and quantitative profiles were similar to reported data for similar products, except minimally processed carrot that had levels of α -carotene equivalent to β -carotene. **Conclusion:** The results demonstrated that carrots are good source of provitamin A even after commercial processing. **Acknowledgment:** This study was financed by the Brazilian Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) through the PRONEX project no. 66.2307/1996-8.

M21 A RED PALM OIL-BASED BREAD SPREAD TO ALLEVIATE VITAMIN A DEFICIENCY IN PRIMARY SCHOOL CHILDREN. ME van Stuijvenberg, DeW Marais, P Wolmarans, S Schoeman, AJS Benadé. Nutritional Intervention Research Unit, Medical Research Council, Cape Town, South Africa.

Background: School feeding offers an excellent opportunity for addressing micronutrient deficiencies in primary school children. Bread and peanut butter are food items widely used in school feeding in South Africa. Peanut butter, although a good source of energy and protein, is not a good source of micronutrients. In addition, it carries the risk of being contaminated with aflatoxin. **Objective:** The aim of this study was to develop a micronutrient fortified bread spread, using red palm oil fat as a base, that can be used as an alternative for peanut butter in school feeding, and to evaluate this spread against peanut butter in a randomised controlled trial. **Design:** Primary school children (n=375), aged 6-11 years from a poor rural community were randomly assigned to one of three treatment categories, each receiving respectively on their bread: (i) peanut butter (PB; n=125); (ii) red palm oil-based spread (RP; n=125); and (iii) red palm oil-based spread fortified with iron, zinc, selenium and vitamin C (RPF; n=125). Each child received one slice of bread with 15 g of spread or peanut butter per school day. The red palm oil-based spread supplied 2.3 mg β -carotene. Sandwiches were distributed under close supervision, and compliance monitored and recorded daily. Blood was collected before and after 7 months of intervention and analysed for serum retinol, serum ferritin, and haemoglobin. **Results:** There was a significant improvement in serum retinol compared to PB in both the RP and RPF groups ($P < 0.05$), with the response being greater in children with initial low serum retinol concentrations. Haemoglobin improved in the children that were anaemic at baseline in both the RP and RPF groups, though the improvement was greater in the RPF group. **Conclusion:** This study showed the red palm oil-based spread to be effective in improving vitamin A status, especially in children with inadequate vitamin A status, and haemoglobin status in anaemic children. This spread can be used as a micronutrient-rich alternative for peanut butter in school feeding, and does not carry the risk of being contaminated with aflatoxin.

M22 MOVING WITH RED PALM OIL TOWARDS DIETARY DIVERSIFICATION STRATEGY FOR CONTROLLING VITAMIN A DEFICIENCY IN BURKINA FASO. NM Zagré, H Delisle, F Delpuech and P Traissac. Helen Keller International, Niamey, Niger; Department of Nutrition, University of Montreal, Canada; UR 106, Institut de Recherche pour le Développement, Montpellier, France.

Background: Controlled trials have demonstrated RPO efficacy, and dietary diversification projects were effective in different settings. In Burkina, a 2 year pilot project was effective to introduce RPO in villages, increase children VA intake from 164 ± 30 to 514 ± 144 μg RAE/d and reduce low serum retinol from 84.5 to 66.9%. Thus, we are suggesting a plan for a progressive move towards a dietary diversification strategy. **Objective:** To select the best sources of VA for children and on that basis develop a combined strategy including RPO and others foods, supplementation and food fortification. **Methods:** We carried out focus groups, market surveys, garden and agricultural surveys, to establish a list and a calendar of VA food sources available in the area. Usual portion size, VA content and carotene bio-efficacy of these foods were used to define a VA score, and then to select the best VA food sources for inclusion in a yearly schedule for VAD control. The national action plan for nutrition was taken into account. **Results:** Out of 26 food sources of VA, the top 8 with respect to their VA score were: liver, RPO, whole milk, eggs, mango fruit, néré fruit (*Parkia biglobosa*), orange sweet potatoes and green-leaf sauces. Then, a progressive 3-step strategy was suggested. Step 1: Promotion and consumption of the 8 selected foods according to seasonal availability, and VA supplementation once a year; step 2: VA capsules of step 1 are replaced by fortified foods; and step 3: a global dietary diversification with a strong and reliable food system. RPO is the key food in this plan and as such, needs support for its production, distribution and promotion. **Conclusion:** Achieving the recommendations to combine VA supplementation with dietary approaches against VAD is a challenge but appears to be essential for the long term control of VAD.

M23 POTENTIAL CONTRIBUTION OF MANGOES TO VA INTAKE IN RURAL BURKINA FASO. NM Zagré, IT Somé, and A Ouattara. Helen Keller International, Niger Office: UFR Health Sciences, University of Ouagadougou, Burkina; Faso; CRSBAN/UFR-SVT, University of Ouagadougou, Burkina Faso.

Background: Previous studies showed a mean daily vitamin A intake of 164 ± 15 μg RAE for young children, mainly provided by dark green leafy vegetables (DGLV) for 43% in rural Burkina. Mangoes are largely produced in Burkina and its β -carotene has better bioavailability than that of DGLV. Unfortunately, they are not yet properly used for VA in Burkina. **Objective:** i) to measure changes in β -carotene content of 2 varieties of mangoes (Amélie and Brooks) after drying and after 6 months storage of dried mangoes, ii) to analyze the possible contribution of mangoes to VA intake in young children. **Methods:** Two samples of 200 g ripened and half ripened fresh mangoes were collected from a drying unit, just before drying in a gas oven. Two other samples of 200 g each were also collected from the same lots, immediately after drying. One of them was immediately stored at -32 C until HPLC analysis, the second was kept during 6 months at room conditions before analysis. Carotenoid content was expressed as μg β -carotene per crude material. Usual portion size of ripened fresh mango for children and mothers' opinion on how to increase consumption of mangoes were obtained through focus group. **Results:** β -carotene content of Amélie and Brooks's varieties were respectively 12.6 ± 0.9 and 12.9 ± 2.2 $\mu\text{g/g}$ for ripened fresh, 6.9 ± 0.7 and 9.3 ± 1.1 $\mu\text{g/g}$ for half-ripened fresh. Content of half ripened dried was 16.8 ± 2.1 and 15.8 ± 3.8 $\mu\text{g/g}$ but decreased to respectively 11.2 ± 2.1 and 9.5 ± 5.1 $\mu\text{g/g}$ after storage. Usual portion size of ripened fresh mango for children was 123 ± 2.4 g, providing a daily intake of around 1600 μg β -carotene (133 μg RAE). Mothers declared children appreciate mango fruits, and suggested to powder dried mangoes to fortify complementary food. They suggested social mobilization for mangoes tree plantation, on the basis of 'One household, one mango tree'. **Conclusion:** Mangoes fruit are well appreciated by children. Along with red palm oil and other VA rich local foods, mangoes might better contribute to children VA intake in Burkina.

M24 VITAMIN A EQUIVALENCY OF β -CAROTENE IN OIL IN HEALTHY DUTCH ADULTS MEASURED USING SPECIFICALLY ^{13}C -LABELLED β -CAROTENE AND RETINOL. CA Bouwman, CE West, RB van Breemen, D Zhu, M van Lieshout, E Siebelink, P Versloot, and AHJ Naber. Department of Gastroenterology, University Medical Centre Nijmegen, Netherlands; Department of Human Nutrition, Wageningen University, Netherlands; Department of Medicinal Chemistry and Pharmacognosy, University of Illinois at Chicago, USA; and Department of Nutrition, North-West University, South Africa

Background: Quantitative data on the absorption and the bioconversion of β -carotene to retinol in humans in different diets is needed. **Aim:** To quantify the vitamin A equivalency of β -carotene in oil using the plateau isotopic enrichment (PIE) technique. **Design:** This study was a cross-over randomized controlled dietary intervention with 2 treatments (oil and mixed diet). Healthy Dutch adults ($n=24$) consumed for 21 days a diet containing vegetables and fruit low in β -carotene with added synthetic β -carotene (4,535 $\mu\text{g}/\text{d}$). During the other 21-day-period, volunteers consumed a diet containing vegetables and fruit high in β -carotene. Every day capsules were consumed with the cooked meal containing 55 μg [$^{13}\text{C}_{10}$] β -carotene and 55 μg [$^{13}\text{C}_{10}$]retinyl palmitate. The PIE technique is based on reaching a plateau of isotopic enrichment during prolonged intake of multiple low doses of labelled β -carotene and retinol, where the level of the plateau depends on the concurrent increase of the body pool of unlabelled β -carotene and retinol. Fasting blood samples were taken and faeces was collected for 72 hours to measure the degree of isotopic enrichment of β -carotene with [$^{13}\text{C}_{10}$] β -carotene and of retinol with [$^{13}\text{C}_9$]retinol and [$^{13}\text{C}_{10}$]retinol using HPLC coupled with APCI LC-MS. The dose-corrected ratio of [$^{13}\text{C}_9$] to [$^{13}\text{C}_{10}$]retinol was used to estimate the vitamin A equivalency of β -carotene in oil. Concentrations of carotenoids and retinol were measured in serum, faeces, vegetables and duplicate diets by HPLC. **Results:** 3.2 μg (95% CI 2.7-3.7) β -carotene in oil has the same vitamin A activity as 1 μg retinol. The bioefficacy of β -carotene in oil is 30%. Results obtained when using data from faeces or the other diet are not yet reported. **Conclusion:** These findings in healthy Dutch adults are in line with previous studies using similar and different techniques and population groups. These data can be used to revise the current recommendations of vitamin A activity of β -carotene in oil.

M26 DAILY CONSUMPTION OF INDIAN SPINACH (BASELLA ALBA) OR SWEET POTATOES HAS A POSITIVE IMPACT ON TOTAL BODY VITAMIN A POOL SIZE IN BANGLADESHI MEN. MJ Haskell, KM Jamil, F Hassan, JM Peerson, MI Hossain, GJ Fuchs, KH Brown. Program in International Nutrition and Dept. of Nutrition, University of California Davis, Davis, CA; Centre for Health and Population Research (ICDDR,B), Dhaka, Bangladesh.

Background: Recent evidence suggests that the vitamin A equivalency of β -carotene from plant sources is lower than previously estimated. The efficacy of plant sources of vitamin A for improving vitamin A status in populations at risk of deficiency should be investigated using a variety of methodologic approaches. **Aim:** To assess the effect of supplementation with 750 μg RE/d (RE= 1 μg retinol or 6 μg β -carotene) for 60 days as cooked, puréed sweet potatoes; cooked, puréed Indian spinach, or synthetic sources of vitamin A or β -carotene on total body vitamin A pool size in Bangladeshi men with low initial plasma retinol concentrations. **Methods:** Total body vitamin A pool size of Bangladeshi men ($n=14/\text{group}$) was estimated using the deuterated retinol dilution technique before and after 60 days of supplementation with either 0 μg RE/d (white vegetables), or 750 μg RE/d as sweet potatoes, Indian spinach, retinyl palmitate, or β -carotene in addition to a low vitamin A diet providing ~200 μg RE/d. The mean changes in vitamin A pool size (final minus initial pool size) in the vegetable and β -carotene groups were compared with that in the retinyl palmitate group to estimate the relative equivalency of these sources of vitamin A. **Results:** The overall mean (geometric mean \pm SD) initial vitamin A pool size was 0.108 ± 0.067 mmol and did not differ by study group. Relative to the low-vitamin A control group, the estimated mean changes in vitamin A pool size were 0.029 mmol for sweet potato, ($p=0.21$), 0.041 mmol for Indian spinach, ($p=0.033$), 0.065 mmol for retinyl palmitate, ($p<0.001$), and 0.062 mmol for β -carotene ($p<0.002$). Vitamin A equivalency factors (β -carotene:retinol, w:w) were estimated as 13.4:1 for sweet potato, 9.5:1 for Indian spinach, and 6.3:1 for synthetic β -carotene. **Conclusion:** These data suggest that daily consumption of cooked, puréed green leafy vegetables or sweet potatoes has a positive impact on vitamin A pool size in populations at risk of vitamin A deficiency.

M25 HUMAN CAROTENOID METABOLISM ASSESSED WITH RADIOISOTOPE TECHNIQUES. BJ Burri (1), AJ Clifford (2). 1. Western Human Nutrition Research Center and University of California, Davis, Davis, California, USA; 2. University of California, Davis, Davis, California, USA.

Recently we used radioisotopes as tracers to assess β -carotene absorption and metabolism in healthy human adults. We use Accelerator Mass Spectrometry (AMS) that measures $^{14}\text{C}/^{12}\text{C}$ ratios to parts per quadrillion (10-15) in milligram-sized samples to quantify the absorption and metabolism of small oral doses of ^{14}C - β -carotene in humans. There are two advantages of radioisotope over the more common stable isotope assessment methods. First, it is much easier to discover, identify, and quantitate carotenoid metabolites, such as retinyl esters. Second, lower concentrations of β -carotene can be fed and traced. When β -carotene is absorbed into the blood, it first appears in 5.5 h and peaks 16 to 24 h after the oral dose. The concentration profile for labeled retinyl esters is different than for retinol, and shows two rapid maxima at 4 and 6 h. The amount of β -carotene absorbed can be quite variable, but part of the variability previously reported is due to the fact that retinyl esters formed from β -carotene appear in serum at the same time as β -carotene itself appears, and these retinyl esters were very difficult to identify and measure prior to the advent of radioisotope tracers. Most carotenoids are excreted in the feces but small amounts appear in urine. Patterns of the ^{14}C in plasma from an oral dose of ^{14}C - β -carotene provided to the same subject in a bolus dose with oil, and without oil, differ. In the absence of fat, the first retinyl ester peak is very small, while the second is unaffected. The appearance of the ^{14}C - β -carotene plasma peak is also much smaller in the absence of fat.

- M27 CAROTENOID CONTENT OF TEN VARIETIES OF ORANGE-FLESHED SWEET POTATOES PROMOTED IN BURKINA FASO.** M Ag Bendeck, IT Somé, O Vebamba, A Tarini, SK Baker and NM Zagré. Helen Keller International (MAB, OV,AT, SKB and NMZ), University of Ouagadougou (ITS).

Vitamin A deficiency (VAD) is a major public health problem in developing countries, especially in Burkina Faso where 40% of the population is under poverty line. In the framework of a UNICEF-HKI gardening project promoting the consumption of foods containing provitamin A carotenoids in Burkina Faso, ten varieties of orange-fleshed sweet potatoes have been evaluated for their carotenoid content.

A fully validated reversed phase (RP 18) HPLC method was used for assessing carotenoid content of the orange-fleshed sweet potatoes. Zeaxanthine (ZEA), lycopene (LYCO), α -carotene (ACAR) and β -carotene (BCAR) were analyzed. Echinenone (ECHI) was used as an internal standard during the extraction procedure.

The analysis of orange-fleshed sweet potato varieties show that the *Jewel*, *Narumintang*, *Caromex Niger* and *taining* had the highest β -carotene content with respectively 1,911 μ g/100 g, 2,348 μ g/100 g, 2,046 μ g/100 g and 774 μ g/100g. In all these varieties, β -carotene represented more than 80% of all provitamin A carotenoids. The *Jewel*, and *Narumintang* were the most concentrated and homogenous in their carotenoid content. Other sweet potato varieties (*Kolokohogo BF*, *Lantaogo 2* and *Ming Shu Niger*) appeared to contain only carbohydrates and little if any carotenoids.

The high β -carotene content of the *Jewel* variety combined with its good cultural output make it the best variety to promote for production and consumption in Burkina Faso.

- M28 VITAMIN A PARTNERSHIP FOR AFRICA: A FOOD BASED APPROACH TO COMBAT VITAMIN A DEFICIENCY THROUGH INCREASED UTILIZATION OF ORANGE-FLESHED SWEETPOTATO.** R Kapinga, P Anderson, D Zhang, M Herman, F Opio. International Potato Center Peru, USDA- ARC-BARC-BSI, 10300, USA and Namulonge Agricultural and Animal Research Institute, Uganda.

Vitamin A for Africa (VITAA) partnership is the first food-based initiative to attack the tragic consequences of Vitamin A deficiency in sub Saharan Africa was launched on May, 9, 2001. VITAA's major objective is to promote high beta carotene sweetpotato as food based approach to address Vitamin A deficiency among children and mothers. Initial countries include: Ethiopia, Tanzania, Kenya, Uganda, South Africa, Ghana and Mozambique. The aim is to make orange-fleshed sweetpotato available on a large-scale, demonstrating the potential of crop-based approaches in alleviating micro-nutrient deficiency. Ex -ante impact assessments indicated that replacing the popular white-yellow fleshed sweetpotato varieties grown by farmers with new high-beta carotene cultivars that meet local preferences would benefit an estimated 50 million children under age of six who are currently at risk. VITAA recognizes orange-fleshed sweet potatoes as a promising solution to Vitamin A deficiency in Eastern and Southern Africa not just because they're rich in beta-carotene, but because they're easy to grow and affordable to the average consumer. VITAA consists of a coordinated set of activities building upon the experiences of successful pilot projects in Kenya, Uganda, South Africa and Mozambique, and promotes wider scale production and use of orange-fleshed sweetpotato, along with other micronutrient-rich foods including yellow cassava and mineral-rich beans. The partnership targets young children and their mothers, who are the most vulnerable to Vitamin A deficiency. We have learnt that adoption is higher if the orange-fleshed sweetpotato find ready markets, both as fresh roots and vines and as processed foods that add value. Researchers at ICRW have concluded that adding as little as 100 grams of orange sweet potato to the daily diet could eliminate or significantly reduce vitamin A deficiency in children and their mothers. These have been confirmed by a major bio-efficacy study from South Africa's Medical Research Council. Initiatives by VITAA links well with the global challenge program on bio-fortification (Harvest Plus) which is working to fortify major developing country staples, such as beans, cassava, maize, rice, wheat, and sweet potato. Key words: Food-based approaches, orange-fleshed sweetpotato, VITAA

- M29 BETA-CAROTENE CONTENT OF SUN-DRIED AND OVEN-DRIED CHIPS OF ORANGE-FLESHED SWEETPOTATO.** PJ van Jaarsveld, De Wet Marais, E Harmse, SM Laurie, P Nestel and DB Rodriguez-Amaya. Nutritional Intervention Research Unit, Medical Research Council, Parow, South Africa; Agricultural Research Council, Roodeplaat, South Africa; Harvest Plus, IFPRI, Washington, DC and Depto. de Ciência de Alimentos, Universidade Estadual de Campinas, Brasil.

Background: Fresh sweetpotato roots are bulky and perishable. Transport and storage can be facilitated and the shelf life extended by processing the roots into dried chips. As part of the VITAA Partnership (Vitamin A for Africa), the effect of sun-drying and oven-drying on the β -carotene content of orange-fleshed sweetpotatoes (OFSP) was evaluated. **Aim:** To determine the β -carotene content in sun-dried and oven-dried OFSP chips. **Methods:** Three batches of β -carotene-rich OFSP, variety Resisto, were made into dried chips under eight different conditions (combinations of sun-, shade-, room-, and oven-(70 C) drying; 1-3 mm, 3 mm, and 6 mm thick slices; 1x1 cm cubes). Chips were ground to a fine powder immediately before being assayed for β -carotene content. Three subsamples for each product were submitted to HPLC analyses after rehydration and extraction of carotenoids with tetrahydrofuran:methanol (1:1). **Results:** Considerable degradation of β -carotene occurred during drying. However, the β -carotene contents in the dried OFSP chips remained high and varied from 98 μ g/g in 1-3 mm thick sun-dried slices to 388 μ g/g in 6 mm thick slices dried in the oven. The three batches of fresh sweetpotatoes used as raw material had 162 to 182 μ g/g fresh roots. Higher levels of β -carotene were obtained in chips dried under the shade compared with sun-drying. Oven-drying 6 mm thick slices gave higher levels of β -carotene than oven-drying 1 x 1 cm cubes and 3 mm thick slices. **Conclusions:** Sun-drying results in much greater losses of β -carotene than oven-drying. Drying under the shade reduces β -carotene losses. Thicker slices retain more β -carotene.

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- M30 CHANGES IN BETA-CAROTENE CONTENT OF SWEETPOTATOES KEPT IN THE FIELD AND DURING POST-HARVEST STORAGE AT ROOM TEMPERATURE.** PJ van Jaarsveld, De Wet Marais, E Harmse, SM Laurie, P Nestel and DB Rodriguez-Amaya. Nutritional Intervention Research Unit, Medical Research Council, Parow, South Africa; Agricultural Research Council, Roodeplaat, South Africa; Harvest Plus, IFPRI, Washington, DC and Depto. de Ciência de Alimentos, Universidade Estadual de Campinas, Brasil.

Background: Under the VITAA Partnership (Vitamin A for Africa), the efficacy of boiled, mashed β -carotene-rich orange-fleshed sweetpotato (OFSP), compared with white-fleshed sweetpotato, has been demonstrated in South African primary school children. OFSP availability can be prolonged by storing unharvested mature sweetpotatoes in the field or harvested intact mature sweetpotatoes at room temperature. **Aim:** To determine the β -carotene content in OFSP during in-ground and room storage. **Methods:** The β -carotene content of OFSP, variety Resisto, stored in the field and intact in a room at ambient temperature was determined every three weeks. For each of the stored samples, 9 OFSP, comprising 4 medium, 4 large and 1 extra large roots, were peeled, chopped, grated and mixed. Six subsamples were submitted to HPLC analyses after extraction of carotenoids with tetrahydrofuran:methanol (1:1). **Results:** During room storage, the β -carotene content of OFSP increased from 130 μ g/g at week 0 to 187 μ g/g at week 9, and decreased slightly to 170 μ g/g at week 12. During in-ground storage, the β -carotene content increased from 130 μ g/g at week 0 to 179 μ g/g at week 18, and decreased to 154 μ g/g at week 22. **Conclusions:** Continued carotenoid biosynthesis occurred in both in-ground and room stored OFSP. The greater increase in the β -carotene content during room storage, compared with the in-ground stored OFSP, can be explained by moisture loss, as indicated by weight loss. The OFSP kept in the field, on the other hand, gained a small amount of moisture. The shelf life of the room stored OFSP in this experiment, however, was only up to 12 weeks. After 12 weeks of room storage and 22 weeks of in-ground storage, the β -carotene content of OFSP was still substantial but declining. Additionally, in-ground storage may be limited by sweetpotato weevil attack and adequate room space might not be available for rural communities. Thus, for longer storage and extended use, OFSP can be cut into chips and dried; the amount of β -carotene retained in dried OFSP chips was determined in another study. Funded by the International Potato Center (Lima, Peru) and USAID, through Award HRN-A-00-98-0047-00 to the MOST Project and the Micronutrient Global Leadership Project.

M31 INTRODUCTION OF ORANGE-FLESHED SWEET POTATOES IN GOURMA PROVINCE, BURKINA FASO. O Vebamba, M Ag Bendeche, L Mariano and SK Baker. Helen Keller International Burkina Faso (OV, MAB, SKB) and UNICEF-Burkina Faso (LM).

Vitamin A deficiency and food insecurity are permanent issues in Gourma Province. To address this, HKI implemented a UNICEF-funded school and community gardening pilot project from 2000 to 2004. This project included a component where three varieties of orange-fleshed sweet potatoes (Jewel, Caromex and Taining) were selected through an experimental process through an experimental process and promoted in 16 project villages.

Two years following implementation, producers and consumers were surveyed to identify farming, conservation and consumption practices during periods of high availability in intervention villages. The survey covered three villages where orange-fleshed sweet potatoes were introduced among farmers producing white-fleshed sweet potatoes, using the school as an entry point (Zone 1). Zone 2 consisted of three villages where promotion was carried out only in schools. In total, 172 men and 230 women were randomly selected and surveyed.

The proportion of men growing orange-fleshed sweet potatoes alone or in association in 2003 was 78.8% and 78.3% in Zone 1 and Zone 2 respectively. The proportion growing orange-fleshed sweet potatoes only was 4.5 times higher in Zone 2 than in Zone 1. Over 50% of the people surveyed stated that maximum conservation time after harvesting was under three months. Ninety percent of people surveyed, mostly women, consumed boiled sweet potatoes between meals at least one day a week. Irrespective of gender and zone surveyed, orange-fleshed sweet potatoes were preferred to the white ones because of their taste, their vitamin A content, and the fact that they are easy to grow.

This experience highlights the potential of orange-fleshed sweet potatoes as a vitamin A source in Sahel regions affected by food insecurity, and findings can be scaled up throughout the Sahel.

Fortification

Monday, 15 November

M32 COMPARISON OF THE CARR-PRICE COLORIMETRIC METHOD TO THE HPLC TECHNIQUE FOR VITAMIN A DETERMINATION IN FORTIFIED OILS. L Borghos (1), M Rahmani (2), K El kari (1), N Benajiba (1), R Chabir (1), K Janah (1), N Schlossman (3), A Souzi (1), N Mokhtar (1), H Aguenou (1). 1- Laboratoire Nutrition Alimentation, Université Ibn Tofail, Kenitra, Morocco. 2-Laboratoire Chimie Technologie Corps Gras, IAV Hassan II-Rabat, Morocco. 3- Global Food, Washington D.C., U.S.A.

Background: In Morocco the prevalence of vitamin A deficiency is a public health problem. The Ministry of Health decided to fortify vegetable oil with retinyl palmitate. A feasibility study was done. The fortified oil is available in the market. However, oil producers are facing quality control problem. Determination of retinyl palmitate in oil by HPLC technique is a demanding and expensive technique particularly for small industries in Morocco. **Objectives:** 1- To set up a reliable and easy to use spectrophotometric technique to assess vitamin A in fortified oil. 2- To validate this technique against the method of choice, the HPLC technique. **Methods:** Two types of vegetable oil (Soybean and Sunflower) were fortified with retinyl palmitate, with the following levels (16x, 4x, 2x, x, 1/2x ; x = 22,7 IU/g). The fortified oil samples, in replicate, were analyzed by the Carr-Price and HPLC methods. The Carr-Price procedure consisted in saponification of oil samples, followed by extraction of vitamin A with ether. The blue chromophore was produced with trichloroacetic acid and showed a maximum absorption at 620 nm. The normal phase HPLC technique was developed in the laboratory and was done by a direct injection. Each method was statistically evaluated for repeatability and reproducibility. **Results:** 1- Mean concentrations of vitamin A in fortified oil samples, as determined by the two methods, were not statistically different ($p > 0.05$). 2- The observed variations between mean results obtained by the two methods, for each level of fortification, were 5.7% and 6.0%, respectively for soybean oil and sunflower oil. 3- A good repeatability was obtained for both methods of analysis, the coefficient of variation was < 10%. **Conclusion:** Since mean values of vitamin A were similar, for a given level of fortification, whether determined by HPLC or by Carr-Price method; it can be concluded that these two methods are comparable and produce statistically identical results. The type of vegetable oil did not affect the determined vitamin A concentrations. Although HPLC is accurate and remains the indicated method for vitamin A analysis in fortified oils, the Carr-Price method presents the major advantage of a reduced cost; which represents a great importance for small industrial units in Morocco.

M33 STABILITY OF VITAMIN A FORTIFIED TABLE SUGAR IN SIMULATED MARKET CONDITIONS ('TAKAL' SYSTEM) IN THE PHILIPPINES. M V Capanzana, MC Saises, JV Vaguchay, DG Ravara, MC Lateo. Food and Nutrition Research Institute, Dept. of Science and Technology, Bicutan, Taguig, Metro Manila, Philippines.

Background: The prevalence of Vitamin A Deficiency (VAD) in the Philippines prompted the study on the fortification of sugar with Vitamin A. The fortification of sugar with Vitamin A was done in collaboration with Victorias Milling Company, Inc. (VMC). The technology was found feasible and the fortified sugar stored in bulk was stable. However, the common way of selling table sugar in the Philippines in the retail market is through a "takal" system, wherein, the sugar is repacked and package in cheaper transparent plastic bags. **Objectives:** The study aimed to determine the stability of vitamin A fortified sugar, repacked in transparent and opaque polyethylene (PE) and polypropylene (PP) bags and stored under simulated market conditions (under fluorescent light and indirect sunlight). **Methodology:** Ordinary white sugar was mixed with vitamin A-premix sugar, repackaged and stored for 4-8 months. The color, vitamin A content and the level of acceptability were monitored. **Results:** After 4 1/2 months of storage under the fluorescent light, the vitamin A content changed from 15.4 to 4.9 µg/g and to 5.2 µg/g for the fortified sugar packed in white PE bag and transparent PE bag, respectively. While the vitamin A content of samples packed in opaque PP bag changed from 14.5 to 7.3 µg/g. after 8 months of storage under fluorescent light. The vitamin A content of samples kept under indirect sunlight packed in white PE bag (15.4 to 5.2 µg/g) and clear transparent PE bag (15.4 to 4.6 µg/g) decreased significantly during the first month of storage. The sample kept under the same condition and packed in opaque PP bag, has vitamin A content of 5.7 µg/g on the 8th month of storage. The fortified sugar was also found highly acceptable and no significant change in color up to the 8th month of storage, regardless of packaging materials and storage conditions. **Conclusion and Recommendation:** The result of the study will serve as basis for the sugar retailers using the "takal" system in their trade in complying with the mandatory fortification of staple like sugar in the Philippines.

M34 STABILITY OF SALT TRIPLE FORTIFIED WITH IODINE, IRON AND VITAMIN A. LL Diosady, T Oshinowo, K Rutkowski, Department of Chemical Engineering and Applied Chemistry, University of Toronto, Toronto, Canada. MG Venkatesh Mannar. President, Micronutrient Initiative, Ottawa, Canada.

Triple fortified salt formulations were prepared by granulating and microencapsulating ferrous fumarate, potassium iodide and various forms of Vitamin A, either individually or in combinations, to form a premix. One part pre-mix was added to 100 parts of salt. Commercial household salt was obtained from Nigeria and Kenya, and fortified in our laboratory. To test the stability of the micronutrients, samples of fortified salt were followed through the normal salt distribution system in 4 areas: The humid lowlands and drier interior of Kenya, and the wet coastal region and dry northern region of Nigeria. Samples were also stored in environmental chambers in our laboratory. Fortified salt was packaged in 250g polyethylene film bags, and 30 packages, containing 29 different salt formulations were overwrapped with high density polyethylene film, in conformity with commercial practice. Each bundle contained a datalogger, that recorded temperature and humidity every 20 minutes. A total of 12 of these bundles were prepared. 4 bundles each were sent to Kenya, Nigeria and held in our laboratory. The bundles were sent through the distribution chain from the plant through to consumer households, recovered, and sent back to Canada for analysis. In all cases the iodine loss was less than 10%, and in most samples ferrous to ferric iron conversion was low, indicating low loss of bioavailability. While Vitamin A losses were significant, ranging from 40-80%, the study confirmed that it is technically feasible to produce triple fortified salt that will retain at least 50% of the added vitamin A for the typical time that salt is stored between manufacturing and consumption. As no special precautions were made to protect the samples from light, improved results can be expected after technological improvements. The laboratory samples demonstrated that good estimates of field stability may be made through stability studies under controlled laboratory conditions.

M36 CAROTENES-IN-OIL: APPROACHES TO INCORPORATING A SAFE AND EFFECTIVE DIETARY VITAMIN A FORTIFICANT/SUPPLEMENT INTO REGIONAL CUISINES: A GUATEMALAN EXPERIENCE. M Orozco, I Ventura, G Montenegro, NW Solomons. CeSSIAM, Guatemala City, Guatemala.

Background: For supplements or fortificants for use in the public health contexts, an appropriate balance of efficacy and safety must be present. Pre-formed vitamin A is highly efficacious for the prevention or cure of hypovitaminosis A, but the UL/RDA ratio for a lactating woman, according to the US-Canada 2001 DRIs, is 2.3/1. Incidents of putative intoxication, such as that reported in Assam, India, raise questions about procedural safety in managing retinyl ester as supplements in the field. Provitamin A carotenes in oil are second only to the retinoid form in terms of specific potency, with oily-based β -carotene having a potential bioefficacy of about 2.0. On the safety side, bioconversion of carotenes is regulated homeostatically by the vitamin A status of the host. **Aims:** Explore the use of processed red palm oil (RPO, CarotinoTM) with a 500 ppm content of mixed β - and α -carotenes (18,420 RAE per 100 g) and Carotino Tocotrienol-Carotene Mixed Concentrate (CTCMC) with a 75,000 ppm content (2.76 x 10⁶ RAE per 100 g) as potential sources of dietary vitamin A for Guatemalan cuisine. **Methods:** We produced two condiment sauces (sweet red tomato, hot green) with the oil content as either RPO or CTCMC. These formats were chosen for compatibility of the pigment colors with the basic food. **Results:** With respect to the RPO-based sauces, acceptable recipes could be made with 0.9, 1.8 or 2.7g/100 g. As used in household recipes in low-income Guatemalan homes, the 0.9% w/w red sauce provided from 11 to 154 RAE to each consuming family member, with a median contribution of 45 additional RAE. Deeply pigmented varieties of the same sauces could also be made with full-strength CTCMC, providing 24,750 RAE per 100 g of 0.9% w/w sauce preparation. **Conclusion:** The standard RPO is too dilute to make a meaningful contribution of vitamin A in a condiment sauce; but recipes made from an appropriately-adjusted oil derived from diluted CTCMC should be able to provide both an efficacious and effective -- and a safe and secure -- dietary source of vitamin A.

M35 HUMAN MILK RESPONSE TO ONE-YEAR OF SUGAR FORTIFICATION WITH VITAMIN A IN THE REPUBLIC OF NICARAGUA. C Wallace, Y Medrano, J Bulux, JE Estes, NE Craft, NW Solomons. Universidad Nacional Autónoma de Nicaragua, Managua, Nicaragua; CeSSIAM, Guatemala City, Guatemala; and Craft Technology, Wilson, NC, USA.

Background: Nicaragua was the last of the 5 Central American republics to mandate the fortification of the national table sugar supply with vitamin A. Fortification began with the cane harvest at the end of 1999. **Aims:** To assess the response of human milk vitamin A concentration to the first year's fortification program in sentinel communities of Nicaragua as an indicator of intervention impact and of benefit to infant nutrition. **Methods:** Full-breast expressions of milk were collected for total vit A concentration measurements from convenience samples of lactating women in 3 sentinel areas -- SD, SN, and DO (15-16 samples per region) -- in distinct points of the Republic in March of 2000 and 2001. **Results:** In March 2000, 2 mo into fortification, the average total vit A of 46 milk samples across 3 regions was 1.91 +/- 0.84 umol/L: 2.27 +/- 1.05 in SD (n=16); 1.68 +/- 0.62 in SN (n=15); and 1.77 +/- 0.69 umol/L in DO (n=15). A total of 8 samples had values of <1.05 umol/L: 2/16 in SD, 2/15 in SN, and 4/15 in DO. In March 2001, after 14 mo of fortification experience, the overall vit A average had increased by 19.4% to 2.28 +/- 1.22 umol/L (n=46, ns); these included an average decrease of -0.18 in SD (n=15, -7.9%, ns), and average increases of +0.18 in SN (n=15, +10.7%, ns), and of +1.07 umol/L in DO (n=16, +60.5%, ns). Deficient values were now found in 2/15 in SD, 2/15 in SN and 1/16 in DO. **Conclusion:** Despite limitations of the small sample-sizes, we interpret the variety in associations of breast milk vit A concentrations with sugar fortification as specific to experiences in the distinct sentinel areas. This is possibly related to differential participation in sugar consumption by mothers across the districts of the nation. **Financed by Task-Force Sight & Life, Micronutrient Initiative and Roche Interamericana.** (NOTE: SD = Santo Domingo; SN = San Nicolas; and DO = Diriomo; ns = Not Significant.)

M37 MICRONUTRIENT INTAKE, ANEMIA, AND VITAMIN A DEFICIENCY IN PANFAR AND PACFO BENEFICIARY PERUVIAN CHILDREN. M Miranda, R Valenzuela, JC Barboza D, CH Domínguez C, SR Caverio Santillán, V Riega, M Calderón, C Rojas. Centro Nacional de Alimentación y Nutrición. Instituto Nacional de Salud. Ministerio de Salud. Lima, Peru.

Background: Subclinical vitamin A deficiency, anemia, due to the iron deficiency in children less than 5 years old are important public health problems in Peru. The government has been developing two Nutrition Programs, PANFAR for children and their mothers and PACFO for children between 6 and 36 mo. PANFAR delivers a food basket that was designed to cover 30% of energy and protein requirements of two adults and two children under five. PACFO delivers a fortified instant porridge that offers 30% of energy requirements and 100% vitamin A and iron. While PANFAR works in 16 regions, PACFO is restricted to other 7 regions with high levels of poverty and undernutrition in the Peruvian Andes. **Aims:** To quantify the consumption of Vitamin A and iron from complementary foods, to determine the anaemia prevalence of PANFAR and PACFO beneficiaries and serum retinol deficiency of PANFAR beneficiaries. **Methods:** There were two cross-sectional studies, with random samples for the consumption study of 912 children for PACFO and 432 children from PANFAR. A 24h recall about the child food consumption was taken from the caregiver. The nutritional recommendations established by FAO/OMS/UNU were used. A sub-sample of 210 children was taken for PANFAR for the retinol serum. The hemoglobin was measured with Hemocue® and the serum retinol with HPLC. The cut off point for anaemia was Hb < 110 g/L and serum retinol concentration < 0.70 umol/L was considered for retinol deficiency. **Results:** The PANFAR food basket contributed with 3.2% and 6.5% of Vitamin A and iron requirements respectively. The PACFO children covered 103.2%, 43.1% of vitamin A and iron requirements adequacy without porridge and these increased to 178.3% and 117.2% respectively. Retinol deficiency prevalence was 27%. Anaemia prevalence among PANFAR beneficiaries was 48.9% and 61.5% for PACFO beneficiaries. **Conclusion:** PANFAR did not supply an important quantity of micronutrients. The diet of the PACFO beneficiaries improved because of the contribution of vitamin A and iron of the porridge, but these it was not reflected in the hemoglobin levels.

- M38 ROLE OF TEMPERATURE IN FORTIFICATION OF SUGAR WITH VITAMIN A.** *SS Sirohi*, for Nutrition & Sugar Consultant, S Bulusu for MI South Asia Regional Office, New Delhi, India.

Background: Role of fortified sugar in the removal of vitamin A deficiency (VAD) has now been established. Many African and Latin American countries have declared mandatory fortification of sugar. These countries are fortifying very small sizes of sugar crystals. All these countries are fortifying sugar at the time of production, when it is hot. On fortification of large size sugar crystals at ambient temperature, there was a problem of segregation. Since many Asian and African countries produce sugar of large crystal sizes of 2.5 mm & above, these countries need proper techniques for fortification of sugar. **Aims:** To determine proper temperatures of sugar crystals for stable bonding of vitamin A premix and to overcome the problem of segregation. **Methods:** The Sugar crystals grow in hexagonal shape. Sugar is embedded in layers on the surface of the crystal during its growth. Pilot plant established for sugar fortification in India have facilities for maintaining the regular flow and heating of sugar crystals. Sugar crystals of different sizes were fortified with vitamin 'A' in lots at different temperature. On heating the crystals, the top layers become soft. The vitamin 'A' premix bonds firmly on its surface during cooling to ambient temperature. Fortified sugar was tested for segregation. **Results and Discussions:** Definite relationship between the size of the sugar crystal and the temperature has been established. The large crystals due to less surface area need higher temperature for stable bonding of premix. **Conclusion:** Temperature of sugar crystals is an important parameter for stable bonding with vitamin A premix to overcome the problem of segregation. For firm bonding, the sugar crystals should be heated to a desired temperature depending on the size of the crystal.

- M39 THE EFFECT OF SALT FORTIFIED WITH IRON, IODINE, VITAMIN A AND B COMPLEX VITAMINS ON THE HEALTH OF CHILDREN.** *Malavika Vinod Kumar*. Sundar Serendipity Foundation, India.

Aim: To test the efficacy of multiple micronutrient fortified salt in improving the health status of school age children. **Methods:** The experimental design was a pretest- posttest design with experimental and control groups on children in the age group 5-15years in residential schools in Chennai, India. There were 119 children in the experimental group and 126 children in the control group. Hemoglobin, Red blood cell count ,hematocrit ,serum vitamin A ,urinary iodine analysis, and clinical examination for vitamin deficiencies were done at baseline and after 1 year of intervention. Deworming was done in both experimental and control groups of children every 6 months. Serum VitaminA was done in a subsample of 76 experimental and 78 control children who had clinical signs of vitaminA deficiency at baseline. Intervention was carried out by using common cooking salt fortified with iron, iodine, VitaminA, VitaminB1, VitaminB2, VitaminB6, VitaminB12, niacin, folic acid and calcium pantothenate in the food cooked in the kitchen of the school of the experimental group for a period of 1 year. Day scholars who attended the day school but who did not reside in the residential school constituted the control group. **Results:** The average hemoglobin in the experimental group before the study was 9.63 gms/dl. This increased to 10.14gms/dl after intervention ($p<0.05$) where as in the control group it was 10.29g/dl at the start of the study but it declined to 10.08g/dl after 1 year and this drop was significant($P<0.05$). Serum vitamin A increased in the experimental group from 33.44mcg/dl at baseline to 42.25mcg/dl at the end of the study which was significant($P<0.05$) where as in the control group it increased from 41.7mcg/dl to 46.1mcg/dl though this increase was not significant. There was also a significant improvement in urinary iodine, hematocrit and red cell count in the experimental group where as a significant drop in all these parameters was seen in the control. **Conclusion:** The study shows that the multiple micronutrients in the fortified salt were bioavailable and effective in alleviating multiple micronutrient deficiencies.

Selected Oral Presentations

Monday, 15 November

- M40 HOMESTEAD FOOD PRODUCTION CONTRIBUTES TO IMPROVING HOUSEHOLD FOOD AND NUTRITION SECURITY.** *G Stallkamp*, S de Pee, A Talukder, D Panagides, A Taher, RA Karim, A Habib, A Baten, A Uddin, N Sultana, MW Bloem. Helen Keller International/Bangladesh, Dhaka, Bangladesh, Helen Keller International/Asia-Pacific Regional Office, Singapore, Helen Keller International/Nepal, Kathmandu, Nepal, Helen Keller International/HQ, NY, USA.

Background: Rural Bangladeshi households have a low micronutrient intake, due to a poor quality and diversity of the diet. In order to improve vitamin A intake from the diet, food-based programs addressing nutrition should also include an animal food component. The Helen Keller International homestead food production (HFP) program conducted a one-year pilot study to introduce animal husbandry into an ongoing home gardening program among households in two rural districts of Bangladesh. **Objective:** To assess whether HFP programs can change consumption patterns of animal foods. **Methods:** Longitudinal data from 400 target and 300 control households were collected at each baseline (BL; Apr-May 2002) and endline (EL; Mar-Apr 2003). Precoded questionnaires were used to obtain information on animal production and consumption. **Results:** The HFP program was able to significantly improve animal food consumption among target households. Egg consumption among children aged 6-59 months of target households in the previous week significantly increased ($p<0.001$) from BL to EL (1 vs. 2 eggs) and compared to controls at EL (0.5 eggs). The percentage of target households consuming animal foods (liver, egg) from the own production significantly increased from BL to EL and compared to controls (at least $p<0.05$). Fish consumption on at least two of the last 3 days by children aged 6-59 months significantly increased ($p<0.001$) from BL to EL and compared to controls at EL. The median income earned from selling HFP produce significantly increased ($p<0.001$) among the target group from BL to EL and compared to the controls. The money was mainly spent on foods such as poultry ($p<0.005$) and fish ($p<0.05$). **Discussion:** Households participating in the HFP program were able to diversify their diet by increasing consumption of micronutrient-rich animal foods and generating income to be spent on additional foods, thus contributing to improved household food and nutrition security. Such programs should be expanded, especially in countries where micronutrient deficiencies are still a significant problem.

- M41 PROMOTION OF PRODUCTION AND CONSUMPTION OF AFRICAN INDIGENOUS VEGETABLES TO IMPROVE INTAKE OF VITAMIN A AND OTHER MICRONUTRIENTS IN TANZANIA.** *D Ash*, Z Lukmanji, B Giyose, M Chadha, M Oluoch. MUCHS-Harvard Group Dept of Community Health, School of Public Health MUCHS, Dar es Salaam, Tanzania, Commonwealth Regional Health Community Secretariat-ECSA, and AVRDC-RCA, Arusha, Tanzania.

We are collaborating with the AVRDC - the World Vegetable Center - on a community nutrition program to promote the production and consumption of vegetables in four districts in Tanzania. The Regional Center for Africa of AVRDC located in Arusha, Tanzania has multiplied base seed of several African indigenous vegetables including African eggplant, African nightshade, amaranthus, Ethiopian kale, okra, and high B-carotene tomatoes. Nutrient analysis reveals that these indigenous vegetables and tomatoes have higher vitamin and mineral content than introduced varieties. The baseline survey conducted in Sept 2003 among 550 households revealed that production of vegetables is hindered by several factors including access to seed stock, lack of agriculture extension services, lack of knowledge on horticultural crops, low rainfall, limited food preservation techniques and inadequate access to market. There is marked seasonal variability and limited variety of vegetables in these four ecologically diverse districts populated by subsistence agriculturalists and pastoralists. Only ¼ of households practice home gardening. Dietary assessment using a validated FFQ, 24 hr dietary recall and market surveys revealed that legumes were not widely consumed. Animal sources of vitamin A rich foods were limited to liver and milk which are not consumed in large quantities except by Maasai. Animal husbandry is centered around livelihood rather than food consumption. Out of 20 vegetables available only 9 were consumed regularly. Onions and tomatoes were the most widely consumed vegetables. Carrots are grown as a cash crop and not frequently consumed. Program interventions include training in homegardening techniques; educational activities centered on causes and consequences of vitamin A and other micronutrient deficiencies; and demonstrations of cooking methods and food preservation techniques to promote dietary diversity. This program is distinct in that very few food based interventions are being actively promoted or implemented in Tanzania now or in the last several years. Lessons learned from this project will contribute to the knowledge base on the effectiveness of food based strategies in reducing the wide gap between actual nutrient intake and recommended intake of key micronutrients. Funded by USAID through a grant to CRHCS-AVRDC.

M42 BETA-CAROTENE CONVERSION TO VITAMIN A: REGULATION IN HUMANS. N Wongsiriroj, J Paik and WS Blaner. Institute of Molecular Biology and Genetics, Mahidol University, Bangkok, Thailand; Institute of Human Nutrition and Department of Medicine, Columbia University, New York, USA.

Background: Provitamin A carotenoids like β -carotene are converted to vitamin A primarily within the intestine. Conversion of β -carotene to vitamin A involves the coordinate actions of 3 enzymes: carotene cleavage enzyme (CCE), retinal reductase, and lecithin:retinol acyltransferase (LRAT). Intracellular retinol-binding proteins, types I and II (CRBPI and CRBP II) are also involved in the process. CRBP II is expressed only in the small intestine whereas CRBPI is found in all other tissues. **Aims:** We investigated the biochemistry of human carotene conversion to vitamin A. We asked if the CRBPs regulate the activity of CCE and explored the importance of 3 different human retinal reductases in vitamin A formation from β -carotene. **Results:** Apo-CRBPI stimulated human CCE activity 9-fold while apo-CRBP II had no effect. Since CRBP II is found only in the intestine, CRBPI is found in all other tissues where CCE is present, this suggests that the conversion of β -carotene to vitamin A is regulated differently in the intestine than other tissues. Our studies of retinal reductases proposed to be important in catalyzing vitamin A formation from β -carotene also indicate that these enzymes have different roles that are tissue dependent. One of these retinal reductases, aldose reductase has an important role in vitamin A formation in skin and possibly some other tissues but others seem to be important in the intestine. **Discussion:** Our findings suggest that the conversion of provitamin A carotenoids to vitamin A is regulated differently and involves different enzymes in the intestine as compared to other tissues. This provides an important basis for regulating β -carotene conversion to vitamin A in a tissue specific manner. Based on our data, conversion in the small intestine is geared towards continuously allowing for optimal rates of conversion whereas conversion in other tissues CCE activity is regulated through a sensing mechanism that assesses vitamin A status.

M44 BIOENGINEERED PROVITAMIN A ENRICHED TROPICAL RICE. K Datta (1), V Parkhi (1), M Rai (1), N Baisakh (1,2), L Torrizo (1), E Abrigo (1), N Oliva (1), MD Khalekuzzaman (1,3), S Rehana (1,4), and SK Datta (1). (1) Plant Breeding, Genetics, and Biochemistry Division, International Rice Research Institute, DAPO Box 7777, Metro Manila, Philippines; (2) Department of Agronomy, 134 Sturgis Hall, Louisiana State University, Agricultural Centre, Baton Rouge, LA 70803, USA; (3) Department of Botany, Rajshahi University, Rajshahi 6205, Bangladesh; (4) Genetics and Plant Breeding Division, Bangladesh Agricultural University, Mymensing, Bangladesh.

Malnutrition, especially vitamin A deficiency (VAD), is a major problem in South Asia where rice is the primary food providing 40-60% of the total calorie intake. However, rice lacks or has a very minimal amount of carotenoid in the grain and could not be considered as a food to alleviate VAD. Hence, bioengineering rice to produce provitamin A and accumulation of β -carotene in the endosperm tissues would be an attractive and alternate strategy towards alleviating this severity. Transgenic indica GoldenRice has been developed at IRRI following the pioneering work in Japonica rice by Ye et al. (Science 2000, 287:303-305). Simultaneously, extensive screening of exotic rice germplasm to identify rice cultivars containing considerable amount of carotenoids is in progress. To achieve β -carotene biosynthesis in the endosperm, we introduced two genes, namely *psy*, driven by endosperm specific Gt1 promoter, and *crt1* fused with CaMV35S promoter and a plastid specific transit peptide through biolistic and *Agrobacterium* methods and using *hph* and POSITECH™ selection systems. Stable integration and inheritance of the transgenes were confirmed through molecular analyses. The expression of the genes was evidenced from RT-PCR, and the characteristic yellow color of β -carotene in the endosperm. The β -carotene content from HPLC quantitation ranged from 0.4 μ g/g to as high as 1.6 μ g/g of seed. Marker free and non-antibiotic *pmi* (phosphomannose isomerase) selected β -carotene rich rice are now being grown in the containment facilities and screen house conditions. Agronomic performance and gene stability would be studied using homozygous lines.

M43 BETA-CAROTENE-RICH ORANGE-FLESHED SWEETPOTATO IMPROVES VITAMIN A STATUS OF PRIMARY SCHOOL CHILDREN IN SOUTH AFRICA. PJ van Jaarsveld, M Faber, SA Tanumihardjo, P Nestel, CJ Lombard, AJS Benade. Nutritional Intervention Research Unit and Biostatistics Unit, Medical Research Council, Parow, South Africa; Department of Nutritional Sciences, UW-Madison, WI, USA and Harvest Plus, IFPRI, Washington, DC.

Background: The efficacy of β -carotene-rich orange-fleshed sweetpotato (OFSP) in improving vitamin A status in children is unknown. A study was carried out in a rural area of KwaZulu-Natal province, South Africa, using the Resisto variety that contained $9,980 \pm 1,167 \mu$ g β -carotene/100 g boiled and mashed OFSP. **Aim:** To determine the efficacy of daily consumption of boiled and mashed β -carotene-rich OFSP in improving the vitamin A status of primary school children participating in a school-feeding program. **Methods:** Children aged 5–10 y were randomly assigned to two groups. On school days and under controlled conditions the intervention group ($n = 90$) consumed about 125 g boiled and mashed β -carotene-rich OFSP, and the control group ($n = 90$) consumed an equal amount of boiled and mashed white-fleshed sweetpotato (WFSP), variety Bosbok that is devoid of β -carotene, for 53 days. All children were dewormed to exclude helminthic infection as a confounder. The modified relative dose response (MRDR) test for vitamin A status was conducted before and after the intervention following a 10-day washout period. **Results:** Vitamin A status improved in the intervention group with the proportion of children with normal vitamin A status (3, 4-didehydroretinol:retinol (DR:R) < 0.060) increasing from 78% to 87% after intervention, while that in the control group decreased from 86% to 82%. The estimated intervention effect for DR:R was: -0.008; 95% CI: -0.015, -0.001; $P = 0.0203$. Compliance was 90% in both groups. Boiled and mashed OFSP contained 12,375 μ g β -carotene (1,030 μ g Retinol Activity Equivalents) per 125 g serving, providing 2.5 times the recommended dietary allowance for vitamin A for 4-8-year-old children (400 μ g/d). The taste of the OFSP was acceptable to nearly all children. **Conclusion:** β -Carotene-rich OFSP is an excellent source of provitamin A and can be promoted as a viable long-term food-based strategy for controlling vitamin A inadequacy. Funded by Micronutrient Initiative, Ottawa, Canada, with support from the International Potato Center's Vitamin A for Africa Initiative, and USAID's Micronutrient Global Leadership and MOST projects. Sweetpotatoes were provided by the South African Agricultural Research Council, Vegetable and Ornamental Plant Institute, Roodeplaat.

M45 INCREASING VITAMIN A BY CONSUMING CHICKEN EGG PRODUCED FROM HENS FED SPIRULINA. WG Piliang (1), W Shatiti, T Panji (2), J Pambudi (3). (1) Bogor Agricultural University (IPB); (2) Forestry Research Institute; and (3) Nutrition Research and Development Center, Ministry of Health, Indonesia.

Background: Vitamin A is still one of the National major problem in Indonesia. Consuming vitamin A in forms of capsules or pills are not very common for people, which are more than half of the total population, live under the poverty level. Consuming eggs are more preferable, more common, and more affordable for these population. **Aim:** To increase vitamin A content and at the same time decrease cholesterol level in eggs. **Methods:** Three levels (0.5%, 1.0%, 1.5%) of Spirulina powder, which is equivalent to 0.03 gr/kg diet, 0.05 gr/kg diet and 0.07 gr/kg diet was included in chicken ration, and were given to 108 laying hens from the age of 22 weeks till 28 weeks old that were divided into 4 treatment groups. All treatment groups were formulated isocaloric and isonitrogenous. The parameters observed were all performances, vitamin A and cholesterol contents in eggs and meat. A completely randomized design was used to analyze all data statistically and an orthogonal contrast test was used to determine the significant results among treatments, if any. **Results:** Spirulina plantensis contains 0.5% carotenoid and 50% of it, is xanthophyll. The supplementation of 0.5%, 1.0%, and 1.5% ground spirulina in 3 treatment diets (T1, T2, and T3) would contribute 0.03 gr, 0.05 gr, and 0.07 gr xanthophyll per kg diet respectively. The higher the spirulina in the diet, the higher the xanthophyll content in the egg yolks. The xanthophyll content in the egg yolks were 0.04 mg, 0.07 mg, and 0.12 mg per 100 gram egg yolk from hens fed T1, T2, and T3 treatment diet respectively. The retinol content in the egg yolk from 3 different treatment diets ranging from 0.224 mg - 0.266 mg per 100 gr sample. The egg yolk cholesterol content from hens fed control diet (without) spirulina was 177.7 mg %, while the lowest egg yolk cholesterol produced from hens fed 1.5% spirulina in the diet was 132.7 mg %. The lutein content in egg yolk was found the highest from hens fed 1.5% spirulina (0.12 mg %) as compared to that of hens fed the control diet (0.015 mg %). The retinol content in egg yolk was also found the highest from hens fed the highest spirulina (0.266 mg/100 gr). In January 2002, it was reported that 10 - 45% Indonesian mothers consumed 110 RE per day of retinol from animal foods which is equivalent to one chicken egg, and is approximately 20% of the recommended daily allowance (RDA) for vitamin A for (non breast-feeding) women. Egg yolk produced from hens fed 1.5% spirulina would provide 266 RE which is equivalent to 2.4 times higher RE than that of the commercial chicken egg and therefore would contribute 48% that of the RDA requirement for retinol. **Conclusion:** Spirulina-enriched eggs could provide 2.4 times higher of RE and lower cholesterol content as compared to that of regular market chicken eggs.

M46 EFFECT OF DIFFERENT COOKING METHODS ON VITAMIN A STABILITY OF FOODS IN DEVELOPING COUNTRIES. V. Abraham, Y Kakuda. Champion Foods, Brampton and University of Guelph, Canada.

Fortification of appropriate foods with Vitamin A is an effective way of increasing Vitamin A intake and reduce the incidence of VAD. Several common foods such as sugar, flour, salt, oil, ketchup, baby foods etc. are recommended to be fortified with the above vitamin but vegetable oil appears to be more suited because of its unique advantages. However, the fortification efforts in many countries have been slow due to the perception on its stability during storage and cooking. Therefore an elaborate study was initiated using five different oils (soybean, sunflower, peanut, mustard and vanaspathi Ghee) fortified with three levels (20,100, 200 iu/gm) of vitamin A. Fortified oils were used to cook several traditional dishes from Asia, Africa, Middle East and South America. Cooking methods included pan frying, shallow frying, deepfrying, pressure cooking, Gravy making, dry curry preparation and sweet dish preparation. The cooked food items were freeze-dried, solvent extracted and vitamin A content determined using the standard HPLC method. For deep fat frying experiments, the vitamin A was measured by analysing the oil itself. In Panfrying operation (stir fry) the vitamin A retention was about 70-75% and in deep fat frying this ranged from 65 to 97% depending on the number of repeated frying. During pressure cooking and shallow frying the vitamin contents were 65% and 70% respectively. When vegetables were used to make curry (boiling) and during dry preparations, the retentions were about 70% each. When fortified oils were used for making sweets (sugi Halwa) the vitamin losses were about 27%. Addition of antioxidants in the oil did not substantially increase the stability. The cooking times (duration) was not an important factor when cooking was carried out in closed vessels. The fortification level does not have significant effect on the retention of vitamin A in cooked foods. Taking all factors into consideration, the vitamin A retention during cooking is about 70-75% and oil fortification maintains its position as a method of choice in developing countries.

M47 CHAPATTI FORTIFIED WITH MICRONUTRIENTS IN IMPROVING VITAMIN A AND IRON STATUS IN SCHOOL-AGE CHILDREN IN RURAL BANGLADESH. AS Rahman, MA Wahed, MS Alam, T Ahmed, F Ahmed, MA Quaiyum, G Robbani, DA Sack. ICDDR,B: Centre for Health and Population Research, GPO Box 128, Dhaka 1000, Bangladesh and MOST, Dhaka, Bangladesh.

Background: Iron and vitamin A deficiencies are the two most common micronutrient deficiencies globally. Food fortification is a very cost effective and sustainable strategy to prevent or correct micronutrient deficiencies. **Aims:** To detect an impact of consuming chapatti (round flat bread) made from fortified wheat flour by school-age children over a period of six months on changes in their vitamin A and iron status. **Methods:** In a double-blind control trial, 352 school-age children (6-15 years old) were enrolled to consume daily two chapattis of 100g nonfortified or fortified wheat flour containing about 20 to 60% of the recommended daily allowance for multiple micronutrients for 6 months. The study was conducted in a rural area of Chittagong district in Bangladesh. Blood samples were collected prior to the start of feeding, three months later and six months later when chapatti feeding was stopped. **Results:** The mean serum retinol level at 6 months was significantly higher in the fortified group (1.06 vs. 0.94 µmol/L, p<0.01). Proportion of subclinical vitamin A deficiency (serum retinol < 0.70 µmol/L) was significantly reduced in the fortified group from baseline (13.6 vs. 15.4%) to 3 months (7.9 vs. 16.2%, p<0.05) and 6 months (7.4 vs. 22.5%, p<0.05). There was no demonstrable effect of fortified chapatti consumption on iron status and on average hemoglobin levels at 3 or 6 months, nor was there any reduction in the proportion of children who had anemia. **Conclusion:** This is the first study in Bangladesh that tested the efficacy of consuming fortified chapatti, which clearly demonstrated a significant improvement in the vitamin A status of the school-age children in rural Bangladesh.

M48 TRIPLE FORTIFICATION OF SALT WITH MICROENCAPSULATED IODINE, IRON AND VITAMIN A: A RANDOMIZED, DOUBLE BLIND, TRIAL. M Zimmermann, R Wegmüller, C Zeder, N Chaouki, F Rohner, T Torresani, R Hurrell. Human Nutr Lab, Swiss Federal Institute of Technology, Zürich, Switzerland; The Ministry of Health, Rabat, Morocco; University Children's Hospital, Zürich, Switzerland.

Background: In developing countries, children are at high risk for goiter, anemia and vitamin A deficiency. In areas of subsistence farming in rural Africa, salt is one of few regularly purchased food items and could be a good fortification vehicle. **Objective:** We tested the efficacy of salt triple fortified with iodine, iron and vitamin A to reduce the prevalence of these micronutrient deficiencies in children. **Design:** In Morocco, we fortified local salt with 25 mg iodine (as potassium iodate), 2 mg iron (as micronized ferric pyrophosphate; mean particle size=2.5 µm), and ≈ 60 µg vitamin A (as retinyl-palmitate). All three micronutrients were microencapsulated together in hydrogenated palm oil containing 1% lecithin, with a 40% substrate:60% capsule ratio and a particle size (X50) of ≈100 µm. After storage and acceptability trials, we compared the efficacy of the triple fortified salt (TFS) to iodized salt (IS) in a 10-month, randomized, double-blind trial in iodine-deficient 6-15 yr-old children (n=161) with a high prevalence of anemia and vitamin A deficiency. **Results:** The color stability of the TFS was excellent due to the use of ferric pyrophosphate (a white-colored, nonsoluble form of iron). During 6 months storage, there were 12-13% and 15-16% losses in the vitamin A and iodine contents, respectively. During the efficacy trial, in the TFS group at 10 months, mean serum retinol (SR) increased from 0.88 to 1.14 µmol/L (p<0.01). Mean hemoglobin increased by 17 g/L (p<0.01), and iron status and body iron stores were significantly increased (p<0.01). There were no significant changes in vitamin A and iron status in the IS group. In both groups, urinary iodine (p<0.001) and thyroid volume (p<0.01) improved significantly from baseline. **Conclusion:** Microencapsulation improves the stability of vitamin A and iodine when added with iron into salt, and enables even low-grade, high moisture salt to be successfully triple fortified. A TFS containing iodine, iron and vitamin A can be an effective fortification strategy in rural Africa.

T1 COMPARISON OF INDICATORS OF VITAMIN A STATUS IN THAI CHILDREN. *NE Craft, C Chitchumroonchokchai, A Boonpradern, and J Erhardt.* Craft Technologies, Inc., Wilson, NC; INMU, Mahidol Univ, Thailand; and SEAMEO, Regional Center for Community Nutrition, Univ. of Indonesia, Jakarta, Indonesia.

Background: Vitamin A (VA) deficiency affects millions of young women and children. There are several tests that have been used to measure vitamin A status – each with advantages and limitations. **Objective:** To compare multiple VA indicators in serum and dried blood spot (DBS) from Thai children to determine the correspondence between methods. **Methods:** Blood samples were collected from 8-15yr old Thai children. Serum retinol, serum RBP, DBS retinol and DBS RBP were measured. **Results:** None of the children had serum retinol in the deficient range (0.7 μ mol). Six children were in the range between 0.70 to 1.05 μ mol. DBS retinol also identified 6 children in the marginal range, 4 in common with those having marginal serum retinol. The correlation between serum retinol and DBS retinol was $r^2=0.68$. DBS retinol was improved by calculating the serum volume based upon a serum [Na⁺] of 140 mEq/L. The correlation between serum retinol and serum RBP was $r^2=0.78$. RBP identified 5 children in the marginal range, 4 in common with those having marginal serum retinol. **Conclusions:** The target population was expected to have marginal levels of VA. No overt VA deficiency was evident in these children. The correspondence between serum retinol and DBS retinol was not as strong as in previous studies but the range of VA values was narrow. Among this group of subjects serum retinol and serum RBP agreed more closely. **Funding provided, in part, by Micronutrient Initiative.**

T3 INFECTION AND INFLAMMATION MAY INFLUENCE MULTIPLE MICRONUTRIENT STATUS IN PREGNANT WOMEN: FINDINGS FROM NEPAL. *I Jiang, P Christian, SK Khatry, T Wagner, L Wu, KP West, Jr.* Center for Human Nutrition, Bloomberg School of Public Health, Johns Hopkins University, 615 N Wolfe St, Baltimore, MD, and Nepal Nutrition Intervention Project, Sarlahi (NNIPS), Kathmandu, Nepal.

Poor micronutrient status and infection coexists in women of developing countries, which may confound the interpretation of serum micronutrient concentrations. We assessed the association between infection and maternal micronutrient status by measuring 1st trimester serum concentrations of multiple micronutrients and C-reactive protein (CRP) and α 1-acid glycoprotein (AGP) in 1165 pregnant women participating in a micronutrient supplementation trial ("NNIPS-3") in Nepal. The presence of acute and chronic infection or inflammation was defined by $CRP \geq 5$ mg/L or $AGP \geq 0.75$ g/L, respectively. After adjusting for age, gestation, diet, socio-economic and seasonal factors, a multiple linear regression analysis showed that a raised CRP level was associated with lower concentrations of serum retinol (by 0.18 μ mol/L, $p < 0.0001$), β -carotene (by 0.04 μ mol/L, $p < 0.05$) and vitamin B6 (by 6.46 nmol/L, $p < 0.005$). Raised AGP concentration was associated with lower serum concentrations of retinol (by 0.121 μ mol/L, $p < 0.0001$), β -carotene (by 0.054 μ mol/L, $p < 0.0001$), α -tocopherol (by 0.75 μ mol/L, $p < 0.005$) and lutein (by 0.102 μ mol/L, $p < 0.0001$). In contrast, serum vitamin B12 concentrations were higher by 23.1 pmol/L ($p < 0.02$) in the presence of chronic infection. In the presence of either acute or chronic infection, serum ferritin and copper concentrations ($p < 0.01$) were elevated. Hemoglobin concentrations were slightly lower (by 2.4 g/L, $p = 0.06$) in women with elevated AGP. Serum concentrations of vitamin D, riboflavin, folate and zinc were not affected by these markers of infection. Concentrations, and thus inference with respect to status, of some micronutrients may be influenced by infection, which in this population of pregnant women was associated with decreased levels of vitamins A, E, B6, β -carotene and other carotenoids. (Funding: by the USAID Ofc of Health and Nutrition, Sight and Life Research Institute, and the Bill & Melinda Gates Foundation).

T2 USE OF THE CRAFTi PORTABLE FLUOROMETER TO MEASURE VITAMIN A IN FORTIFIED FOODS AND BLOOD. *NE Craft, JE Estes, HC Furr.* Craft Technologies, Inc., Wilson, NC, USA. www.crafttechnologies.com.

Background: Vitamin A deficiency (VAD) is a preventable disease that affects millions of young women and children. The use of VA fortified foods has become an effective mechanism for combating VAD. Due to the increase in VA fortification, it is important to test both blood levels and the content of VA in fortified foods to monitor the stability and adequacy of fortification. **Objectives:** To develop a portable method to measure VA content of blood and fortified foods and to compare the results to standard methods. **Methods:** A modified fluorometer (CRAFTi) that can be operated by various power sources, including a 12 volt battery, and field-friendly extractions were developed. Plasma samples were measured for retinol by HPLC and using the CRAFTi. Aliquots (25 μ L) of ~100 plasma samples were diluted with buffer and measured using the CRAFTi. Thirty fortified sugar samples were tested for VA by HPLC, spectrometry (SPEC) and the CRAFTi method. In addition, the CRAFTi was used to test sugar VA in the field and compared to the SPEC method currently being used. **Results:** Under lab conditions, retinol was measured in ~100 plasma samples by HPLC and using the CRAFTi method. The correlation (r^2) between the two sets of data was 0.82 with a slope approximating 1. For sugar, the correlation ($n=30$) between HPLC and CRAFTi was $r^2=0.999$ and between SPEC and CRAFTi was $r^2=0.983$. The correlation ($n=219$) between SPEC and CRAFTi under field conditions was $r^2=0.986$. **Conclusions:** These results indicate that the CRAFTi methods provide results equivalent to standard methods currently used to measure VA. They can be used in a field setting to accurately measure VA in blood or fortified sugar. We are currently developing field-friendly methods for milk and flour. **Funding provided by Micronutrient Initiative and USDA-SBIR #NCK-2002-03047.**

T4 DEVELOPMENT OF SCREENING INDICATORS FOR RANKING AREAS AT RISK OF VITAMIN A DEFICIENCY IN THAILAND. *K Maleevong (1), E Wasantwisut (2), S Sinawat (1), M Pradipasen (3), J Pattaraarchachai (4), S Durongdej (3).* Nutrition Division, Department of Health, Ministry of Public Health (1), Institute of Nutrition, Mahidol University (2), Department of Nutrition, Faculty of Public Health, Mahidol University (3), Department of Community Medicine, Faculty of Medicine, Thammasat University (4).

Background: Lessons learned from the experience on the eruption of active xerophthalmic cases in Thailand as "the tip of the ice-berg" underline the importance of early detection in order to curb the problem in time. **Aim:** To develop community based screening indicators for identifying areas at risk of VAD. **Method:** 12 villages of Lower Southern Thailand previously identified with various degrees of VAD were randomly selected to participate in the study. Data collected from 300 children aged 24-71 months included anthropometric measurements, serum retinol (SR) analysis, data on dietary intakes, illness, and socioeconomic status. A subsample of 120 children were tested for Modified Relative Dose Response (MRDR). Statistics used for data analysis were factor analysis, discriminant analysis and Receiver Operating Characteristic curves. The cut off point of each screening indicator to be high risk area of VAD was set in reference to the prevalence of 15% of children with $SR < 0.70 \mu$ mol/l. **Result:** By comparing SR to the MRDR ≥ 0.06 used to detect areas of inadequate vitamin A status, the cut-off value of $SR < 0.70 \mu$ mol/l showed the high efficiency (78%). Six screening indicators that can best discriminate between high and low risk of VAD as evidenced by $SR < 0.70 \mu$ mol/l were: vitamin A intake by Modified Dietary assessment (MDA), ownership of home and land for agriculture (H.own/L.own) access to social service of maternal education and antenatal care (ANC/EDU), Nutritional status (NUTR), immunization (EPI) and infectious diseases of diarrhea and upper respiratory tract infection with fever (URI/DIARR). The discriminant equation (D) was $D = 10 + 5(MDA) + 5(H.own/L.own) + 4(ANC/EDU) + 3(NUTR) + 3(EPI) - 3(URI/DIARR)$. If the total scores is less than 10.0, the areas will be classified as high risk of VAD. At this proposed score, the efficiency of identifying VAD as a public health problem was 83.3%. **Conclusion:** A set of community based screening indicators for ranking areas at risk of VAD in Southern Thailand included vitamin A intake, ownership of home and land for agriculture, access to social service of maternal education and antenatal care, nutritional status, immunization and infectious diseases of diarrhea and upper respiratory tract infection with fever. Application of these screening indicators in other regions as well as possible inclusion in a surveillance system are needed.

T5 HIGHER CONCENTRATIONS OF HOLO-RETINOL BINDING PROTEIN IN VITAMIN A-SUFFICIENT COMPARED TO -DEFICIENT NEPALESE WOMEN IN THE LAST TRIMESTER OF PREGNANCY. S Sankaranarayanan*, M Suárez, D Taren, D Genaro-Wolf, Burris Duncan, K Shrestha, N Shrestha, FJ Rosales**. *The Huck Institutes of the Life Sciences, **Department of Nutritional Sciences, The Pennsylvania State University, University Park, PA; Boston College, Boston, MA; University of Arizona, Tucson, AZ; Tribhuvan University, Kathmandu, Nepal; National Eye Hospital, Kathmandu, Nepal.

Transfer of Vitamin A (VA) from mother to fetus increases during the last trimester of pregnancy enhancing fetal VA stores, and holo-RBP (retinol bound to retinol-binding protein alone) plays an important role in the delivery of retinol across the placenta. We assessed whether VA status affects the concentration of holo-RBP during the last trimester (24-39 wk). This was a cross sectional study of a sub-sample of women (n=259), who participated in the Night blindness Threshold Test study at the Nepal National Maternity Hospital, Kathmandu, Nepal. Weeks of gestation were determined by recall history of last menstrual period. Serum samples were analyzed for retinol by HPLC; RBP, Transthyretin (TTR) and alpha-1 acid glycoprotein by radial immunodiffusion. Holo-RBP concentrations were calculated based on dissociation constants for holo-RBP and apo-RBP. Women were young and clinically healthy with no reported signs and symptoms of abnormal pregnancy. Among these women, 27% were anemic (Hb <11 g/dl), and 33% had VA deficiency either by using RBP: TTR index (≤ 0.36) or serum retinol ($< 1.05 \mu\text{mol/L}$). Holo-RBP was significantly correlated with RBP:TTR index ($r=0.86$), serum retinol ($r=0.31$), gestational weeks, RBP, and TTR. The RBP:TTR index explained 74% of the variance in holo-RBP concentration, while retinol explained only 10% in a hierarchical stepwise regression analysis. Based on the above results, subjects were divided into VA-deficient and -sufficient using RBP:TTR index. Holo-RBP concentrations were significantly higher in VA sufficient women (n=185; Mean \pm SD=48 \pm 16 nM) compared to VA deficient women (n=74; 28 \pm 6 nM). Both groups were further stratified into three gestational groups (i:24-28 wk, ii:29-33 wk, iii:34-39 wk). Compared to VA deficient women, the concentration of holo-RBP in VA sufficient women significantly increased from group i (44 \pm 12.0 nM) to group iii (56 \pm 22.0 nM). The interaction between VA status and gestational weeks was significant in a factorial analysis. Our results indicate that VA deficient mothers have lower concentrations of holo-RBP that remain unchanged throughout the last trimester. We suggest re-examining current recommendations so that VA supplements could be provided in the last trimester of pregnancy to enhance VA stores of mothers and infants in populations, where VA deficiency is a public health problem.

T7 VALIDATION OF THE MODIFIED RELATIVE DOSE RESPONSE TEST AGAINST LIVER VITAMIN A FOR APPLICATION TO INFANTS AND WOMEN USING A SWINE MODEL. SA Tanumihardjo, AR Valentine and RL Surlis. University of Wisconsin-Madison, Dept. Nutritional Sciences, Madison, WI, USA.

Background: The modified relative dose response (MRDR) test is widely used in public health research to assess vitamin A (VA) status of populations and individuals. However, validation of the method against liver reserves in humans and method adjustments intended to make the test more useful in large field studies and/or less invasive have not been systematically verified. **Aim:** To compare the similarity between modified tests and the standard MRDR test, and validate both modified and standard tests against liver reserves of VA, we used a swine model. **Methods:** The standard MRDR test was applied to weanling piglets (n = 35) and sows (n = 5). MRDR values were compared to hepatic VA reserves from four different studies. The piglets received varying diet restrictions to ensure a broad range of VA liver reserves and the sows received a standard diet. The MRDR test was performed by giving each piglet 5.3 μmol and each sow 35 μmol of 3, 4-didehydroretinyl acetate and taking a blood sample 4-5 hours after dosing. This is the standard procedure used in developing countries. **Results:** Piglets with liver reserves $< 0.06 \mu\text{mol VA/g}$ invariably had MRDR values ≥ 0.060 , the accepted cut-off for subclinical deficiency. Almost half of piglets with liver reserves ≥ 0.06 and $\leq 0.10 \mu\text{mol VA/g}$ had an MRDR value ≥ 0.060 . In contrast, sows with a mean liver reserve of $0.73 \pm 0.21 \mu\text{mol/g}$ had a mean MRDR value of 0.018 ± 0.013 confirming adequate vitamin A status. Serum volumes as small as 200 μL , half the volume of the current standard analytical method, yielded accurate MRDR values. **Conclusions:** The MRDR test is applicable to infants and women and established cut-offs for deficiency remain valid. Normal physiology begins to deteriorate at $\leq 0.10 \mu\text{mol VA/g}$ liver. As 200 μL of serum can be used in the test, only 0.5 mL of blood needs to be collected from an infant. This adjustment allows for easier application of the test to infants from whom it is difficult to obtain a large venous blood sample, thus increasing the utility of the test for researchers. This project was supported by the International Potato Center, NIH NIDDK61973 and USDA-NRI 2003-35200-13754.

T6 HPLC METHODS FOR VITAMIN A IN SERUM AND CAROTENOID ANALYSIS: RESULTS OF VALIDATION PROCEDURE. IT Some, MN Zagre, M Ag Bendeck, H Deïse and IP Guissou. Laboratoire de Chimie Analytique, de Bromatologie, et de Toxicologie, UFR/SDS, Burkina Faso.

Background: Vitamin A deficiency is a major public health problem in developing countries and is not yet properly assessed. Recent studies showed poor performance in vitamin A analysis in developing countries while few African laboratories can afford carotenoid determination. **Methods:** This validation of retinol analysis was undertaken in hexane and in spiked serum. Carotenoid analysis was validated in hexane. The usual validity criteria for chemical determination were used. For retinol analysis, a liquid-liquid extraction from serum was done using hexane, with retinol acetate as internal standard. Echinenone was used as internal standard for carotenoids. Both methods used a reversed phase column RP 18 from Supelco (USA). The mobile phase of retinol analysis consists of a ternary phase containing 95% of methanol, 3 % of acetonitrile and 5 % of water whereas in carotenoid analysis, a mixture consisting of 70% of acetonitrile, 10 % of methanol and 10 % of methylenechloride was used. The HPLC methods were coupled with UV detection at 325 nm for retinol and retinol acetate and 450 nm for carotenoids analysis. **Results:** Good linearities ($r_2 = 0.99$) were obtained for all compounds. The carotenoids were zeaxanthine, echinenone, lycopene, β -cryptoxanthine and β -carotene. The dynamic range for all compounds goes from 0.25 pmoles μL to 1.50 pmoles μL . For retinol validation, the recovery for the spiked serum was between 93 and 103 % compared to the regression line in hexane and the between-day variation goes from de 0.69 to 3.78 % depending on the concentration. These recoveries were $100 \pm 10 \%$ for carotenoids and the precision as assessed by the coefficients of variation were less than 10 % for each carotenoid. The limit of quantification as well as limit of detection were around 0.10 pmoles μL for all the compounds. **Conclusions:** The methods are robust and the validated methods are used for the determination of vitamin A status in different studies undertaken in Burkina Faso and in the determination of carotenoids content in food. Key words: HPLC, Vitamin A deficiency, β -carotene

T8 ESTIMATION OF VITAMIN A DEFICIENCY IN INFANTS. FT Wieringa, MA Dijkhuizen and CE West. Depts. of Int. Med. and of Gastroent. and Hepat., Univ. Med. Ctr. Nijmegen, Netherlands; and Dept. Human Nutr., Wageningen Univ. Netherlands.

Background: It is now generally accepted that plasma retinol concentrations $< 0.70 \mu\text{mol/L}$ indicate marginal vitamin A deficiency. However, the appropriateness of this value in infants has not been established. **Aim:** To evaluate the appropriateness of plasma retinol concentrations $< 0.70 \mu\text{mol/L}$ as a cut-off value for indicating marginal vitamin A deficiency in infants. **Design:** Using data from a cross-sectional survey and an intervention trial in Indonesia, in which pregnant women were supplemented with β -carotene or placebo, plasma retinol concentrations of mother-infant pairs were examined. **Results:** In the cross-sectional survey, plasma retinol concentrations of infants (n=155), aged 2-10 months, were not only related to maternal vitamin A status ($\beta = 0.30$, $P < 0.001$), but also negatively correlated with age ($\beta = -0.17$, $P = 0.026$). In mother-infant pairs (n=214) in both the cross-sectional study and the placebo arm of intervention study, the prevalence of low plasma retinol concentrations in infants was much higher (57%) than in their mothers (20%). This may suggest physiologically lower retinol concentrations in infancy. Given the strong correlation in vitamin A status between mother and infant, the prevalence of vitamin A deficiency may be assumed to be approximately similar. Although supplementation with β -carotene and zinc during pregnancy reduced the prevalence of vitamin A deficiency in mothers (21% vs 9%, placebo vs supplementation) as well as in their infants (65% vs 33%), the prevalence of deficiency in infants was much higher in both groups. A cut-off value for vitamin A deficiency in infants of $0.50 \mu\text{mol/L}$ instead of $0.70 \mu\text{mol/L}$ would estimate the proportion of infants with vitamin A deficiency to be 27% and 7% respectively, which is much more in line with the prevalences in their mothers. **Conclusions:** The current cut-off values of plasma retinol concentrations for indicating marginal vitamin A deficiency in infants may not be appropriate, and more accurate cut-off values for infants need to be established.

- T9 IS THERE AN ASSOCIATION BETWEEN VITAMIN A STATUS AND SEVERITY OF ACUTE RESPIRATORY INFECTION IN CHILDREN?** M El-Mougi, S Gomaa, H Koura, R Fayad, H Ali, MA Aal. Pediatric Dpt Bab-E1-Sharaya Hospital, Cairo, Egypt.

Background: In Egypt 11.9% of preschool children are suffering from subclinical vitamin A deficiency (VAD). This is observed to be closely related to acute respiratory infection (ARI) among infants and children. **Aims:** to find the vitamin A status in ARI and its relation to the severity of illness. **Methods:** A hospital based case-control study was conducted. Inclusion criteria were presence of cough and or difficulty of breathing for a duration \leq 3 days, age 1-36 months and weight for length \geq 70% of reference median. Cases (n=25) included pneumonia (n= 15) and severe pneumonia (n=10) according to WHO classification while controls (n=25) were having cold. Each enrolled child was submitted to serum retinol estimation at 0 hour and 5 hours after oral administration of 1000 ug retinyl ester in oil to estimate the relative dose response (RDR). **Results:** cases and controls were comparable regarding age (11.7 \pm 10.5 and 12.2 \pm 9.8 months respectively), sex distribution, weight for length, plasma protein and type of feeding. The serum retinol was lower in pneumonia and severe pneumonia (21.9 \pm 5.4 and 23.4 \pm 6.5 ug/dl respectively) versus cold (25.3 \pm 8.9 ug/dl), however, the difference did not reach statistical significance. The positive RDR test ($>$ 20%) was 100% among cases with severe pneumonia and 14(93.3%) and 24(96%) for pneumonia, and cold respectively. Marginal serum retinol (10-20ug/dl) was more frequent among severe pneumonia (4, 40%) than pneumonia (4, 26.6%) and cold (5, 20%) **Conclusion:** ARI and in particular pneumonia and severe pneumonia tend to be associated with low or marginal serum retinol. It appears that it leads to depletion of vitamin A stores as measured by RDR test. This is in spite of the routine administration of 100,000 U of Vitamin A to all infants at 9 months though compliance to such procedure is not comprehensively evaluated.

- T11 SERUM VALUES OF INTERLEUKIN 10 APPEAR DIMINISHED IN CHILDREN WITH VITAMIN A DEFICIENCY DISORDERS.** J Leal, HV Castejón, T Romero, P Ortega, G Gómez, D Amaya, J Estévez. Biological Research Institute "DRES. Orlando J. Castejon and Haydee V. Castejon". Faculty of Medicine. Zulia University. Maracaibo, Venezuela.

Background: Vitamin A deficiency disorders (VADD) have been associated with alteration of cellular differentiation, the integrity of the epithelial mucosa, the production of antigens by epithelial cells, besides non-specific immune response, cellular immunity, and humoral immunity, and also increased children morbidity and mortality rate due to acute respiratory and intestinal infections. **Aim:** We evaluated both the functional status of vitamin A and serum concentration of Th1–Th2 cytokines in 138 pre-school children (F=72; M=66; 4–7y old) living in slums in Maracaibo, Venezuela, with adequate nutrition assessed by clinics and anthropometry. **Methods:** Vitamin A status was detected by ICEPO Conjunctival Impression Cytology (CIC) technique which determines sufficiency (Normal CIC, control) or deficiency (Abnormal CIC) of vitamin A. The cytokines IL-10, IL-4 and IFN- γ (pg/mL) were analyzed by ELISA method; and IL-2 (U/mL) by the EALISA method. Student's t test was applied to detect differences between values ($p < 0.05$). **Results:** No one child presented clinical evidence of VADD; 71 children (51.40%) exhibited normal CIC (control), whereas 67 children (48.60%) presented abnormal CIC indicative of sub-clinical manifestation of VADD. Prevalence was higher, although non significant in females, children 5-6y old and indigenous individuals (51.39%, 64.18% and 60.40%, respectively). Diminished serum concentration of IL-10 was detected in VADD children, in comparison with control group (4.41 \pm 1.27 pg/mL vs. 6.03 \pm 3.90 pg/mL) ($p < 0.03$). The rest of studied cytokines did not show significant differences with respect to control. **Conclusions:** The IL-10 diminution in VADD children would be related with alteration of inflammatory response at the level of respiratory and intestinal epithelia affected by infections. (Subventioned by CONDES-LUZ).

- T10 SEQUESTRATION OF VITAMIN A (VA) MAY JUSTIFY THE GENERAL USE OF VA SUPPLEMENTS TO TREAT MEASLES INFECTION.** SH Gieng, FJ Rosales. Department of Nutritional Sciences, The Pennsylvania State University, University Park, PA, USA.

Measles, a significant public health problem in the world, is associated with enhanced secretion of interleukin (IL)-6, inflammation, and subsequent hypoproteinemia. Using continuous IL-6 infusion to model measles-induced hypoproteinemia, we assessed tissue VA changes to understand how hypoproteinemia affects VA metabolism in the body. VA sufficient male Sprague-Dawley rats (177-199 g) were killed at 0 d (n=3) or continuously infused with PBS (n=8) or IL-6 (n=8, 65 μ g/kg/d) for 3 d (0.1 ml) or 7 d (0.2 ml) via osmotic minipumps implanted s.c. Blood samples, food intakes, and body weights were collected daily. Tissues were obtained at 0, 3 and 7 d and their VA levels were measured by HPLC after a liquid-liquid extraction, Folch purification or solid-phase extraction. Megalin (the proximal tubule receptor for the reabsorption of RBP) was measured by immunofluorescence. Plasma α -1-acid glycoprotein (AGP) was determined by radial immunodiffusion. Inflammation was confirmed in IL-6 by higher plasma AGP levels vs. PBS after 21 h up to 7 d. Plasma retinol (ROH) in IL-6 remained lower relative to baseline vs. PBS after 44 h (-49%, $p < 0.05$) up to 7 d. This was accompanied by a higher hepatic ROH vs. PBS at 7 d (+68%, $p < 0.05$). Hepatic and renal retinyl palmitate and retinoic acid, and renal megalin content and functionality did not differ between groups. Food intake and weight gain did not differ between groups. Hypoproteinemia explained by VA excreted in the urine or decreased food intake is unlikely because neither megalin levels and function nor food intake differed between groups. Other explanations may include an increased ROH catabolism or that plasma ROH was sequestered in the liver. We believe in the latter because of the increased hepatic ROH at 7 d. Besides the obvious misclassification of VA status due to inflammation, more important is to determine how ROH is sequestered and whether or not prolonged hypoproteinemia causes VA deficiency (VAD) in extra-hepatic tissues. This mechanism may explain the associated severity of measles infection. Taken together, these results suggest that ROH is sequestered in the liver during inflammation, possibly producing VAD in other tissues. Therefore, the general use of VA supplements for the treatment of measles infection in developed and less developed countries may be justified in order to overcome this.

- T12 EFFECTS OF MULTIPLE MICRONUTRIENT SUPPLEMENTS AND A FOOD RATION INTERVENTIONS AMONG ADULT MEN AND NON-PREGNANT AND NON LACTATING WOMEN LIVING WITH HIV/AIDS ON MICRONUTRIENT STATUS.** ASW Mburu, D Mwaniki, DL Thurnham, A deWagt and L Selenje Centre for Public Health Research, Kenya Medical Research Institute, Nairobi, Kenya, Northern Ireland Centre for Food and Health, University of Ulster at Coleraine, Coleraine, Northern Ireland, UK, Nutrition Section, UNICEF HQ, New York, USA, Nutrition Section, UNICEF-East and Southern Africa Regional Office (ESARO), Nairobi, Kenya.

Micronutrient deficiency is of public health significance in Sub Saharan Africa, a problem made worse by HIV/AIDS. Iron, zinc and vitamin A, which are the three most prevalent micronutrient deficiencies, also have significant roles in maintaining general health and wellbeing. Single micronutrient supplementation is widely used in combating micronutrient deficiency, however multiple micronutrient supplementation has been less explored. The effect of multiple micronutrient supplementation on the iron, vitamin A and zinc status of adult men and NPWL women living with HIV/AIDS was investigated, in a double blinded placebo controlled supplementation intervention using the UNICEF multiple micronutrient with added β -carotene. A food ration of precooked Maize: Soya flour (90%:10%) was provided to both groups. Follow up was for a period of 6 months. A total of 179 subjects were recruited, 116 women and 63 men. Results are presented as medians [25th and 75th percentiles]. In the placebo group, haemoglobin (Hb) at week 12 was significantly higher than baseline Hb ($P < 0.05$). There were no significant longitudinal differences in the supplement group. At week 12, β -carotene concentrations in the supplement group were significantly higher than at baseline 0.262 [0.106-0.421] μ mol/l and 0.754 [0.274-1.016] μ mol/l at week 12 ($P < 0.001$). β -carotene concentrations at week 12 were higher in the supplement group than in the placebo group (0.754 [0.274-1.016] μ mol/l vs. 0.210 [0.121-0.305] μ mol/l). There were significant differences in retinol concentrations between baseline and week 12 in both groups: supplement (baseline 1.23 [0.95-1.66] μ mol/l : week 12:- 1.42 [1.02-1.84] μ mol/l; $P < 0.05$) and placebo (baseline 1.20 [0.86-1.42] μ mol/l : week 12:- 1.37 [1.07-1.52] μ mol/l; $P < 0.05$). Zinc concentrations did not change significantly between baseline and week 12 or between the two groups. Zinc and retinol's plasma proteins are both negative acute phase reactants possibly explaining the absence of significant differences between groups. The suppression of circulatory iron concentration because of HIV induced inflammation, possibly resulted in the absence of changes in Hb concentrations in the supplement group, despite the presence of iron as well as a potent antioxidant base. The protracted effects of inflammation in HIV emphasize the importance of identifying additional markers less influenced by infection, to better assess the effects of supplementation. Acknowledgements to UNICEF for funding this study.

T13 SEROLOGICAL RESPONSES TO HEPATITIS B AND HAEMOPHILUS INFLUENZA B VACCINES IN INFANTS RECEIVING VITAMIN A IN GHANA. S Newton, S Owusu-Agyei, C Zandoh. Kintampo Health Research Centre, Kintampo Ghana.

Background: In 1995 the WHO coordinated a multi center trial to assess the benefits and safety of combining maternal (200,000IU) and low dose infant vitamin A supplementation (25,000IU) with EPI in a placebo controlled trial. The benefits on morbidity were not sustained beyond age 6 months when the infants would have received their conventional vitamin A supplements. The WHO is currently evaluating the response in doubling the post-partum dose to 400,000IU and the child doses to 50,000IU at each EPI contact. The Ministry of Health in Ghana has since January 2002 substituted DPT with the pentavalent vaccine (DPT-HepB+Hib) into her immunization programme. While we know the effect of Vitamin A on seroconversion to DPT, we do not know the effect on hepatitis B and *haemophilus influenzae* B. **Aim:** To evaluate the seroconversion rates of administering the pentavalent vaccine with vitamin A supplements using two different supplementation regimes.

- Supplementation of mothers (400,000IU) vitamin A at 6 weeks in two divided doses and supplementation of children (50,000IU) vitamin A at 6,10 and 14 weeks.

-Supplementation of mothers alone (400,000IU) vitamin A at 6 weeks in two divided doses.

Methods: Potential mothers will be visited at home by trained field workers, 7-10 post delivery and recruited into the trial. The trial will be explained verbally to the mother and consent sought for participation into the study. At the first EPI contact (6 weeks) a blood sample (1 ml heel prick sample) "pre-sample" will be collected from the child before any vaccination or dosing with vitamin A, for the assessment of antibodies for Hepatitis B and *Haemophilus influenzae* b. Four weeks after the third immunization i.e. at 18 weeks, children will be revisited and a "post sample" collected. The child then exits the study. **Programme implication:** The results from this study will be discussed at the meeting, we believe it will help allay the anxieties from EPI programmers about using EPI as a vehicle to delivering essential micronutrient interventions.

T14 SERUM RETINOL, INFECTION AND INTESTINAL PARASITES IN VITAMIN A SUPPLEMENTED CHILDREN IN NIGER. OZ Rhissa*, A Diawara*, H Hamani**, H Delisle*. *Université de Montréal, Canada; **Helen Keller International, Niger.

Introduction: Vitamin A (VA) supplementation twice a year should be effective in controlling VA deficiency in children. However, it is possible that a good proportion of children are again deficient only a few months after taking the supplement in areas with high rates of infection and intestinal parasites.

Objective: To identify health-related factors associated with child VA status 3 months after taking the VA supplement. **Methods:** 102 children aged 24-36 months were randomly selected in a district of Niamey, the capital city, and in four villages in a radius of 100 km from the capital. Serum retinol was used to assess VA status. Intestinal parasites were identified using two complementary stool tests. Recent child morbidity and sanitation were documented by observation and questionnaire. **Results:** The rate of low serum retinol ($<0.70\mu\text{mol/l}$) 3 months following supplementation was barely lower than before taking the supplement (34.4% vs 39.8%). Intestinal parasites, primarily protozoa (*G. intestinalis*, *E. histolytica*), were present in nearly 60% of the children. Health-related variables significantly associated with a better VA status in the follow-up survey included the absence of intestinal helminth (*H. nana*, *Oxyurus*), the presence of latrines in the home and access to running water. Children with symptoms of infection in the previous fortnight tended to have lower serum retinol concentrations than children who had not been ill. **Conclusion:** Additional measures of sanitation and control of infection/infestation are required for increased effectiveness of VA supplementation.

Funding: HKI, Thrasher Research Fund, CIDA.

T15 EFFECT OF RED PALM OIL ON RESPIRATORY TRACT INFECTION AMONG ADOLESCENT SCHOOL GIRLS. (1) N Sultana, PhD, Clinician, Institute of Public Health Nutrition, Dhaka, Bangladesh. (2) SMK Ali, PhD, Prof of Clinical Nutrition, INFS, Dhaka, Bangladesh. (3) M Rashid, PhD, Prof of Nutrition, NIPSOM, Dhaka, Bangladesh.

A cross sectional study was conducted to find out if school-going girls receiving Red Palm Oil in biscuits have a lower incidence of respiratory tract infection than in control girls.

The study was carried out amongst 150 students (100 cases and 50 controls) aged 13-15 years of grades IX and X attending a Government Girls' High School in Dhaka city. Each girl was supplemented with four biscuits made by adding Red Palm Oil shortenings, containing approximately 1500 μg of β -carotene. The girls consumed the same amount of biscuits for a period of 90 days.

A 24 hours dietary survey revealed that the mean vitamin A intake of study and control groups were 748.52 ± 62 IU and 776.98 ± 72 IU respectively. Those girls receiving Red Palm Oil had a 15% average positive growth (height for age) while no such change observed in the control group.

The incidence of respiratory tract infections reduced to 17% from 38% at base line with an overall improvement of 21% ($p < 0.02$). In contrast infections of similar nature in the control group showed a slight non-significant increase from 36% to 40%.

Red Palm Oil is the richest natural source of carotenoids (pro-vitamin A) as well as Vitamin E (composed chiefly of tocopherols and tocotrienols), both of which act as powerful antioxidants. The antioxidant function of these micronutrients were seen in previous studies to lower morbidity and mortality in pregnant/lactating as well as in other women of child bearing age. These findings also hold good in teenage girls where a substantial decrease in morbidity (respiratory tract infection) is observed.

T16 MATERNAL VITAMIN A STATUS AND LEVELS OF VITAMIN A IN BREAST MILK: A STUDY CONDUCTED IN A SEMI URBAN COMMUNITY OF PAKISTAN. R Bilal, S Roohi, F Siddiqui, A Yameen, Z. Latif, A Qadeer** and KA Abbass***. Address: Life Science Group, RIAD, PINSTECH PO NILORE, Islamabad Pakistan, *Allergy and Vaccine Production Laboratory, Biological Production Division, NIH, Islamabad, Pakistan, **Indoor lab., Pakistan Institute for Medical Sciences, Islamabad Pakistan, *** Prof of Pediatrics, Shifa College of Medicine Islamabad, Pakistan.

Background: Breast milk is generally higher in nutritional value than alternative foods and liquids fed to children, and it protects the infant against infectious diseases that can deplete vitamin A stores. Exclusive breastfeeding is recommended up to six months of age in infant, to provide optimum nutrition and as defense against infections. Studies have shown that the risk of vitamin A deficiency is higher for young children whose mothers are VA deficient. VA intake of a breastfed child depends on the VA status of the mother, the stage of lactation, and the quantity of breast milk consumed; therefore a systematic study was undertaken in a semi-urban community in Islamabad Pakistan, to assess the nutritional status of mother and relate it to the quantity and quality of breast milk, so as to determine its nutritional adequacy for the children. **Aim:** To check the nutritional adequacy of breast milk of malnourished mothers for quantity and quality, including retinol concentrations; 2) To measure the serum retinol concentration in malnourished pregnant women during last trimester of pregnancy and relate it to retinol in breast milk at one month post partum. **Method:** Malnourished pregnant women were selected on the basis of BMI, hemoglobin and serum ferritin during the last trimester of pregnancy. Blood samples were collected in the ninth month of pregnancy. The method of Faizan et al (1995) using HPLC was used to determine serum retinol concentration. Breast milk intake output was determined by deuterium dilution method at 1 month post partum. Milk samples were also collected from a subset, to determine the retinol concentration. The HPLC method of Tanumihardjo (2001) was used with some modifications for milk retinol estimates. **Results:** Milk intake averaged 740 ml/day, which is consistent with reports from other developing countries. Mean serum retinol was 33.6 ± 12.9 ug/dl and mean retinol in breast milk was 12.6 ± 12.5 ug/dl, which is significantly low in terms of meeting the VA requirement of the babies. **Conclusion:** The breast milk output of mothers was adequate. However, the quality of milk was poor for nutritional adequacy of VA. This raises the need of improving the nutritional status of the mother for quality milk output, so that exclusive breastfeeding can prevent morbidity and mortality in children.

T18 EFFECTS OF VITAMIN A SUPPLEMENTATION ON IMMUNITY IN PREGNANT AND LACTATING GHANAIAI WOMEN. S Cox, P Arthur, BR Kirkwood, JN Bulmer, K Yeboah-Antwi, H Tagbor and EM Riley. London School of Hygiene and Tropical Medicine, Keppel Street, London, WC1E 7HT, UK. Kintampo Health Research Centre, Ghana Health Service, PO Box 200, Brong Ahafo Region, Ghana. University of Newcastle, Victoria Royal Infirmary, Newcastle upon Tyne, NE1 4LP, UK. St Theresa's Hospital, PO Box 30, Nkoranza, Brong Ahafo Region, Ghana.

In animal models vitamin A deficiency (VAD) is associated with reductions in antibody responses and alterations in the balance of pro-inflammatory (Th1) to anti/non-inflammatory (Th2-Th3) cytokine responses. Despite the repeated demonstration that vitamin A supplementation (VAS) in populations with a high prevalence of clinical and/or subclinical VAD can reduce child mortality from infections, few studies have investigated effects of VAS on immune functions in humans, and none in pregnancy. Within a community trial of maternal VAS we investigated effects of VAS on cellular and humoral immunity in pregnant and lactating women. Cytokine responses to the mitogen PHA and the tuberculosis antigen PPD were assessed by ELISA in whole blood assays. Pregnancy, independent of VAS, reduced ratios of pro- to non-inflammatory cytokine responses. At post partum, but not during pregnancy, VAS significantly increased ratios of pro-inflammatory IFN- γ and TNF- α to non-inflammatory IL-10 ($p=0.03$ & $p=0.04$). Hence, VAS appears to reinforce/accelerate reversal of pregnancy-induced Th2/Th3 bias in the perinatal period and may therefore reduce the risk of perinatal infection. VAS was also associated with decreased plasma levels of IgG specific for erythrocytes infected with a placental isolate of *P. falciparum* ($p=0.002$); measured using flow cytometry. In addition, VAS was non-significantly associated with a decreased risk of active placental infection at delivery, compared to past, resolved infection (OR = 0.42, $p=0.08$). These results suggest that VAS may increase cell mediated immunity to malaria in pregnancy, resulting in a lower prevalence of active infection at delivery and therefore lower levels of malarial specific IgG. Taken together, our results suggest that VAS may have clinically important effects on immune functions in pregnant and lactating women, deserving further investigation.

T17 LOW BREAST MILK VITAMIN A AND ASSOCIATED RISK FACTORS AMONG LACTATING WOMEN OF THE KAREN TRIBE IN NORTHERN THAILAND. U Chittchang, P Sungpuag, A Nitithamying, N Silalai, P Sakharin, B Bampenpol, V Dhananiveskul, E Wasantwisut. Institute of Nutrition, Mahidol University, Thailand.

Background: Cases of xerophthalmia were reported among breast fed infants of Karen hilltribe in Northern Thailand. Potential underlying causes including maternal nutrition, dietary intake, quality of breast milk are essential for planning preventive strategies. **Aims:** To assess breast milk quality and identify associated risk factors. **Methods:** Breast milk of mothers during 2-12 months postpartum from the case-reported area (mountainous, far from market and rarely used cooking oil) and non-case reported area (peri-urban close to the market and district hospital) were collected to determine concentrations of vitamin A, fat, and caloric density. Twenty-four-hour dietary recall, anthropometry of mother and child were collected during dry and rainy seasons. **Results:** In the mountain area, energy intakes in the dry season (1,328 Kcal) were lower than that of rainy season (1,808 Kcal). The peri-urban group consumed higher calories than the mountain group. Breast milk vitamin A concentration was lower in the mountain lactating women (14.4 ± 2.6 ug/100 ml) compared to the peri-urban area group (24.5 ± 2.6 ug/100 ml). In the dry season, vitamin A in breast milk was significantly lower than those of rainy season. 83% of mothers in mountain area had breast milk vitamin A lower than 8 ug/g milk fat. In addition, caloric distribution from fat in both areas were less than 10 % through out the year. **Conclusion:** Breast milk vitamin A Karen lactating women were lower than normal. Risk factors associated with low breast milk vitamin A are low energy/fat intake in maternal diet, dry season, mountain areas. These factors can be used to plan dietary interventions targeting mothers in case-reported area to improve quality of breast milk and further prevention of infant xerophthalmia.

T19 THE ROLE OF GRANDMOTHERS 'MUSO KOROKA' IN STRENGTHENING POST PARTUM VITAMIN A SUPPLEMENTATION IN MALI: A QUALITATIVE ANALYSIS. D Kone, AM Sangaré, L Mahy, SI Bamba, H Diarra, J Abel. Helen Keller International Mali (DK, AMS, LM), Ministry of Health (SIB), Save the Children US (HD), The Grandmother Project (JA).

Background: Mali ranks 172th out of 175 countries in the Human Development Index (UNDP 2003). The high under-one mortality rate (113/1000) indicates that over 11% of children born will die before their first birthday; of these, half will die within their first month of life (M/DHS, 2001). Vitamin A Deficiency is a public health problem. **Objectives:** To strengthen the role of grandmothers (GMs) as key household health advisors by increasing their knowledge of priority nutrition practices particularly during pregnancy, the post partum (pp) period and with newborns. **Methods:** A qualitative community study showed that GMs are the primary resource persons for all issues related to women during pregnancy and the pp period. Prior to this study, GMs had never been invited to participate in community-level health or nutrition education activities. From July 2002, a strategy to involve GMs in nutrition communication activities, using stories and songs, was implemented in 48 villages in Koulikoro region. One of the priority messages was for GMs to encourage pregnant women to attend pre/postnatal visits. **Findings:** An evaluation in August 2003 showed that VAC coverage for pp women within 40 days of delivery increased from 7.5% to 80% in areas with functional health centres (HC) and from 4.5 to 20% in areas without HC. In the region, only 37% of women deliver in health facilities. The evaluation also showed that communication between mothers and GMs improved. **Conclusion:** VAC coverage appears to have increased considerably. This may be partly attributed to the innovative GM strategy: the influential GMs are encouraging young women to attend prenatal sessions, and take their VAC at the health centres (even when delivering their babies at home). GMs promote acceptance of new community norms which greatly facilitates adoption of improved practices by young women and their husbands.

T20 VITAMIN A-DEFICIENCY AND TRANSPLENTAL VITAMIN A DELIVERY. L Quadro (1,2), L Hamberger (2), CL Mendelsohn (3), ME Gottesman (2), V Colantuoni (1), WS Blaner (4). 1. Department of Biological and Environmental Sciences, University of Sannio, 82100 Benevento, Italy; 2. Institute of Cancer Research, 3. Department of Urology and 4. Department of Medicine, Columbia University, College of Physicians and Surgeons, New York, NY, USA.

Background: Vitamin A is an essential nutrient needed by humans to maintain good health. Among various essential physiological processes, vitamin A is required for normal embryonic development. Indeed, maternal sub-clinical vitamin A-deficiency is associated with maternal mortality, congenital abnormalities, including ocular, cardiac and urogenital defects, and low birth weight. The developing embryo acquires vitamin A from the maternal circulation through the placenta. Thus, the maternal vitamin A status influences significantly the vitamin A transfer to the fetus. **Aim:** To understand how optimal transfer of vitamin A to the developing fetus is achieved and to identify origins of adverse consequences associated with impaired maternal vitamin A status. **Methods & Results:** The use of an animal model is required to address these questions. Retinol bound to retinol-binding protein (RBP) and chylomicrons (postprandial vitamin A) are the major forms of vitamin A in the bloodstream. As our model, we have studied pregnant wild type and mice lacking RBP receiving different levels of vitamin A in their diet. We demonstrated that dietary (postprandial) vitamin A can serve as an important source of vitamin A for the embryo especially when the availability of maternal retinol-RBP is impaired. We also demonstrated that vitamin A deprivation during pregnancy of mice lacking RBP affects embryonic development as a consequence of a reduced vitamin A transfer across the placenta. **Conclusions:** Mice lacking RBP provide a uniquely useful model to study the impact of the maternal vitamin A status on transplacental delivery of vitamin A. Our data elucidate the role of maternal retinol-RBP and postprandial vitamin A in maintaining normal fetal development. They indicate that both of these pathways can contribute to support normal fetal development and vitamin A store accumulation. However, in a condition of severe maternal vitamin A-deficiency, the role of embryonic RBP becomes also crucial to ensure adequate distribution of vitamin A to the developing tissues.

T21 STRENGTHENING VITAMIN A SUPPLEMENTATION PROGRAMS THROUGH EFFECTIVE MONITORING: EXPERIENCES FROM INDIA, SOUTH AFRICA AND UGANDA. R Harvey (1), V Shastri (1), CB Witten (2), G Nchukana (3), L Sserunjogi (1). (1) MOST/USAID, (2) University of the Western Cape, South Africa, (3) Department of Health, Eastern Cape Province, South Africa.

Background: The keys to improving coverage of vitamin A programs are assuring logistics and an effective contact between providers and caretakers. To be effective, the contact must ensure that the correct dose is provided and that the caretaker understands that it is vitamin A her child has received, that she has done the right thing in bringing the child, and that she should return for another supplement in 6 months. **Aim:** To describe the monitoring methods used to review and strengthen vitamin A supplementation programs in 3 countries. **Methods:** Based on preceding work in immunization and growth promotion programs, short checklists were developed to assess provider skills and behaviors, exit interviews to assess the understanding caretakers gained from the encounter with providers and communication campaigns, and clinic audit to assess logistics and supplies at the service delivery point. These were designed for use by local program managers to enable them to evaluate their own programs. A sample of clinics or distribution points were selected in each area and rapid assessments were conducted using these tools during the distribution. In addition, interviews were conducted with service delivery personnel and program management, and program statistics compiled to review coverage. Collected data were fed back quickly into the program to improve training, support, communication, protocols, as needed, and to provide baselines for future activities. **Results:** In all three countries coverage of children 6-11 months was higher than in children 12-59 months, particularly where supplements were provided through routine services. Some areas still had problems with supplies. Coverage levels varied by catchment area, coverage correlated closely with level of planning and social mobilization in each district. In all three countries, nurses demonstrated basic understanding and skills for service provision, however there was minimal communication with caretakers. Understanding among caretakers was closely associated with the level of interaction with the service provider. Messages of when a child should return for the next dose were not sufficiently conveyed in any program. **Conclusion:** The assessment allowed program managers to re-visit VAS program objectives and expectations for service providers. It allowed specific problems to be identified and solutions to be defined for prompt action. Communications activities became better focused to reflect the changing needs of the program. Positive findings also highlighted achievements of the program.

T22 MONITORING OF VITAMIN A SUPPLEMENTATION IN UTTAR PRADESH REFLECTS CHALLENGES, NEED FOR CAPACITY BUILDING. R Tandon, VD Shastri, R Harvey. MOST/USAID, New Delhi, India.

Background: The Government of India plan for 2002-07 calls for integrating vitamin A supplementation (VAS) with routine child health services. MOST, the USAID Micronutrient Program, worked with other international agencies to assess the program in Uttar Pradesh. **Aim:** To determine the quality of services delivered during Vitamin A supplementation and routine immunization (VAS/RI) days, and to assess gaps in capacity building, information/ education/ communication (IEC), supply and logistics. **Method:** This paper summarizes the findings of monitoring exercise carried out during two successive rounds of VAS/RI. Sites were chosen from 15 randomly selected blocks of Uttar Pradesh. Observations were recorded about the immunization site, VAS procedures, and vaccine administration. Selected caregivers who brought children for VAS also took part in exit interviews. Finally, tally sheets completed by service providers underwent review. **Results:** VAS/RI services are highly compromised in Uttar Pradesh. Correct VAS dosing for children by age is not regularly ensured. Clean new syringes and needles were used in about 1/5th of cases observed, and needle disposal was frequently unsatisfactory. Very few children were asked to wait for 10 minutes following vaccination in order to be checked for related complications. At 1 in 3 sites, the cold chain was not maintained, and vaccines were improperly stored at 1 in 10 sites. Only half of mothers and other caregivers were informed by workers that the syrup being given to their child contained vitamin A. Less than 1/3rd of women were able to name a single benefit of Vitamin A. Around 3/5th of women were not told to bring their children for the next dose after 6 months, and when asked during exit interview if they would be willing to do so, only 2/5th of women agreed. At least 75% reported being unaware in advance that vitamin A would be distributed at the immunization site. **Conclusion:** There are still wide gaps in VAS/RI service delivery. Heightened training and capacity building are needed for field level functionaries. IEC/BCC activities must be prioritised in order to ensure that mothers and caregivers understand the importance of vitamin A and take advantage of the integrated program.

T23 EFFECT OF VITAMIN A AND ZINC SUPPLEMENTATION ON IMMUNE RESPONSE IN INDONESIAN PRESCHOOL CHILDREN. *MI Kartasurya, F Ahmed, GC Marks, HW Subagio, E Purwaningsih, MZ Rahliudin.* School of Population Health, The University of Queensland, Australia. Medical Faculty and Public Health Faculty, Diponegoro University, Semarang, Indonesia.

Background: The effects of vitamin A or zinc alone on immune function have been recognised. While the roles of zinc in vitamin A metabolism have been known for some times, very few studies have explored the effect of the interaction between vitamin A and zinc on immune function. **Aims:** To investigate the interaction of vitamin A and zinc in their effect on child immune response. **Methods:** This randomised controlled study was conducted on 831, 2-5 year old children in Semarang, Indonesia. The children were randomly divided into 2 groups, who received a daily supplement of either zinc (10mg elemental zinc) or placebo syrup for 4 months. Both groups also received a single dose of vitamin A capsule (200,000 IU) after 2 months of zinc supplementation. Two months after the zinc supplementation and just before the vitamin A supplementation, 80 children were randomly selected from each group and samples were collected to measure the serum IgG and salivary IgA levels. At the end of zinc supplementation (2 months after the vitamin A supplementation), another 80 children from each group were randomly chosen for the same immunological parameter measurements. Therefore, 4 groups were compared in this study: zinc only, vitamin A and zinc, vitamin A only and no zinc no vitamin A. **Results:** The results were based on the preliminary data analysis. At baseline, no significant difference was found in physical characteristics, hair zinc and serum retinol among the groups. Mean serum IgG and salivary IgA levels were not significantly different between zinc and placebo group either after 2 or 4 months of zinc supplementation. When the effect of vitamin A supplementation was examined in children with or without zinc, mean serum IgG and salivary IgA levels were also not significantly different. However, when looking at the frequency distribution patterns, we observed a change in the lower end of the distributions for salivary IgA and toward the higher end for serum IgG in the group who received both vitamin A and zinc. **Conclusion:** Vitamin A supplement alone or in combination with zinc did not affect the mean values for serum IgG and salivary IgA. Analysis of distributional changes indicate that those in both vitamin A and zinc group have some benefit compared to other group, especially those with low levels of salivary IgA. (Funded by Nestle Foundation Research Grant)

T24 SEASONAL INFLUENCES ON VITAMIN A INTAKE AND PREGNANCY OUTCOME IN WOMEN FROM URBAN SLUMS OF DELHI. *SJ Passi, B Tamber Aeri.* Reader in Nutrition, Research Scholar, Department of Foods and Nutrition, Institute of Home Economics (University of Delhi), F-4 Hauz Khas Enclave, New Delhi 110 016, INDIA.

Several factors have been associated with the high incidence of low birth weight deliveries -- maternal nutrition being the most important one. In the present study an effort has been made to find out the maternal factors influencing birth weight of the new-born; as well as whether fluctuations in seasonal availability and thus the consumption of micronutrient rich fresh vegetables and fruits bring about any variation in the pregnancy outcome/birth weight of the baby. **Methodology:** Secondary data from birth-records (n=36,555) have been gathered from a major government hospital (for the years 1989, 1998 and 1999; n = 33,786) and a maternity center (for five consecutive years 1997-2001; n = 2769) catering to health needs of lower socio-economic group. Data relating to maternal parameters and the new-born including the birth weight have been recorded. Further, primary data were also gathered from a cohort of 201 pregnant women followed from early pregnancy till childbirth. Their dietary intake, anthropometry (Ht, Wt, MUAC, abdominal girth, fundal height), Hb status and other parameters were studied at 18±2; 24±2; 30±2; and 36+ wks of gestation and the birth wt/birth length were recorded. **Results:** Secondary data indicated that birth weight of the new-born was significantly affected by the maternal age, pre-delivery body weight, haemoglobin status, parity, period of gestation and pregnancy-induced hypertension (p<0.05). Further, monthwise data indicated that babies born in February-March had the highest while those born in August had the lowest mean birth weight - both for the segregated and the pooled data (p< 0.05). The incidence of LBW deliveries was the minimum during March and the highest in August. Multiple linear regression analysis of the primary data (n=201) indicated that the dietary intake at 18±2 wks of gestation did not seem to affect the birth weight (r²=12); during 30±2 wks (r²=0.32), the intake of micronutrients especially iron, vitamin A and riboflavin had a significant influence; at term the energy, calcium and vitamin A intakes significantly influenced the birth weight (r²=0.34). Further, a stepwise multiple linear regression analysis indicated that haemoglobin status; vitamin A intake; past obstetric history; and weight gain at 30±2 weeks of gestation were significantly associated with birth weight. **Conclusion:** Results indicate that maternal nutritional status strongly influences the pregnancy outcome. Further, the seasonal availability/accessibility of micronutrient rich fresh foods, particularly DGLV/other vegetables/fruits and their increased consumption even by women from poorer communities bringing about an improvement in the birth weight/the pregnancy outcome. Hence, efforts need to be made to improve dietary intake particularly that of vitamin A through increased consumption of fresh vegetables/fruits and other food sources like Red Palm Oil.

T25 RISK FACTORS FOR NIGHT BLINDNESS AMONG NON-PREGNANT WOMEN IN INDONESIA. *M Sari, S de Pee, S Halati, E Martini, MW Bloem.* Helen Keller International (HKI), Jakarta, Indonesia and HKI Asia-Pacific Regional Office, Singapore.

Objective: To identify risk factors for night blindness among non-pregnant women in rural and urban poor populations of Indonesia. **Design:** A case-control study. **Setting and Subjects:** Data used for analysis were collected by the HKI/GOI Nutritional and Health Surveillance System (NSS) between Dec 2001 – May 2003 in rural East Java and South Sulawesi and urban poor areas of Surabaya and Makassar. The prevalence of night blindness among non-pregnant women in those four sites ranged from 0.93-4.03%. In total, 1217 cases and 3306 randomly selected controls (ratio of 1:3 per site) were included for analysis. **Methods:** Univariate and multivariate logistic regression models were used to estimate odds ratios (ORs) of factors associated with night blindness. **Results:** Multiple logistic regression analysis revealed that night blindness in the last pregnancy (OR 48.2, 95% CI 29.4-78.9), diarrhoea in the previous week (OR 1.7, 95% CI 1.0-3.0), parity>3 (OR 1.6, 95% CI 1.3-1.9), open latrine (OR 1.2, 95% CI 1.0-1.5), illiteracy (OR 1.4, 95% CI 0.9-2.1), not breastfeeding (OR 1.3, 95% CI 1.1-1.6), and lower educational level of mothers were associated with night blindness among non-pregnant women. **Conclusions:** Prevalence of night blindness among non-pregnant women in rural East Java and South Sulawesi and urban poor of Surabaya and Makassar was high and during pregnancy it was above the threshold of a public health problem (>5%). Night blindness during the previous pregnancy was strongly related to current night blindness. Programs to break this cycle of VAD, which affects both mothers as well as their infants, are urgently needed. Other risk factors include diarrhoea, high parity and low socio-economic status.

T26 RISK FACTORS FOR XEROPHTHALMIA AMONG MOTHERS AND THEIR CHILDREN AND FOR MOTHER-CHILD PAIRS WITH XEROPHTHALMIA IN CAMBODIA. RD Semba, S de Pee, D Panagides, O Poly, MW Bloem. Department of Ophthalmology, Johns Hopkins School of Medicine, Baltimore MD, Helen Keller International – Asia Pacific and New York, Ministry of Health, Kingdom of Cambodia.

Objective: To characterize the risk of xerophthalmia among non-pregnant women and children and risk factors for households in which both mother and child had xerophthalmia. **Methods:** In case-control analyses of > 15,000 households in the National Micronutrient Survey of Cambodia, univariate and multivariate logistic regression was used to estimate odds ratios (O.R.) for non-pregnant mothers, children, and mother-child pairs with xerophthalmia, using night blindness as the indicator. **Results:** Of 10,942 children, age \geq 18 to < 60 months, and 9,587 non-pregnant women, the adjusted prevalence of xerophthalmia was 0.67% and 1.90%, respectively. In multivariate analyses, a child was at higher risk of xerophthalmia when the mother had xerophthalmia (O.R. 4.36, 95% Confidence Interval [C.I.] 2.25-8.46) and a mother was at higher risk of xerophthalmia when a child had xerophthalmia (O.R. 9.21, [3.56-23.82]). Households were at higher risk to have both mother and child with xerophthalmia if there was a history of diarrhea in the mother (O.R. 6.48 [1.49-28.23]) or child aged 0 to \leq 60 months (O.R. 10.16 [1.55-66.62]) in the last two weeks. **Conclusions:** Xerophthalmia clusters among mothers and children in Cambodia and is associated with diarrheal disease. Interventions to address vitamin A deficiency should take a life-cycle approach, focus on vitamin A intake as well as diarrheal disease, and be aimed at the household level.

Recent Surveys

Tuesday, 16 November

T27 DAILY VITAMIN A INTAKE AND NUTRITIONAL DISORDERS IN PRESCHOOL CHILDREN: CASE OF THE NORTHWEST AREA OF MOROCCO. K El kari (1), L Borghos (1), N Benajiba (1), R Chabir (1), K Janah (1), N Schlossman (2), E Rjimat (3), A Bour (1), N Mokhtar (1), H Aguenau (1). 1- Laboratoire Nutrition Alimentation, université Ibn Tofail, Kenitra, Morocco. 2- Global Food, Washington D.C., U.S.A. 3- Ministère de la Santé, Direction de la Population.

Introduction: In an epidemiological study carried out among pre-school children in Northwest of Morocco, we found that, 25% of these children are stunted, 10% are wasted, 6% are under weight and 40.9% are vitamin A deficient. **Objective:** to determine the daily vitamin A intake (DVAI) and its impact on nutritional status in pre-school children of the Northwest Region of Morocco. **Methods:** 437 children aged between 6-59 months were selected for the study. A questionnaire was used to collect information on age, sex and nutritional status by anthropometrical measurements. Food frequency questionnaire (FQ) and the 24 hour dietary recall were used to assess dietary intake. Daily vitamin A Intake (DVAI) was calculated using a locally developed Software (Bilnut) based on the Moroccan diet. **Results:** 1- The mean DVAI of pre-school children was $451.5 \pm 16.8 \mu\text{g RE/d}$. 2- The percentage of the children whose DVAI < RDA was 53.7%. 3- The proportion of vitamin A from Vegetable (pro-vitamin A) was high (78.5%). 4- The Mean DVAI in children from rural area was $532.12 \pm 16.8 \mu\text{g RE/d}$. However in urban area the mean DVAI was only $383.6 \pm 19.1 \mu\text{g RE/d}$, the difference is statistically significant ($p = 0.000008$). 5- 42.5% of children from rural area have a DVAI < RDA compared to 62.3% in urban area 6- The consumption of vegetables and the fruits is more important in rural area. 7- The DVAI decreases when the number of children by household increases ($R = -0.83$). 8- The correlation between the DVAI and the various indices of the nutritional status (WHZ, WAZ and HAZ) is highly positive ($R \geq 0.75$). **Conclusion:** It seems that, in pre-school children of Northwest Region of Morocco, 1- The percentage of the children with DVAI < RDA is high. 2- The major source of vitamin A is from vegetables 3- The area of residence and the number of the children by household affect the DVAI. 4- Low Daily vitamin A Intake seems to be a risk factor of malnutrition of children in the Northwest area of Morocco. Key words: Daily vitamin A intake, pre-school children, nutritional status, Northwest Region of Morocco.

T28 VITAMIN A DEFICIENCY DISORDERS IN PRE-SCHOOL CHILDREN OF ERITREA. Z Alemu, S Mohammed, Primary Health Care Division, MOH, Eritrea.

Background: Micronutrient malnutrition is a major nutritional disorder in many developing countries. Vitamin A Deficiency Disorders (VADD) seems to prevail in Eritrea according to ecological indicators. **Aim:** to estimate the prevalence of VADD among pre-school children of Eritrea. **Methods:** A national cross-sectional population-based survey was carried out in December 2002. Following a double stage cluster sampling procedure 2131 children from 6-59 months of age, of both sexes, from urban and rural areas were screened for vitamin A status in December 2002. VADD was assessed by clinical signs of xerophthalmia, serum retinol levels (HPLC), and vitamin A rich-food intake (Food Frequency Questionnaire). Additionally, anthropometric measurements were taken and growth status was evaluated by the indices weight-for-age, height-for-age and weight-for-height, according to WHO criteria. **Results:** The prevalence of night blindness was 0.6% (95%CI 0.3-1.2), Bitot's spots 6.2% (95%CI 4.9-7.5), corneal xerosis 4.1% (95%CI 3.1-5.3) and corneal scars 4.1% (95%IC 3.1 – 5.3). Around 42.2% (95%CI 40.4-45.1) of children had serum retinol below $0.70 \mu\text{mol/L}$. Male ($p = 0.001$) and youngest ($p = 0.000$) children were more vulnerable to deficiency. The occurrence of infectious diseases ($p = 0.000$) and low immunisation coverage rates ($p = 0.004$) was strongly related to VADD. Vitamin A rich-food intake was very low. Only 17% (95%CI 15.4 – 18.7) and 23% (95%CI 21.2 – 24.9) of children consumed animal or plant sources, at least 3 times/week, respectively. According to the WHO/NCHS cut-off point (-2 SD), 38.2% (95%CI 36.1 – 40.3) of children were underweight, 38.4% (95%CI 36.3 – 40.3) stunted and 9.7% (95%CI 8.5 – 11.1) wasted. Growth faltering was associated with VADD. Stunted ($p = 0.016$), wasted ($p = 0.000$) and underweight ($p = 0.001$) children are more likely to have hyporetinolemia. **Conclusion:** VADD was considered a public health problem in the Eritrean context, according to the guidelines outlined by WHO. Concerted actions to overcome VADD are strongly recommended in this setting.

T29 SUBCLINICAL VITAMIN A DEFICIENCY IN ISRAELI-BEDOUIN TODDLERS. CL Coles (1), A Levy (2), R Gorodischer (3), R Dagan (4), RJ Deckelbaum (5), WS Blaner (5) and D Fraser (1,2), 1) S Daniel Abraham International Center for Health and Nutrition, Ben-Gurion University of the Negev, Beer Sheva, Israel; 2) Epidemiology and Health Services Evaluation Department, Faculty of Health Sciences, Ben-Gurion University of the Negev, Beer Sheva, Israel; 3) Department of Pediatrics, Soroka University Medical Center/Ben-Gurion University of the Negev, Beer Sheva, Israel; 4) Pediatric Infectious Disease Unit, Soroka University Medical Center/Ben-Gurion University of the Negev, Beer Sheva, Israel; 5) Department of Pediatrics and Institute of Human Nutrition, College of Physicians and Surgeons, Columbia University, New York, USA.

Objective: This study was designed to estimate the prevalence of and evaluate risk factors for subclinical vitamin A deficiency in Arab-Bedouin children at age 18 months, followed from birth. **Design:** Community-based, prospective, cohort study conducted in Rahat, a large Arab-Bedouin township, located near the city of Beer Sheva in the Negev region of southern Israel. **Subjects:** Healthy Bedouin infants (n=117) from the township, born at Soroka University Medical Center (SUMC) in Beer Sheva were randomly recruited at birth. Enrollment was restricted to well infants born weighing > 2,500 g at birth. **Results:** More than 15% of the children had serum retinol concentrations below 0.7 micromol/L. Male sex (Odds Ratio 4.17 [1.14 - 15.32], p=0.031), stunting at age 12 months (OR 10.09, [2.00 - 50.97], p=0.05), and warm season at age 18 months (OR 6.20 [1.36-28.28], p=0.018, were associated with vitamin A deficiency. Maternal education decreased the risk of vitamin A deficiency (OR 0.81, [0.68 - 0.95], p=0.011). **Conclusions:** Study results indicate a significant vitamin A deficiency problem among Bedouin children. Deficiency may be prevented by increasing dietary intake of vitamin A, especially during the warm season. Other interventions include preventing and controlling diarrheal diseases in order to avert nutritional stunting, and providing nutritional education to women of childbearing age.

T31 CO-EXISTENCE OF MICRO AND MACRONUTRIENT DEFICIENCIES AMONG CHILDREN 24-84 MONTHS OLD IN MARACAIBO, VENEZUELA. HV Castejón, P Ortega, D Amaya, J Leal, G Gómez. Biological Research Institute, Venezuela.

Iron deficiency anaemia has been associated with alteration of child development and psychomotor function, being myelination and dopaminergic functioning especially vulnerable. Iron deficiency, at different ages, has different effects on CNS, some of which may be reversible and others not. Vitamin A deficiency (VAD) and growth retardation have been related with anaemia. The present work was conducted in 202 Venezuelan children aged 24-84 mo, (104 girls, 98 boys) to evaluate the co-occurrence of anaemia, VAD and growth retardation by means of blood hemoglobin concentration (values <110 g/L in children < 60 mo old and <115 g/L in children 60 - 84 mo indicate anaemia), HPLC serum retinol (values < 20 µg/dL reveal VAD) and anthropometric indices (Height//Age and Weight//Age Z scores ≤ - 2 SD express stunting and underweight, respectively). Table displays the prevalence of conditions:

CONDITIONS	Total n:202 -100%	24 - < 48 mo n: 27-13.37%	48 - < 72 mo n: 13-64.85%	72 - 84 mo n: 44-21.78%
Vitamin A deficiency (VAD)	44 21.78	7 25.92	26 19.84	11 25.00
Anaemia	88 43.56	11 40.74	61 46.56	16 36.36
Stunting	29 14.36	2 7.40	17 12.97	10 22.72
Underweight	19 9.40	0 0.00	13 9.92	6 13.63
VAD + Anaemia	17 8.41	3 11.11	12 9.16	2 4.54
VAD + Stunting	6 2.97	1 3.70	4 3.05	1 2.27
VAD + Underweight	3 1.48	0 0.00	2 1.52	1 2.27
Anaemia + Stunting	13 5.94	1 3.70	9 6.87	3 6.81
Anaemia + Underweight	7 2.97	0 0.00	5 3.81	2 4.54
VAD + Anaemia + Stunting	2 0.99	0 0.00	2 1.52	0 0.00
VAD + Anaemia + Underweight	0 0.00	0 0.00	0 0.00	0 0.00

Prevalence of micronutrient deficiencies was higher, thus they should be simultaneously treated as virtually independent. CONDES-LUZ.

T30 DISCREPANCY BETWEEN VITAMIN A AND IRON AND ZINC STATUS IN 6-71-MONTH-OLD CHILDREN IN THE NORTHERN CAPE PROVINCE, SOUTH AFRICA. MA Dhansay, AC Joseph, SE Schoeman, AKC Joseph, JA Laubscher. Nutritional Intervention Research Unit and Biostatistics Unit, Medical Research Council, Cape Town and Sol Plaatje Municipality, Kimberley, South Africa.

Background: A national survey (SAVACG 1994) of South African children aged 6-71 months showed a 33% prevalence of vitamin A deficiency. Each of the provinces chose its own type of vitamin A supplementation, viz. targeted and/or blanket as part of the EPI. No national policy exists for addressing iron deficiency among young children. **Aim:** To determine vitamin A, iron, and zinc status in 6-71-month-old children, and to compare this with data from the SAVACG Study. **Methods:** A community-based cross-sectional study was done in Kimberley, Northern Cape Province, South Africa. In March 1999 the following regimen applied: 100 000IU retinol (Arovit®) at 9 months and 200 000IU at 18 months. No maternal supplementation was given. Children 6-71 months old (n=263) were studied: birthweight was recorded; weight and length/height measured; and haemoglobin (Hb), ferritin, retinol, and zinc were determined on blood obtained by antecubital venipuncture. Children were divided into those who were likely to have received vitamin A (VAG), or not (NVAG), based on age. **Results:** Mean VAG age was 26.6+/- 11.3mo, and NVAG 49.6+/-18.8mo (p<0.01); birthweight was 2908.6g and 2911.8g (NS); LBW 23%. Stunting 22%, underweight 12%, and wasting 0.8% was found. Mean retinol was 32.2+/- 9.9µg/dL and 30.7+/- 10.4µg/dL (NS); Hb 10.8 +/-1.1gdL and 11.4+/-0.9g/dL (p<0.01); ferritin 10.5+/-17.0µg/L and 12.9+/- 15.8µg/L (p<0.05); zinc 70.0+/-12.1µg/dL and 71.1+/-12.8µg/dL (NS). Overall prevalence of retinol<20µg/dL was 19.0%; ferritin<12µg/L was 85.8%, and zinc<70µg/dL was 55.3%. There was no difference between VAG and NVAG prevalence for retinol, ferritin or zinc. Anaemia (Hb<11g/dL) was present in 44.9%, and iron deficiency anaemia (Hb<11g/dL and ferritin<12µg/L) in 33.8%. Anaemia was more prevalent (55% vs 28%) in VAG. **Conclusion:** The prevalence of VAD was similar (19 vs 18.5%) but the prevalence of anaemia and iron deficiency anaemia was far higher than in the 1994 national study, 44.9% vs 21.5% and 33.8% vs 10.9%, respectively, emphasising the need for area-specific data. The results show that single nutrient interventions are not the answer. Fortification of maize meal and wheat flour with iron, retinol and zinc has been legislated in SA, which may help to address the problem. The younger age group, however, may need specific multi-micronutrient supplementation.

T32 VITAMIN A STATUS OF CHILDREN UNDER-5 IN NIGERIA: RESULTS OF THE NIGERIA FOOD CONSUMPTION AND NUTRITION SURVEY. B Maziya-Dixon (1), IO Akinyele (2), RA Sanusi (2), EB Oguntona (3), E Harris (4). 1. International Institute of Tropical Agriculture, Ibadan, Nigeria; 2. University of Ibadan, Ibadan, Nigeria; 3. University of Agriculture-Abeokuta, Abeokuta, Nigeria; 4. Beltsville Human Nutrition Research Center, USDA, Beltsville, MD, USA.

Vitamin A deficiency is a serious and widespread public health problem in developing countries. It is a common cause of childhood morbidity and mortality. In Nigeria, the infant and under-five mortality is 114/1000 and 187/1000 per thousand live births, respectively. To reduce the prevalence of vitamin A deficiency in Nigeria, the International Institute of Tropical Agriculture (IITA), in collaboration with the Federal Government of Nigeria (FGN), the United States Department of Agriculture (USDA), and various universities and institutions in the country conducted a baseline nationwide food consumption and nutrition survey in 2001 to inform strategies to address vitamin A deficiency in Nigeria. One of the objectives of the survey was to assess the vitamin A status of children under-5 years of age. A total of 12 States, 72 Local Government Areas, 216 Enumeration Areas, and 6480 households with a mother and child pair were sampled. Blood samples were collected for the determination of serum retinol. Results indicate that nationwide 29.5% of children under-5 was vitamin A deficient. The level of vitamin A deficiency was high at 31.3% in the dry savanna, 24.0% in the moist savanna, and 29.9% in the humid forest. More children with clinical deficiency lived in the humid forest (7.1%) than in the dry savanna (3.1%) and moist savanna (2.4%). The distribution of vitamin A deficient children under-5 was 25.6% in the rural, 32.6% in the medium, and 25.9% in the urban sectors. Further analysis revealed that 7.5% of the children in the medium sector, 3.4% in the urban sector, and 2.2% in the rural sector were clinically deficient. In conclusion, vitamin A deficiencies are a severe public health problem in Nigeria. While the proportion of children with low serum vitamin A levels varies agro-ecologically and across sectors, it is a significant public health problem in all agro-ecological zones and sectors.

T33 HIGH PREVALENCE OF ANEMIA, ZINC AND SUB-CLINICAL VITAMIN A DEFICIENCY IN INFANTS FROM 5-8 MONTH OF AGE IN A DISTRICT IN THE NORTHERN MOUNTAINOUS AREA IN VIETNAM. NX Ninh (1), HK Lap (2), CT Huong (1), NV Nhien (1), PV Hoan (1), NC Khan (1). (1) National Institute of Nutrition, Hanoi; (2) Thainguyen Medical College.

Background: Micronutrient deficiencies, such as vitamin A deficiency (VAD), iron deficiency anemia (IDA) and zinc deficiency (ZnD) are very frequent in children in developing countries. There was no data on these micronutrients in mountainous areas in Vietnam. **Aims:** To identify the micronutrient status such as IDA, sub-clinical-VAD, ZnD, and their risk factors associated to develop a suitable intervention approach. **Methods:** 323 infants and their mother from 6 communes, belong to Donghy district, a Northern mountainous areas in Vietnam were randomly selected to the study. Weight and length of the infants were measured by using specific instrument for infant and noted in one decimal precision, and then WAZ and HAZ-score were calculated by using NCHS reference. Two ml of venous blood was taken from 8h00-10h00 at the morning to determine the micronutrient status. Hemoglobin (Hb), serum retinol, and serum zinc were determined by using Cyanmethemoglobine, HPLC and AAS method respectively. Anemia, ZnD, and sub-clinical VAD were defined as Hb<110g/L, serum zinc <10.7 μ mol/L and serum retinol <0.7 μ mol/L. Other risk factors were determined by interview the mother of the infants. **Results:** Prevalence of stunting and wasting was 11.5% and 3.1% respectively. Prevalence of anemia, of sub-clinical VAD and ZnD were 77.7%, 39.3% and 38.7% respectively, belong to severe level in public health significance. Among 251 anemic infants, there were 112 (35%) ZnD infants, 107 (33%) sub-clinical VAD infants, and 87 (27%) infants combined with ZnD and sub-VAD. The infants of minority ethnic had twice-three time higher risk of anemia, ZnD and sub-clinical VAD than children of Kinh ethnic. Some of nutritional knowledge and practice of mother on breast-feeding, child-care, complementary food was improper. **Conclusion:** Prevalence of anemia, ZnD and sub-clinical VAD in infants from 5-8 month of age in a district along the northern mountainous area in Vietnam was belong to severe level of public health significance. The intervention approach should be concentrated on nutritional and practical communication, and accompanying with multi-macronutrient supplementation or providing complementary food fortified with vitamin A, Fe, Zn, and other micronutrients.

T35 VENEZUELAN NATIONAL SURVEY ON VITAMIN A DEFICIENCY IN CHILDREN FROM 6 TO 59 MONTHS OLD. MT Zabala, W Escalante, L Gómez, G Nadaff, M Páez, L Solano, M Perdomo. Instituto Nacional de Nutrición, MSDS. Fondo Internacional de las Naciones Unidas para la ayuda a la Infancia, UNICEF. Centro de Investigaciones en Nutrición (CEINUT), Universidad de Carabobo. Fundación de Epidemiología (Fundepi).

In order to determine prevalence of vitamin A deficiency in children from 6 to 59 months old, a national survey was conducted. Estimating a vitamin A deficiency prevalence of 10%, a sample of 1,393 children, obtained between August 2001 and September 2002, stratified by Unsatisfied Basic Needs method, according to age, gender, and rural or urban housing was assessed. Socio-demographic data and a blood sample was obtained from each child. C-reactive protein to detect acute infection and serum retinol were measured by nephelometry and HPLC, respectively. IVACG criteria was used to determine vitamin A deficiency (deficiency: serum retinol below 20 μ g/dL, marginal: 20-29.99 μ g/dL). 203 children were excluded from the survey due to high levels of C-reactive protein (<10 mg/L). Serum retinol concentration was 21.2 \pm 11.6 μ g/dL and no vitamin A deficiency was found. Marginal values of serum retinol were found in 5.27% of the children, without significant differences by gender. Prevalence by age were: 5.49% in children aged 6 to 23 months, 4.66% in children from 24 to 35 months, 6.92 % in children from 36 to 47 months and 2.49% in children from 49 to 59 months, being this last group significantly different from the others. According to socio-economic level, prevalence of marginal status was significantly different between level I (2.45%) and level II (6.95). Prevalence in rural and urban area was no statistically different (6.26% and 4.33%, $p>0.05$); and no difference was found between indigenous and non-indigenous children (5.77% and 5.02%, respectively). It is concluded that vitamin A deficiency was not found and no public health problem is present at the actual time but a situation of marginal status was observed and preventive measures should be taken in order to prevent further deterioration.

T34 MATERNAL VITAMIN A STATUS AND IRON STATUS VIS-A-VIS GROWTH, DEVELOPMENT AND HEALTH OF INFANTS FROM THE LOWER SES. K Paintal (1), SJ Passi (2). (1) Senior Research Fellow - ICMR; (2) Reader in Nutrition. Department of Foods and Nutrition, Institute of Home Economics (University of Delhi), F-4 Hauz Enclave, New Delhi - 110016, INDIA.

For children, in deprived settings, an adequate vitamin A status is more critical for protection against co-morbid illnesses rather than for growth and development. Breast milk vitamin A is protective against the development of deficiency symptoms and correcting the low vitamin A content of breast milk (in case of malnourished mothers) within the first four weeks of delivery by supplementing a concentrated dose of oral vitamin A can be an effective short-term preventive strategy, while efforts to improve their dietary intake could be a long term solution. **Objectives:** To estimate the dietary vitamin A and iron intakes of the nursing mothers and study how the maternal nutritional status as well as breast milk vitamin A levels influence the health, growth, development and morbidity patterns of young infants (0-6 months of age). **Methodology:** In a longitudinal cohort study, 87 infants from urban slum (n=42) and rural area (n=45) were followed from birth till 6 months of age. Monthly home visits were made and the required data were gathered on maternal dietary intake, maternal anthropometry and Hb level; breast-feeding patterns -- duration and frequency, quantification of breast milk (24hr infant test-weighing), vitamin A concentration (colorimetric estimation), infant's growth (anthropometry) and morbidity patterns. **Results:** The dietary data indicated that, the intake by the nursing mothers for all the macro/micro nutrients was much below the RDA. The mean energy and protein intake was 1295.2 \pm 510.5 kcal/day and 39.7 \pm 16.2g/day. The dietary vitamin A intake was 864 \pm 481.6 μ g/day (1st month), 867.5 \pm 456.9 μ g/day (4th month) and 808.8 \pm 437.69 μ g/day (6th month). Their mean iron intake was only 30% of the RDA; 9.3 \pm 4.1 mg/day (1st month), 8.9 \pm 4.1 mg/day (4th month) and 8.44 \pm 4.2 mg/day (6th month). The mean vitamin A concentration of the breast milk was 51.04 \pm 33.67 μ g/dl; although with the advancement of lactation, the mean vitamin A levels in breast milk had decreased, indicating a possible depletion of the maternal vitamin A stores. The morbidity pattern of the infants was found to be significantly associated with the volume and frequency of breast milk consumption ($p<0.05$). With regard to the breast milk vitamin A levels, the odds of morbidity was 0.96. The WAZ scores of 35.6% infants were between -1SD to -1.99SD while Z scores of 14.5% infants were (\leq 2SD), indicating that in a large number of these infants growth faltering had set in or they were moderately/severely malnourished. This, in a large number of cases could be contributed to recurring morbidity wherein Vitamin A status of the mothers could have a possible role to play.

T36 STATE-OF-THE-ART VITAMIN A ASSESSMENT METHODOLOGIES: REPORT OF A JOINT IAEA AND USAID EXPERT CONSULTANCY. SA Tanumihardjo, HC Furr, P Nestel, and N Mokhtar. Dept. Nutritional Sciences, UW-Madison, Madison, WI; CraftTechnologies, Wilson, N.C.; International Food Policy Research Institute, Washington, D.C., USA; and International Atomic Energy Agency, Vienna, Austria.

Background: In February 2004, the International Atomic Energy Agency (IAEA) and the United States Agency for International Development (USAID) brought together experts to discuss the progress of development of state-of-the-art methods to assess vitamin A status. **Aim:** To discuss the current status of vitamin A-related tracer/tracee studies as they relate to international health and to explore ways to expand their application. **Methods:** The methods reviewed included the modified relative dose response (MRDR) test, the deuterated retinol dilution (DRD) test, the ¹³C-retinol isotope dilution (¹³C-RID) test, and studies that included either deuterated- or ¹³C-labeled β -carotene. Both assessment of vitamin A status and bioefficacy of carotenoids were discussed. **Results:** Several field studies have been conducted with the MRDR test. New data in piglets suggest that the MRDR test can categorize vitamin A status in relation to liver reserves of a population. The MRDR has been used to determine the bioefficacy of sweet potatoes. The DRD test is a very sensitive indicator of vitamin A status and can be used to give a quantitative estimate of total body reserves of vitamin A. Both octadeuterated- β -carotene and β -carotene labeled with ten ¹³C's have been used to look at fruit and vegetable bioefficacy. β -Carotene bioequivalence from fruit and vegetables has been estimated using stable isotope methodologies. A shorter 3-day DRD test looks very promising. Active research is further developing mathematical models of vitamin A metabolism to generate appropriate prediction equations. **Conclusions:** The sophistication of methods to determine vitamin A status has greatly improved in the past decade. When looking at the continuum of indicators that can be used to assess vitamin A status, one needs to keep in mind the advantages and constraints of the methods as applied to the population of interest. The method chosen whether stable isotopes, MRDR test or functional indicators will be dictated by resources available and access to appropriate collaborations. Funded by IAEA and USAID.

T38 COMBINED MEASUREMENT OF RBP, STFR AND CRP IN ONE DRIED BLOOD SPOT (DBS) – A SIMPLE AND INEXPENSIVE EVALUATION OF VITAMIN A, IRON AND INFECTIOUS STATUS. JG Erhardt, JE Estes, NE Craft. SEAMEO, Regional Center for Community Nutrition, University of Indonesia, Jakarta, Indonesia and Craft Technologies, Inc, Wilson, NC, USA.

Background: Iron and vitamin A deficiency are worldwide two of the most prevalent micronutrient deficiencies. Therefore a simple and cost effective measurement of these deficiencies is of high priority. RBP for the vitamin A status and sTfR for the iron status are promising indicators that are readily amenable to dried blood spots. In addition, CRP can be used to test for the presence of infection which influences the assessment of the Vitamin A and iron status. **Aims:** The objectives of this study were first to establish a simple and inexpensive ELISA method for each of the analytes, RBP, sTfR and CRP using a common approach. Then to apply these methods to appropriately diluted dried blood spot extracts. **Methods:** RBP, s-TfR and CRP in a 6 mm DBS punch were extracted with water overnight in the fridge. The same extract was used at different dilutions in each of the sandwich ELISA's. Antibodies for RBP and CRP were from DAKO, Denmark and for sTfR from Hytest, Finland. **Results:** The CV's of RBP, sTfR and CRP in DBS were < 10% with good linearity ($r^2 = 0.99$) for the calibration curves. Good correlations ($r^2 > 0.90$) were observed between DBS RBP and plasma retinol by HPLC; and for sTfR and CRP in DBS with plasma sTfR and CRP measured by commercially available kits. **Conclusion:** This procedure enables the reliable and cost effective determination of vitamin A and iron status in DBS without venous blood sampling, centrifugation or freezing which is especially useful for remote areas in developing countries.

T37 RAPID, FIELD-BASED ASSESSMENT OF VITAMIN A DEFICIENCY AMONG POPULATIONS USING RETINOL BINDING PROTEIN. J Hix, C Barfield, T Burgess-Cassler, I Buchanan, J Gorstein, and M Tam. Program for Appropriate Technology in Health (PATH) and International Health Program, School of Public Health, University of Washington, Seattle, WA; and Vista Diagnostics, Kirkland, WA.

Retinol binding protein (RBP) has been established as a surrogate indicator of serum retinol to assess vitamin A (VA) status at the population level. We have developed two assays for analysis of RBP. The enzyme immunoassay (EIA) is a low-cost tool for quantitative VA assessment at the reference level that produces results in an hour. The rapid, simple, immunochromatographic strip (ICS) test to provide a semi-quantitative estimate of RBP relative to serum retinol was developed as a tool to further extend vitamin A deficiency (VAD) assessment into the field.

To demonstrate utility of the RBP-EIA, PATH analyzed 90 dried blood spot (DBS) specimens collected as capillary blood from children in Zimbabwe. These were compared to serum retinol analyzed by high performance liquid chromatography (HPLC). Statistical analyses were conducted to assess agreement between the two indicators. When the data were dichotomized using internationally accepted 0.70 μ mol retinol/L cutoff value to classify VAD, 60% sensitivity and 98% specificity were calculated. By raising the cutoff value to 0.775 μ mol retinol/L, as suggested by receiver operating characteristic analysis, there was significant improvement in sensitivity (80%) with little change in specificity (95%).

The ICS test is designed to estimate RBP and determine VAD relative to serum retinol cutoff of 0.70 μ mol/L recommended by WHO/IVACG and uses 5 μ L of serum. Assay time is 10 minutes. In an initial laboratory validation using sera collected in Nicaragua, the RBP-ICS correlated well with serum retinol, but with a slightly higher estimate of VAD in this specimen panel. Comparing the RBP-ICS vs. HPLC retinol values, sensitivity and specificity were 72.7% and 93.3%, respectively, with a screening efficiency of >91% in determining VAD.

Based on preliminary evaluation, significant correlation was observed between the RBP-EIA and HPLC-retinol in estimating VAD from DBS. These results point to the potential use of DBS samples from capillary blood as specimens for VA assessment. These would be simpler to prepare than serum and easier to transport to reference centers for analysis, but must be collected and handled correctly. We also conclude that the rapid and simple ICS method using serum specimens is promising and could provide sufficient accuracy as an additional tool for field use in micronutrient programs.

T39 VALIDITY OF BLOOD SPOT IN ASSESSING VITAMIN A DEFICIENCY IN PREGNANT NEPALESE WOMEN. R Klemm, P Christian, N Craft, SK Khatry, KP West, Jr. Ctr for Human Nutr, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD, USA; Nepal Nutrition Intervention Project-Sarlahi (NNIPS), Kathmandu, Nepal and Craft Technologies, Wilson, NC, USA.

Background: There is a need to develop logistically simple, inexpensive yet valid field methods for assessing vitamin A status. This study compared validity of blood spot retinol (BSR) as an indicator of vitamin A status in relation to serum retinol (SR) in pregnant Nepalese women. **Methods:** Blood samples were collected by venipuncture from 146 pregnant women enrolled in a community-based maternal vitamin A and beta-carotene supplementation trial (West et al BMJ 1999). Millipore blood-collection cards were spotted with whole blood that remained in butterfly tubing following venipuncture, dried overnight at ambient temperature, placed in ziplock plastic bags with loose silica desiccant, stored at -10 C for several months, shipped unfrozen in styrofoam boxes, stored at -20 C and analyzed by HPLC a year after collection. BSR levels were compared against SR levels, unadjusted and adjusted for concurrent Hb, gestational age and triglyceride levels. **Results:** Mean \pm SD SR and BSR concentrations were 1.17 \pm 0.40 and 1.22 \pm 0.42 μ mol/L. BSR correctly identified 18 of 20 subjects whose SR was <0.70 μ mol/L (90% sensitivity) and 126 pregnant women who were not deficient (100% specificity), yielding a PPV of 100% and a NPV of 98.4%. BSR alone explained 69% of the variation of SR ($R^2=0.69$) in this sample of pregnant women whose SR concentrations ranged from 0.20 to 2.52 μ mol/L. Adjustment for Hb concentration, gestational age or triglyceride level did not change the R^2 . **Conclusion:** BSR exhibited excellent sensitivity, specificity and predictive values vs the conventional SR cutoff of 0.70 μ mol/L. BSR is a valid, simple alternative for assessing prevalence of VA deficiency in populations where logistical simplicity for specimen collection is paramount. Funded by USAID Ofc Hlth, Inf Dis & Nutr, Wash DC; The Gates Foundation, Seattle, WA & Sight & Life Research Institute, Baltimore, MD, USA.

T40 IMPACT OF C-REACTIVE PROTEIN ON RETINOL CONCENTRATIONS OF ZAMBIAN CHILDREN. CA Northrop-Clewes, C Mwela, C Kankasa, J Welsh, E Politzer, W Siamasantu, L Grummer-Strawn. Centers for Disease Control and Prevention, Atlanta, USA, MOST, Zambia, University of Zambia, National Food and Nutrition Commission, Zambia.

Background: The presence of infection as measured by a raised C-reactive protein (CRP) concentration has been shown to reduce plasma retinol concentrations by 25% (Thurnham et al Lancet, 2003). **Aims:** To look at the impact of CRP on plasma retinol concentration in children 6-59 months. **Methods:** A national random cluster survey collected capillary blood at two time points, in July 2003 just after a Child Health Week (CHW) when vitamin A capsules were distributed, and in November just before the next CHW. The final biochemical results are presented. **Results:** Of the 380 children surveyed in July and 386 in November, plasma retinol concentrations were measured in 318 samples in July and 342 in November. The overall mean (SD) retinol concentrations in July and November were 0.73 (0.26) and 0.71 (0.25) $\mu\text{mol/L}$ respectively ($P = 0.488$, ANOVA). Retinol concentrations $< 0.35 \mu\text{mol/L}$ were found in 5% of children at both time points and values $< 0.7 \mu\text{mol/L}$ in 51% of children in July and 54% November. CRP results were available from 120 (38%) subjects in July and 178 (52%) in November. The table shows plasma retinol concentrations corrected for the presence of infection where CRP was $\geq 5 \text{ mg/L}$. Using the corrected values, 33 and 43% of children had retinol concentrations $< 0.7 \mu\text{mol/L}$.

	July Retinol $\mu\text{mol/L}$		November Retinol $\mu\text{mol/L}$	
	Uncorrected	Corrected	Uncorrected	Corrected
CRP $\geq 5 \text{ mg/L}$	0.61 n=51	0.76 n=51	0.62 n=68	0.77 n=68
CRP $< 5 \text{ mg/L}$	0.87 n=67	0.87 n=67	0.80 n=109	0.80 n=109
Total	0.73 n=118	0.82 n=118	0.71 n=177	0.79 n=177

Conclusion: Correcting for the presence of infection using CRP alone raised the mean plasma retinol concentrations by approximately 10% overall. The retinol concentrations of those with no infection, as defined by a normal CRP value, were 13-20% lower than the UK mean for pre-school children (1.0 $\mu\text{mol/L}$).

T41 PREGNANCY AFFECTS PLASMA CONCENTRATIONS OF RETINOL AND ACUTE PHASE PROTEINS. MA Dijkhuizen, FT Wieringa and CE West. Depts. of Int. Med. and of Gastroent. and Hepat., Univ. Med. Ctr. Nijmegen, Netherlands; and Dept. Human Nutr., Wageningen Univ. Netherlands.

Background: Physiological changes during pregnancy affect plasma retinol concentrations. Retinol concentrations are also affected by the acute phase response (APR), with thresholds established for several acute phase proteins (APP). However, pregnancy also affects APP concentrations. **Aims:** To quantify the effect of pregnancy on retinol and APP concentrations, and to determine appropriate thresholds in pregnancy. **Design:** Plasma concentrations of retinol, C-reactive protein (CRP) and $\alpha 1$ -acid glycoprotein (AGP) were measured in 120 Indonesian pregnant women, participating in a supplementation trial, in the 1-st and 3-rd trimester of pregnancy and 6 mo post-partum. **Results:** Mean plasma retinol concentrations declined by 20% from the 1-st (1.04 $\pm 0.25 \mu\text{mol/L}$) to the 3-rd trimester (0.83 $\pm 0.25 \mu\text{mol/L}$) and did not differ among the groups. Concentrations in the 1-st trimester were 10% higher than 6 mo post-partum (placebo group), interpreted as a progressive decline in vitamin A status during pregnancy and lactation. Concentrations in the 3-rd trimester however were 12% lower than 6 mo post-partum, probably reflecting reversible effects of hemodilution. CRP concentrations were significantly increased during pregnancy, with the highest concentrations in the 3-rd trimester. In contrast, AGP concentrations were significantly decreased during pregnancy, with the lowest concentrations in the 3-rd trimester. Assuming similar infection rates in pregnancy as at 6 mo post-partum (with CRP $> 5 \text{ mg/L}$ or AGP $> 1.0 \text{ g/L}$), more appropriate thresholds during the 1-st and 3-rd trimester were estimated for CRP (11.2 and 12.0 mg/L) and AGP (0.69 and 0.49 g/L). **Conclusion:** Pregnancy affects plasma concentrations of retinol and APP, making the determination of vitamin A status and APR during pregnancy less straightforward. Current definitions may not be appropriate. New cut-off values for APP during pregnancy are proposed. More data are required on plasma retinol concentrations in pregnancy.

T42 COMPLEX INTERACTIONS WITH INFECTION & DIET MAY EXPLAIN SEASONAL GROWTH RESPONSES TO VITAMIN A IN PRESCHOOL CHILDREN. H Hadi, MJ Dibley, and KP West Jr. Ctr for Health and Human Nutr, Gadjah Mada University, Indonesia; Ctr for Clin Epid & Biostatistics, Faculty of Health, University of Newcastle, Australia; Ctr for Human Nutr, Dept of International Health, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD, USA.

Background: The effect of vitamin A supplementation on growth is modified by age, respiratory infection, initial vitamin A status and season. However, the biological mechanism behind the seasonal effect of vitamin A on growth remains unclear. **Objective:** To explore the potential contribution of respiratory infections and vitamin A intakes to the seasonal effect of vitamin A supplementation on child growth. **Methods:** Data from a randomized double-blind placebo controlled trial, in which a single high dose of vitamin A or placebo was given every 4 months to 1405 children aged 6-48 months were used for the analysis. In total 4430 child-treatment-cycles were examined, and for each cycle the children had their dietary intake, percentage of days with respiratory infections, weight and height measured. **Results:** This study showed that a significant effect of vitamin A supplementation on linear growth was observed in all seasons in children with a low burden of respiratory infections i.e. $< 21.5\%$ of days with respiratory illness. In each season, the highest effect was found in children with a low burden of respiratory infections and low vitamin A intakes i.e. intakes $< 400 \text{ RE/d}$. Children with a high burden of respiratory infections or high vitamin A intakes benefited less from vitamin A supplementation for their linear growth than children with a low burden of respiratory infections and low vitamin A intakes. Finally, there was no benefit for linear growth from vitamin A supplementation in children with both a high burden of respiratory infections and high vitamin A intakes regardless of the season. **Conclusions:** The effect of vitamin A supplementation on growth is dependent on season. Respiratory infections and vitamin A intakes are important factors underlying the seasonal effect of vitamin A supplementation on growth.

T43 IMPACT OF NEONATAL AND MATERNAL VITAMIN A SUPPLEMENTATION ON ANEMIA AMONG INFANTS BORN TO HIV-POSITIVE AND HIV-NEGATIVE MOTHERS IN ZIMBABWE. MF Miller, RJ Stoltzfus, PJ Iliff, LC Malaba, NV Mbuya, JH Humphrey. National Cancer Institute, Bethesda MD; Dept Intl Hlth, Johns Hopkins School of Public Health, Baltimore MD; Univ of Zimbabwe, Harare; DNS, Cornell University, Ithaca NY.

Background: Vitamin A has long been known to play a role in hematopoiesis. **Aims:** To determine whether vitamin A supplementation (VAS) reduces anemia (hemoglobin $< 105 \text{ g/L}$) in Zimbabwean infants and to examine potential underlying causes of postnatal anemia. **Methods:** We followed from birth to 8-14 mo of age 225 babies born to HIV-negative mothers, and 210 babies born to HIV-positive mothers who themselves became infected and 742 who remained uninfected. Mother-infant pairs were enrolled in the Zimbabwe Vitamin A for Mothers and Babies (ZVITAMBO) project and randomized to treatment: (1) mother 400,000 IU, infant 50,000 IU (AA, $n=295$), (2) mother 400,000 IU, infant placebo (AP, $n=302$), (3) mother placebo, infant 50,000 IU (PA, $n=293$), (4) mother and infant placebo (PP, $n=287$). **Results:** There was no effect of VAS on anemia in univariate analysis, but after adjusting for other determinants of anemia, there was a significant interaction between infant and maternal VAS on anemia ($P=0.01$). Compared to the PP group, the adjusted odds ratio (95% CI) for anemia associated with the AP, PA and AA groups, respectively, was 0.86 (0.59, 1.23; $P=0.41$), 0.65 (0.45, 0.94; $P=0.02$), and 1.07 (0.75, 1.55, $P=0.70$). Anemia was more common in HIV-positive infants (76.7%) than in negative babies of HIV-positive mothers (38.3%) and HIV-negative mothers (43.6%), and predictors of anemia differed by infant infection status. Infant infection independently increased the risk of anemia 6-fold after adjusting for other determinants of anemia. The common predictors of anemia among HIV-negative and positive infants were male sex, lower total body iron at birth, and exclusive breastfeeding $< 6 \text{ wk}$. Additionally among HIV-positive infants, risk of anemia increased with earlier infection, lower maternal CD4+ lymphocyte count at delivery, and common morbidity (fever, diarrhea and/or cough). Six-month plasma ferritin $< 12 \mu\text{g/L}$ was a risk factor among HIV-negative but not positive infants. Maternal HIV infection alone did not cause anemia. **Conclusions:** Prevention of infantile anemia should include efforts to increase the birth endowment of iron, prevent HIV infection and promote exclusive breastfeeding. VAS may play an important role in reducing anemia, but the dosing strategy should be further explored.

T44 IMPACT OF POSTPARTUM VAS OF HIV+ AND HIV- WOMEN AND THEIR INFANTS ON SERUM RETINOL CONCENTRATION AND MORBIDITY. J Humphrey, L Malaba, P Iliff, F Muzengeza, J Hargrove, R Ntozini, and the ZVITAMBO Study Group. University of Zimbabwe (Harare), Harare City Health Dept, Johns Hopkins Bloomberg School of Public Health (Baltimore, MD, USA), McGill University Health Centres Research Institute (Montreal, Quebec, Canada).

ZVITAMBO was a randomized placebo (PL)-controlled, 2X2 factorial design trial to investigate the impact of a single large dose of VA to infants (50,000 IU), their mothers (400,000 IU), or both during the immediate post-partum period. 14,110 mother-baby pairs were enrolled and followed at 3 monthly intervals for 12-24 mo. At baseline, 4496 (32%) mothers were HIV+. At the XXI IVACG, we presented primary outcomes: the intervention had no effect on infant mortality, postnatal mother-to-child HIV transmission, incident maternal HIV infection, or maternal mortality. Further analysis of these data suggests there was little VA deficiency in the study population. Among HIV-women, the mean change in serum retinol (SR) between baseline and 6 wk was greater for VA compared to PL group, but the distribution at 6 wk in both groups was similar to that of well-nourished populations. Among HIV+ women, a treatment effect was observed only among those whose baseline CD4 was <200 cell x 10⁶/l. At 6 wk, among all other HIV+ women (except those with CD4<200 in the PL group), mean SR was ~1.22 µmol/l with ~30% remaining <1.05 µmol/l, regardless of their baseline CD4 or whether or not they had received VA. Among women in the VA group, the 6 wk SR distribution was about 35% higher among HIV- compared to HIV+ women, even those with the highest CD4 counts, suggesting that the hyporetinolemia of HIV is not responsive to VA supplementation and may result primarily from a chronic response to HIV itself, and only secondarily to opportunistic infections which occur primarily during end-stage HIV disease. If true, SR surveys in HIV endemic areas should include HIV testing. Further lab and data analysis exploring this hypothesis is underway and will be presented. Preliminary analysis suggests that while VAS did not affect mortality, it may have reduced severe morbidity. Among HIV+ women during the 6 wk following supplementation, VAS was associated with a 21% reduction in sick clinic visits and a 40% reduction in hospitalizations. Similar analyses are being conducted beyond the first 6 wk for HIV+ women and over the first year of life for HIV+ and HIV- infants, and will be presented. Funded by Canadian International Development Agency and United States Agency for International Development.

T46 TREATMENT EFFECTS OF MATERNAL MICRONUTRIENT SUPPLEMENTATION VARY BY PERCENTILES OF THE BIRTH WEIGHT DISTRIBUTION IN NEPAL. J Katz*, P Christian*, K West*, SK Khatri**, SR Shrestha**, SC LeClerq*, F Dominici* and S Zeger*. *Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA; ** Nepal Nutrition Intervention Project Sarlahi, Kathmandu, Nepal.

Antenatal micronutrient supplementation increased mean birth weight by 40-70 g in a rural population in Nepal (BMJ 2003;326:571-6). The impact was estimated by calculating the mean difference in birth weight between control and treatment groups assuming a constant treatment effect across the distribution of birth weights. We propose an analysis that compares differences (and confidence intervals) in birth weight between treatment and control groups modeled as a non-linear, but smooth function of the percentile of the birth weight distribution. Supplementation groups were folic acid, folic acid+iron, folic acid+iron+zinc and a multiple micronutrient supplement all with vitamin A compared against the control group (vitamin A alone). Treatment effects in the multiple micronutrient group appeared to be constant across the birth weight distribution, whereas the effect of folic acid+iron was observed mainly in the lower and middle parts of the birth weight distribution, while being close to 0 or negative in the upper tail. The biologic pathways affecting intrauterine growth may vary by micronutrients such that some (such as iron) may confer a benefit among the most vulnerable infants, whereas others may have a more constant effect across the spectrum of birth weight. Future analytic approaches of estimating benefits of maternal supplementation on birth weight should examine whether there is a constant or variable effect across the distribution of birth weight. This study was funded by USAID, Washington DC; Bill & Melinda Gates Foundation, Seattle; Unicef, Nepal; Task Force Sight and Life Research Institute, Switzerland; Roche, Brazil and CE Jameison, Canada.

T45 IMPACT OF ANTENATAL MICRONUTRIENT SUPPLEMENTATION ON SELF-REPORTED LABOR AND DELIVERY COMPLICATIONS AND PUERPERAL MORBIDITY. P Christian, KP West Jr., J Katz, SK Khatri, SR Shrestha. Center for Human Nutrition, Johns Hopkins Bloomberg School of Public Health, Baltimore MD and the Society for Prevention of Blindness, Kathmandu, Nepal.

Reproductive morbidity is high in rural underserved populations where access to antenatal and obstetric care is lacking. The extent to which antenatal micronutrients can prevent maternal morbidity is not known. We present data from a randomized controlled, trial in Nepal which examined the efficacy of 4 combinations of supplemental antenatal micronutrients (folic acid, folic acid+iron, folic acid+iron+zinc and a "multiple micronutrient" (MM) supplement with all 3 plus 11 others, on birth outcomes. Almost 95% of women in this area deliver at home. Women were visited at home shortly after birth and interviewed about labor and delivery complications. They were also visited daily for the next 9 days to get 24-h histories on 12 morbidity symptoms and for body temperature measurement. There was an increased risk of obstructed and prolonged labor (>15 h), longer time of "pushing", and forceps/vacuum/C-section-assisted deliveries associated with MM supplementation. On the other hand, symptoms of premature rupture of membrane were lower in women who received MM. Folic acid supplementation alone was associated with fewer reports of convulsions, and placental retention and breakage, whereas folic acid + iron may have also reduced risk of severe illness in the 7-d preceding birth, symptoms of excessive bleeding at birth and unconsciousness in the 24 h after birth. None of the micronutrient combinations affected occurrence of breech presentation or gestational duration of pregnancy. In the 9 days following the day of birth, symptoms of poor appetite and diarrhea/dysentery were lower in all micronutrient groups compared to controls. Fever, as reported in the past 24 h and measured (≥ 100 degrees F) at the time of the home visit, and sepsis (defined as foul smelling vaginal discharge + fever) were lower in groups that received folic acid+iron, folic acid+iron+zinc and the MM vs. controls. Our data suggest that certain combinations of micronutrients, including MM, may reduce risk of some obstetric complications. However, MM may also increase risk of obstructed and prolonged labor, possibly by increasing birth size of infants in the upper tail of the birth weight distribution. Funded by the USAID Ofc of Hlth, Inf Dis & Nutr, Wash DC, UNICEF Nepal, The Gates Foundation, Sight & Life Research Institute, Baltimore, MD, and Roche Pharmaceuticals, Brazil.

T47 DIFFERENT COMMUNICATION STRATEGIES CAN INCREASE WOMEN'S AWARENESS ABOUT VITAMIN A RICH FOODS IN INDONESIA. S Sukotjo, A Rice, E Martini, S Halati, S de Pee, S Kosen, J Palmer, Helen Keller International-Indonesia (HKI), Ministry of Health/Government of Indonesia (GOI), Jakarta, Indonesia.

Background: Improving the daily dietary intake of vitamin A (VA) rich foods is an important strategy for combating VA deficiency among mothers and children. Health communication programs can influence behaviors related to maternal and child survival, such as improving the dietary intake of VA rich foods. Problems faced in Indonesia in the dissemination of health messages include the vast geographical area (>17,000 islands spread out between the Indian & Pacific oceans) with more than 400 languages in different cultural settings and wide variations in socio-economic status (SES). **Aims:** To explore the different sources of information about VA rich foods that women receive in Indonesia, which could help future program planners design strategies to strengthen other nutrition and health seeking or disease prevention behaviors. **Methods:** Data collected by the GOI/HKI Nutrition and Health Surveillance System from Oct 2002–Sept 2003 on ~30,000 households in the rural areas of 8 provinces across Indonesia were analyzed to compare where and how women had received messages about VA rich foods in the past. **Results:** ~40-80% of women had heard about VA rich foods. Among those women, less than 30% heard messages from mass media channels that included broadcast and print materials. School is another place where mothers had heard about VA rich foods. In East Java, more than 50% of the women had received such information at school, which suggests that school health programs can be an effective way to educate future generations of parents about current health issues. However, in areas where mothers had lower levels of education, low SES, and lived in a poor environmental setting, their sources of information were more likely to be through interpersonal communication with health workers, cadres, doctors or friends. In a district located in one of the poorest areas in the eastern part of Indonesia, over 90% of the 78% of mothers who had heard about VA rich foods had heard about them through this type of communication. **Conclusion:** Program planners of large-scale maternal and child survival communication programs in Indonesia need to understand the different situation in each area and use appropriate strategies to utilize the existing communication channels and local social systems in order to be effective. **Supported by:** USAID Cooperative Agreement No: 497-A-00-99-00033-00

T48 IRON STATUS IS ASSOCIATED WITH PUPILLARY REACTION TIME AND PREDICTS GREATER DARK ADAPTATION RESPONSE TO IRON AND RIBOFLAVIN SUPPLEMENTS IN PREGNANT NEPALI WOMEN PROVIDED WITH ULTRA-RICE. JM Graham, MJ Haskell, P Pandey, RK Shrestha, KH Brown, LH Allen. Program in International Nutrition and WHNRC, University of California, Davis CA and Nepali Technical Assistance Group, Kathmandu, Nepal.

Vitamin A (VA) treatment fails to cure night blindness in >30% of pregnant Nepali women. Iron (ID) and riboflavin (RD) deficiencies are common in this group (40% and 86% in our pilot study) potentially affecting VA utilization and photoreceptor function respectively. Therefore we compared the effect of VA plus supplemental iron and riboflavin on pupillary response threshold (PRT) and plasma retinol, compared to VA alone. Pregnant (2-7 mo gestation) night blind (XN, present in 8.4% of those screened) women in the Terai were randomly assigned to 6 mg riboflavin + 30 mg Fe (n=53) or a placebo-control capsule (n=43) daily under supervision for 6 wk, in addition to VA fortified Ultra Rice™ (0.85 mg RE=2839 IU/d). Erythrocyte riboflavin (ER), plasma retinol and ferritin, hemoglobin (Hb) and PRT were measured pre- and post-intervention. At baseline 40% had BMI <18 kg/m², >50% had RD or IDA, 82% had impaired PRT, and 23% had low plasma retinol. PRT was negatively associated with ferritin (r=-0.333, P<0.001) and retinol (r=-0.318, P=0.001). The riboflavin + Fe group had greater increases in ER (92±7 vs -10±9 nmol/L, P<0.001) and ferritin (3.4±1.3 vs -0.3±1.3 ug/L, P<0.005) compared to controls. RD fell from 60% to 6% and IDA from 35% to 15%, but both increased in controls. Ultra Rice™ improved overall plasma retinol by 2.88±1.4 ug/dL compared to baseline, but not differently between groups. PRT scores improved from baseline. Final scores did not differ between treatments but there was more reduction in prevalence from baseline in the riboflavin + iron group vs controls (P<0.04). PRT score improved more in women with poorer iron (P=0.01) or VA (P=0.04) status at baseline in both groups. ID women at baseline changed PRT score more when supplemented with iron+riboflavin and Ultra Rice™, compared to Ultra Rice™ alone (-1.41±0.2 vs -0.65±0.25, P=0.08). This change in PRT was significantly associated with change in riboflavin status. Thus PRT improvement was greatest in women with iron deficiency at baseline, suggesting poor iron and possibly riboflavin status impairs dark adaptation. Bill and Melinda Gates Foundation.

T50 VITAMIN A SUPPLEMENTATION IMPROVES IODINE EFFICACY IN GOITROUS, VITAMIN A-DEFICIENT CHILDREN RECEIVING IODIZED SALT. M Zimmermann, R Wegmüller, F Rohner, C Zeder, N Chaouki, T Torresani. Human Nutr Lab, Swiss Institute of Technology Zürich, Switzerland; The Ministry of Health, Rabat, Morocco; and the University Children's Hospital, Zürich, Switzerland.

Background: In many developing countries, children are at high risk for both the iodine deficiency disorders (IDD) and vitamin A deficiency (VAD). In animal studies, VAD is associated with abnormal thyroid function, including: 1) modification of thyroid hormone transport; 2) increased thyroid size and thyroid hormone levels; and 3) interference with normal TSH suppression by thyroxine. **Objective:** To determine the effect of VAD and vitamin A supplementation on thyroid function in iodine- and vitamin A-deficient children receiving iodized salt. **Design:** In Moroccan schoolchildren (n=436) with a high prevalence of VAD and IDD, urinary iodine concentration (UI), serum retinol (SR), retinol binding protein (RBP), C-reactive protein (CRP), transthyretin (TTR), thyrotropin (TSH), thyroxine (TT4), and ultrasonographic thyroid volume (Tvol) were measured and analyzed by regression. Then, in a double-blind, randomized, placebo-controlled 10-month trial, children with IDD and VAD (n=153) were given iodized salt (20 µg iodine/g salt) and either vitamin A (200,000 IU as retinyl palmitate) or placebo at 0 and 5 months. At 5 and 10 months, baseline measurements were repeated. **Results:** In the baseline regression, increasing VAD severity was a significant predictor of greater thyroid volume and higher concentrations of TSH and TT4. During the intervention trial, at 10 months, median UI in both groups increased from 12 µg/L to ≈102 µg/L (p<0.001). Mean SR increased from 0.72 to 1.04 µmol/L in the treated group (p<0.01) and did not change in the placebo group. Median TSH, mean Tvol and goiter rate significantly decreased in the vitamin A-treated group compared to placebo (p<0.05). Mean TT4 significantly increased in the placebo group (p<0.05), but did not change in the treated group. **Conclusion:** Moderate VAD in IDD-affected children increases risk for goiter but may decrease risk for hypothyroidism. In IDD and VAD-affected children who receive iodized salt, concurrent vitamin A supplementation improves the efficacy of the iodine.

T49 IRON, ZINC AND VITAMIN A SUPPLEMENTATION IN INFANTS: INTERACTIONS AND EFFECTS ON IRON AND ZINC STATUS. SEAMTIZI study group: ET Wieringa*, J Berger, MA Dijkhuizen, A Hidayat, NX Ninh, B Utomo, E Wasantwisut, and P Winichagoon. Dept. Int. Med., UMCN, Nijmegen, Netherlands; Nat. Inst. Nutr., Hanoi, Vietnam; Inst. Rech. Dev., Lab. Nutr. Trop., Montpellier, France; Univ Indonesia and Univ Trisakti, Jakarta, Indonesia; Inst. Nutr., Mahidol Univ. Bangkok, Thailand. * Corresponding author, other authors are listed alphabetically. SEAMTIZI: South-East Asia Multi-country Trial on Iron and Zinc supplementation in Infants Study Group.

Background: Vitamin A, iron and zinc deficiency are prevalent worldwide. Large scale supplementation efforts are undertaken, but interactions between micronutrients may have important consequences for supplementation efforts. **Aim:** To investigate effects of iron, zinc and vitamin A supplementation in infants on indicators of iron and zinc status. **Design:** Pooled analysis of a double-blind placebo-controlled multi-country trial with 4 study sites in Indonesia, Thailand and Vietnam. Infants (4-6 mo old, n=2603) were supplemented with iron(10 mg) and/or zinc(10 mg) daily for 6 mo. **Results:** Combined supplementation of iron and zinc was less effective than either iron or zinc alone. The prevalence of anemia was reduced by 21% as compared to 28% after iron alone, and the prevalence of zinc deficiency was reduced by 10% as compared to 18% after zinc alone. Supplementation of iron reduced the effect of zinc supplementation (interaction P<0.01), but had no separate effect on zinc status. Zinc supplementation had a separate, negative effect on hemoglobin concentrations (Hb) (effect size -2.5 g/L), but no interaction with iron supplementation. Intriguingly, boys had a better response to iron supplementation than girls (effect size 12.0 vs 6.8 g/L). Although Hb after iron supplementation was similar in boys and girls, boys not receiving iron had a significant larger decrease in Hb over time than girls (P<0.01). Vitamin A capsule distribution (VAC) at baseline also affected iron supplementation. VAC was related to lower Hb in infants not receiving iron (3.3% lower), and slightly higher Hb in infants receiving iron (2.2% higher). **Conclusions:** Combined micronutrient supplementation is effective and desirable, not only in view of the high prevalence of deficiencies, but also as interactions among micronutrients modulate the effects of supplementation. Iron supplementation is safe and effective, either alone or combined with zinc. However, supplementation of zinc negatively affects iron status. Furthermore, VAC may increase anemia prevalence in the absence of iron supplementation. Intriguingly, male infants are more at risk for iron deficiency than female infants.

W1 RANDOMIZED STUDY OF THE IMPACT OF DIFFERENT DOSES OF VITAMIN A ON CHILDHOOD MORBIDITY AND MORTALITY. C Benn, C Martins, A Rodrigues, I Lisse, P Aaby. Projecto de Saude de Bandim, Bissau, Guinea-Bissau and Department of Epidemiology Research, Danish Epidemiology Science Centre, Statens Serum Institut, Copenhagen, Denmark.

The beneficial effect of vitamin A supplementation (VAS) on child mortality in low-income countries is assumed to be due to the prevention of vitamin A deficiency (VAD). However, it may not be self-evident that the effect is due to the prevention of VAD. For instance, there is no clear evidence that a large dose is better than a small dose, the tendency being rather the opposite in existing literature. We therefore examined whether the half compared with the full dose of VAS currently recommended by WHO gave an equally good protection against childhood morbidity and mortality.

VAS was offered to children aged 6 months to 5 years in connection with an oral polio immunization campaign in Guinea-Bissau. Mothers accepting to participate drew a number indicating which dose their child should receive. The effect of dose of VAS on hospitalizations and survival was measured over the next 6 and 9 months.

We found that half the recommended dose of VAS given with oral polio vaccine was associated with significantly reduced mortality in girls and no differential effect for boys (Table). Consistently for girls, half the recommended dose of VAS was associated with a lower case fatality rate at the hospital. The results suggest that the effect of VAS may not be mediated merely through prevention of VAD. The optimal dose of VAS may differ for boys and girls.

Table. Mortality during 6 and 9 months of follow-up according to dose of vitamin A supplementation for children aged 6 months to 5 years of age. Guinea-Bissau, November 2002-August 2003.

Dose of vitamin A	Deaths/number of children [days-at-risk]		
	Boys	Girls	All
6 months			
Recommended	6/1304 [233834]	15/1228 [219887]	21/2532 [453721]
½ recommended	12/1235 [221149]	3/1224 [219433]	15/2459 [440582]
Mortality ratio*	0.50 (0.19-1.34)	5.38 (1.55-18.6)	1.45 (0.75-2.82)
9 months			
Recommended	13/1304 [342733]	20/1228 [322779]	33/2532 [665512]
½ recommended	15/1235 [324833]	6/1224 [322396]	21/2459 [647229]
Mortality ratio*	0.88 (0.42-1.84)	3.57 (1.43-8.89)	1.63 (0.94-2.82)

* adjusted for district, maternal age and education, and electricity in household

W2 VITAMIN A CAPSULE COVERAGE AMONG BANGLADESHI CHILDREN 6-11 MONTHS OF AGE: THE NEED FOR IMPROVEMENT. N Akhter, G Stalkamp, S de Pee, D Panagides, MR Howlader, AQ Mondal, NS Sharif, MW Bloem. Helen Keller International/Bangladesh, Dhaka, Bangladesh, Helen Keller International/Asia-Pacific Regional Office, Singapore, Helen Keller International/HQ, NY, USA.

Background: The 1997 Bangladesh national vitamin A deficiency (VAD) survey showed that VAD is common among Bangladeshi children aged 6-11 months (27% with serum retinol <0.70µmol/L). Young children have VAD because the diet of their mothers generally lacks sufficient vitamin A and there is very low postpartum vitamin A capsule (VAC) coverage, both affecting vitamin A levels in the breast milk. In addition, complementary foods, being predominantly cereal-based, are often low in vitamin A. Under the current policy, children at nine months of age should receive 100,000 IU of vitamin A with measles immunization. **Objective:** Assess VAC coverage among children aged 6-11 months. **Methods:** Data were collected on 11,304 children aged 12-23 months in rural Bangladesh in 2002 by the Nutritional Surveillance Project of Helen Keller International and the Institute of Public Health Nutrition. Through precoded questionnaires, mothers were asked if the child was immunized for measles vaccination at the age of 6-11 months, and whether he/she received a VAC along with the measles vaccine. The information was validated with the immunization card if available. **Results:** In rural Bangladesh, 70.6% [95% C.I. 69.7, 71.6] of children received a VAC between 6-11 months of age, 12.2% [10.3, 14.1] received the measles vaccine but no VAC, and 17.2% [15.5, 18.8] received neither. Among children in functionally landless households the coverage of VAC was 69%, while it was 75% in households owning more land (p<0.005). Coverage also varied among sub-districts (9-96%). **Conclusion:** VAC coverage among 6-11 mo old infants is considerably lower than among 12-59 mo old children (>90%). Improvements and/or changes of the existing mechanism for reaching 6-11 mo old children need to be considered in order to increase coverage among this vulnerable age group.

W3 POSTPARTUM VITAMIN A CAPSULE COVERAGE IN BANGLADESH. T Chowdhury, G Stalkamp, S de Pee, D Panagides, MR Howlader, AQ Mondal, NS Sharif, MW Bloem. Helen Keller International/Bangladesh, Dhaka, Bangladesh, Helen Keller International/Asia-Pacific Regional Office, Singapore, Helen Keller International/HQ, NY, USA.

Background: Maternal vitamin A deficiency (VAD) is a major health problem in Bangladesh. Requirements during pregnancy and lactation are high but many women cannot afford vitamin A rich foods, especially animal food products. VAD in mothers can lead to ill health and death during pregnancy and the postpartum period; it also affects infant's vitamin A stores. The Government of Bangladesh advocates that women should receive a high potency vitamin A capsule (VAC) containing 200,000 IU within six weeks of delivery. **Aim:** To assess the postpartum vitamin A capsule coverage in rural Bangladesh. **Methods:** Data were collected by the Nutritional Surveillance Project of Helen Keller International and the Institute of Public Health Nutrition in 2002 from 32,070 mothers who had a full term pregnancy during the previous three years. The mothers were asked whether they suffered from night blindness during pregnancy and also whether they received VAC within six weeks of delivery. **Results:** Data showed that the prevalence of night blindness among mothers in their most recent pregnancy in the previous three years was 1.6% [95% CI 1.5, 1.8]. In two out of the 24 surveyed sub-districts, the prevalence was above the 5%-threshold of a public health problem (8.2% and 7.4%). Only 3.6% [95% CI 3.4, 3.8] of women in rural Bangladesh received a high potency VAC during their postpartum period. Highest coverage was observed in two sub-districts where the Bangladesh Integrated Nutrition Project was operational: 28.4% and 15.5%. **Conclusion:** Coverage of postpartum vitamin A supplementation in Bangladesh is extremely low and demands immediate attention because VAD is a major health problem in Bangladeshi mothers and has serious consequences for the health and survival of women and their infants. Opportunities for an effective delivery system should be explored.

W4 VITAMIN A INTAKE AMONG CHILDREN THAT RECEIVED AND THOSE THAT DID NOT RECEIVE A VITAMIN A CAPSULE IN THE URBAN SLUMS OF JAKARTA AND IN RURAL WEST JAVA, INDONESIA. S Halati, A Rice, S de Pee, E Martini, R Moench-Pfanner, S Kosen, MW Bloem. Helen Keller International-Indonesia, Ministry of Health/Government of Indonesia, Jakarta, Indonesia.

Background: Vitamin A (VA) deficiency is a major public health problem among children in developing countries that increases severe child morbidity and mortality. Children with a low dietary VA intake are at risk of VA deficiency. In Indonesia, all 6-59 mo-old children are eligible for the national VA capsule (VAC) supplementation program. The national goal is to achieve an 80% coverage rate. **Aims:** To compare the dietary VA intake of children who received (recipient) and did not receive (non-recipient) a VAC in the previous 6 months in the urban slums of Jakarta and the rural areas of West Java, Indonesia. **Methods:** Data collected from ~600 children by the GOI/HKI Nutrition and Health Surveillance System from June-July 2003 were analyzed. VA intake was estimated by the 24-VASQ (24-hour VA Semi-Quantitative) method. VAC coverage was measured as VAC receipt in the last six months. **Results:** VAC coverage among 6-11 mo-old children was 79% in the urban slums of Jakarta and 75% in rural West Java. Among 12-59 mo-old children, VAC coverage was 84% in Jakarta and 70% in West Java. Among 6-11 mo-old children, the proportion that consumed <50% of their Recommended Daily Allowance [RDA=350 retinol equivalents/day (RE/d)] was 50% in Jakarta (among both capsule recipients & non-recipients), while it was 85% among capsule recipients and 67% among non-recipients in West Java. The median VA intake of capsule recipients and non-recipients was 200 RE/d and 155 RE/d, respectively in Jakarta, and 58 RE/d and 110 RE/d, respectively in West Java. Among 12-59 mo-old children, the proportion that had a dietary VA intake <50% of the RDA was 40% and 52%, respectively in Jakarta, while it was 61% and 70%, respectively in West Java. The median VA intake was 256 RE/d among capsule recipients and 125 RE/d among non-recipients in Jakarta, while it was 120 RE/d and 103 RE/d, respectively in West Java. **Conclusion:** None of the 6-59 mo-old children achieved 100% of their RDA of VA from food. Children in the urban poor area had a higher VA intake than those in the rural area. In the urban area, capsule non-recipients had a lower VA intake than recipients, indicating that they had an even higher unmet need for VA. These data suggest that VA supplementation remains necessary for all children 6-59 mo-old in Indonesia. Supported by: USAID Cooperative Agreement No:497-A-00-99-00033-00

W6 LOW VITAMIN A CAPSULE COVERAGE RATES AMONG POST-PARTUM WOMEN IN CENTRAL JAVA, INDONESIA. WHAT ARE THE LIMITING FACTORS? E Martini, A Rice, S de Pee, S Halati, S Sukotjo, MW Bloem, S Kosen. Helen Keller International-Indonesia (HKI), Ministry of Health/Government of Indonesia (GOI), Jakarta, Indonesia.

Background: Vitamin A (VA) supplementation of postpartum women has important health benefits for mothers and their breastfeeding infants. The additional VA improves breast milk quality, boosts resistance to severe disease, and may increase child survival. Unfortunately, VA coverage among postpartum women in Indonesia is extremely low. **Aims:** To assess VA capsule coverage rates among postpartum women in Central Java, Indonesia and to investigate the limiting factors that influence it. **Design:** Cross-sectional data on nutrition, health, socio-economic status, and patterns of health care utilization from the GOI/HKI Nutrition and Health Surveillance System in Central Java from Jun-Aug 2003 were analyzed. VA capsule (1 x 200,000 IU) coverage among postpartum women (n=6980) was assessed along with the timing of when the mothers received VA, where they delivered their baby, who attended their birth, and whether the mother was active as a health cadre (volunteer health workers). **Results:** The coverage rate in Central Java was 19.3%. More than 50% of these mothers got VA within 2 days after delivery. Mothers who were active as health cadres, 4% of the sample, had higher coverage (38%) compared to mothers who were not (19%). Mothers who delivered their baby in Puskesmas (sub-district public health centers)/village maternity clinics had higher coverage (30%) compared to those who delivered in maternity hospitals (25%), a midwife's house (23%), or at home (16%). Mothers whose delivery was attended by a midwife or doctor had higher coverage (23% coverage for those groups) compared to those attended by another helper or who gave birth by herself (18%) or who was attended by a traditional birth attendant (13%). **Conclusion:** Vitamin A coverage rates among postpartum women in Central Java was low. Additional efforts with different approaches are needed to improve coverage of the postpartum VA supplementation program, which has important health benefits for postpartum mothers and their infants. Supported by: USAID Cooperative Agreement No: 497-A-00-99-00033-00

W5 SUSTAINING VITAMIN A SUPPLEMENTATION: TESTING A COMMUNITY-DIRECTED, INTEGRATED APPROACH IN CAMEROON. N Haselow, J Akame, Pountougnigni, M Nankap, D Sibetcheu, I Atangana. Helen Keller International/Cameroon, Ministry of Public Health/Cameroon.

Problem: The prevalence of vitamin A deficiency in Cameroon is 39% (2001) yet Cameroon does not have a sustainable delivery mechanism to provide two annual doses of vitamin A to children 6-59 months. A combination of strategies will be necessary. **Objective/conceptual framework:** To test the feasibility and scale up the delivery of vitamin A (VA) by trained community distributors of ivermectin (CDDs) to children and women within 2 months post partum (pp) via the community-directed treatment (ComDT) strategy. Since ComDT is funded for the next 5 years and will need to be implemented for 15-20 years to control onchocerciasis, it is a potentially sustainable delivery mechanism for VA as well. **Program Design:** Over 2150 community-selected CDDs will receive an integrated training on VA and onchocerciasis and provided the means to deliver VA capsules as they deliver ivermectin. Support materials will be used to sensitize communities. 300 nurses have been trained to monitor program activities and supervise CDDs. **Evaluation Methods:** A pilot study was conducted in 2003 in 1 health district (HD) of Center Province by the MOH and HKI to test the feasibility of integrating VA into ComDT. Results were positive with 100% of children 6-11 months, 84% of children 12-59 months, and 26% of women pp receiving a VA supplement. Problems were noted and corrections made to the program design, messages and support materials. The adjusted design is now being scaled up throughout 15 HDs of Center Province. Monitoring checklists are being used to further assess the process and mid-term and final evaluations will be conducted to assess coverage rates for both VA and ivermectin. **Program implications:** Based on evaluation results, a 'How to' Guide will be elaborated and shared with partners implementing ComDT throughout Cameroon and in other countries. ComDT is implemented in all 10 provinces and potentially can provide VA to 2/3 of all HDs in Cameroon at least once/year and possibly twice/year.

W7 EVALUATION OF THE NEWLY PROPOSED VITAMIN A SUPPLEMENTATION REGIMEN FOR POST PARTUM MOTHERS USING STABLE CARBON ISOTOPES. K Tchum, S Newton, S Tanumihardjo, B de Benoist, S Owusu-Agyei. Kintampo Health Research Centre, UW Madison and WHO.

Background: Vitamin A deficiency is a major public health program in many developing countries. Because serum retinol concentrations are homeostatically controlled and can be depressed by infection, other indicators of vitamin A status have been developed. To this end, two sensitive indicators of vitamin A status, the MRDR test and the 13C2- retinol isotope dilution assay are being applied to a program in Ghana designed to improve total body reserves of vitamin A in lactating women. **Objectives:** 1. To determine the length of time mothers are protected against depletion after receiving either 400,000 IU of vitamin A in two doses of 200,000 IU 24 hours apart or one dose of 200,000 IU. The MRDR test will be used at bi-monthly intervals for 5 months post dosing to assess changes in vitamin A status. 2. To determine the degree of dilution in the vitamin A body pool after dosing women with either 200,000 or 400,000 IU of vitamin A using stable 13C2-retinol as a tracer. **Methods:** For objective one potential mothers are visited at home by trained field workers 7-10 days after their delivery and recruited into the trial. Baseline MRDR tests are performed for all women. The women are divided into three groups, each group is invited back once at month 1,3 or 5 for a second MRDR assessment. For objective 2, after a 10 ml baseline blood sample, a 5mg dose of 13C2-retinyl acetate will be administered to 20 women one week prior to administering the high dose post partum capsules. A second blood sample will be collected before giving the high dose to determine the enrichment of the serum retinol pool with 13C2-retinol. After allowing the high doses to equilibrate for three weeks with the retinol pool, a follow up blood sample will be drawn. This will provide information on the degree of dilution of the labeled retinol for the two separate dose levels. The research is on-going. **Program implications:** We plan to use stable carbon methods to answer public health questions concerning vitamin A. This will aid vitamin A supplementation programs through evaluation of outcomes.

W8 SUCCESSFUL VITAMIN A DISTRIBUTION CAMPAIGNS IN MADAGASCAR. S Rakotonirina, A Randrianaivo, V Andrianantoandro, H Rasamimanan, A Cyridion, B Andriamitantoa. Ministry of Health, UNICEF, LINKAGES, MOST, USAID Madagascar.

Issue: A national survey, conducted in 2000 by the Ministry of Health, revealed that 42% of Malagasy children suffer from vitamin A deficiency, along with 29% of all women. **Objective:** To eliminate vitamin A deficiency amongst vulnerable groups by 2015. **Framework:** Vitamin A distribution campaigns are part of an overall strategy to reduce malnutrition in the country. They became a reality in 1997, when they were organized jointly with polio eradication efforts. From 2000 onwards, the government decided to intensify its efforts and organized bi-annual campaigns. These were implemented on a national scale in partnership with several agencies and networks. The Vitamin A Task Force — that spearheads this effort — is coordinated by the Nutrition Department of the Ministry of Health, which works through its decentralized divisions at the district and provincial level. Local and traditional leaders play an important role (by informing and mobilizing their constituents) as partners in this process. The task force's decentralized structure enables the distribution of materials, equipment, guidelines and leaflets for community mobilizes as well as serves as a mechanism for improved campaign monitoring and evaluation. **Program description:** Campaign activities include refresher training for some 5,000 health workers and 15,000 community mobilisers, the development of communication materials along with radio and TV spots, a census of eligible children and a final evaluation of processes and results. The success of the campaign lies in the partnership and organizational efforts of the vitamin team, namely the Ministries of Communication, Education and Health, UNICEF, WHO, USAID (MOST, LINKAGES) and SALAMA (a parastatal that distributes essential drugs). **Outcomes and results:** Between 2000 and 2003, vitamin A coverage rates rose from 67 % to 91 %. In 2002, alone, the campaign reached 100% of all eligible children of Madagascar, mostly due to efforts to eradicate polio at the same time.

W9 COMMUNITY-BASED VITAMIN A SUPPLEMENTATION EVEN IN EMERGENCY SITUATIONS. Pierre Adou, Félicité Tchibindat, Micheline Ntiru, Maguette Ndiaye. Helen Keller International, UNICEF.

Introduction: Since September 2002, Côte d'Ivoire has been in conflict, with northern and western regions under rebel control. As a result, the health and nutrition status of the population, particularly in the rebel-held areas has exacerbated. Vitamin A deficiency affects over 30% of the population, and the only strategy to address this, until recently, has been supplementation during annual National Immunization Days. **Methodology:** Since early 2003, community-based vitamin A supplementation was implemented in the districts under rebel control, as well as those under government control. After training, volunteers/distributors are provided with a box of vitamin A capsules and a pair of scissors and go door-to-door to supplement children. **Results:** Twenty six out of 64 total health districts are covered under this strategy. The approach has been implemented by 4 NGOs and 7 community-based organizations, mobilizing 38 coordinators, 237 supervisors, 1813 distributors and 1329 social mobilizers. In total 926, 636 children between 6 and 59 months, representing 71.4% of the total, received one vitamin A capsule in 2003. Using this community-based strategy, the cost of supplementation per child has been evaluated as 0.085\$ in the government-held areas, and 0.11 dollars in the rebel-held areas. However, during the JNVs, it is 0.188 dollars. **Lessons Learned:** i) mobilizing communities to take charge of their health problems is necessary for the success of any public health program. ii) it is beneficial to foster collaboration between the health sector and other related sectors. iii) cost effectiveness of various strategies must be evaluated and taken into consideration. **Conclusions:** It is necessary to give a second dose of vitamin A outside NIDs, and implement sustainable strategies to replace NIDs as they are phased out. Even in emergency situations, we can effectively and sustainably supplement children with vitamin A. In addition, this approach can serve as an entry point for other nutrition and health activities.

W10 POST PARTUM VITAMIN A SUPPLEMENTATION: INTEGRATED, ROUTINE HEALTH CENTER DELIVERY IN COTE D'IVOIRE. P Adou, M Ntiru, E Kouakou, M Ndiaye. HKI Cote d'Ivoire, Ministère de la Santé Publique (MSP).

Introduction: In Côte d'Ivoire, National Immunization Days (NIDS) have been the principal strategy to provide at least one dose of vitamin A among children. As NIDs will be phased out with the certification of the eradication of polio in 2005, planning and implementation of more sustainable strategies for supplementation of children is underway. In addition, the vitamin A needs of post partum women have not been addressed adequately, despite evidence that by the ninth month of pregnancy, women are deficient. Since August 2003, vitamin A supplementation (VAS) of women in their immediate post partum is being implemented on a pilot basis in three health centers in the district of Abidjan Central. **Methodology:** Thirty health agents have been trained so far, including 4 doctors, 3 social assistants, midwives and nurses. Refresher training will take place every two years. Doctors monitor the activities, and the department director analyses the results and sends the information to the National Nutrition Programme (PNN). **Results:** Approximately 1430 children 6 -11 months, 1880 children 12-59 months and 3544 women in their immediate postpartum, have been supplemented. Amongst these mothers, 2270, or 64%, returned to the health centers the day after their delivery to receive the second dose of vitamin A. **Lessons Learned/Conclusions:** Lessons learned will inform scaling up, and planning of other nutrition and health activities: i. Sensitization and training of health personnel on vitamin A is key to the success of routine, quality, sustainable supplementation. ii. Once the need has been created, women demand, and are enthusiastic about vitamin A capsules for themselves and their children. iii. There is no major constraint to the rapid roll-out of this strategy to all the health centers in the country. As no information exists on the impact of supplementation on the mother and child in the country, it would be beneficial to conduct a research survey to inform future activities.

W11 SUSTAINING HIGH VAC COVERAGE BEYOND NIDS IN THE PHILIPPINES. EG Barquilla, EE Villate, EP Puertollano, MFD Reario, EA LaFuente. HKI/Philippines, L Paulino, Department of Health.

Background: In 1993, the Philippines was one of the first countries to distribute VAC nationwide through National Immunization Days (NID), in April, and National Micronutrient Day (NMD) or Araw ng Sangkap Pinoy (ASAP) in October. The Philippines achieved impressively high VAC coverage levels of 88-93% in 1993-96. However, coverage dropped to 78% in 1997-98, below the national target of 90%. In 1999, NIDs were no longer national in scope so the DOH launched a new strategy to distribute VAC, dubbed Preschoolers Health Week or Garantisadong Pambata (GP). This weeklong event is conducted twice a year and offers a comprehensive package of health services for children aged 0-59 months, including VAC distribution, routine immunization, weighing, deworming, distribution of toothbrushes, information on safe toys, and promotion of healthy habits and increased consumption of foods rich in vitamin A, iron and iodine. Strategies used to gain support for the GP from local chief executives and stakeholders were social mobilization and capability building. For the past 4 years, Helen Keller International in coordination with DOH and the LGUs conducted VAC coverage surveys with financial assistance from USAID in 9 out of 16 regions. **Aim:** To assess VAC coverage through Preschoolers Health Week and to identify factors that maintain high coverage in 9 out of 16 regions. **Methods:** The surveys were conducted in all provinces and selected cities in 7 regions of the country in 2000 then in 9 regions of the country in 2001, 2002 and 2003. Barangays or clusters in these provinces/cities were selected based on probability proportional to size sampling. **Results:** The over-all VAC coverage in the HKI/USAID assisted regions in 2000 and 2001 was 85% and it increased to 89% in 2002 (coverage results for 2003 will be available in November 2004). Thus, for the past 3 years, the VAC coverage was sustained at high levels even after the cessation of the national NID's. This level of success was attained through awareness campaign conducted by health workers, broadcast, print and interpersonal communication, the vitamin A capsules that were already available, and the setting up of GP centers. **Conclusions:** Preschoolers Health Week sustains high VAC coverage and is an effective delivery mechanism beyond NIDs.

W13 DISTRIBUTION OF VITAMIN A CAPSULES COUPLED WITH MEASLES VACCINATION CAMPAIGN: THE GUINEA EXPERIENCE. A Touré, MC Messier, Z Touaoro. Helen Keller International (HKI) Guinea.

Background: Guinea has high infant and maternal mortality rates. It is estimated that 25% of children 6-59 months are vitamin A deficient. Since the year 2000, the Ministry of Health (MOH) has been distributing vitamin A capsules (VAC) twice a year: the first round using a health center (HC) based strategy and the second round (4-6 months later) using National Immunization Days (NIDs). The official coverage rates have averaged more than 90%. When NIDs ended in 2002, it was imperative to find a strategy to maintain high coverage in a cost-effective manner. In November 2003, Guinea undertook a national measles vaccination campaign (NMVC) for children aged 9 months to 15 years. Coupling these two activities presented an opportunity to maintain high coverage while maximizing the use of resources. **Objectives:** To ensure at least 80% VAC coverage for 6-59 month old children by coupling VAC distribution with the NMVC. **Methodology:** All agencies involved, including HKI, MOH, UNICEF and WHO, made a concerted effort to reach all target populations, as well as to harmonize training and monitoring tools and approaches. Intense advocacy was targeted at high-level decision-makers. VAC distributors were added onto teams of vaccinators. Mass media was used for sensitization, and a seven-day national campaign (except in the capital) using fixed and mobile teams was conducted. **Results:** National VAC coverage rates reached 102.2%. A majority of regions (7/8) and Health Centers (89%) reported coverage above 80%. Cost of distribution was approximately US\$0.021/child. **Conclusion:** This campaign reported the highest coverage rate ever since VAC distribution started. Compared to HC-based distribution, coupling resulted in a lower cost per child supplemented (\$0.025 vs. \$0.021), estimates similar to those attained in Ghana. With better coordination, particularly during the planning phase, it is thought that these costs can be lowered further. Rates above 100% should be validated by an independent survey as the total targeted population may have been underestimated.

W12 THE NATIONAL VITAMIN A PLUS CAMPAIGN: A SUCCESS STORY FOR VITAMIN A PROGRAMME IN BANGLADESH. S Begum, UNICEF, Dhaka, Bangladesh.

In Bangladesh, the prevalence of night blindness in children has been sustained below the 1% threshold that signals a public health problem. This remarkable achievement is largely due to the high coverage (as high as 87%) of vitamin A capsules (VACs) among children aged 12-59 months twice a year, since the distribution of VACs was linked with the National Immunization Days (NIDs) since 1995. The NIDs became an annual event in 2003 and will be discontinued after 2005, which has made it necessary to identify alternative strategies to sustain the high coverage of VAC. The Government of Bangladesh recognized that distributing multiple nutrition and health interventions would be more cost-effective and therefore took the initiative to implement a package of health and nutrition services for children through a 'National Vitamin A Plus Campaign' which was held on Oct. 2003. The three interventions selected for this campaign were: a) Vitamin A (200,000 IU) supplementation to children 12- 59 months, b) Albendazole (400 mg) administration to children aged 24-59 months, c) Salt-testing for iodine in all government and non-government primary and secondary schools. The benefits of the Campaign, which are expected to have contributed towards lowering child morbidity and mortality are: (1) Sustained high VAC coverage of 12-59 months, thereby preventing vitamin A deficiency and its consequences. (2) Achieved high coverage of albendazole administration among children aged 24-59 months which reduced burden of soil-transmitted helminths. (3) Increased awareness among school children on the harmful consequences of iodine deficiency disorders and the importance of consuming iodised salt. Data from the National Surveillance Project of Helen Keller International indicate that the Vitamin A Plus Campaign 2003 achieved a coverage of 89%. Future Campaigns will always include VAC distribution, but will add different additional interventions, such as measles vaccination. It is expected that the Campaigns will be held annually in 2004 and 2005, and biannually from 2006.

W14 HIGH VITAMIN A SUPPLEMENTATION COVERAGE IN NIGER: THE CHALLENGES OF MAINTAINING SUCCESS SIX YEARS LATER. R Dania, O Mahamadou, H Hamani, X Crespin, A Mamadouitaibou, N Zagré, SK Baker. MOPH Niger, UNICEF Niger, Helen Keller International Niger and Africa.

Background: As one of the poorest countries in the world, with very high levels of child mortality (274/1000), malnutrition (32% chronic) and vitamin A deficiency (2.1% night blindness prevalence), Niger has taken a lead in vitamin A supplementation, and has been able to maintain a coverage of more than 75% of children 6-59 months, twice a year since 1999. Maintaining the success of past years is however a major challenge. **Objectives:** Subsequent to the integration of vitamin A distribution into National Immunization Days (NIDs) in 1997 and 1998, the objective was, as of 1999, to ensure that at least 80% of children aged 6-59 months receive a twice-yearly dose of vitamin A and that at least 75% of post partum women receive a high vitamin A dose within 40 days of delivery. **Methods:** Vitamin A was integrated into NIDs in 1997 and 1998; in 1999 National Micronutrient Days were organized for the distribution of a second vitamin A dose, six months after NIDs; in 2002 National Micronutrient Days were organized to cover the 27 polio-free districts, with no NIDs. **Results:** Since mass supplementation started in Niger, each round covers more than 80% of children aged 6-59 months, as well as other target groups including post-partum women for vitamin A (more than 50%) and pregnant women for iron+folic acid (more than 50%). **Conclusion:** The Niger experience shows that even the poorest countries can successfully provide vitamin A supplementation and reach high levels of coverage, even with the phasing-out of NIDs; however, maintaining the success of past years still remains a major challenge. Countries like Niger should maintain bi-annual supplementation for many years. Lessons learned from this experience and the strategies to maintain long-term success will be presented.

W15 ADDRESSING THE SECOND GENERATION CHALLENGES IN VITAMIN A SUPPLEMENTATION IN TANZANIA. B Mlay, I Kabir, UNICEF Tanzania. F Modaha, Tanzania Food and Nutrition Centre. J Mugyabuso, HKI. B Kindoli, World Vision.

In Tanzania Vitamin A deficiency has long been recognized as a major public health problem affecting both children and women. The national prevalence study, 1997 (UNICEF and TFNC) in mainland Tanzania showed that 24 percent of children under five years and about 69 percent of lactating women have vitamin A deficiency. For Tanzania mainland the infant and under five mortality is estimated to be 99 and 158 per 1,000 live births respectively (TRCH 1999) For Zanzibar the infant and under five mortality is estimated to be 90 and 114 per 1,000 live births respectively.

A mixture of different approaches has been implemented in Tanzania to reduce the severity of VAD. These include:- disease targeted, Routine supplementation (EPI+), VAS integrated with SNIDS. Tanzania is among the countries implementing VAS Post NIDs strategies since 2001 by providing children aged 6 to 59 months with 2 doses VAS through community based supplementation around national events / Child days every year, June and December. Tanzania has realized high coverage of 80 percent in June 2001, and 90% and above in every subsequent supplementation.

With the high national VAS coverage, Tanzania has moved to another level of trying to address the second generation challenges that is :- Sustaining the high national coverage attained, targeting - hard - to reach by mapping out and reaching every child to ensure the best start of every child, raising postpartum VAS coverage with only 44% hospital deliveries. Even in the districts with high coverage there are pockets of villages with low coverage. Some of the districts continuously have low coverage. Proper recording to ensure that every child/ postpartum mother receive VAS and follow - up of the defaulters is a challenge.

Currently, Tanzania is also moving towards integrating VAS and de-worming for children 1-5 years national wide, which is also a great challenge. Tanzania will share its experiences in addressing these challenges and the cost per child will be included in the presentation.

W16 SUSTAINING HIGH VAC SUPPLEMENTATION COVERAGE IN A DECENTRALIZED SET-UP: A LOCAL GOVERNMENT EXPERIENCE IN THE PHILIPPINES. EP Puertollano, EE Villate, MFD Reario, EG Barquilla, EA LaFuente, HKI/Philippines, E Grande, Department of Health Region VIII, N Rich, SO. Leyte Provincial Health Office.

Background: The implementation of the local government code RA7160 or the decentralized system of government since 1991, gave the local government units (LGUs) full responsibility in the management of programs and projects that include health and nutrition. So. Leyte, a province in Region VIII, is one of the provinces where HKI, with funding support from USAID provided its Technical Assistance in the Micronutrient Supplementation Project. In 2000, when the project was initiated, support for VAC supplementation coming from the local governments chief executives was very limited. However, VAC coverage was high in 2000 (95%) because of the support from the DOH Central Office and HKI assistance. **Aim:** To generate local level support to sustain high VAC coverage for the province. **Design and Methods:** HKI utilized two approaches: 1.) social mobilization, focused on advocacy activities, and 2.) building the capacity of the local task forces to generate support from the local chief executives and other stakeholders. Members of the local task forces came from the different units of the LGU and were organized at all levels. They were trained to manage the VAC supplementation project and on social mobilization that included advocacy, networking and resource generation. Advocacy activities were conducted with the local chief executives especially with the governor, who later became the prime advocate of micronutrient supplementation. These activities were supported by IEC materials. **Results:** Local chief executives at all levels included in their annual budget allocation for the implementation of the MN Supplementation Program. The budget allocated by the LGUs ranged from Php 200,000 to 1 Million (USD 3,637 to 18,182). These allocations include purchase of micronutrient supplements and other logistics, traveling expenses of health workers and social mobilization activities with the beneficiaries. High VAC coverage among children 12-59 months in So. Leyte was sustained at 92.2%, 92.9% and 99.6% in year 2001, 2002 and 2003 respectively. **Conclusion:** Social mobilization activities particularly advocacy will encourage local chief executives to include in their budget local financial support to sustain high VAC supplementation coverage.

W17 EFFECTS OF THE CHILD SURVIVAL PROGRAM ON THE REDUCTION OF SERUM RETINOL DEFICIENCY IN CHILDREN UNDER FIVE YEARS OF AGE. PROJECT HOPE, PERU. JC Alegre, S Contreras, K Delgado. Project HOPE, Millwood, VA, USA. JL Chirinos. Universidad Peruana Cayetano Heredia, Facultad de Salud Publica, Lima, Peru. L Benavente. Formerly with Project HOPE, now with MCDI, Silver Spring, MD, USA.

In 1996 Project HOPE started to implement a child survival (CS) project with partial funding from USAID, in 162 rural communities of Region San Martin, Peru with technical assistance from Universidad Peruana Cayetano Heredia. The CS project was primarily focused on promoting healthy behavior practices of caregivers at the community level with a mix of CS interventions aimed at reducing morbidity and mortality rates of children under five years of age in a resource-limited setting.

The project revealed that the promotion of active feeding practices with a varied diet with locally available foods has a sustainable impact in reducing low levels of serum retinol among young children in rural communities of Region San Martin. Quantitative biochemical analyses from cross-sectional household surveys indicate a reduction of the prevalence of low levels of serum retinol in children aged 6-35 months of age from 68.0% (<0.7µmol/L; n=307) in 1997 to 29.2% (<0.7µmol/L; n=298) in 2003. The analyses followed liquid chromatography procedures and IVACG guidelines for quality purposes.

In addition, even a greater reduction of low levels of serum retinol (12.0% in 2000) was achieved as a result of vitamin A (VA) direct supplementation campaigns. Project HOPE, with the support of Sight and Life, was able to work together with the Regional MOH in San Martin to provide single capsules of VA mega-dose to children in the same age group who participated in regular immunization campaigns.

Starting in 2000, the median intake of VA foods increased as a result of the promotion of active feeding practices of locally available foods rich in lipids and VA, while supplementation of VA campaigns ceased. The promotion activities included training of community health workers, implementation of Trial of Improved Practices (TIPs) activities, and the use of job aids by health promoters and district-level health workers during diet counseling to caregivers.

Key words: high-risk groups, vitamin A, serum retinol, vitamin A deficiency, community-based programs, child survival, behavior practices, TIPs.

W18 HEALTH WORKER TRAINING AND MULTIMEDIA STRATEGIES ARE KEYS TO SUCCESS FOR ZAMBIA'S CHILD HEALTH WEEKS. C Mwela, W Himanteeka, M Mwanza, W Siamusantu, A Chipukuma. MOST/USAID, National Food and Nutrition Commission, and Zambia Integrated Health Project, Lusaka, Zambia.

Background: In Zambia, Child Health Weeks (CHWs) provide vitamin A supplementation (VAS) twice annually as part of a package of child survival services. Specialized health worker training has enabled CHW implementation in all 72 districts. A multimedia strategy for raising caregivers' awareness of CHW activities and creating demand for CHW services is also in place. Coverage of VAS rose from 64% in 1997 to >95% in 2003. **Aim:** To describe how health worker training and multimedia approaches to social mobilization have contributed to CHW success in Zambia. **Methods:** We reviewed assessments of health worker knowledge, attitudes, and practices surrounding CHWs, and of mothers' and caregivers' awareness of the event. **Results:** Of 300 health workers from 30 randomly selected districts, nearly 63% reported having participated in training for CHW implementation. Approximately 88% of the training participants responded that they use information from the program's monitoring system for annual planning, and share the results of M&E activities with fellow workers. In two districts following the September 2002 and February 2003 rounds, caregivers in 750 households were selected for interview using EPI-type cluster sampling. In both surveys, 43% of women indicated electronic media (radio and television) as a source of knowledge about the CHW. Around 47% in September and 75% in February named health workers as a source of knowledge. In both surveys, smaller percentages reported hearing about the CHW through print (2% and 11%) and folk (6% and 18%) media channels. **Conclusion:** Training methods and materials for health workers implementing CHWs in Zambia have been widely utilized. Former trainees appear highly motivated to collect monitoring information and use it for program planning. Health workers remain an important source of information about CHWs. Media messages, in particular through television and radio, have also been effective at raising awareness and support for CHWs among mothers and caregivers. Folk media and print have played a lesser role but are still considered good support media.

W19 DO'S AND DON'TS: CONVINCING THE PRIVATE SECTOR TO SUPPORT FORTIFICATION ACTIVITIES IN MALI. A Cissé, L Mahy, SK Baker, SC Diarra, YY Dicko. Helen Keller International Mali (AC, LM), Helen Keller International- Africa Region (SKB), ASCOMA (SCD), HUICOMA (YYD).

Background: Vitamin A (VA) deficiency is widespread among Malian vulnerable groups (36% of children under 5 low serum retinol, 5.8% of women reported night blind during last pregnancy). To reduce this public health problem, fortification (FF) of locally produced foods has been accepted as a sustainable strategy. **Objectives:** To raise awareness on food FF and convince donors, government and civil society to get involved in public-private partnerships. **Methods:** Frequent one-on-one and in-depth discussions with key individuals; identification of an interested private-sector partner; creation of a National FF Committee (NFC); high level advocacy. **Findings:** The NFC (24 members from 8 sectors) has been actively involved in creating favorable environment for food FF. In 2002 a feasibility study for vegetable oil FF was conducted, as well as many visits to HUICOMA, the only vegetable oil producer in Mali. The HUICOMA technical director and NFC members attended a Micronutrient Initiative-sponsored West African FF meeting (Accra, 2002). The NFC was key in the development of a project proposal submitted to GAIN (2003). A formal decree confirming the NFC was signed by the Prime Minister; the Malian First Lady agreed to be godmother of the project. **DO:** bring together a group of experts and legalize their structure later; create confidence of the private sector by ensuring government and consumers' association support; facilitate contact of interested private sector with other companies in the region. **DON'T:** be afraid of dealing with the private sector; be discouraged by first negative responses of private sector. **Conclusion:** Mali was selected to receive GAIN funding for the FF of cotton seed vegetable oil with VA. Commitment from the private sector, support from the consumer association, political will from the government are key to the successful bid. Fortified oil is scheduled to be on the Malian market in March 2005.

W21 EVALUATION OF IRON/FOLATE AND VITAMIN A SUPPLEMENTATION PROGRAMS IN GUINEA. Z Touaoro, IK Barry, MC Messier, A Touré, MC Balde, M Donzo. Helen Keller International-Guinea (ZT, MCM, AT), Institute for Nutrition and Child Health (IKB, MCB, MD).

Background: In Guinea, 79% of children 6-59 months and 63% of pregnant women are anemic. The Vitamin A Deficiency (VAD) rate for children 6-59 months is estimated to be 25%. National micronutrient supplementation programs include twice yearly Vitamin A Capsules (VAC) distribution for children 6-59 months and Iron/Folate distribution throughout pregnancy. However, these programs have never been evaluated. **Aims:** The aims of this project were to 1) Determine VAC coverage rates for children for the most recent distribution; 2) Determine pregnant women's adherence to iron/folate and chloroquine treatment; and 3) Evaluate the knowledge, attitudes and practices (KAP) of health workers concerning micronutrient deficiencies. **Methodology:** A cross-sectional survey with a nationally representative sample (1913 caretakers of children and 1885 pregnant women) was implemented. Questionnaires were administered to 126 health workers. **Results:** It was found that 67% of children had received one VAC during the most recent distribution. The majority (80.4%) of pregnant women received iron/folate tablets during their last prenatal visit; of those, 85% reported taking one tablet per day for 30 days. Of those who abandoned treatment, 53% cited nausea as the main cause. 90.8% of women received chloroquine. Concerning KAP, the majority of health agents could not cite more than one sign of VAD (72%), nor more than one consequence of VAD (88%). In addition, the majority of health agents could not cite more than one sign of iron-deficient anemia (91%), nor more than one iron-rich food (77%). **Conclusion:** There is a substantial disparity between the official coverage rate reported by the Ministry of Health (93%) and the effective VAC coverage rate observed by this study (67%); this disparity could in part be due to underestimation of population increase in Guinea. The iron/folate and chloroquine supplementation program seemed efficient in reaching a large proportion of pregnant women. Yet, considering the high prevalence of anemia, the recommended three prenatal consultations may not be sufficient to treat/prevent anemia. Health workers' lack of knowledge in nutrition may also be a factor. Thus, nutrition should be reinforced in pre-service and in-service curricula to support efforts to reduce micronutrient deficiencies.

W20 COMMUNITY VOLUNTEERS: AN EXCELLENT CHANNEL FOR POSTPARTUM VITAMIN A SUPPLEMENTATION IN DINGUIRAYE, GUINEA. MC Messier, L. Touré, S. Sidibé. Helen Keller International-Guinea (MCM, LT) and Africare (SS).

Background: Guinea has high infant and maternal mortality rates. An estimated 25% of children have vitamin A deficiency (VAD). Dinguiraye is one of the poorest and most remote areas of Guinea and nutrition and health indicators in this area are abysmal. **Aim:** Decrease VAD in postpartum women and their 0-6 months old infants by supplementing women with two vitamin A capsules (VAC) within six weeks after delivery. **Methodology:** HKI trained 170 members of Africare's Community Distributors Network (composed of health and field workers, traditional birth attendants and volunteers) to distribute VAC free-of-charge to women following the IVACG recommendations. Monitoring tools were designed for people with low literacy levels, and distributors reported their monthly distribution levels to the health center where they had received their supplies of VAC. Distributors were provided with promotion tools. **Results:** VAC coverage levels among targeted women increased from the baseline of 5% to 40.8% within two years of the intervention. Of those covered, 64.7% received VAC within one week after delivery. Mother's knowledge of the importance of vitamin A increased from 29.5% to 63.3%, and 50.2% of women could cite a vitamin A-rich food compared to 17.3% before the intervention. Unexpected results from the program include the increased official reporting of births by families in order to access free VAC, illustrating the fact that a great demand for the capsules was created. **Conclusion:** Community Distributors were found to be important resources and channels for improving awareness of vitamin A deficiency and ensuring high VAC coverage for postpartum women. Challenges will be to ensure regular supplies of VAC, timely and accurate reporting, cost recovery, and the sustainability of interventions once PVOs have ceased activities in the area.

W22 LARGE SCALE-UP OF VAC DISTRIBUTION PILOT PROJECT IN CAMBODIA THROUGH COORDINATED EFFORTS AMONG PARTNER AGENCIES AND EFFECTIVE USE OF AVAILABLE RESOURCES. J Diekhans*, S de Pee**, MM Lang*, K Hou*, K Ou***, SN Prak***, R Moench-Pfanner**, MW Bloem**. Helen Keller International, Cambodia* and Asia-Pacific Regional Office** and National Nutrition Program/Ministry of Health of Cambodia***.

Background: In 2001, Helen Keller International (HKI) in collaboration with the Ministry of Health (MoH) successfully implemented a pilot project to improve VAC coverage in Cambodia. Results revealed a significant increase in VAC coverage among children 6-59 months old as well as in mothers' knowledge related to VA/VAC. Routine immunization outreach twice yearly through health centers was found to be a good channel for VAC distribution. Village-health-volunteers played an important role in raising awareness and community mobilization. However, large-scale expansion faces various difficulties, particularly transportation and regular support for outreach activities. **Objective:** To overcome the constraints and to achieve the expansion of the VAC distribution program to 16 or more Operational Districts (ODs) between 2002 - 2005 (target population: 196,303 children 6 - 59 months). **Method:** To overcome the constraints related to routine outreach, HKI partnered with agencies already supporting outreach and aided them with integrating VAC distribution. Efforts were coordinated to assist the MoH in expanding the program to another 16 ODs. Roles and responsibilities were defined with HKI located at national level and partner agencies at provincial/OD level and a detailed workplan was prepared. A common scale-up strategy was used that included a training cascade, monitoring and supervision. Distribution was conducted by government HC staff with support from partner agencies and HKI. **Results:** In the six new ODs introduced, VAC coverage rates increased markedly among children 6-59 months from 22-85% to 83-91% and among postpartum women from 2-32% to 26-65%. Mothers' knowledge related to VA/VAC also improved. To date the National VAC Program has been implemented in 13 ODs. **Conclusions:** Findings reflect the success of the VAC distribution program strategy in general and the collaboration of partner agencies. The cooperation of various partner agencies with defined roles and responsibilities appeared to be a good approach to effectively use resources and to rapidly expand the National VAC Program.

W23 COMMUNITY AND NON-GOVERNMENTAL ORGANIZATIONS' ROLES IN ACCELERATING VITAMIN A SUPPLEMENTATION: A SOUTHERN PROVINCE PERSPECTIVE. BK Kasawa, TS Chisanga. Central Board of Health, Zambia.

Background: Southern province together with the rest of the country embarked on mass Vitamin A supplementation campaign in 1999. The programme has since taken a new twist with the integration of other maternal and child health activities. These include de-worming, immunizations, growth monitoring and promotion, family planning, prevention and management of diarrhoea and prevention of malaria through the promotion of insecticide treated mosquito nets. **Aim:** Is to reduce childhood morbidity and mortality among children 6-59 months. It is anticipated that this new initiative would contribute to the reduction of incidence rates of malaria, diarrhoea, protein energy malnutrition, measles and childhood blindness to significant levels. **Role of community:** Individuals included in the programme are; community health workers, trained traditional birth attendants and lay vaccinators. They are prepared to motivate clients, give key messages and administer Vitamin A. They document activities, conduct growth monitoring and promotion, administer de-worming tablets and treat mosquito nets. Volunteers participate in preparations and evaluation of child health week activities. **Role of Non Governmental Organizations:** NGOs include the faith based organization, and civic society who are members of the technical committees. They provide additional funding and materials such as fuel, transport, and participate in supervising of the volunteers. **Achievements/implications:** Due to consented efforts of the stakeholders, the following coverage results have been realized as from 78% in 2000 to 98% in 2003. Improved mobilization of community and financial resources and sustained social mobilization have been achieved. Removal of myths that surrounded Vit A supplementation and reaching the hard to reach that are not normally covered during routines. Clients receive enhanced integrated package of health care services. **Conclusion:** Sustained high coverage of Vit A and other maternal and child health services could be realized through active participation and support of communities and NGOs.

W25 EVALUATION OF THE NATIONAL VITAMIN A SUPPLEMENTATION PROGRAM IN SCHOOL CHILDREN IN A RURAL AREA OF SRI LANKA. TMJC Madatuwa, STC Mahawithanage, UG Chandrika and AR Wickremasinghe. MOH/DDHS office, Yatiyantota, Kegalle; Department of Applied Nutrition, Wayamba University of Sri Lanka, Kuliypitiya; Department of Biochemistry, Faculty Medical Sciences, University of Sri Jayewardenepura and Department of Community Medicine and Family Medicine, Faculty of Medicine, University of Kelaniya, Sri Lanka.

Background: The Ministry of Health in Sri Lanka commenced a Vitamin A supplementation program of school children with a megadose of 100,000 IU of Vitamin A in school years 1, 4 and 7 in 2001. **Aims:** To evaluate the Vitamin A supplementation program of school children in a rural area of Sri Lanka. **Methods:** A cross sectional study was conducted among two groups of children in school years 1 and 5 comprising children supplemented with an oral megadose of Vitamin A (100,000 IU) (n=452) and children who were not supplemented (controls) (n=294). Children or mothers were interviewed, and children underwent a clinical examination and a sample of blood was taken for estimation serum Vitamin A levels by HPLC. **Results:** Supplemented children had a higher proportion of males, were younger, lived under poorer conditions, and had more evidence of chronic malnutrition as compared to controls. The prevalences of ocular manifestations of Vitamin A deficiency were similar in the 2 groups. Serum Vitamin A levels of supplemented children were significantly higher than that of the controls (39.1±14.0 µg/dl vs 35.0±15.0 µg/dl) but the levels declined gradually since time of supplementation (45.3±13.0 µg/dl, 39.3±14.3 µg/dl, 36.1±12.6 µg/dl, and 32.8±15.0 µg/dl in children supplemented within 1 month, 1-6 months, 7-12 months and 13-18 months of supplementation, respectively). Vitamin A levels were significantly greater in supplemented children, as compared to controls, only if supplementation was done within 6 months after adjusting for sex, parent's education, type of house and age. **Conclusion:** The improvement in serum Vitamin A levels using the oral megadose Vitamin A supplementation with 100,000 IU is seen only within six months after supplementation. Hence, the current strategy may not be the most appropriate in this population in Sri Lanka.

W24 EVALUATION OF A PILOT PROGRAM FOR POST-PARTUM VITAMIN A SUPPLEMENTATION IN MAPUTO CITY, MOZAMBIQUE. S Khan, S M Mocumbi, C Ismael, V Van Steirteghem, and S P Meershoek. Ministry of Health (SK, SMM), UNICEF (VVS), and Helen Keller International (CI and SPM).

Background: In May 2002 the Mozambican Ministry of Health started a pilot program for post-partum vitamin A supplementation (VAS) in Maputo City. Staff of all maternity wards in Maputo city were trained on technical and logistical aspects of the program. Guidelines were established and a reporting system was designed. In January 2004 this experience was evaluated. **Objectives:** To collect best practices for revision and expansion of the post-partum VAS program to other maternities in the country. **Methods:** Observation and interview sessions were conducted with health staff and clients to collect information on knowledge and perceived benefits of VAS, practices and recording of VAS, training and supervision. **Results:** Health staff had adequate knowledge on VAS and benefits of VA. Mothers knew they received VAS and that it is good for their health, without being able to detail why exactly. VAS was correctly administered in all maternities. Coverage data show that 80% of the estimated number of women who gave birth in 2003 received VAS. Missed opportunities include mothers who were transferred directly after birth, some mothers who gave birth during the weekend and mothers who did not give birth at the maternity ward and did not go to post-partum consultation. In the bigger maternity wards, coverage data were also affected by failures in recording. Initial training of health staff was found to be adequate, but mechanisms to train newly appointed staff were not always in place. Frequent supervision has contributed to high coverage data. **Conclusions:** Post-partum VAS should be expanded to the rest of the country. Proper training and regular supervision of staff is essential, and should emphasize on possible missed opportunities and recording. Administering VAS at exit of the maternity is preferred as it provides better opportunities to explain benefits and insist on need for VAS of the newborn after 6 months.

W26 IMPACT OF VITAMIN A SUPPLEMENTATION ON HEALTH STATUS AND ABSENTEEISM OF SCHOOL CHILDREN IN SRI LANKA. STC Mahawithanage (1), UG Chandrika (2), AR Wickremasinghe (3) and ND Karunaweera (1). Malaria Research Unit, Faculty of Medicine University of Colombo (1); Department of Biochemistry, Faculty of Medical Sciences, University of Sri Jayewardenepura (2); and Department of Community Medicine and Family Medicine, Faculty of Medicine, University of Kelaniya (3), Sri Lanka.

Background: Although benefits of Vitamin A supplementation of children have been documented, some studies report no beneficial effects. **Aims:** To determine the impact of Vitamin A supplementation on health status and absenteeism of school children. **Methods:** A randomized double blind clinical trial over a period of 1 year was conducted in a rural area of Sri Lanka involving 659 school children attending years 1-5 (aged 5 to 11). Children were assigned to either 200,000 IU of Vitamin A (n=322) or placebo (n=337) once every 4 months. Socio-demographic data of children were obtained at the baseline survey. Anthropometric measurements were taken and haemoglobin levels were assessed at the baseline and after intervention. A sample of blood was taken from a subgroup of children (n=187) before administration of each dose for estimation of serum Vitamin A levels by HPLC. School absenteeism was recorded with the reason for absenteeism. **Results:** 613 children completed the trial. Average school absenteeism due to ill health and non-health related causes were 8.6±8.0 days and 20.6±15.0 days respectively. There were no significant differences in age, sex, school absenteeism during last year (only for children in school years 2-5), haemoglobin levels, serum Vitamin A levels (only for children in the sub group) and anthropometric indices (WAZ, WHZ and HAZ) between the Vitamin A and placebo groups at baseline. Vitamin A levels increased in the treatment group between the 1st and 2nd administration (4.5±17.3 µg/dl) but not in placebo group (-2.2±17.5 µg/dl). The change in serum Vitamin A levels after 8 months, as compared to baseline, between the two groups was significant (p<0.001) (8.2±18.4 µg/dl in treatment vs -2.8±16.4 µg/dl in placebo). Changes in anthropometric indices and haemoglobin levels between the two groups were not significant. During the follow up period, absenteeism due to ill health (7.7±7.4 days in treatment vs 8.6±8.3 days in placebo) and due to non-health related causes (20.3±15.7 days in treatment vs 19.1±14.5 days in placebo) were similar in the two groups. **Conclusion:** Vitamin A supplementation with 200,000 IU every 4 months over 1 year had no impact on health status or school absenteeism of children inspite of improved Vitamin A status.

W27 INSTITUTIONALIZING THE DISTRIBUTION OF VITAMIN A IN THE DECENTRALIZED HEALTH SYSTEM OF ZAMBIA. C Mwela, F Mubanga, W Himanteeka, W Siamusantu, M Mwanza. MOST Project and National Food & Nutrition Commission, Lusaka, Zambia.

Background: In 1996 the Central Board of Health in Zambia initiated health reforms which required its 72 districts to be responsible for a comprehensive approach to primary health care. This reform was implemented with funding through a 'basket' of donor funds. Universal vitamin A supplementation (VAS) at a national level was introduced in 1998 but was perceived as a 'selective service' and thus excluded from basket funds. It relied on special donor funding. Institutionalizing national VAS required its inclusion in the 5-Year National Health Strategic Plan (NHSP) and budget allocations through the district health plans. Financial sustainability requires independence from special donor funds. **Aim:** To describe the process and success of advocacy in incorporating VAS into national and district annual plans. **Method:** We reviewed all district plans from 1997 to 2003, the NHSP, and also reviewed records of planning meetings. **Results:** In 2000 VAS was made one component of the Child Health Week program (CHW), a package integrating six preventive child health services. The Nutrition Commission led advocacy at the national level to the Intersectoral Committee on Child Health, and to district health planning teams during their annual reviews at the start of each budget cycle. The benefits of VAS were presented together with those of other preventive services and the efficiency of the outreach strategies used by CHWs was also highlighted. In 1997 VAS was included in 67% of the district annual plans, and this increased to 100% for VAS as part of CHW in 2002 and 2003. For the first time in 2004, the National Government has encouraged districts to allocate basket funds to support CHW activities, thus reducing reliance on special donor funding. **Conclusion:** The CHW concept has been included in the national health strategic plan as well as in all the district annual health plans. The number of districts using basket funds for CHW activities in June 2003 will indicate likely sustainability.

W29 NATIONAL VITAMIN A PROMOTION CAMPAIGNS INCREASE VITAMIN A CAPSULE COVERAGE RATES AMONG 6-59 MONTH OLD CHILDREN IN INDONESIA. AL Rice, R Untoro, Sunarko, R Adirza, MW Bloem. Helen Keller International-Indonesia (HKI), Ministry of Health/Government of Indonesia (GOI).

Background: From August 2001 – February 2003 a series of national vitamin A (VA) promotion campaigns were conducted prior to every national VA distribution month (February and August) for preschool age children in Indonesia. Television and radio ads were broadcast and printed promotional materials (banners, posters, flyers, etc.) were distributed to all government health centers across the country for display in their areas. **Aims:** To evaluate the impact of the mass media promotion campaigns on VA capsule coverage rates among 6-59 month old children using GOI/HKI Nutrition and Health Surveillance System (NSS) data. **Design:** NSS survey data collected from ~24,000 households in 8 rural provinces and ~6,000 households in 4 urban poor areas after the February 2003 VA distribution month were analyzed to compare mother's exposure to VA campaign messages with VA capsule receipt among their children. During the survey, mothers were asked to recall if they remembered seeing a TV spot about VA or seeing the VA mascot's picture on any other media materials. Mothers were also asked to recall if their children received a VA capsule in the past 6 months. **Results:** In the rural areas, 81% of the 6-59 month old children received a VA capsule and 76% had mothers who were exposed to the VA promotion campaign. Among children whose mothers were not exposed to the promotion campaign, only 65% received a VA capsule. In comparison, 86% of the children whose mothers were exposed to the campaign received a VA capsule. Similar results were observed in the urban poor areas (data not shown). 14% of the children whose mothers were exposed to the campaign still did not receive a VA capsule. When asked why not, the mothers most commonly said it was because they had not visited a health center or a health post. **Conclusion:** Mother's exposure to VA campaign messages was positively associated with VA capsule receipt in their 6-59 month old children. Health promotion campaigns that use a combination of mass media channels can positively influence families' participation in health and nutrition programs in both rural and urban poor areas of Indonesia. Supported by: USAID Cooperative Agreement No: 497-A-00-99-00033-00.

W28 USING VITAMIN A STRATEGY TO BOOST ROUTINE IMMUNISATION IN BIHAR. YN Pathak, G Verma and S Jacob. Department of Health, Govt. of Bihar, Patna, India, UNICEF Bihar, Patna, India.

Background: Bihar State initiated distribution of Vitamin A in a standalone campaign mode in 2000 following ICMR reports of alarmingly high prevalence of Vitamin A deficiency disease in 1998 and successfully completed three rounds of VA supplementation till October 2001 with a coverage of 90%. To improve program sustainability it was decided to integrate it with routine systems, although vitamin A was being distributed with Routine Immunization the coverage of complete immunization (all doses of five vaccines received by one year) was very low around 10%. **Aim:** To increase vitamin A coverage in routine immunization through routine systems. **Methods:** The Government began the process of an integrated Vitamin A strategy in a strengthened routine immunization system in August 2003. The first task was to define the site and day of every outreach session and functionaries responsible in a detailed district micro-plan. Approximately 5800 Health staff were trained to make micro-plans. Once the microplans were ready the districts organized joint training of Health and ICDS (Integrated Child Development Services a Government program to address development and nutrition needs of children and women) field staff (approximately 60,000) to organize, conduct, record and report outreach sessions. The state also operationalised 38 teams to ensure social mobilization in all the districts. A state Core Group of about 40 individuals was used to support districts in the implementation of microplans and monitoring the process, which began towards the end of November 2003. Display material such as posters, folders and leaflets were developed for outreach sessions. **Results:** The output of the Bihar activities has been a 66% coverage of children 9months to 5 years with one dose of vitamin A plus a remarkable improvement in the coverage of individual vaccines ranging from 27 – 50% by March 2003. **Conclusions:** Intensive efforts to distribute vitamin A in the routine system have given a boost to coverage of vaccines in routine immunization by operationalising the process of holding outreach sessions in villages and not only at Health Centers.

W30 SUCCESS STORIES FROM WEST AFRICA: NUTRITION NETWORKING THROUGH THE ECOWAS NUTRITION FORUM. I Thiam (1), K Samba (2), SM Diene (3), MA Bendech (4), AN Wade (3), M Ntiri (4), K Joiner (1), SK Baker (4). 1. West African Health Organisation; 2. Academy for Educational Development/SARA Project; 3. BASICS II; 4. Helen Keller International.

The 15 member nations of the Economic Community of West African States (ECOWAS) have a combined population of over 250 million with a weighted under-5 mortality rate (U5MR) of 180. Recent analyses indicate that 41.9% of children in the region are at risk of vitamin A deficiency (VAD) and that adequately controlling VAD will reduce U5MR by 24.7%, averting over 245,000 child deaths a year (VM Aguayo et al). Formal nutrition networking started among Francophone countries in 1996, and expanded to all ECOWAS countries in 1999. Pre-existing regional health structures were merged into the West African Health Organization (WAHO), the official health agency of ECOWAS, in 2000 and the networking, now known as the ECOWAS Nutrition Forum, co-ordinated by WAHO since 2001. Annual meetings of the Forum bring together nutrition actors of the region for review of activities, technical update, exchange of best practices and setting objectives for the coming year. Exchange continues among Forum members between meetings through e-mail, web site and specific workshops. Annual meetings have taken on increasing national-level visibility providing invaluable advocacy: the 2002 Forum was opened by the Vice President of The Gambia and the 2003 Forum was opened by the Prime Minister of Guinea. Regional advocacy, goal setting, exchange of best practices, technical updating/capacity building and public accountability has led to a number of concrete advancements in vitamin A programs including: (1) acceleration of mass VA supplementation, (2) adoption of the objective of sustained twice-yearly VA supplementation levels of at least 80% for children under 5 by all member states, (3) acceleration of food fortification initiatives including 2 Private Sector-Public Sector Dialogues on Food Fortification, (4) acceleration of advocacy through PROFILES analyses and presentations on VAD at 2 WAHO Assembly of Health Ministers. As the Forum is supported by a number of partners (USAID through BASICS II, SARA and MOST projects; UNICEF, WHO, Helen Keller International, World Bank, the Micronutrient Initiative, FAO) it has also facilitated donor coordination in the region. This model of networking has been critical to advancing VA programs in one of the neediest regions of the world. The combination of a technical network with a regional political structure permits direct impact on policies.

W31 A RAPID ASSESSMENT OF THE MANAGEMENT OF THE VITAMIN A SUPPLEMENTATION PROGRAMME IN THE EASTERN CAPE, SOUTH AFRICA. CB Witten (1), R Harvey (2), T Puoane (1), N Kama (3) and G Nchukana (3). (1) University of the Western Cape, (2) MOST/USAID, (3) Department of Health, Eastern Cape Province.

Background: Since 2001, the Eastern Cape Provincial Department of Health has implemented a universal vitamin A supplementation (VAS) Programme, strategically adapting the South African National VAS policy to target children 6-24 months. A series of training and capacity building sessions were conducted in 2002-2003 for provincial and middle managers and service delivery personnel. Technical assistance and financial support have been provided by University of Western Cape and USAID/MOST. In October 2003 a rapid assessment was conducted of the Eastern Cape programme. **Methodology:** In five purposefully selected districts, 27 clinics were selected (ten rural and 17 peri-urban). Clinic observations and exit interviews, clinic audits, and in-depth nurse interviews were conducted, and in-depth management interviews were completed. **Findings:** 1) Most children were appropriately dosed following standard protocols. The supplementation was appropriately recorded in four out of five cases. 2) 200,000 IU capsules were adequately stocked, properly stored, and available at 23 of 25 audited clinics, while 100,000 IU capsules were often out of stock. 3) Nurses are so hampered by time constraints that few engage caregivers in dialogue or effectively provide counseling or refer to materials, other than as a tool to indicate a return date. Of those health workers who did engage the caregivers in conversation, the majority mentioned programme messages that VAS was good for the health of the child. 4) Feedback on the newly implemented media campaign designed to increase demand indicated that approximately half of the caregivers had heard the radio messages. Other print materials were still in the process of being delivered, thus making it difficult to assess their effectiveness in a clinical setting. 5) Lack of integration and coordination among child health programmes and the pressures of other primary health care programmes creates some management frustration. **Conclusions:** Information, education, communication (IEC) and counseling materials are not yet viable options in overworked clinic settings. In-service training sessions and formative supervision need to be strengthened to address improved counseling techniques, use of IEC materials, and appropriate dosing of children under 12 months when only 200,00 IU capsules are available. Based on findings, programme indicators are being revised to better facilitate programme monitoring. The assessment process and quick feedback of findings have helped dialogue and participatory decision-making to further strengthen the programme.

W32 DEVELOPING AN INFORMATION, EDUCATION & COMMUNICATION (IEC) STRATEGY FOR XHOSA-SPEAKING CHILD CAREGIVERS TO SUPPORT THE ROUTINE VITAMIN A SUPPLEMENTATION PROGRAMME IN THE EASTERN CAPE, SOUTH AFRICA. CB Witten (1), R Romano (2), M Chopra (1), N Kama (3) and G Nchukana (3). (1) University of the Western Cape, (2) Academy for Educational Development, (3) Department of Health Eastern Cape Province.

Background: In 1994 the South African Vitamin A Consultative Group (SAVACG) found that in the Eastern Cape Province 31% of pre-school aged children were vitamin A deficient. In 2001 the Eastern Cape Provincial Department of Health implemented a universal vitamin A supplementation (VAS) programme for children aged 6-24 months integrated with routine EPI. Technical assistance was provided by the University of Western Cape (UWC) with USAID/MOST technical and financial support. **Methodology:** UWC developed a communication strategy targeting Xhosa-speaking child caregivers from peri-urban and rural areas and conducted formative research to assess knowledge, attitudes and practices related to vitamin A. The research also examined trusted sources of health information, appealing messages, and attractive health attributes of vitamin A. **Findings:** The majority of the participants had not previously encountered vitamin A or health information on VAS. Once women were informed about vitamin A, they were eager to obtain it for their child. The most frequently cited channels for health information were radio, church (women's groups) and health facilities. While nurses were considered the most trusted and valued sources of health information, they were also considered difficult to approach. The most noteworthy and attractive health attribute of the VAS programme is that vitamin A saves lives and prevents early infant death. **Action:** A set of broadcast messages and two graphic designs were subsequently developed and pre-tested with similar focus groups. Two attractive posters and a leaflet featuring both clinic and community settings were developed with the call-to-action message: "Go to the clinic when your baby is age 6, 12, 28, and 24 months" supported by motivational messages: "Your baby needs vitamin A" and "Your baby deserves to be healthy." **Conclusions:** A five-month print and radio campaign for Xhosa-speaking caregivers using local radio and community newspapers, posters and pamphlets, distributed through health facilities and women's groups, was launched in September 2003. This campaign and technical assistance provided by the UWC and MOST has resulted in a fourfold increase in vitamin A coverage in the province.

W33 CONTINUING PARTNERSHIPS FOR SUSTAINABLE PREVENTION OF VITAMIN A DEFICIENCY IN CAMBODIA. Y Yim, DD Shaw, V Ly, DJ Fisher. World Vision Cambodia, Phnom Penh, Cambodia.

Issue: Vitamin A deficiency (VAD) is a public health problem in parts of Cambodia. World Vision Cambodia (WVC) and partners have implemented a VAD prevention project in Kompong Thom Province. Phase 1 results (2000-2001) were presented at the XXI IVACG meeting in 2002. Phase 2 (2002-2003) results are presented here. **Objective:** To develop sustainable community-based interventions to prevent VAD and reduce the prevalence of night-blindness in children and mothers. **Framework:** Multi-sectoral capacity building partnerships with the Ministries of Health, Education, Agriculture and Rural Development and local authorities continued from Phase 1. Community participation and integration of activities into long-term community development programs increased in Phase 2. **Program Design:** Phase 1 interventions continued. Village Development Committees (VDC) supported semi-annual Vitamin A capsule (VAC) distribution linked to enhanced measles immunization and Traditional Birth Attendants (TBA) distributed post-partum VAC. There was promotion of optimal breast-feeding practices, health and nutrition education, and home and school gardens. Key groups for increased training in Phase 2 were VDCs, TBAs, Health Centre staff and school teachers. An external Consultant led the final evaluation of Phase 2 using quantitative and qualitative methods. **Results:** Night-blindness prevalence in children aged 18-59 months decreased from 11% (1999) to 3% (2001) and 0.5% (2003) and in mothers from 6.4% (2001) to 4.1% (2003). These rates are now below the WHO public health problem levels of 1% for children and 5% for women. Rates for exclusive breast-feeding, post-partum VAC coverage, measles immunization and knowledge of the correct causes of night-blindness among all groups increased. Strengthened partnerships between the communities, government agencies and WVC were noted. **Implications:** Four sustainability strategies have been initiated: integration into community development programs; partner capacity building; increased community participation; and nutritional behaviour change focused on Vitamin A rich foods. A planned evaluation in three years will assess the sustained success of these strategies.

W34 ANTERIOR FONTANELLE BULGING AFTER VITAMIN A SUPPLEMENTATION GIVEN WITH DPT, POLIO AND MEASLES VACCINES IN THE FIRST YEAR OF LIFE. ME Penny, M Ram, WHO/CHD Immunization-Linked Vitamin A supplementation study group, Instituto de Investigación Nutricional, Lima, Peru and Department of International Health, Johns Hopkins Bloomberg School of Public Health, Baltimore MD.

Taking advantage of routine pediatric immunization health contacts is an efficient way to dispense intermittent high dose vitamin A supplementation but reported bulging of the anterior fontanelle has caused concern. A large multisite randomised controlled trial of postpartum plus immunization linked supplementation was designed to include examination for bulging fontanelle. The study was conducted in India, Ghana and Peru. Mother infant pairs were randomised to receive either retinol palmitate or placebo (vitamin E) orally, postpartum, and with infant vaccines as shown in the table. Mothers randomised to supplementation received 200,000 IU postpartum. Children who had received placebo at the first three doses received 100,000 IU with measles vaccination (dose 4). The children's fontanelles were examined before each immunization-vitamin A/placebo dose and 24 and 48 hours afterwards. The overall incidence of bulging at all sites is shown in the table.

Vaccine & Supplement	Supplement group	Control group	Difference (95% CI)
Dose of retinol	Placebo	25,000 IU	
Dose 1	5/4629 (0.11%)	13/4626 (0.28%)	0.17 (-0.01, 0.35)
Dose 2	7/4554 (0.15%)	28/4526 (0.62%)	0.46 (0.21, 0.72)
Dose 3	13/4451 (0.29%)	39/4437 (0.88%)	0.59 (0.27, 0.90)
Dose of Retinol	100,000 IU	25,000 IU	
Dose 4	30/3985 (0.75%)	7/3672 (0.18%)	-0.58 (-0.87, -0.28)

Bulging was more common in Ghana, the highest reported rate was 1.9% in the supplemented group at the third dose. Within country increased rates of bulging were only significantly more common at the second dose in Ghana, at the third dose in Ghana and India and at the fourth dose in India. Bulging was associated with fever (odds ratio 3.44, 95%CI 2.13, 5.55) but caused little maternal concern. It usually appeared within 24 hours and had resolved by 48 hours.

We conclude that there is an increased risk of bulging fontanelle when vitamin A is given with childhood immunizations but the risk is small and the effect mild and transient.

W36 RANDOMISED TRIAL OF A NEWLY PROPOSED REGIME FOR VITAMIN A SUPPLEMENTATION OF YOUNG INFANTS LINKED TO THE EPI IN GHANA. S Newton, C Zandoh, B Kirkwood, S Owusu-Agyei. Kintampo Health Research Centre and LSHTM.

Background: In 1993 the WHO proposed the delivery of a post partum dose of vitamin A (200,000 IU) to mothers and three doses of 25,000 IU vitamin A to young infants with each of their DPT/Polio doses. This was tested in a multi-center trial in Ghana, India and Peru. It assessed the benefits and safety of combining maternal and low dose infant vitamin A supplementation with EPI in a placebo controlled trial. This was found to be safe but the proposed dosing regime provided only a small improvement to infant vitamin A status at 6 months of age; by 9 months when they would normally have received their first supplements the benefits from the early doses had disappeared. The WHO is currently evaluating the response in doubling the post-partum dose to 400,000 IU and the child doses to 50,000 IU at same EPI contacts. The trial started in September 2002 and is due to end in August 2004. **Objectives:** 1. Measure the effect of 400,000 IU of vitamin A given in two divided doses of 200,000 IU to mothers and 3 doses of 50,000 IU of vitamin A given to their infants concurrently with DPT/Polio immunizations, on vitamin A status at 26 weeks of age. 2. Compare the effect of such a regimen to that of the previously recommended regimen of 200,000 IU of vitamin A given to mothers and 3 doses of 25,000 IU of vitamin A to their infants concurrently with DPT/Polio immunizations. 3. Measure the side effects of 50,000 IU of vitamin A administered with DPT/Polio immunizations. **Methods:** Trained fieldworkers identify mothers soon after birth, consent is sought and they are recruited into the trial. Mother-child pairs are visited at each of the EPI visits at home at 6, 10 and 14 weeks, where vitamin A doses and immunizations are administered and breast milk and blood samples collected. **Programme implication:** If the safety of this new regime is confirmed and the benefits are sustained beyond 9 months of age, it will help allay the anxieties from EPI programmers about using EPI as a vehicle to delivering essential micronutrient interventions to young infants.

W35 THE SAFETY AND EFFICACY OF VITAMIN A SUPPLEMENTATION ALONGSIDE ROUTINE VACCINATIONS: A RANDOMISED CONTROLLED TRIAL IN TANZANIA. B Idinjili, H Masanja, H Urassa, W Bunini, E Harmse, JJ Aponte, T Goodman, E Kahigwa, H Mshinda, D Ross, D Schellenberg, Ifakara Health Research and Development Centre, Ifakara, Tanzania; Saint Francis Designated District Hospital, Ifakara; MRC laboratories, Cape Town, Republic of South Africa; Centre for International Health, Hospital Clinic, Barcelona, Spain; WHO/Vaccines and Biologicals, Geneva, Switzerland; London School of Hygiene and Tropical Medicine, London, UK.

Background: Vitamin A deficiency (VAD) is a major public health problem in Tanzania, where it affects children as young as 6 months old, and where routine supplementation begins at age 9 months. Given the high prevalence of VAD and the high mortality before this age, vitamin A status needs to be improved in early infancy. An earlier placebo-controlled trial in Ghana, India and Peru showed no significant impact of the lower dose regimen within the current trial (see below) on infant morbidity and only a transient decrease in VAD. **Aim:** To compare the safety and efficacy of two regimens of vitamin A supplementation delivered alongside EPI vaccines during the first 6 months of life. **Design:** A randomised double blind clinical trial was conducted in Ifakara, southern Tanzania. A total of 780 consenting infant-mother pairs were allocated to either a lower or a higher dosing regimen. Mothers in the lower dose arm received 200,000 IU of vitamin A within 24 hours of delivery and their infants received three doses of 25,000 IU at the time of routine DPT/polio vaccinations at approximately 1, 2 and 3 months of age. Mothers allocated to the higher dose regimen received a second 200,000 IU dose of vitamin A when bringing their child for routine vaccination at 1 month of age, and their infants received three doses of 50,000 IU at 1, 2 and 3 months of age. Safety data were generated by a hospital-based, paediatric clinical surveillance system, augmented by active case detection in mothers and children in the 48 hours after each dose. The primary efficacy end point was the prevalence of VAD at six months of age, defined on the basis of mRDR testing. Secondary analyses compared the prevalence in infants of VAD (defined on the basis of serum retinol concentrations and mRDR), anaemia, malaria and malnutrition at 6 and 9 months, and breast milk retinol concentrations. **Results:** Field activities of this WHO-supported trial were completed in December 2003. Results will be presented at the meeting.

W37 MILK RETINOL AND OLIGOSACCHARIDE CONCENTRATIONS IN GAMBIAN WOMEN FOLLOWING TWO DOSES 200,000 IU RETINYL PALMITATE POST PARTUM. DI Thurnham, L Connery, R Henaff, M Darboe, CA Northrop-Clewes, A Prentice. Northern Ireland Centre for Food and Health, University of Ulster. Nutrition & Public Health Intervention Research Unit, London School Hygiene Tropical Medicine, UK.

Background: It was recently suggested that increased amounts of vitamin A (VA) to mothers post partum (pp) and to infants in the first 6 mo may be needed in developing countries to improve infant VA nutrition, reduce morbidity and improve growth. Human milk oligosaccharides (HMO) are the third largest component in milk. They have antibacterial properties and their synthesis may be influenced by VA status. **Aims:** To determine whether improved maternal VA status alters milk retinol and HMO concentrations. **Methods:** 220 mothers were recruited during the last trimester and, together with their infants, were randomly allocated to receive the high VA treatment ('txt': mothers 2 x 200,000 IU retinyl palmitate pp, infants 3 x 50,000 VA in first 6 mo) or standard Gambian Government recommendations ('control': mothers 200,000 IU pp, infants no VA until ~7-8 mo). Mothers gave 6 milk samples, monthly up to 6 mo pp. Retinol was extracted and measured by HPLC. HMO were isolated by ultrafiltration and separated into 8 fractions using gel permeation HPLC. **Results:** Samples from 150 mothers have so far been analysed and the last samples will be collected in March 2004. Mean concentrations of milk retinol in the combined txt & control groups for the first 100 mothers for mo 1 to 6 were 1.98, 1.62, 1.63, 1.49, 1.39 & 1.05 µmol/L or 47, 42, 42, 41, 40 & 45 nmol/g fat. The code will be broken when analyses are complete (~June) but for a sub-sample analysis of HMO, the code was broken for 20 randomly selected samples (11 control, 9 txt) and total HMO concentrations were higher in the txt group from mo 2-6 incl. (NS). **Conclusions:** As the code is not broken we currently do not know if milk retinol is increased by the high dose of VA. However, the sub-sample analysis suggests that total HMO concentrations may be increased by the VA treatment, which may enhance the antibacterial properties of the milk. **Acknowledgements:** We thank BASF Ltd who supported the analyses on the milk samples and Hoffman La Roche who provided the VA.

W38 SUSTAINING THE GAINS OF VITAMIN A SUPPLEMENTATION: INNOVATIVE WAYS OF INTEGRATING VITAMIN A SUPPLEMENTATION INTO CHILD HEALTH SERVICES IN GHANA. E. Amoahful (1), R. Agble (1), A. Nyaku (2), 1. Nutrition Unit, Ghana Health Service, Ghana; 2. MOST, The USAID Micronutrient Program, Ghana.

Introduction: The Ghana Health Service (GHS) has been implementing twice yearly Vitamin A Supplementation policy targeting children aged 6 to 59 months. Strategies used were mass vitamin A distribution to provide the first dose and the second dose was given as part of the National Immunization Days six months later. Although these campaigns have resulted in achieving over 90% coverage, it is important to explore ways of making supplementation more sustainable and ensuring that target children receive two doses a year. The GHS has defined a framework for the integration of vitamin A supplementation into child health services whilst sustaining caregiver interest and high coverage. The new strategy involves using Child Health Promotion Weeks as one-stop opportunities for providing key services and facts on preventive health care. **Aim:** The aim is to institute a number of sub district activities designed to improve efficiency and quality of service delivery, utilization by caregivers and coverage of several key child health services. This will be complemented by improved outreach and facility based routine services. **Strategy:** A package of services will be provided covering, vitamin A supplementation, immunization, re-treatment of Insecticide Treated Materials, growth monitoring and promotion; adequate supply of child health record cards and birth registration. Additionally, routine services will be strengthened through staff re training, provision of revised tools, use of opportunistic contacts and care giver education. A comprehensive communication and education will improve knowledge and skills of health workers. These will be supported by information campaigns to improve the knowledge of caregivers and create demand. Joint planning and logistics mobilization is a major feature. A monitoring framework has been designed to capture data on; provision of services including proportion of staff trained, quantities of commodities and information provided and; service utilization. **Outcome:** The outcomes include: Improved efficiency through the combination of services reducing number of trips thus making services more attractive to caregivers; Retrained health workers and improved quality of child health services; Improved utilization of services by care givers resulting in increased coverage; Establishment of cost effective systems for providing a package of services.

W40 IMPLEMENTATION OF VAD PROGRAM 2003-2010 POST NIDS EXPERIENCE OF RWANDA. A. Ndagiyimfura, Consultant et al. Ministry of Health, UNICEF, USAID, WFP.

Background: Recent surveys in Rwanda show that VAD is a significant public health problem. In 2000, rates of maternal, infant and young child mortality were very high, respectively about 1071/100 000, 107/1 000 and 196/1000. The main causes of those high rates were attributable to the malaria, acute respiratory infections, diarrhoea and malnutrition. **Objective and new strategies:** The goal is to eliminate the VAD by 2010 and maintain its elimination after 2010. The main strategies are: Supplementation of pregnant women, lactating women after delivery, and infants 0-5 years; Advocacy and social mobilisation against VAD; Promotion of exclusive breastfeeding to six months; Improvement of management of childhood illnesses; Improvement of bioavailability, accessibility and consumption of foods rich in vitamin A; Food fortification in vitamin A. **Implementation:** prevention efforts against VAD began in 1991. The strategy includes supplementation of target groups using a routine system that covers 20%. To increase the coverage level, supplementation was linked to NIDs from 1998 to 2003. Coverage was high during this period. At the end of the NIDs program, this activity was integrated to the World Health Week in April and National Health Worker Day in October from 2003 to 2006. The first campaign began in November 2003 with a very high coverage level of about 93.1% for infants, 102.9% for children and 47.8% for lactating women six weeks after delivery. This activity involves different services as Nutrition and Reproductive Health Division, Immunization and Health Worker Program and the PMTCT. The program deploys health workers to deliver vitamin A after their training. **Assessment and evaluation:** There is a supervision team at all levels of supervision and reporting tools for campaign and routine supervision. Each kind of supervision has its calendar of implementation. It provides a global evaluation all three years. **Implications:** The visit of MOST Project consultancy in 2003 allows having a sustainable program. It is possible to access target groups by means of campaigns and the routine system twice each year by 2006. Fortification of foods with the vitamin A is a long-term intervention. In this period of NIDs and vitamin A supplementation, it is observed that death due to measles has been reduced. By 2000, the prevalence of malnutrition and mortality levels in infants and young children were reduced if compared to previous years. Birth weight has increased. If the level of iodized salt consumption (92%) and vitamin A status are high as above, we think both strategies will inspire the reduction of iron deficiency.

W39 VITAMIN A CAPSULE DISTRIBUTION IN MALI THROUGH NATIONAL NUTRITION WEEKS: REACHING AND MAINTAINING HIGH VA SUPPLEMENTATION COVERAGE. A. Cissé, E. Ouattara, D. Koné, L. Mahy, K.D. Sy, M. Diarra, L. Nichols, P. Signé, S. Zigirumugabe. Helen Keller International Mali (AC, FO, DK, LM), Ministry of Health (KDS, MD), ABT Associates (LN), UNICEF (PS), USAID (SZ).

Background: In Mali, VA deficiency (VAD) is a public health problem: 6.7% of rural women of reproductive age have been night blind during their most recent pregnancy (M/DHS-2001). VA supplementation is part of the Ministry of Health's (MOH) package to reduce VAD. VA capsules (VAC) are delivered through National Nutrition Weeks (SIAN) to children 6-59 months and post partum women. **Objectives:** To ensure twice-yearly VA supplementation of 6-59 months children with at least 80% coverage. **Methods:** Distribute VAC through SIAN using a mix of delivery strategies: fixed centres, outreach, campaign, routine. **Findings:** Mali had good results organizing Regional Micronutrient Days (RMD) progressively from one (in 2000) to 5 regions in 2001 (78 to 100% VAC coverage range). With NIDs phasing out and conscious of the importance of VA supplementation, the MOH adapted the RMD strategy and organized a first SIAN in June 2003, SIAN II (January 2004) and SIAN III (June 2004). A mix of distribution strategies has been used appropriate to the local situation. Coverage results are high (>90%). A national rapid coverage survey has been organized after SIAN II: data on coverage, information source, implication of partners at the peripheral level have been collected and will be available at the IVACG meeting. Coverage data will be linked to delivery method and will reveal strengths and weaknesses. **Conclusion:** In Mali, the transfer process from NID-supported supplementation, to NIDS with Regional Micronutrient Days, to National Nutrition Weeks has been smooth and is an example of a PVO initiative scaled up with MOH and donors support. Lessons learned from past editions will continue to be shared with implementation partners and will lead to 100% coverage nationwide in the near future. The MOH intends to institutionalize SIAN: they are included in the National Strategic Food and Nutrition Plan (2004-2008).

W41 VITAMIN A DEFICIENCY IS VIRTUALLY UNDER CONTROL IN NICARAGUA. J. Mora, J. Bonilla, GE Navas, A. Largaespada. USAID/MOST, Nicaragua Ministry of Health, Institute of Nutrition of Central America and Panama (INCAP).

Vitamin A was a problem of public health significance in Nicaragua. A national survey in 1993 showed that 31% of the children under five years of age had subclinical vitamin A deficiency (VAD - low levels of plasma retinol) and their vitamin A intake was only 208 micrograms of retinol equivalent (ug RE); i.e. 52% of the recommended daily intake (RDI). An integrated approach to VAD control was planned to include supplementation of children 6-59 months at 6-month intervals, fortification of sugar and a communications plan to improve dietary practices. Vitamin A supplementation was launched by the Ministry of Health in 1994 as an emergency measure to be integrated within the already successful twice-yearly "Child Health Weeks" (Jornadas Nacionales de Salud), which had been in operation since the previous decade. The campaign-type approach involves periodic training of health personnel and systematic social mobilization of different stakeholders to secure active community participation and high demand for the services offered (immunizations, vitamin A and iron supplementation, deworming, health education, oral rehydration packages, and other preventive services). After 6 years of sustained high coverage every six months, a national survey in 2000 revealed a dramatic decline of VAD in children, with national prevalence <9%. In 2003, after three years of supplementation, sugar fortification and social communication efforts, an assessment made as part of the recently established Integrated Nutrition Monitoring and Evaluation System demonstrated that VAD no longer existed in children. A perfectly normal plasma retinol distribution was found, with only 2% of low values, despite unchanged high rates of infection (20%) as indicated by high levels of α_1 -acid-glycoprotein. The combination of supplementation and fortification may have increased retinol stores high enough to secure normal levels of plasma retinol even in the presence of infection. VAD in children is virtually under control in Nicaragua. Its long-term sustainability will be contingent upon continued food fortification and targeted supplementation of young children.

W42 BUILDING A MULTISECTORAL VITAMIN A PROGRAM IN UGANDA: ESTABLISHING SUSTAINABLE ROLES. L Sserunjogi, PWJ Harvey, MOST/USAID, Kampala, Uganda and Johns Hopkins Bloomberg School of Public Health, Baltimore MD.

Background: An analysis of the nutrition situation in Uganda in 1999 indicated that vitamin A deficiency (VAD) was prevalent and was an important cause of the high child mortality rate. VA guidelines were out of date and supplement distributions were neither regular nor achieving high coverage. By 2003 new initiatives were launched in the health, agriculture, and food industry sectors and held promise to achieve adequate VA intake in the population. Policy review, stakeholder participation, and operations research were key strategies in building sustainability for these initiatives. **Aim:** To achieve sustained adequate vitamin A intake among 80% of preschool children. **Method:** The Ministry of Health (MOH) was supported in reviewing and strengthening guidelines and producing communication materials. With coordinated support from several donors, district health staff developed and refined different strategies to reach maximum numbers of young children with supplements and sometimes other preventive services. The agricultural sector and private food industries implemented the food-based components of the program. **Results:** The MOH officially launched vitamin A bi-annual supplementation months, and also used integration with NIDs for measles and polio campaigns to supplement more children. After a successful launch of an improved variety of orange-fleshed sweet potato in one district and its adoption by a local women's group, the Ministry of Agriculture aggressively promoted this crop through women's groups in more than 30 districts. Private food industries have embraced an initiative to fortify oil with VA and maize meal with multiple micronutrients. **Conclusion:** This multi-sector approach led to a comprehensive and sustainable micronutrient program in Uganda where all technical sectors became invested in their roles to address the problem. This approach motivated collaboration and coordination for a common cause.

W44 VITAMIN A DISTRIBUTION ENHANCES VACCINE COVERAGE WITHIN ROUTINE IMMUNISATION. G Verma, S Jacob. UNICEF, Bihar.

Background: Jharkhand State came into existence on 15th November 2000 with a legacy of a high prevalence of malnutrition 54% with ample evidence of the prevalence of Vitamin A deficiency as a public health problem. The government efforts at vitamin A supplementation in routine immunisation reached only 8% of the population. In 2003 the Government of Jharkhand decided to strengthen its routine systems to increase vitamin A coverage through a fixed health day strategy to cover the whole state. The period covered was May to July 2003. **Aim:** To increase the coverage of Vitamin A within routine immunisation using the fixed Health day strategy. **Methods:** Micro-planning for the fixed health day strategy was the first step and about 300 functionaries were oriented on preparation of microplans, which were developed through participatory exercises by district and block health teams. Before implementation of the microplans some 23,000 field functionaries were trained on technicalities of administration of vitamin A and different vaccines. Communication strategy included the use of state team of 25 link persons who were identified and trained jointly by the GOJ and Unicef to support the districts in all activities including microplanning, training of functionaries and field workers and implementation and monitoring of fixed health days. Display materials were specially designed for each outreach sessions such as posters, folders, tally sheets, leaflet of Do's and Don'ts. **Results:** During the June round approximately 63% children 9m – 5 years received a mega dose of vitamin A. An independent survey by MOST revealed that around 90% functionaries were aware of correct practises related to vitamin A and vaccine administration and were found doing so. Vaccine coverage increased to 20 – 38% during this period. **Conclusions:** Integrating vitamin A in routine immunisation and intensifying the efforts to increase the coverage of vitamin A through a fixed health day strategy can help to enhance access to immunisation services.

W43 THE STATUS OF VITAMIN A SUPPLEMENTATION FOR YOUNG CHILDREN AND POSTPARTUM WOMEN. JKL Mugyabuso (1), M Nturu (2), M Tharaney (1), SK Baker (2), FT Modaha (3) and G Mulokozi (3). (1) Helen Keller International Tanzania, (2) Helen Keller International Africa Region and (3) Tanzania Food and Nutrition Centre.

Background: Vitamin A supplementation (VAS) has been the major Vitamin A Deficiency (VAD) intervention in Tanzania since 1987. Diverse approaches have been implemented in order to address low coverage of VAS to young children and postpartum women (PPW). The country has recorded coverage of above 90% in VAS of children aged 6-59 months during national commemoration of the Day of African Child (DAC) and World AIDS Day (WAD) since 2001. But over 6 years VAS coverage PPW has remained below 62% and little is known about the associated constraints. **Objective:** To assess the status of VAS systems and draw lessons for improvement, sustain coverage of VAS to the children to above 90% and raise VAS coverage of PPW from 60% to at least 80% by the end of 2004 in pilot areas. **Methods:** Assessment of VAS systems involved interviews to health/nutrition managers at facility to national levels, health workers (HW), community-owned resource persons (CORPs), community leaders and mothers of children aged less than 5 years. Approaches for accelerating VAS included fostering partnership and community participation, developing and implementing a communication strategy and training of HW and CORPs on management of VAS. **Results:** There are favorable policy environments and standardized monitoring systems. Constraints included inadequate adherence to policy guidelines by HWs, low rate of facility deliveries, slow pace of incorporating VAS in comprehensive council health plans, irregularity in training HWs and CORPs, shortage of HWs and inadequacies in data management and reporting. Experience in mobilizing communities and HWs to accelerate VAS for PPW in pilot areas will be presented during the IVACG meeting. **Conclusion:** Gaps in policy, implementation and monitoring systems should be immediately addressed to improve performance of VAS program. The experiences learned in accelerating VAS of PPW in pilot areas should be extended to other councils of Tanzania. **Supported by MI, CIDA, UNICEF and MOST-the USAID Micronutrient Program.**

W45 SCALING-UP CHILD HEALTH SERVICES: A DECADE'S EXPERIENCE OF THE NEPAL NATIONAL VITAMIN A PROGRAM (NVAP). R Shrestha, P Pandey, A Whalley - NTAG, S Pandey - MoH, P Mathema - UNICEF, S Hodgins - NFHP, J Quinley, R Dharampal - USAID. Kathmandu, Nepal.

Nepali studies have shown that supplementation of high-dose vitamin A capsules reduces child mortality by up to 30%. In response, MoH organized a national level workshop attended by government, donor agencies and partner organizations, thus establishing NVAP in 1993. The program supplements children aged 6-60 months with semi-annual vitamin A capsules, and doses post-partum women within 6 weeks of delivery. The program uses a community-based distribution system, with Female Community Health Volunteers (FCHV) to supplement vitamin A capsules in each village. To motivate FCHVs and mobilize community people, the program was implemented through a cycle of activities (training, promotion, supplementation, monitoring) to develop ownership. NVAP district start-up training activities have been supported by a Nepali NGO, the Nepali Technical Assistance Group (NTAG). Starting with 8 districts in 1993, the program expanded to all 75 districts in October 2002. NVAP has maintained coverage rates above 85% since 1993 and reduced the prevalence of Bitot's spots to 0.33% (WHO cut-off level <0.5%). NVAP has been a major player in the decrease in child mortality during the past decade and is responsible for saving 15,000 under-five lives every year. NVAP is a cost effective program, at just US\$0.74 per child each year and its infrastructure has enabled the implementation of deworming to children aged 2-5 years at almost no additional implementation cost. An impact study of the deworming program reported decreased anemia prevalence rates among children in the program districts. NVAP monitoring now incorporates deworming coverage, iron supplementation and iodized salt consumption. NVAP is a successful and cost-effective model of distribution, utilizing non-traditional methods of volunteer motivation. The past decade showed that by establishing a network of motivated persons, additional programs that share common distribution needs can be added onto current programs. Unlike countries that implemented vitamin A distribution using the polio model, NVAP has developed a successful semi-annual distribution system that now distributes deworming tablets and monitors the coverage of each tablet separately to ensure reporting accuracy. NVAP network has also been used to improve ANC services to nightblind pregnant women and to treat with low-dose vitamin A capsule.

W46 THE NICARAGUA NATIONAL INTEGRATED NUTRITION MONITORING AND EVALUATION SYSTEM (SIVIN). A Barrera, I Sandino, A Largaespada, L Saavedra, L Yllescas, Y Solorzano, J Bonilla, J Mora. USAID/MOST, UNICEF and Nicaragua Ministry of Health.

The Nicaraguan Ministry of Health (MOH), with assistance from USAID/MOST, the US Centers for Disease Control and Prevention (CDC), the Micronutrient Initiative (MI) from Canada, UNICEF and the Institute of Nutrition of Central America and Panama (INCAP), developed and is in the process of establishing a centralized, modular, Integrated National Nutrition Monitoring and Evaluation (M&E) System (SIVIN) for periodic program M&E and decision-making. The system entails periodic collection, analysis and use of data on the process and outcome of program implementation, and on biological indicators of nutritional status for impact evaluation. SIVIN uses information from health service statistics and existing program monitoring systems, as well as a especially designed national household survey. The survey covers a nationally representative sample of 150 clusters (census segments) or 1500 households with children under 5 years of age, from four geographic strata. This sample is covered in three-years, with a randomly selected sub-sample of 50 clusters (500 households) visited each year. A trained MOH field team dedicates one week a month to completing a household interview, conducting anthropometric measurements of women and children, and collecting biological specimens (blood, urine) and samples of fortified foods (sugar, salt, bread). The first year (2002-2003) of SIVIN operation produced key information, including relevant micronutrient data revealing that vitamin A and iodine deficiency are virtually under control; high coverage rates of vitamin A supplementation in children (>85%) are sustained in both annual rounds but remain very low in post-partum women (13%); iron supplementation in pregnant women has increased to >80% and in children to >60%; sugar, wheat flour and salt fortification are properly implemented, with high coverage and quality; sugar and salt meet nearly 50% and >100% RDIs for vitamin A and iodine, respectively, whereas wheat flour provides only 1.4 mg of iron per person/day; anemia rates in women continue to decline significantly (34% in 1993, 24% in 2000, 16% in 2003) and, for the first time, those in children are dropping (29% in 1993 and 2000, 23% in 2003). SIVIN findings are now the basis for nutrition policy/program decision-making in Nicaragua.

W48 COMPARISON OF VITAMIN A COVERAGE ACCORDING TO ADMINISTRATIVE VS. SURVEY DATA. H Gardner, R Flores, K Sullivan, R Martorell, N Aburto, E Boy and I Darnton-Hill. Rollins School of Public Health, Emory University, Atlanta, GA, Nutrition Section, UNICEF, New York, NY and The Micronutrient Initiative, Ottawa, Canada.

Background: Two primary strategies are used for estimating vitamin A supplement coverage that we refer to as administrative vs. cross-sectional survey approaches. Administrative coverage estimates are typically obtained following mass distribution campaigns where the number of children who received a supplement is divided by the estimated total number of children, usually from census data. Cross-sectional survey coverage estimates typically rely on caretaker recall and are usually defined as the percentage of children receiving a vitamin A supplement in the last six months. **Aims:** To compare estimates of vitamin A supplement coverage derived from administrative and survey approaches. **Methods:** Officially reported administrative and survey coverage estimates were compared between 17 countries between 1995 and 2002. Comparison pairs were chosen such that there was concordance between the timing of mass distribution campaigns and data collection for the national cross-sectional surveys. **Results:** Administrative coverage estimates were systematically higher than cross-sectional survey estimates: 69 vs. 45% on average. **Conclusion:** Administrative estimates may be biased if the number of children who received supplements is not accurate or if the population size is over- or underestimated. Cross-sectional survey estimates may be biased depending on the accuracy of maternal recall. In order to accurately assess efforts to achieve high coverage of vitamin A supplementation, further investigation is necessary to determine methods that result in valid coverage estimation.

W47 EMPIRICAL EVALUATION OF THE IMPACT OF A LARGE SCALE VITAMIN A SUPPLEMENTATION PROGRAMME IN NORTHERN GHANA. P David, E Boy. John Snow, Inc Boston MA USA, Micronutrient Initiative Ottawa, ON Canada.

Objectives: 1) To assess whether a large-scale vitamin A supplementation (VAS) programme has been delivered effectively to children in northern Ghana and whether an expected mortality decline has occurred, and 2) to illustrate a methodology for programme evaluation, highlighting the challenges and opportunities that face evaluators, planners and policy-makers wanting confirmation of programme impact. **Methods:** This retrospective study assembled and compared existing pre-intervention data from household surveys, health service and program statistics with available data on programme implementation from the Ministry of Health, on severe morbidity from the health services, and on mortality and potential confounding factors from household surveys at two time periods post-implementation. **Results:** Current coverage by the national supplementation programme approaches 80% in the 3 northern regions, and other indicators suggest that it has been implemented effectively. While the mortality data are probably imperfect, they indicate a sharper decline in mortality between ages 1 and 4 than among infants since the programme began. Our data provide no evidence that other measurable factors are significant influences in the mortality decline observed. The biggest observed change occurred in the coverage of the supplementation programme. **Conclusions:** A more elaborate and costly study design would be necessary to provide more definitive statements of impact, and rule out the many other factors that can affect child survival. For evaluating the impact of a large-scale programme to provide an intervention of known efficacy such as VAS, careful monitoring of programme coverage should provide sufficient information to make decisions regarding expansion, contraction or closure of the programme.

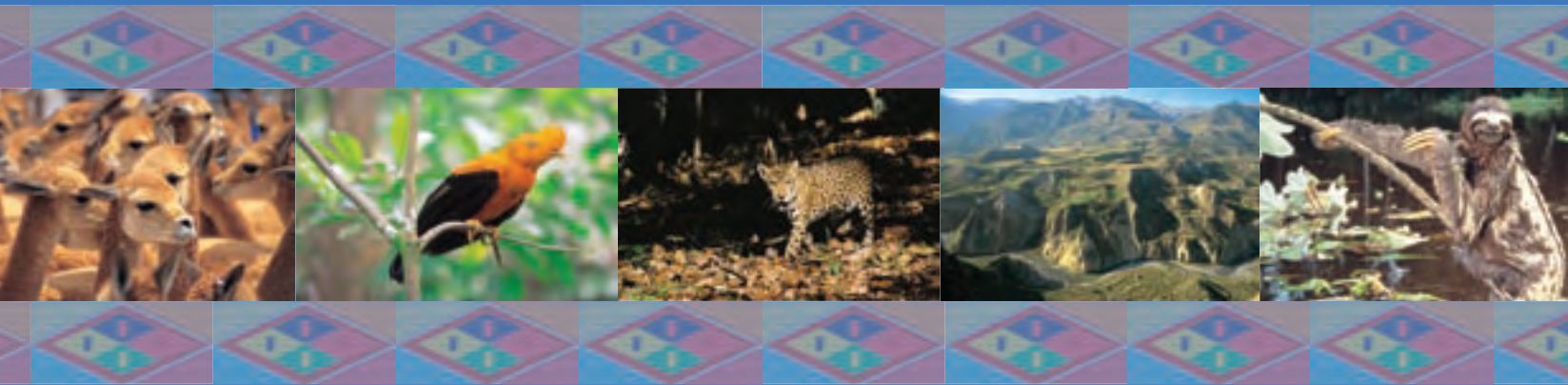
W49 CAN UNICEF VAC COVERAGE RATES BE USED TO INDICATE WHICH COUNTRIES REQUIRE ADDITIONAL ASSISTANCE TO ELIMINATE VAD? J Mateer (1), C MacDonald (1), E Boy (2), (1) World Vision Canada, Mississauga, Canada. (2) The Micronutrient Initiative, Ottawa, Canada.

Issue: UNICEF vitamin A capsule (VAC) coverage rates are often cited as the benchmark for eliminating vitamin A deficiency (VAD). They are also used as a guideline for strategic investment of resources to reduce VAD and child mortality, however, their programmatic relevance at the sub-national level is less certain. **Objective:** To determine if UNICEF VAC coverage rates are applicable to regions of countries supported by World Vision (WV). **Framework:** Cross sectional surveys determined VAC coverage and clinical signs of VAD among children under five years of age (U5) in WV intervention areas, covering the following total populations: Afghanistan:110,000; Chad:239,565; Tanzania:743,730; Zambia:1,258,570; India:1,531,600. Results served as baseline data for programs funded by Micronutrient Initiative and were compared to UNICEF national VAC coverage rates. **Outcome:** WV data revealed lower VAC coverage in all countries at a regional level, as compared to UNICEF national statistics¹. Whereas UNICEF rates indicate VAD is unlikely to be a public health problem in 4 of the 5 countries (VAC coverage >80%), WV data indicates that VAD is indeed a public health problem. Each country had at least one indicator above the WHO cut-off point; 3 countries had nightblindness in children >1.0% and 4 countries had Bitot's spots >0.5%.

Country	% VAC Coverage in U5		% of children with VAD WV Survey	
	UNICEF 2001	WV Survey 2002&2003*	Nightblindness 24-71 mos	Bitot's spots 6-59 mos
Afghanistan	84	67* (n=821)	1.8 (n=941)	2.0 (n=947) [^]
Chad	91	66 (n=1789)	1.17 (n=1789)+	0.1 (n=1789)
Tanzania	93	73* (n=900)	1.6 (n=895)+	2.9 (n=899)
Zambia	83	67 (n=979)	0.6 (n=974)	0.8 (n=974) [^]
India	25	15 (n=2005)	0.3 (n=2259)+	1.5 (n=2981)

+Children 6-59mos
[^]Children 24-71mos

Implications: WV results suggest further effort is needed to increase VAC coverage to > 80% for children in these regions in all 5 countries, in contrast to UNICEF data. National level statistics cannot be used alone to indicate areas of potential VAD, especially in areas with little access to health care. Also, methods of determining VAC coverage vary. UNICEF's rates are based on national data evaluating the number of children who have received a VAC within the previous year, whereas WV's rates are based on a survey of children receiving VACs in the previous year in the intervention areas.
¹ State of the World's Children 2004



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