



**Report of the XXI International  
Vitamin A Consultative Group  
Meeting**

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**Improving the  
Vitamin A Status  
of Populations**

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**Marrakech, Morocco  
3-5 February 2003**





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XXI International Vitamin A  
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**3–5 February 2003  
Marrakech, Morocco**

**Rapporteurs: Dr. Philip W.J. Harvey  
Ms. Tory M. Taylor**

**Collaborator: Dr. Omar Dary**



**morocco**



### **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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### Contributors to the XXI IVACG Meeting

The XXI IVACG Meeting was co-hosted by IVACG and the Local Organizing Committee of the Moroccan Ministry of Health and representatives of United Nations technical agencies, the private sector, multilateral agencies, and nongovernmental organizations in Morocco, with funding from the Government of Morocco. The Office of Health, Infectious Disease and Nutrition, Bureau for Global Health, U.S. Agency for International Development, and the Moroccan Ministry of Health assumed major responsibility for organizing the meeting.

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

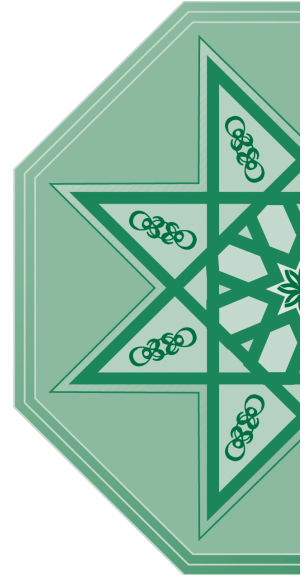
Task Force SIGHT AND LIFE

UNICEF

The Micronutrient Initiative

The Procter & Gamble Company

H.J. Heinz Company



## Local Organizing Committee in Morocco



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## 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

*IVACG Statement: The Annecy Accords to Assess and Control Vitamin A Deficiency: Summary of Recommendations and Clarifications (2002)*

*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)*

*Strategic Placement of IVACG in the Evolving Micronutrient Field (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 XXI IVACG Meeting. The U.S. Agency for International Development, through the Micronutrient Global Leadership cooperative agreement provided the primary support for the XXI IVACG Meeting. The Moroccan Ministry of Health, through the Local Organizing Committee collaborated in organizing the meeting, and also oversaw the regional symposium and the study tours, providing participants an opportunity to learn about micronutrient deficiency control programs in Morocco.

The IVACG Secretariat gratefully acknowledges additional contributions from Task Force SIGHT AND LIFE, UNICEF, The Micronutrient Initiative, The Procter & Gamble Company, and H.J. Heinz Company for the XXI IVACG Meeting.

The IVACG Steering Committee members: Mr. David Alnwick; Dr. Omar Dary; Dr. Frances R. Davidson, IVACG Secretary; Dr. Suttalak Smitasiri; Dr. Alfred Sommer, IVACG Steering Committee Chair; Dr. Kraisid Tontisirin; Dr. Clive E. West, and Dr. Keith P. West, Jr. 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 meetings sessions.

IVACG extends a special thanks to co-rapportuers for the meeting Dr. Philip Harvey and Ms. Tory Taylor, and contributor Dr. Omar Dary. The rapporteurs did a superb job at cohesively summarizing the meeting's presentations and discussions into this report. The rapporteurs thank Dr. Roy Miller, Executive Director of the MOST Project, and Ms. Ruth Harvey of the MOST Project for their assistance and support through the writing phase.

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 vitamin A control programs.

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



## Summary

The 21st meeting of the International Vitamin A Consultative Group (IVACG) convened in Marrakech, Morocco, February 3–5, 2003. The Minister of Health of the Government of Morocco extended a gracious welcome to the large and diverse group of attendees. The meeting, titled “Improving the Vitamin A Status of Populations,” reflected new developments and a synthesis of existing knowledge in the science, policy, implementation, and assessment of vitamin A interventions. Although the scope of the presentations was broad, several issues emerged as unifying themes; these are highlighted in the summary that follows.

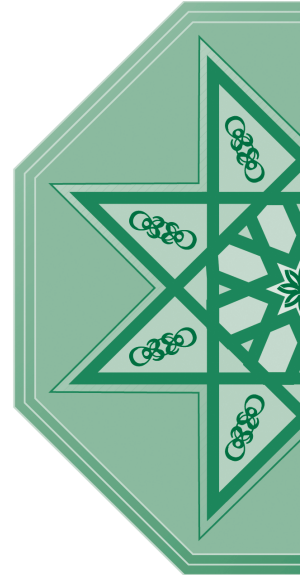
In 2002, IVACG published revised recommendations for supplementation protocols and guidelines and for assessing the vitamin A status of populations, known as the Annecy Accords. The revisions clarify the terminology to be used in describing vitamin A deficiency and vitamin A deficiency disorders. They also introduce night blindness during pregnancy as an indicator of vitamin A deficiency for populations. Recognizing recent evidence that supplementation and dietary diversification alone, if based solely on plant sources, are inadequate for normalizing vitamin A status in young children, the recommended supplementation doses were doubled for new mothers and their infants under six months old.

Innovations in the control and prevention of vitamin A deficiency are at a crucial stage in the process of establishing sustainability. The scientific basis for intervening is strong and unambiguous, various approaches are being implemented successfully, and donor support has facilitated broad program expansion. However, many supplementation programs have relied for their success on the infrastructure of national immunization days (NIDs), which are being phased out. For sustainability, programs will require an expanded base of committed policy makers and enhanced local leadership. Without these and other changes, vitamin A initiatives will remain vulnerable.

Supplementation in the post-NIDs era faces formidable challenges, but various countries have made substantial progress in identifying and implementing successful alternative strategies that do not rely on NIDs. In Africa, where vitamin A distribution linked to NIDs was both widely implemented and tremendously successful, the transition to other methods has been of special concern. Reports are encouraging and confirm that non-NIDs programs can reach a large proportion of children over a period of many years. Periodic extended outreach, often packaged with other preventive services and supported by an active promotional component, has been the key to success for these programs.

Information on the relative costs and effectiveness of vitamin A programs is increasingly sought by policy makers and funding agencies. The literature on cost-effectiveness is limited to supplementation and fortification programs. Recent studies presented at the meeting confirm that vitamin A supplementation is a highly cost-effective child survival intervention.

Fortification programs, which are also cost effective, are undergoing rapid expansion in many countries, and the Global Alliance for Improved Nutrition plans to mobilize additional resources to support them. IVACG attendees heard reports on successful fortification experiences in South Africa and in Central America. One report described a cooking oil fortification program under way in Morocco, along with the research on nutrient stability and preferred packaging that are supporting the program.





Recent vitamin A deficiency prevalence surveys in Malawi and Mozambique confirmed that it remains a major problem in those countries. Data presented from subnational surveys in other countries in Africa, South Asia, and parts of the Middle East confirm that the problem remains widespread. In Latin America, deficiency has been largely controlled through fortification of sugar and preventive supplementation. Several countries introduced maternal night blindness indicators into population-based studies, and most continued to use the standard high-performance liquid chromatography method for analyzing plasma or serum retinol concentration. Promising new methods of assessing vitamin A deficiency through papillary dark adaptometry and the Night Vision Threshold Test are being developed and validated.

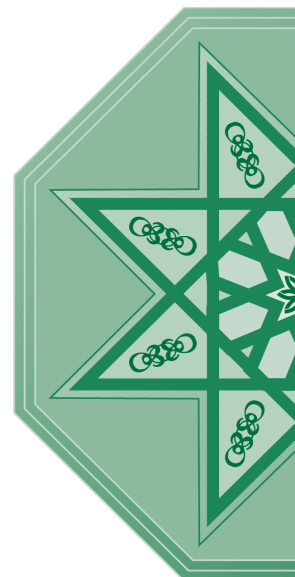
Continuing efforts to develop interventions to promote the production and consumption of vitamin A-rich foods were well represented. A program to integrate animal husbandry into home gardening and several education-based programs were described. Also notable are efforts to introduce beta-carotene-rich sweet potato into the diets of people in sub-Saharan Africa. Newly developed cultivars with high yields and preferred taste and texture are being disseminated. These products may contribute substantially to the vitamin A requirements of large population groups in the region.

A number of successes and challenges in communications and behavior change interventions were highlighted. Examples were given of targeted, evidence-based advocacy being instrumental in enlisting the support of policy makers for programs as well as of the central role of effective communication in increasing caregivers' demand for supplements. Several studies documented marked improvements in community knowledge about vitamin A and its benefits through such programs. In countries where decentralization has challenged supplementation coverage, strengthening management capacity together with strong promotional and educational efforts are credited with sustaining programs through difficult times.

Although the benefits and cost-effectiveness of reducing vitamin A deficiency are well established, the agenda for biological vitamin A research remains important. In this area, recent developments highlight the complexities of interactions between nutrients. Several reports on studies involving beta-carotene, zinc, and iron illustrated these complexities. Studies on the biological impact of vitamin A are being undertaken in increasingly variable environments. For example, a study in Zimbabwe sought to determine whether vitamin A supplementation given to mothers, infants, or both at delivery would reduce infant mortality, mother-to-child transmission of HIV during breast-feeding, or new HIV infections in postpartum women. Other presentations described the impact of vitamin A supplementation on the response to vaccines.

In discussions of future directions for vitamin A programs, some major institutional challenges were identified. Among them was a common perception of vitamin A deficiency as a marginal issue, perhaps because of the often invisible effects of the deficiency but also because of a lack of awareness of its benefits for child survival. Vitamin A is often omitted from essential drug lists, training curricula, and health information systems. The prominence of micronutrient risk factors in the 2002 World Health Organization's Global Burden of Disease analysis illustrates the high cost of inaction and provides evidence supporting renewed advocacy. Identifying synergies with other programs and promoting public-private partnerships are among the many strategies that can be used to overcome these obstacles.

At the conclusion of three highly productive days spent sharing program and research experiences, participants were encouraged to celebrate the collective accomplishments of the vitamin A community and to continue their efforts.



## PROGRAM AT A GLANCE

### XXI IVACG Meeting

<b>SUNDAY</b> <b>2 FEBRUARY</b>		<b>TUESDAY</b> <b>4 FEBRUARY</b>		<b>WEDNESDAY</b> <b>5 FEBRUARY</b>	
1600-1800 Registration Location: Sheraton Marrakech Conference Center		1600-1800 Registration Location: Sheraton Marrakech Conference Center		1600-1800 Registration Location: Sheraton Marrakech Conference Center	
<b>MONDAY</b> <b>3 FEBRUARY</b> Location: Palais des Congrès		<b>TUESDAY</b> <b>4 FEBRUARY</b> Location: Sheraton Marrakech Conference Center		<b>WEDNESDAY</b> <b>5 FEBRUARY</b> Location: Sheraton Marrakech Conference Center	
0800 Registration continues from Sunday evening		0800 Registration/Exhibits Open		0800 Registration/Exhibits Open	
0900-1030 <b>Inauguration</b>		0830-0845 <b>Physiology and Biochemistry</b> 0845-0930 <b>Assessment of Night Blindness/Dark Adaptometry</b> 0930-1000 <b>Supplements: Dosing Schedules and Safety</b>		0830-0930 <b>Dietary Approaches: Choosing Your Food</b> 0930-1030 <b>Dietary Approaches: Food Fortification</b>	
1030-1100 Break		1000-1100 Poster Session and Break		1030-1130 Poster Session and Break	
1100-1230 <b>Global and Regional Status of Vitamin A</b>		1100-1230 <b>Biologic Impact: Dosing Infants and Mothers</b>		1130-1230 <b>Dietary Approaches: Food Fortification (continued)</b>	
1230-1430 Lunch		1230-1430 Lunch and Poster Viewing		1230-1430 Lunch and Poster Viewing	
1430-1500 <b>Keynote Address: Vitamin A in a Global Context</b> 1500-1600 <b>Supplements: Post-NIDS and Reaching Mothers</b>		1430-1530 <b>Supplements: Economics</b> 1530-1630 <b>Nutrient Interactions</b>		1430-1530 <b>Integrated Approaches and Communication and Behavior Change</b>	
1600-1630 Break		1630-1730 Poster Session and Break		1530-1630 Poster Session and Break	
1630-1715 <b>Supplements: Post-NIDS and Reaching Mothers (continued)</b>				1630-1730 <b>Present and Future Challenges</b> Concluding Remarks	
1715 Meeting Adjourns Set up for exhibits and Tuesday's posters		1730 Meeting Adjourns Set up Wednesday's posters		1730 End of IVACG's formal sessions	
1800 Welcome Reception		1900-2000 Special Evening Session: Which Micronutrients for What Outcomes?			

# XXI IVACG Meeting Program

3–5 February 2003

## Sunday, 2 February 2003

1600-1800 Registration

## Monday, 3 February 2003

Co-Chairs: Dr. Alfred Sommer and Prof. Fatima-Zohra Squali-Houssani

0800 Registration continues

0845 Participants and guests are seated

0900 **Inauguration of the XXI IVACG Meeting**

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1030 **Break**

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1100 **Global and Regional Status of Vitamin A**  
Moderator: Mr. David Alnwick

1100 Regional Status of Vitamin A  
Dr. Anna Verster  
Dr. Abdelwahab Zerrari  
Prof. Mohamed Rahmani

1145 Global Status of Vitamin A: Building on Hanoi  
Dr. Alfred Sommer

1210 From Saving Sight to Saving Lives: The Diffusion of Vitamin A  
Dr. Duff Gillespie

---

1230 **Lunch**

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1430 **Keynote Address: Vitamin A in a Global Context**  
Dr. Dean Jamison

1500 **Supplements: Post-NIDS and Reaching Mothers**  
Moderator: Dr. Werner Schultink

1500 **M1\*** Planning for Vitamin A Supplementation After NIDS: Alternative Service Delivery Models that Work  
Ms. Ruth Harvey

### Panelists

1515 **M2** Evaluation of Three Years of Non-NIDS Vitamin A Supplementation: Experiences and Lessons from Ghana  
Ms. Esi Foriwa Amoafu

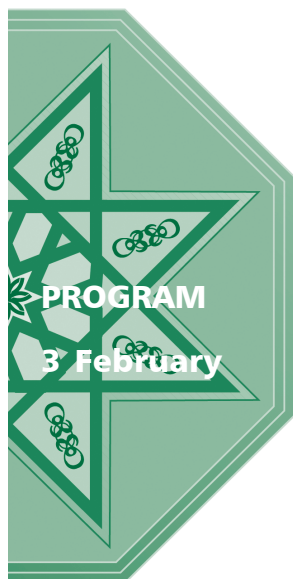
1525 **M3** Vitamin A Supplementation Program for Children in Bangladesh: Strategic Changes in Distribution and Its Experiences  
Dr. Syeeda Begum



*\* Readers can use the codes next to presentation titles to locate abstracts of the presentations beginning on page 49. Abstracts are not available for all presentations.*

## Monday, 3 February 2003 (continued)

- 1535 **M4** Ensuring Vitamin A Supplementation Through Routine Health Services in Mozambique  
Mrs. Sonia Khan
- 1545 **M5** Using Community Directed Treatment with Ivermectin (CDTI) as a Vehicle for Vitamin A Supplementation in Nigeria  
Dr. Mousa Obadiah
- 
- 1600 **Break**
- 
- 1630 **Supplements: Post-NIDS and Reaching Mothers (continued)**  
Moderator: Dr. Werner Schultink
- 1630 **M6** Is There Life After NIDS? Non-NIDS Distribution of Vitamin A  
Ms. Karen Codling
- 1640 **M7** Maintaining High Vitamin A Supplementation Coverage in a Resource-Poor Environment: Lessons from Niger  
Dr. Victor M. Aguayo
- 1645 Panel Discussion
- 1715 End of day's formal sessions  
Set up for exhibits and Tuesday's posters (at Sheraton Marrakech Conference Center)
- 1800 Welcome Reception



## Tuesday, 4 February 2003

Chair: Mr. David Alnwick

0800 Registration/Exhibits Open

### 0830 **Physiology and Biochemistry**

**T55** Recent Advances in Vitamin A Research  
Prof. Clive E. West

0845 **Assessment of Night Blindness/Dark Adaptometry**  
Moderator: Dr. Keith P. West, Jr.

0845 **T52** Pupillary Dark Adaptometry: An Overview  
Dr. Nathan Congdon

0855 **T53** Respondents  
Relationships Among Indicators of Vitamin A Status in Nightblind and  
Non-nightblind Pregnant Nepali Women  
Dr. Marjorie Haskell

0900 **T54** Reported Night Blindness: The Night Vision Threshold Test and Serum  
Retinol Concentrations as Indicators of Vitamin A Deficiency  
Dr. Douglas Taren

0905 Open Discussion

0930 **Supplements: Dosing Schedules and Safety**  
Moderator: Dr. Bruno de Benoist

0930 **T46** High-Dose Maternal and Infant Vitamin A Supplementation in Rural Kenya  
Dr. Rosemary Ayah

0940 **T47** Pharmacokinetics of Vitamin A in Non-pregnant Women and Impact on Safety  
Dr. Dietrich Hornig

0950 Open Discussion

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### 1000 **Poster Session and Break**

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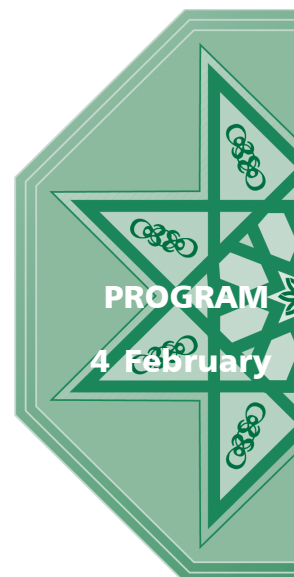
1100 **Biologic Impact: Dosing Infants and Mothers**  
Moderator: Dr. Anna Verster

1100 **T48** Impact of VAS of Mothers and Babies on Infant Mortality, HIV MTCT, and New  
Maternal HIV Infections  
Dr. Jean H. Humphrey

1130 Open Discussion

1145 **T49** Impact of Newborn Vitamin A Dosing on Case-Fatality from Common  
Childhood Illnesses  
Dr. James Tielsch

1155 **T50** Vitamin A Supplementation and Childhood Mortality: Amplification of the  
Non-specific Effects of Vaccines?  
Dr. Christine Stabell Benn



## Tuesday, 4 February 2003 (continued)

1205 **T51** The Effect of Vitamin A Supplementation on IgG Titer: A Study from Central Java, Indonesia  
Dr. Hamam Hadi

1215 Open Discussion

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### 1230 Lunch and Poster Viewing

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1430 **Supplements: Economics**  
Moderator: Dr. Penelope Nestel

1430 Policy Implications of the Economic Evaluation of Vitamin A Deficiency Control Programs  
Dr. Kevin Frick

#### **Panelists**

1450 **T44** Cost Analysis of the National Vitamin A Supplementation Programs in Ghana, Zambia, and Nepal: Synthesis of Three Studies  
Mr. Bechir Rassas

1500 **T45** Cost-Effectiveness of Delivering Low-Dose Vitamin A Integrated with Other Community Health Activities in Vietnam  
Dr. Tran Tuan

1510 Open Discussion

1530 **Nutrient Interactions**  
Moderator: Dr. Emorn Wasantwisut

1530 **T56** The Effect of Treatment with Vitamin A Alone or in Combination with Iron in Iron Deficient Anemic Children in Ismailia City  
Dr. Hassan Ali Abdelwahid

1540 **T57** Respondent  
Iron Supplementation in Infants Induces a Redistribution of Vitamin A  
Dr. Frank T. Wieringa

1545 **T58** Zinc Supplementation Enhances the Conversion of  $\beta$ -Carotene to Vitamin A  
Dr. Marjoleine A. Dijkhuizen

1555 **T59** Effect of Maternal Micronutrient Supplementation on Vitamin A Status During Pregnancy  
Dr. Parul Christian

1605 Open Discussion

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### 1630 Poster Session and Break

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1730 End of day's formal sessions  
Remove Tuesday's posters  
Set up Wednesday's posters

1900 Special Evening Session: Which Micronutrients for What Outcomes?  
Dr. Parul Christian





## Tuesday Posters

### Posters on Assessment and Monitoring and Evaluation

- T1** Vitamin A Deficiency Among Children Living in the Kingdom of Morocco: Comparison of Ophthalmologic and Biochemical Assessments  
Prof. Amina Berraho
- T2** Measurement of Vitamin A Status Using a Single-Tube Extraction Method and Improved HPLC Separation  
Dr. Jürgen G. Erhardt
- T3** Combined Measurement of Retinol and STFR in One Dried Blood Spot (DBS) Stored at Room Temperature  
Dr. Jürgen G. Erhardt
- T4** Validation of a Rapid Enzyme Immunoassay for the Quantitation of Retinol Binding Protein (RBP-EIA)  
Mr. John Hix
- T5** The Role of District Ophthalmologists in Surveillance of Blinding Xerophthalmia in North West Frontier Province of Pakistan  
Dr. Muhammad Aman Khan
- T6** A Portable Dark Room (PDR) for Dark Adaptation and to Assess Night Blindness  
Prof. Larry Medlin
- T7** Application of Isotope Techniques in Assessing and Monitoring Vitamin A Nutrition in Interventions  
Prof. Najat Mokhtar
- T8** Usefulness of Plasma Alpha-Carotene for Assessing Dietary Red Palm Oil Intake  
Dr. Christine A. Northrop-Clewes
- T9** A Small Physiological Dose of Vitamin A (17.5 micromol) Takes 4 Years to “Disappear” in Healthy Individuals  
Dr. Sherry A. Tanumihardjo
- T10** Usefulness of Plasma Lutein as a Biomarker in Breast Milk  
Prof. David I. Thurnham
- T11** Improvement in Vitamin A Capsule Coverage in Cambodia: The Success of Village Health Volunteers as Social Mobilizers  
Ms. La-Ong Tokmoh
- T12** Night Blindness Among Women Is a Good Indicator of Vitamin A Deficiency in a Population Experiencing Crisis  
Dr. Harriet Torlesse

### Posters on Biological Impact

- T13** The Role of Vitamin A and Other Antioxidants in the Incorporation of Calcium into the Lattice Structure of Bone  
Dr. Samuel Koranteng Ameyaw
- T14** Low and High Vitamin A–Iron Dose Ratios: Its Effects on the Micronutrient Status of Adolescent Girls  
Dr. Imelda Angeles-Agdeppa



## Tuesday Posters (continued)



- T15** Daily Low Doses of Vitamin A Compared with Single High Dose Improves Survival of Malnourished Children in Senegal  
Dr. Philippe Donnen
- T16** Effect of a Combined Supplementation of Vitamin A and Zinc in the Prevention of Vitamin A Deficiency: A Controlled Randomised Trial  
Dr. Margarida Lola
- T17** Compliance with Vitamin A Capsule Supplementation: A Program for Prevention of Vitamin A Deficiency in Indonesia  
Mrs. Rosnani Pangaribuan
- T18** The Impact of the National Vitamin A Supplementation Program on Subclinical Vitamin A Deficiency in Preschool Children in the Philippines  
Dr. Maria Regina A. Pedro
- T19** Vitamin A Supplementation at Birth and 6-Month Infant Mortality Among Children of Mothers with Night Blindness in South India: The VASIN Study  
Ms. Sethu Sheeladevi
- T20** The Effect of a Multiple Micronutrient Food Supplement on the Nutritional Status of Preschool Children  
Mrs. Malavika Vinod Kumar

### Posters on Supplements

- T21** Costing Towards Sustainability for Vitamin A Supplementation Programme  
Dr. Ravishwar Sinha
- T22** Regional Micronutrient Days in Mali  
Dr. Amenatou Cissé
- T23** Implementation of Vitamin A Supplementation in South Africa  
Ms. Ntombi Mazibuko
- T24** Impact of Vitamin A Supplementation Delivered with Oral Polio Vaccine as Part of the Immunization Campaign in Orissa, India  
Dr. Jonathan Gorstein
- T25** Vitamin A Supplementation Delivery System for Children and Women in Tanzania  
Mr. Joseph K. L. Mogyabuso
- T26** Institutionalizing Two-Dose Vitamin A Supplementation: From National Immunization Days to Child Health Days—Examples from Tanzania and the Philippines  
Dr. Meera Shekar
- T27** When Will Vitamin A Supplementation Be Taken Seriously?  
Mr. Ram K. Shrestha
- T28** Second Dose of Vitamin A Nationwide in DR Congo  
Dr. Claire L. N. Sita

### Posters on Recent Surveys

- T29** The Potential Contribution of Vitamin A Deficiency Control to Child Survival in Sub-Saharan Africa  
Dr. Victor M. Aguayo

## Tuesday Posters (continued)

- T30** Vitamin A Situation Assessment in Malawi: Results from the National Micronutrient Survey  
Ms. Emily Bobrow
- T31** Vitamin A Nutriture Amongst Pregnant Women in Three Urban Slum Communities of Delhi: A Pilot Study  
Dr. Umesh Kapil
- T32** Micronutrient Consumption in Tribal Populations: Case Study on Bhil Tribe of Dang District, Gujarat, India  
Dr. Gopa Kothari
- T33** National Survey on Vitamin A Activities Morocco 2000  
Dr. El Arbi Rjimati
- T34** The Mortality Response to the Vitamin A Distribution Program in Nepal  
Dr. Shea Rutstein
- T35** Vitamin A Deficiency and Anemia in Pre-school Children from Sergipe, Northeast Brazil  
Dr. Leonor Maria P. Santos
- T36** Vitamin A Deficiency and Anemia in Children and Women: Findings from a Nation-Level Survey in Mozambique  
Dr. Ricardo Thompson
- T37** Coexistence of Vitamin A Deficiency and Anemia Among Children Living in Urban Slums in Dhaka City, Bangladesh  
Mr. M. A. Wahed

### Posters on Vitamin A Physiology

- T38** Vitamin A Deficiency and Protein-Energy Malnutrition Are the Antecedent Risk Factors for Maternal Night Blindness in Nepal  
Dr. Tianan Jiang
- T39** Poverty-linked Vitamin A Deficiency (VAD) in Jordan Is Endemic and Coupled with Compromised Vitamin E Status  
Dr. Ibrahim Khatib
- T40** Interaction Between Vitamin A and Iron Status: Evaluation of Vitamin A Supplementation Strategy in Morocco  
Ms. Rkia Lourhaoui
- T41** Enhanced Vitamin A in Serum, Liver, and Milk in Lactating Sows Following a Dose of Preformed Vitamin A  
Ms. Kristina L. Penniston
- T42** Antioxidant Protection and Prooxidant Stress in Malnutrition  
Prof. Fátima-Zahra Squali-Houssaini
- T43** Vitamin A Deficiency and Risk Factors Among Preschool Aged Children in Pohnpei, Federated States of Micronesia (FSM)  
Ms. Carrie M. Yamamura



## Wednesday, 5 February 2003

Chair: Dr. Suttalak Smitasiri

0800 Registration/Exhibits Open

0830 **Dietary Approaches: Choosing Your Food**

Moderator: Dr. Vinodini Reddy

0830 **W53** Content and In Vitro Accessibility of Provitamin A Carotenoids from Fruits and Cooked Leafy Vegetables

Ms. Generose Ishengoma Mulokozi

0840 **W54** Integration of Animal Husbandry into Home Gardening Programs to Increase Vitamin A Intake from Foods

Mr. Aminuzzaman Talukder

0850 **W55** The Potential Impact of Beta-Carotene-Rich (BCR) Sweetpotatoes on Vitamin A Intake in Sub-Saharan Africa

Dr. Jan W. Low

0900 **Panel Discussion**

Dr. Harriet Torlesse

Dr. Regina Kapinga

0930 **Dietary Approaches: Food Fortification**

Moderator: Dr. Roy Miller

0940 **W56** Long-Term Effectiveness of a  $\beta$ -Carotene Fortified Biscuit in Maintaining Improved Vitamin A Status

Dr. Martha E. Van Stuijvenberg

0950 **W57** Respondent  
The Effect of Vitamin A-fortified Cooking Oil Intake on the Serum Retinol Level of 4 to 6 Years Old Children

Mrs. Luz V. Candelaria

1000 **W58** Overview of the Development of the National Food Fortification Programme

Ms. Maudé de Hoop

1010 Respondent  
Evaluating Fortification Programs

Dr. Philip Harvey

1015 **W59** Evaluation of a Surveillance System for the Program of Sugar Fortification with Vitamin A at the Household Level

Mrs. Carolina Martínez

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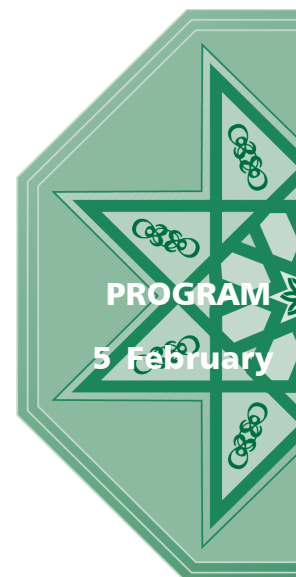
1030 **Poster Session and Break**

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## Wednesday, 5 February 2003 (continued)

- 1130 **Dietary Approaches: Food Fortification (continued)**  
Moderator: Dr. Roy Miller
- 1130 **W60** Quality Control (QC)/Quality Assurance (QA) and Monitoring System of the Sugar Fortification Program in Central America  
Dr. Omar Dary
- 1145 GAIN's Start: Programmatic, Operational and Governance Challenges  
Mr. Rolf C. Carriere
- 1200 Open Discussion
- 
- 1230 **Lunch and Poster Viewing**
- 
- 1430 **Integrated Approaches and Communication and Behavior Change**  
Moderator: Mrs. Rosanna Agble
- 1430 **W61** The Philippines' Vitamin A Supplementation Program: Indicative Impact, Policy and Program Implications  
Dr. Corazon V. C. Barba
- 1445 **W62** Respondent  
Vitamin A Programs in Indonesia: Supporting National Program Activities During the Ongoing Process of Decentralization  
Dr. Rachmi Untoro
- 1450 **W63** Evaluation of Vitamin A Supplementation Program in India: What Ails Routine Programs?  
Prof. Narendra K. Arora
- 1500 **W64** Social Marketing of Red Palm Oil in Rural Burkina Faso: An Effective Strategy to Improve Vitamin A Status of Women  
Dr. Noel Marie Zagre
- 1510 **W65** Respondent  
Changing Behavior: Popularizing Vitamin A Rich Foods  
Ms. Louise Sserunjogi
- 1515 Open Discussion
- 
- 1530 **Poster Session and Break**
- 



## Wednesday, 5 February 2003 (continued)



- 1630      **Present and Future Challenges**  
            Moderator: Dr. André Briend
- Panelists**
- 1630      Perspectives from a Non-Governmental Organization  
            Mr. Shawn K. Baker
- 1640      Perspectives from a Bi/Multilateral Organization  
            Dr. Hans Schoeneberger
- 1650      Country/Regional Perspective  
            Prof. Najat Mokhtar
- 1700      Open Discussion
- 1715      **Concluding Remarks**  
            Dr. Alfred Sommer
- 1730      End of IVACG's formal sessions  
            Remove posters  
            Remove exhibits

## Wednesday Posters

### Posters on Dietary Approaches: Choosing Your Food

- W1** Feeding of Children from 0 to 59 Months  
Mrs. Iman Barakat
- W2** Studies on Bioavailability and Bioconversion of Papaya (*Carica papaya*) Carotenoids  
Ms. Udumalagala Gamage Chandrika
- W3** Improvement of Burkinabe Diet with Carotenoid-Rich Foods  
Dr. Philippe Chevalier
- W4** Guidebook of Local Carotene-Rich Foods to Improve the Carotene Content of Sahelian Diets  
Dr. Philippe Chevalier
- W5** Sources of Provitamin A Carotenoids in Micronesia: Banana, Taro, Breadfruit, and Pandanus  
Ms. Lois Englberger
- W6** Estimating Usual Dietary Intake from Single 24-Hour Recalls of Children in the Philippines  
Dr. Philip Harvey
- W7** Recovery from Impaired Dark Adaptation Does Not Differ Among Nightblind Pregnant Nepali Women Who Receive Small Daily Doses of Vitamin A as Either Liver, Vitamin A-fortified Ultra-Rice™, Green Leafy Vegetables, Carrots, or Vitamin A Capsules  
Dr. Marjorie Haskell
- W8** Vitamin A Intake and Factors Affecting the Bioefficacy in Egypt  
Dr. Nabih A. Ibrahim
- W9** Meeting Vitamin A Requirements Through Local Foods in an Iranian Province: A Semi-theoretical Calculation  
Prof. Seyed Masoud Kimiagar
- W10** Indigenous Peoples' Traditional Food Systems Are Sources for Vitamin A and Other Micronutrients  
Dr. Harriet Kuhnlein
- W11** Natural  $\beta$ -Carotene Crystals Isolated from GAC Fruit Rich in Carotenoids (Provitamin A) for Prevention of Vitamin A Deficiency in Viet Nam  
Dr. Bui Minh Duc
- W12** Crude Palm Oil: Prevention and Treatment of Avitaminosis A  
Ms. Olga Lucia Mora
- W13** Effect of Emerging Industrial Technologies on the Bioavailability of B-Cryptoxanthin in Humans  
Dr. Begoña Olmedilla
- W14** High  $\beta$ -Carotene Sweetpotato Processing for Increased Vitamin A Intake: Gender Implications and Potential for Sustainable Technology Adoption in Siaya District, Kenya  
Ms. Mary Anyango Oyunga-Ogubi



## Wednesday Posters (continued)



- W15** Vitamin A Content in Katuk Leaves (*Sauropus androgynus* L. Merr) and Its Effect in Enhancing the Performance of Laying Hens  
Dr. Wiranda G. Piliang
- W16** Bleached Red Palm Oil and Vitamin A Status of Cameroonian Children  
Mr. Daniel Sibetcheu
- W17** The Difference in Bioavailability of Beta-Carotene from Three Types of Carrots  
Dr. Sherry A. Tanumihardjo
- W18** Evaluation of the Retention of  $\beta$ -Carotene in Boiled, Mashed Orange-fleshed Sweet Potato  
Dr. Paul Van Jaarsveld
- W19** Isotopic Tracers for Studying Carotenoid Bioefficacy  
Dr. Machteld Van Lieshout
- W20** Addressing Vitamin A Deficiency Through Diet Diversification: A First in Mpumalanga Province, South Africa  
Mrs. Lynn Viljoen
- W21** Carotenoid Value of Green Rice  
Dr. Le Thuy Vuong
- Posters on Dietary Approaches: Food Fortification**
- W22** Optimizing Vitamin A Retention in Consumer Packaged Fortified Vegetable Oils  
Dr. Varghese Abraham
- W23** Food Fortification Vehicles for the Control of Vitamin A Deficiency in West African Women and Children: Findings from a Multi-country Study in Burkina Faso, Guinea, Mali, and Niger  
Dr. Victor M. Aguayo
- W24** Rapid Semi-quantitative Chemical Assay Kit for Vitamin A in Fats and Oils  
Prof. Joseph Arul
- W25** Stability of Vitamin A and  $\beta$ -Carotene in Fortified Vegetable Oils  
Dr. Saraswati Bulusu
- W26** Effect of Temperature and Light Exposure on Vitamin A Stability in Fortified Soybean Oil  
Dr. L. Borghos
- W27** Building a Public-Private Partnership for Fortifying Staples in the Philippines  
Ms. Evelyn Carpio
- W28** Vitamin A Fortification of Salt  
Ms. Tanya Guay
- W29** Vitamin A Content in Banaspati Ghee and Edible Oil Produced in Pakistan and Stability of Vitamin A During Cooking  
Dr. Tajammal Hussain
- W30** Effect of Cooking, Packaging and Storage on Vitamin A Stability in Fortified Maize Meal  
Mrs. Gladys Kabaghe



## Wednesday Posters (continued)

- W31** Comparison of the Carr-Price Assay for Vitamin A Determination in Fortified Oil, Sugar, Salt and Flour with the Standard HPLC Method  
Dr. Yukio Kakuda
- W32** Vitamin A in Maize and Flour: An Inter-laboratory Exercise  
Prof. Demetre Labadarios
- W33** Rapid Test for Vitamin A Levels in Maize Meal  
Prof. Demetre Labadarios
- W34** Food Consumption Data Strengthens Planning in a Food Fortification Program  
Mr. Hector Coronel Maglalang
- W35** A Cut-Off Point Method to Determine Vitamin A in Sugar and Other Foods for Fast Screening in Monitoring Programs  
Mrs. Carolina Martinez
- W36** Sequential Application of Two Forms of Deuterium-labeled Retinyl Ester Whole-Body-Dilution Tracers to Monitor the Impact of One Year of Sugar Fortification with Vitamin A on Vitamin A Status of Nicaraguan Schoolchildren  
Dr. Judy D. Ribaya-Mercado
- W37** Technology for Fortifying Large Crystal Size Plantation White Sugar with Vitamin A  
Mr. S. S. Sirohi

### Posters on Integrated Approaches and Communication and Behavior Change

- W38** Control of Subclinical Vitamin A Deficiency (VAD) in the Huallaga Valley of Peru  
Dr. Luis Benavente
- W39** Micronutrient Health in Mali: Pre-service Training and Health Worker Practice  
Dr. Amenatou Cissé
- W40** Risk Factors for Night Blindness Among Pregnant Women in South India: The VASIN Study  
Dr. Joanne Katz
- W41** The Contribution of Vitamin A from a Multi-micronutrient-fortified Condiment Spread to the Total Dietary Vitamin A from Main-Dish Recipes of Urban and Rural Low-Income Guatemalan Households  
Dr. Monica Orozco
- W42** Perceptions of Nightblind Women, Their Families and Community Leaders on Causes, Treatment and Strategies for Coping with Nightblindness During Pregnancy  
Ms. Pooja Pandey
- W43** Mother-to-Mother Support Groups as Channel for Nutrition Education  
Mr. Jan Petersen
- W44** Improving Vitamin A Coverage (VAC) Among 6-Month to 5-Year-Old Children in the Autonomous Region of Muslim Mindanao (ARMM)  
Ms. Eva P. Puertollano



## Wednesday Posters (continued)



- W45** Increasing Children's Vitamin A Intake Through Day Care Programs: An Example from Guatemala  
Dr. Marie Ruel
- W46** Proximity Communication in Order  
Mrs. Paulette Magbunduku-Elamba
- W47** Developing a Community Based Approach to Gardening in Burkina Faso: The Role of Female Village Social Workers  
Dr. Mohamed Ag Bendeck
- W48** Combatting Vitamin A Deficiency by Integrating Vitamin A Supplementation in the Primary Health Care Activities and Promoting the Consumption of Food Rich in Vitamin A  
Prof. Marie-Claire Yandju
- W49** Partnerships for Sustainable Prevention of Vitamin A Deficiency in Cambodia  
Dr. Yaren Yim
- W50** Integrated Community Development to Control Vitamin A Deficiency  
Dr. Fatima-Zohra Akalay
- W51** Micronutrient Deficiencies and Their Economic Implications in Morocco  
Dr. El Arbi Rjimati
- W52** A Model for Institutionalization of Community-based Vitamin A Supplementation in Senegal  
Prof. Gu'elaye Sall

## Report on Presentations

More than 650 policy makers, program managers, planners, and scientists from some 70 countries took part in the three-day XXI International Vitamin A Consultative Group (IVACG) Meeting. More than 50 oral presentations were given, and open discussion sessions encouraged dialogue on issues of interest. The body of high-quality work exhibited in the almost 100 posters presented was a major strength of the meeting. Poster sessions offered attendees a chance to follow up on specific subjects and contributed to the extensive networking that IVACG meetings uniquely enable.

## Inauguration

IVACG attendees heard inaugural remarks by representatives of the United Nations, the Government of Morocco, and the U.S. Agency for International Development. In opening the meeting, Dr. Mohamed-Cheikh Biadillah, Minister of Health of the Kingdom of Morocco, acknowledged that hosting the IVACG meeting gave his country an important new impetus to implement programs to improve the quality of foods consumed by mothers and their infants. Dr. Biadillah reflected on the country's ambitious National Micronutrient Deficiency Control Program, initiated in 1998. He pledged to provide vitamin A supplements to all Moroccan children at risk of deficiency and to pursue the fortification of cooking oil with vitamin A. He remarked that the meeting presented an excellent opportunity for strengthening professional networks and made clear his expectation that Morocco would draw on the lessons of other countries' successful experiences and disseminate lessons of its own.

Mr. James Bednar, director of the U.S. Agency for International Development (USAID) mission to Morocco, offered a short history of micronutrient interventions in the United States and commented on the human, social, and economic benefits of correcting and preventing deficiencies of vitamin A and other nutrients. He outlined the coordinated support of USAID, the Ministry of Health, and other local and

international organizations to Morocco's national micronutrient program. Mr. Bednar challenged participants to take full advantage of this chance to share experience and findings from around the world.

Mr. David Alnwick, project manager for Roll Back Malaria at the World Health Organization (WHO), highlighted the potential benefits of interdisciplinary approaches to nutrition and health, typified by the success of distributing vitamin A supplements to children through national immunization days (NIDs). Mr. Alnwick noted that IVACG meetings foster communication among scientists, policy makers, and program implementers, benefiting them all. Dr. Rainer Gross, chief of the Nutrition Section of the United Nations Children's Fund (UNICEF), highlighted global progress towards improving the vitamin A status of populations, especially through supplementation. Challenges include guaranteeing multisectoral involvement and expanding postpartum supplementation and food-based programs. Ms. Ellen Muehlhoff, a senior nutrition officer at the United Nations Food and Agriculture Organization (FAO), described her organization's objective: to ensure that all people have access at all times to sufficient nutritious food to allow an active and healthy life. She emphasized the advantages of food-based programs, including crop and animal production, fortification, and food and nutrition education.

Dr. Alfred Sommer, chair of the IVACG Steering Committee, acknowledged the support of Roche to IVACG over a period of three decades. To Dr. Martin Frigg, editor of the *Sight and Life Newsletter*; Dr. Sommer presented a plaque in honor of *Sight and Life's* 15 years of service in improving vitamin A status around the world. Attendees observed a moment of silence in memory of Dr. Paul Arthur, a former IVACG Steering Committee member, who died unexpectedly on March 9, 2002. The vitamin A and international health community will miss him and will cherish the memories of his dedicated efforts on behalf of children and women everywhere.

*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.*

## Introduction

Dr. Sommer summarized “The Annecy Accords to Assess and Control Vitamin A Deficiency,” an IVACG statement distributed at the conference. IVACG had commissioned a series of position papers that were presented and discussed by an expert panel in October 2000 in Annecy, France. Recommended revisions to supplementation protocols and guidelines for assessing the vitamin A status of populations were presented for final agreement during the 20th IVACG meeting in Hanoi, Vietnam, in February 2001. An extensive summary of these papers and the evidence supporting the recommendations was prepared by Dr. Sommer and Dr. Frances R. Davidson, IVACG secretary, for *The Journal of Nutrition* (2002;132[9S]:2843S–2850S).

The term “vitamin A deficiency” was previously used to refer to clinical, biochemical, and other conditions, both individually and together. With revisions in terminology to resolve confusion, “vitamin A deficiency” (VAD) now refers to a state in which liver stores of vitamin A are below 20  $\mu\text{g/g}$  and its surrogates (e.g., serum retinol concentration, relative dose response, and modified relative dose response). “Vitamin A deficiency disorders” (VADD) refers to all physiological disturbances caused by low vitamin A status. VADD includes the clinical signs and symptoms of deficiency (e.g., increased infectious morbidity and mortality, growth restriction, anemia, xerophthalmia, and dark adaptometry). It also includes effects previously termed subclinical, such as impaired iron metabolism, disrupted cellular differentiation, and depressed immune response. Use of the designation “subclinical” is not recommended, as it suggests that systemic non-ocular manifestations of VAD are less consequential than overt symptoms. In fact, these conditions can be severe and are associated with marked increases in mortality risk.

Dr. Sommer briefly reviewed the revisions recommended in the Annecy Accords and presented the rationale for each. A number of new criteria are proposed to determine more accurately whether or not VAD is a problem of public health significance in a given population. Night blindness during the last live-birth pregnancy in at least 5% of women is considered indicative of VAD in the wider population. An under-five

mortality rate (U5MR) exceeding 50 per 1,000 live births also suggests that VAD is likely. Where U5MR is between 20 and 50 per 1,000 live births, VAD may be a problem and further inquiry is warranted. The serum retinol concentration cutoff for individual deficiency has been raised to 20  $\mu\text{g/dL}$ , with high-performance liquid chromatography (HPLC) the only acceptable laboratory method of analysis.

The Accords also clarify recommendations for intervention strategies. Dietary diversification alone, if based solely on plant sources, is now deemed inadequate for normalizing vitamin A status, particularly in young children. Recent evidence suggests that the bioavailability of beta-carotene is, at best, half the level it was previously thought to be. As a result, widespread VAD is not likely to be correctable through diet alone in developing countries where populations depend heavily on traditional plant-based foods. Supplementation for mothers and young children remains an essential intervention. The size and frequency of suggested supplement doses for new mothers and their infants have been increased. Fortification of commonly consumed foods that contain vitamin A was acknowledged as an important means of reducing the prevalence and severity of VAD. Finally, Dr. Sommer pointed out the essential role of monitoring and evaluation in ensuring the progress of interventions towards achieving their objectives.

Dr. Duff Gillespie, of the David and Lucile Packard Foundation, in Los Altos, California (USA), presented a historical perspective on developments in the science, policy, and program aspects of vitamin A, using as a framework Rogers’ Diffusion of Innovations theory. Dr. Gillespie tracked how vitamin A-related technological innovation has passed through the first four stages described by Rogers — knowledge, persuasion, decision, and implementation — and emphasized that an enhanced effort was now required to establish the fifth and final stage, confirmation. Dr. Gillespie identified the linkage of vitamin A supplementation with NIDs, particularly in Africa, as a fortuitous event that precipitated the rapid expansion of programs. He proposed that the vitamin A community is situated at a “tipping point,” a pivotal period in which a technology either finds wide acceptance and its use expands very rapidly, or it continues to be used only by those who adopted it early on. Dr. Gillespie warned that supplementation

programs are vulnerable at this time both because NIDs are being phased out and because programs have remained largely donor driven. Acknowledging that the full potential of vitamin A interventions has yet to be achieved, he urged action to beyond the “tipping point” to reach the final, sustainable stage, confirmation. Suggestions included the following:

- Expanding the base of committed policy makers
- Establishing fortification programs to reduce dependence on supplementation, at least for children aged 36–59 months and for women
- Expanding the reach of supplementation programs to underserved populations and implementing programs that can operate independently of NIDs
- Creating demand for vitamin A

During the second fortification session on Wednesday morning (the third day of the meeting), Mr. Rolf Carriere, of the Global Alliance for Improved Nutrition (GAIN), in Geneva, Switzerland, reflected on the prospect of ending malnutrition and the potential role of public-private-people’s partnerships in this endeavor. Mr. Carriere remarked that dramatic poverty reduction and unprecedented social progress had historically occurred in tandem. He suggested that the slow progress towards eliminating malnutrition in endemic areas is due primarily to inadequate resource transfer, but that failings in the vision and leadership of the international nutrition community underlie this cause. Mr. Carriere challenged participants to overcome a number of psychological forces that contribute to inaction and described GAIN as a new approach to building effective partnerships. Initiated by the Bill & Melinda Gates Foundation, USAID, and the Canadian International Development Agency (CIDA) and backed by agencies of the United Nations as well as researchers and private-sector concerns, GAIN was launched at the United Nations General Assembly Special Session on Children on May 9, 2002. It aims to reduce micronutrient malnutrition through fortification of mostly staple foods consumed by poor and deficient populations. GAIN will work through new national fortification alliances, pursuing a partnership approach.

## Scientific Presentations

### *Global and regional status of vitamin A*

#### Focus on Morocco

The 1996 National Micronutrient Survey in Morocco was the first to provide nationally representative data on VAD for any North African country. Across the region, the prevalence of ocular signs ranged from 0% to 0.2%, below the WHO cutoffs for a public health problem. However, HPLC analysis showed serum retinol concentrations below 0.70  $\mu\text{mol/L}$  (20  $\mu\text{g/dL}$ ) in 41% of children aged 6–71 months. Food frequency scores were generally low, reflecting intakes of dietary vitamin A below the recommended levels.

The survey helped generate commitment to the development of Morocco’s National Vitamin A Deficiency Program. Dr. Abdelwahad Zerrari, of the Ministry of Health, in Rabat, Morocco, described the program for IVACG participants, stating as a goal the elimination of VAD by 2004. NIDs and other semiannual national events will provide universal supplementation for young children in Morocco. Policies are also in place to support therapeutic supplementation for sick children and distribution of vitamin A capsules to women within one month after delivery. Capsule coverage in recent years has hovered around 50% for children aged 6–12 months, and it has been even lower for older children and new mothers, despite the country’s commitment and efforts to reach the entire at-risk population. A communications campaign using the tagline “Sena Wa Salama” (Good Health and Well-Being) has been designed to encourage consumers to participate in supplementation events and to choose foods that are rich in or have been fortified with vitamin A. In an innovative community development initiative in ten villages in southern Morocco, material on vitamin A was integrated into literacy training as a means of increasing knowledge and awareness (W50<sup>1</sup>).

Fortification of cooking oil with vitamin A is already in progress in Morocco. Oil was selected because its production is largely centralized and daily mean per capita consumption is a relatively high 32 grams.

<sup>1</sup> Abstract numbers correspond to the presentation abstracts displayed at the end of the report. Abstracts are not available for all presentations.



Research to support this program has been under way for some time. Prof. Mohamed Rahmani, of the Institut Agronomique et Vétérinaire Hassan II, in Rabat, Morocco, discussed the results of a study on the stability of retinyl palmitate added to soybean oil during storage and cooking (W26). Stability during storage was minimally affected by temperature, but greatly affected by light conditions. Diffuse daylight led to the loss of two-thirds of the initial concentration of the vitamin after six months. Boiling also caused significant losses, but other common cooking methods proved less damaging. Notably, the addition of vitamin A at levels up to 67 IU/g did not affect consumer acceptance of the oil.

Dr. Anna Verster, of the WHO Eastern Mediterranean Regional Office (EMRO) in Cairo, Egypt, described ongoing fortification efforts in Morocco and the region. EMRO member states met in June 2002 to assess the status and scope of fortification efforts in the region and to encourage the involvement of the vegetable oil manufacturing sector. Participants called for the formation of a technical committee to include member states, WHO, UNICEF, the Micronutrient Initiative (MI), USAID, and other bodies. The committee will develop a regional plan and offer technical guidance and support to countries carrying out fortification programs. Morocco is also investigating the possibility of milk fortification, and a technical dossier is under development.

### Global Prevalence

Programs have grown and diversified rapidly in recent years. The 21st IVACG meeting sessions referenced population serum retinol concentrations or dietary vitamin A intake levels from more than 40 countries, at least 28 of which have relatively recent national estimates. Countries in Asia and in sub-Saharan Africa report the highest prevalences of VAD. Estimates of VAD in African children ranged from 24% to 70%, with most in excess of 50%. In South Asia, where fewer national statistics are available, the reported prevalence of VAD ranged from about 30% to 50%. In the Middle East, estimates ran between 9% and 62%, with most below 30%. Many of the countries of Latin America continue to reduce the prevalence of VAD with fortification of sugar and with preventive supplementation.

With alternative supplementation delivery mechanisms being implemented to replace

NIDs, and with fortification and other food-based initiatives expanding their reach, the sound development and evaluation of programs is more important than ever. Prevalence data can help cultivate donor and stakeholder support and clarify program goals. Such data aid in identifying the groups in greatest need of interventions, achieving appropriate intensity, and selecting best practices within national and local contexts. Perhaps most significantly, they can be used to measure program success, providing an evidence base and a powerful incentive for future investments in vitamin A programs.

Four poster presentations focused on the results of recent population-based surveys of VAD prevalence that had not previously been widely disseminated (Table 1). National data from Morocco (T1) are outlined above, under Focus on Morocco. Results at the national level were also presented for Malawi and Mozambique. Malawi's 2001 National Micronutrient Survey (T30) identified the prevalence of low and deficient serum retinol concentrations in children aged 6–36 months (59%) and aged 6–12 years (38%).

In Mozambique, the survey included children aged 6–59 months and their mothers (T36). Although designed to provide the first nationally representative estimates of vitamin A and iron deficiency, a cholera outbreak in one province precluded investigators from visiting six of the 40 selected geographic clusters. Because of participants' strong opposition to having venous blood drawn, the dried blood spot technique was used to measure retinol concentrations. Plasma retinol concentrations between 0.35 and 0.70  $\mu\text{mol/L}$  were found in 56% of children and 11.2% of women. Another 15% of children and 0.9% of women had levels below 0.35  $\mu\text{mol/L}$ .

VAD was also identified as a problem of public health importance in subnational surveys in Brazil (T35).

The wide array of clinical, biochemical, and dietary methods available for the assessment of vitamin A status merits special note. Individual measures are selected variously for their applicability, validity, reliability, ease of use, cost, and cultural appropriateness. The prevalence of clinical signs of deficiency has often been used to indicate whether a population is likely to have a serious public health problem. However, xerophthalmia and other ocular signs are

**Table 1. Recent population-based prevalence surveys**

Country	Year (Name)	Population	Results	References	
Brazil	1998	Children 6–60 months in Sergipe state	SR < 0.70 $\mu\text{mol/L}$ : 32.3%	T35	
Malawi	2001 (National Micronutrient Survey)	Children 6–36 months Children 6–12 years Women 15–45 years Men 20–55 years	SR < 0.70 $\mu\text{mol/L}$ 6–36 months: 59.2% 6–12 years: 38.3%	SR < 1.05 $\mu\text{mol/L}$ * Women: 89.9% Men: 81.8%	T30
Morocco	1996	Children 6–71 months	SR < 0.70 $\mu\text{mol/L}$ : 40.9% SR < 0.35 $\mu\text{mol/L}$ : 3.2% (severely deficient)  XN: 0.1%      X2: 0.1% X1A: 0.2%    X3A: 0% X1B: 0%      X3B: 0%	T1 W26 W51	
Mozambique	2001 (National VAD and Anemia Survey)	Children 6–59 months and their mothers	SR = 0.35–0.70 $\mu\text{mol/L}$ : SR < 0.35 $\mu\text{mol/L}$ :	Children: 56.0% Women: 11.2% 15.2%    0.9%	T36 M4

\* Nearly 90% of cases were below 1.05  $\mu\text{mol/L}$ , an unusually high figure that calls for confirmation. SR, serum retinol concentration; XN, night blindness; X1A, conjunctival xerosis; X1B, Bitot's spots; BC, beta-carotene; X2, corneal xerosis; X3A, corneal ulceration/keratomalacia (involving less than one-third of the corneal area); X3B, corneal ulceration/keratomalacia (involving one-third or more of the corneal area); VAD, vitamin A deficiency; VA, vitamin A.

relatively rare and represent only the most severe cases of deficiency, particularly in children. This limits their usefulness in all but the largest studies, in which sufficient numbers of participants can be enrolled for the detection of prevalences of clinical signs — and changes in prevalence — with statistical precision.

Night blindness as a clinical measure has several advantages over others. It is less costly, non-invasive, and simple to assess (particularly in areas where a local term exists for the condition). Several IVACG presentations offered examples of using night blindness during pregnancy as a clinical parameter for VAD. A study in India included women in their second and third trimesters of pregnancy attending prenatal clinics at a New Delhi hospital (T31). Nearly 5% of the 829 respondents reported night blindness in their current pregnancy, and almost 3% also recalled having night blindness during a previous pregnancy. Data from Nepal (W42, T38) suggest that up to 16% of pregnant women are affected in some regions.

### Keynote address: Vitamin A in a global context

Dr. Dean Jamison, of the National Institutes of Health, in Bethesda, Maryland (USA), delivered the keynote address, in which he clearly articulated the vital role that efforts to improve the vitamin A status of populations

have in global development. He reviewed three central issues in the debates on health and development — the link between economic growth and health, the prominence of nutrition risk factors in the global disease burden, and the cost-effectiveness of vitamin A interventions — and elaborated their implications for future efforts to control VAD and related conditions.

*The link between economic growth and health:* Dr. Jamison described great gains in both prosperity and health over the last century and concluded that while income growth and improved health are indeed related, the relationship is a reciprocal one. He asserted that the positive impact of improved health on income is great, and often overlooked. While income growth can and does lead to improvements in health, Dr. Jamison argued persuasively that the impact of income growth may be less substantial than other factors. Using data from Mexico, he illustrated how improved technologies for vitamin A supplementation and micronutrient fortification were more important in reducing infant mortality than was increased income.

*The increasing prominence of nutrition risk factors in WHO's Global Burden of Disease analysis:* The 1993 WHO Global Burden of Disease analysis has been updated and enhanced by taking into account the attributable fractions of mortality and Disability Adjusted Life Years (DALYs) of many risk factors contributing to the overall disease

burden. The importance of nutrition is more fully realized in the updated work. Undernutrition during pregnancy and childhood accounts for more than 6 million deaths annually. In developing countries with high mortality, undernutrition and deficiencies of vitamin A, iron, and zinc figure prominently among the major determinants of both mortality and DALYs.

*The cost-effectiveness of vitamin A interventions:* In comparing the benefits and costs across a broad range of public interventions, high-dose vitamin A supplementation and fortification with vitamin A remain among the most attractive investments. Both types of programs are highly cost-effective in terms of both lives saved and DALYs.

## **Supplementation: Post-NIDs and reaching mothers**

### **Programs for children**

#### **Overview**

Supplementation programs were described in oral presentations during Monday's and Wednesday's afternoon sessions and in a number of poster presentations. Programs were represented from 14 countries in Africa, seven in Asia, and three in Latin America. WHO's introduction of NIDs in the mid-1990s was a historic event for vitamin A supplementation. Programs began to link their operations with polio eradication efforts, and they met with unprecedented success. In Africa the linkage constituted a breakthrough, dramatically improving coverage for the once-a-year distribution with NIDs. In Asia, where many countries had previously established programs, the introduction of NIDs was clearly beneficial, though its effect was less marked.

Maximizing the child survival impact of vitamin A supplementation requires at least twice-yearly distribution, and NIDs provided only one round. Significant effort has been invested in instituting delivery mechanisms for a second round. As countries eradicate polio and phase out NIDs altogether, the successful implementation of these alternative distribution mechanisms becomes even more important. Africa in particular faces substantial challenges to sustaining high levels of coverage after NIDs are phased out.

Ms. Ruth Harvey, of MOST, the USAID Micronutrient Program, in Arlington,

Virginia (USA), reviewed national supplementation programs that have been implemented independently of NIDs (M1). She focused on models that have achieved long-term success, defined as having a) provided two doses of vitamin A each year to children 12–59 months of age, b) operated for at least four years, and c) maintained coverage of at least 70%. Seven countries with available coverage data met these criteria: Bangladesh, Indonesia, Nepal, the Philippines, Niger, Zambia, and Nicaragua. Ms. Harvey noted that Ghana and Senegal met all criteria except for the four-year time frame. She found that the seven successful non-NIDs programs were now using one of three kinds of delivery mechanisms for vitamin A:

- Vitamin A days/national micronutrient days, twice yearly (Bangladesh, Nepal, and Niger)
- Child health weeks, a component of a package of preventive services, twice yearly (the Philippines, Zambia, and Nicaragua)
- Distribution during regular monthly outreach on two selected months per year (Indonesia)

A fourth option, using one of the mechanisms listed above for children aged 12–59 months combined with “everyday Expanded Program on Immunization (EPI) and clinic-based services” to reach children aged 6–12 months, had been tried earlier in some countries and then been revised. Ms. Harvey pointed out that none of the successful programs had used “everyday EPI and clinic-based services” as the sole distribution mechanism for vitamin A and reached high coverage. However, in addition to one of the mechanisms listed above, most of these countries also have supplements available year-round at health service points for targeted prevention and treatment and had trained health workers to identify and dose children who had been missed during the distributions.

Briefly summarizing the history and characteristics of individual programs, Ms. Harvey described how each one continued to evolve to best function in its unique country context. She noted the commonly heard criticism that twice-yearly distributions are “vertical” and not “integrated,” yet for these seven countries the distributions function as part of the health system and offer an integrated package of preventive services (Table 2). Moreover, experience has shown



**Table 2. Preventive health services offered along with vitamin A supplementation**

Service	Philippines	Nicaragua	Zambia	Indonesia	Bangladesh*	Nepal	Niger
Immunizations	•	•	•	•	•		•
Iron supplements for women		•		•			•
Iron supplements for children	•						
Provision of ORS packets		•		•			
Growth monitoring	•		•	•			
Deworming	•	•	•			•	•
Iodized salt promotion/testing	•						
Nutrition education	•	•		•		•	
Promotion of fortified foods	•						
Contraceptives available		•		•		•	
Retreatment of bednets			•				
Referrals to health services	•	•		•		•	
Water treatment		•	•				

\* Bangladesh is reported as planning to include other preventive services in 2003.  
ORS, oral rehydration salts

that the vitamin A programs achieve good coverage in typically underserved areas and that they can draw people into services where utilization previously has been low. The programs' outreach activities have primarily involved caregivers bringing children to a central site and, unlike NIDs, do not rely on expensive house-to-house campaigns.

Ms. Harvey concluded that the successful programs all adopted a specific strategy of twice-yearly distributions accompanied by special promotion activities and that these activities can become institutionalized within the health sector and achieve and maintain high coverage over many years.

### Africa

Supplementation programs in Niger, Ghana, Mozambique, and Nigeria were described. Dr. Victor Aguayo, of Helen Keller International, in Bamako, Mali, described the vitamin A supplementation program in Niger (one of the region's poorest countries, with a child mortality rate of more than 300 per 1,000 live births) as "an inspirational success story for many other West African countries" (M7). Advocacy for vitamin A supplementation was carefully targeted, and it built on the single message that controlling VAD can avert over 25,000 child deaths per year. Program evidence from Asia was used to demonstrate that the Government of Niger and its development partners could deliver a vitamin A intervention that would substantially reduce child mortality. In 1997, Niger became the first country in Africa to effectively integrate vitamin A supplementation into NIDs, and it achieved more than 80% coverage. In 1999, the first-ever national micronutrient day (NMD) was

added to provide the second annual dose of vitamin A. Since then, more than 80% of children in Niger have benefited from twice-yearly supplementation. Dr. Aguayo attributed Niger's success to five principles: targeted, evidence-based advocacy; government leadership of the process; sustained partnership among government, NGOs, and multilateral partners; careful planning, training, and implementation at the district level with centralized oversight and coordination; and effective communication and social mobilization.

Ms. Esi Amoaful, of the Ghana Health Service, in Accra, Ghana, described evaluation activities undertaken to strengthen the implementation of non-NIDs vitamin A supplementation in Ghana (M2). National distribution of vitamin A was initiated in 2000 with a NIDs program, and a stand-alone distribution program was implemented later that year to ensure that children received a second dose. A special coverage survey was undertaken after each non-NIDs round to assess the effectiveness of the distribution in the absence of the NIDs infrastructure. These surveys produced an independent estimate of coverage to check against tally sheet estimates as well as other information about implementation. For example, they identified reasons children did not receive supplements, the most used sources of information about the distribution, and the quality of the interaction between provider and client. This information helped strengthen logistics management and the efficiency of program implementation. It also was incorporated into service providers' training, provided a sense of direction for program managers, and formed an evidence base for advocacy to

enlist policy makers' commitment to sustaining the program.

Mozambique, like Niger, has an alarmingly high child mortality rate (246 per 1,000 live births), and thus stands to save an enormous number of lives by implementing vitamin A programs. Ms. Sonia Khan, of the Ministry of Health, in Maputo, Mozambique, described Mozambique's experience with vitamin A supplementation (M4). The first distribution, undertaken in 1999 in conjunction with the final round of NIDs in the country, reached more than 3 million children. Over the next two years, vitamin A was distributed once a year through Mother and Child Health Days, reaching an estimated 79% of the target group in 2000 and 91% in 2001. In areas especially affected by flooding, a second distribution was piggybacked onto measles vaccination programs. In 2002, the supplementation program was transferred to routine well-baby clinics. After the transition, estimated coverage fell to around 40%. Several strategies are planned for improving coverage in Mozambique. These include maximizing opportunities to distribute supplements through regular health services, such as sick-child contacts, community outreach, and emergency response activities; continued attention to training and supervision; coverage monitoring; and increasing social mobilization efforts.

An innovative approach to distributing vitamin A supplements was piloted in two districts in Nigeria, another country with a particularly high child mortality rate (192 per 1,000 live births) (M5). Dr. Mousa Obadia, of Helen Keller International, in Jos, Nigeria, described how supplementation was effectively incorporated into the Community-Directed Treatment with Ivermectin (CDTI) program, which was designed to control onchocerciasis, a parasitic disease prevalent in 32 of 36 Nigerian states. With NIDs being phased out in Nigeria, this pilot program was designed to test the feasibility of an alternative distribution mechanism. The CDTI program is community based, and workers are selected and remunerated by community leaders. In the same way that collaborating with NIDs increased the cost-effectiveness of the vitamin A program, coordination with the CDTI program can lower the price of delivering supplements. Delivering vitamin A in pilot communities in Nigeria was estimated to cost US\$0.15 per child, and expanding the program to all CDTI commu-

nities is expected to further reduce the cost to US\$0.10. Several important challenges were identified during the pilot phase. First, the CDTI program is run once a year, and a second dose of vitamin A still must be delivered each year. Second, workers are familiar with the material incentives offered by programs for polio and Guinea worm eradication and hence are reluctant to perform distribution functions without such incentives. Finally, the program relies on the primary health care system, which is weak in many communities.

## Asia

National supplementation programs from Bangladesh, the Philippines, and Indonesia were described, along with an evaluation of programs in India. Presentations captured the region's long-term experiences with supplementation programs. The program in Bangladesh is one of the oldest, dating to 1973, and Dr. Syeeda Begum, of UNICEF, in Dhaka, Bangladesh, briefly reviewed its history (M3). The program originally relied on twice-yearly house-to-house distributions lasting one month each; coverage rarely exceeded 50%. The strategy for children aged 6–12 months changed in 1991 to a more passive, health center-based distribution associated with EPI contacts, but coverage remained low. In 1995, the Ministry of Health's Institute of Public Health Nutrition assumed responsibility for the program. For children 1–5 years of age, one annual vitamin A distribution was linked to the newly introduced NIDs program, and coverage rates increased dramatically. Encouraged by this, the government initiated a National Vitamin A Week for the second dose, which, like the NIDs in Bangladesh, was primarily center based.

In recent years advocacy, social mobilization, and mass media efforts have helped sustain coverage at levels exceeding 80% in Bangladesh. A national survey conducted in 2001 found a prevalence of night blindness below 1%, well below the prevalence of 3% measured in the early 1980s, and below the WHO level indicating a public health problem. Plans have been made to introduce a National Child Health and Nutrition Week in 2003 and to expand the range of preventive services offered along with vitamin A supplementation.

National programs in the Philippines and in Indonesia were described in some detail during the Wednesday afternoon session. Dr. Corazon Barba, of the Food and Nutri-

tion Research Institute, in Manila, Philippines, described the Philippines program and the substantial body of monitoring and evaluation work that has been an essential component of its management plan (W61). Initiated in 1993, the program mobilized village health workers and other volunteers to distribute vitamin A supplements every April and November. While most distribution takes place at health centers, workers provide house-to-house follow-up where necessary.

Until 1997, vitamin A supplements were provided in the Philippines through national micronutrient days, a centrally managed program of the Department of Health. High coverage was achieved with this approach, but in 1997, as part of a broad administrative restructuring of public-sector responsibilities, local government units assumed responsibility for the program. Dr. Barba discussed the decline in coverage that accompanied this transition and the response it drew. Efforts were made to strengthen the management capacity of local government units, to increase health workers' motivation, and to renew the program's focus on poor and at-risk children. In 1999, the Department of Health, in partnership with local government units, introduced *Garantisadong Pambata*, or Preschoolers' Health Week, designed to create awareness and advocacy for better child care. During *Garantisadong Pambata*, a range of health services, including vitamin A supplementation, are delivered to children under five.

The presentation highlighted how monitoring data collected after each distribution round has strengthened advocacy and commitment to the program among local government executives. As in Ghana, periodic surveys have also provided valuable feedback from caregivers and others and helped shape training programs for health workers and volunteers.

The collection of high-quality, comprehensive data from representative samples and use of appropriate statistical methods are essential to the effective evaluation of programs. Data collected in the 1993 and 1998 National Nutrition Surveys in the Philippines have contributed to a clearer understanding of the program's impact and the factors that affect vitamin A status. Describing the results of multivariate analyses that take into account interactions between important determinants of vitamin A status, Dr. Barba confirmed that the

elevation of serum retinol concentration after supplementation lasts about four months. Also consistent with previous research, reduced serum retinol concentrations were associated with anemia, stunting, or infection in the two weeks before the survey.

Dr. Rachmi Untoro, of the Ministry of Health, in Jakarta, Indonesia, spoke about the national supplementation program in Indonesia (W62). The program is implemented through the Posyandu system — a network of 250,000 integrated community health posts offering regular outreach services. Vitamin A is distributed in February and August through this network; other primary health care services are provided each month (Table 2). Although vitamin A has been part of the Family Nutrition Improvement Program since 1979, Dr. Untoro focused specifically on the past four years, addressing the challenges that arose from government decentralization and the additional assistance provided at the national level to support the program through this transition. In Indonesia, as in the Philippines, when program management and responsibility were devolved to district level, coverage rates fell. A variety of strategies to increase coverage were employed in 2002. These include a national mass media campaign to promote the distributions; advocacy aimed at district-level decision makers and program managers; printed materials distributed to health centers; and use of the national polio immunization day in September to dose children who were missed in the August distribution.

Provincial coverage rates were presented using data from the nutrition surveillance system run jointly by the Government of Indonesia and Helen Keller International. These data showed that coverage improved substantially between 1999 and 2002 and that national coverage data from the Ministry of Health's facility-based reporting system were affected by underreporting. Coverage for children aged 12–59 months ranged from 60% to 70% over the period 1999–2001 and increased to 70%–85% in 2002 as a result of the additional program activities. In 1999, a new target group was added to the program — infants aged 6–11 months. Specific promotional activities resulted in additional increases in coverage for this group, from 40% in 1999 to about 85% by 2002. Dr. Untoro concluded that the transition to local management requires ongoing support. Advocacy and promotion for vitamin A

months, district-level capacity building to enhance activity management and monitoring, and continued partnership between government, the private sector, and communities will be required.

Prof. Narendra Arora, of the All India Institute of Medical Sciences, in New Delhi, India, presented the results of a process evaluation of the strengths and limitations of the supplementation program in India and determinants of client behavior. The study was conducted across 15 states using in-depth interviews and focus group discussions with program stakeholders, including planners, managers, service providers, NGO and community leaders, and clients (users and non-users of supplementation). The results showed wide variability in the implementation of the program and highlighted the passive approach that many service providers and program managers had adopted. The study noted an overall lack of conceptual clarity about program objectives, delivery, and target groups among service providers and managers, suggesting a need to develop operational manuals and to review training strategies. Prof. Arora called for an overall reorientation of the program to focus on reaching 100% of clients with a more proactive approach to delivery, better planned and coordinated management of services, and communication to increase community awareness of the program as well as the need for other health services.

Ms. Karen Codling, of UNICEF's East Asia and Pacific Regional Office, in Bangkok, Thailand, considered the likely impact that the phasing out of NIDs would have on programs in that region. Prevalence data suggest the need for national supplementation programs in at least ten countries. Ms. Codling tracked the expansion of programs from four countries in 1995 to eight in both 1998 and 2001. She noted that the number of programs achieving 90% coverage increased steadily during this period to eight in 2001. Ms. Codling found reason to be optimistic that the phase-out of NIDs would not present major problems in the region. She observed that NIDs had already ended in Vietnam, the Philippines, and Cambodia without lasting negative consequences. While all of the programs continue to accept donated supplements provided with funds from Canada, Ms. Codling remarked that no country is totally reliant on external funding for vitamin A distribution, and several countries already purchase at least some of the required supplies independently.

Many posters reported progress in supplementation programs. The leaders of the Nepal program titled their presentation with the question "When Will Vitamin A Supplementation Be Taken Seriously?" (T27). In Nepal, female community health volunteers have undergone extensive training in the management of vitamin A distribution activities and have consistently achieved coverage above 90%. The success and popularity of the program have greatly elevated the status of female community health volunteers in their communities. Over the past two years, deworming has been added to the program at very little additional cost, and it can be expected to have a major impact on the prevalence of anemia in the country. It is clear that when a supplementation program is taken seriously, other services can be added to it. As the authors of the poster suggested, "vitamin A supplementation programs can serve as the engine for public health interventions instead of acting as the caboose." Other national programs described in posters included the Democratic Republic of Congo (T28, W46, W48), Mali (W39), South Africa (T23), and Tanzania (T26, T52).

Several posters described pilot studies covering smaller areas, such as two or three districts, for example, in Cambodia (T11, W49), Peru (W38), and Senegal (W52). Such pilot studies usually achieve impressive results, often with innovative but resource-intensive approaches to social mobilization. Results from these small-scale programs should be interpreted with some caution until it has been demonstrated that the approaches used can be scaled up to cover larger populations.

### **Elements of program success**

The meeting's plenary and poster sessions were rich with lessons from experience. The scope of the lessons is broad, but certain program characteristics appear to contribute fundamentally to success. Most fall into six categories:

1. A strategy defined for twice-yearly vitamin A supplementation with specific plans to reach children aged 12–59 months
2. A combination of strong coordination and leadership at the national level, with thorough program planning and problem solving at district and local levels
3. An integrated package of preventive services



4. Effective advocacy, promotion, and community mobilization
5. Particular attention to logistics and the training, motivation, and supervision of health workers and volunteers
6. Strong, active monitoring with information fed back into program management systems

### Economics of supplements

The session on the economics of supplements was presented on Tuesday afternoon. Policy makers and those responsible for allocating resources for health care must evaluate programs to choose those that are most appropriate, effective, and affordable. With programs competing for limited resources, measuring the cost-effectiveness of vitamin A interventions is increasingly recognized as a priority. A number of oral presentations and several posters included cost estimates, reflecting this growing recognition. Prof. Kevin Frick, of the Johns Hopkins Bloomberg School of Public Health, in Baltimore, Maryland (USA), gave an overview of the technical aspects of economic evaluation and described its policy implications. He distinguished cost-benefit from cost-effectiveness analyses and reviewed various concepts, including Quality and Disability Adjusted Life Years, direct and indirect costs, and discounting. Prof. Frick reminded attendees that responses to cost analyses often depend on *who incurs the cost* and *who derives the benefit* of investments. Governments, donors, and national and international corporations will be most interested in minimizing their own expenditures. In a search of the literature, Prof. Frick identified fewer than a dozen papers on the cost-effectiveness of supplementation and fortification with vitamin A, and virtually nothing on dietary change. He suggested that future research include programs addressing dietary change, including bioengineering, and also more thoroughly capture indirect costs.

Two reports of specific studies followed the overview. Mr. Bechir Rassas, of MOST, the USAID Micronutrient Program, in Arlington, Virginia (USA), described cost analyses of national supplementation programs in Ghana, Nepal, and Zambia (T44). He categorized costs as program specific (incurred exclusively for the delivery of the supplement) or shared (incurred with or without the supplementation program, such as personnel and capital expenses). Mr. Rassas estimated the average total annual

cost per child dosed at US\$1.13, of which personnel accounts for 48%, capital 15%, and program-specific costs the remaining 37%. Assuming a 23% reduction in mortality from vitamin A supplementation, Mr. Rassas estimated that the average cost per death averted through these three country programs was US\$23. Dr. Tran Tuan, of the Research and Training Center for Community Development, in Hanoi, Vietnam, described a study in Vietnam that compared the cost and the effects of distributing 50,000 IU supplements monthly through routine EPI services with the standard practice of semiannual 200,000 IU supplementation (T45). Comparisons were made in a single district, with ten communities in each group. Monthly supplementation was more effective than the semiannual program at reducing the prevalence of VAD. The bulk of the cost for the monthly program was related to training and was incurred during the start-up phase. When fully integrated with other community health services, the monthly distribution model is expected to cost just US\$0.56 per child covered per year, and US\$2.58 per life saved. These estimates are substantially lower than any other published estimates of cost-effectiveness, although they must be interpreted with caution until the model has been established as effective and sustainable on a larger scale.

Several posters estimated the costs involved in supplementation programs, although they referred to different cost components and hence are not readily comparable. In Nepal, the cost of biannual dosing was estimated at US\$0.63 per child (T27). The costs presented from programs in India (T21) and Nigeria (M5) were substantially lower but referred only to the marginal costs of adding supplementation to other programs.

### Programs for women

Sixteen presentations noted programs delivering high-dose vitamin A supplementation to mothers soon after delivery. Postpartum supplementation is an important strategy for increasing the vitamin A content of breast milk and thus the intake of breast-feeding infants and it also improves the vitamin A status of women.

Although few details of programs were available, the information presented suggests a lack of consistency in the protocols, which may be cause for concern. Because high-dose vitamin A supplementation can cause adverse effects early in pregnancy, postpar-

tum programs specify a time period after delivery within which dosing must occur. Current IVACG guidelines define this period as six weeks, but only two of the presentations specifically referenced this limit. Seven presentations specified only “in the early postpartum period,” six presentations mentioned various periods specified in days, weeks, or months after delivery, and one made no mention of a time period at all. The summary of the Annecy Accords, which was distributed to all participants and is available from the IVACG Secretariat, contains clear guidelines that should prove useful to supervisors of postpartum supplementation programs.

Coverage data were presented for ten of the programs mentioned, and these also show wide variation. The data are difficult to interpret because most reports do not specify the denominator used in making the estimates — for example, whether all women giving birth are included or only those who delivered in health facilities. Despite such uncertainties, it is clear that coverage was low: only three programs reported coverage greater than 50%.

## **Dietary approaches**

### **Choosing your food**

Interventions that promote the production and consumption of foods rich in micronutrients have several advantages over other types of programs. They often improve dietary quality beyond increases in the target nutrient, contribute to food security and family income, and empower women. Presentations described a wide variety of work being undertaken on this approach. Wednesday’s morning session included presentations on an *in vitro* model for assessing the bioavailability of carotenoids in fruit and vegetables, the integration of animal husbandry into home gardening, and the dissemination of orange-fleshed sweet potato in East and Southern Africa.

Ms. Generose Mulokozi, of the Chalmers University of Technology, in Gothenburg, Sweden, reported on work in Tanzania using an *in vitro* model for estimating “bioaccessibility” as a proxy for bioavailability of provitamin A carotenoids in vegetables and fruits (W53). She reported high variability in the composition of the tested foods. *In vitro* accessible all-trans beta-carotene varied between 7% and 100% in fruits and between 4% and 15% in leafy

vegetables cooked without oil. The beta-carotene in vegetables cooked with oil was two to five times more accessible than that in vegetables cooked without oil. Great variability in accessibility was also noted between different varieties of the same fruit.

Mr. Aminuzzaman Talukder, of Helen Keller International, in Kathmandu, Nepal, described recent developments in initiatives promoting home gardening in Bangladesh, Cambodia, and Nepal (W54). In December 2001, poultry, dairy cow, and fish production were introduced into ongoing home gardening activities in Bangladesh. Poultry production alone was introduced in Cambodia and Nepal. Results from the poultry components were presented. Data collected after one year showed progress in households that had adopted the intervention. Income increased, and egg and liver consumption rose substantially from baseline levels. Reports that the money earned from poultry production was spent predominantly on food were also encouraging. Mr. Talukder concluded that integration of animal husbandry with existing gardening programs has been relatively easily achieved so far and has resulted in increased consumption of dietary sources of vitamin A and other micronutrients.

Dr. Jan Low, of Michigan State University, in East Lansing, Michigan (USA), provided an update on the potential impact of beta-carotene-rich sweet potatoes on vitamin A intake in sub-Saharan Africa (W55). While the high nutrient content of these new cultivars is of great interest to nutritionists, subsistence farmers are adopting them because they offer high yields and have an attractive taste and texture. Working with the International Potato Center and plant breeders in African research institutions, Low and colleagues have released 31 beta-carotene-rich varieties with the low to medium dry-matter content preferred by children. More recently, 40 new varieties with the high dry-matter content preferred by adults in this region have been identified, and clones are being multiplied at this time for field experimentation. Beta-carotene-rich sweet potatoes have some major advantages as a vitamin A intervention. Sweet potatoes are a secondary staple in the region, and farmers are more likely to try new cultivars of a familiar crop than to adopt a new crop. Sweet potatoes are also relatively easy to grow, an attribute that carries special appeal for populations broadly affected by HIV/AIDS and other circumstances that can disrupt labor.

Dr. Low presented estimates of the potential of sweet potatoes to help populations in the region meet their vitamin A requirements. Using a set of conservative supply and demand assumptions together with sophisticated mapping technology, she calculated that for East African children aged 6–59 months, beta-carotene-rich sweet potato would contribute 40% of the Recommended Dietary Allowance (RDA) if it completely replaced white sweet potato in the diet. The adoption of beta-carotene-rich sweet potato at these levels would have its greatest impact in Rwanda, Burundi, and Uganda, and a lesser but nevertheless substantial impact in Tanzania and Kenya. The crop would allow some 10 million children at risk of VAD to meet their full RDA, and it would provide a substantial contribution to meeting the RDA for another 40 million. Dr. Low recommended that in future research, emphasis be placed on decreasing the seasonality of production rather than on increasing the provitamin A content of the cultivars.

More than 25 abstracts reported on investigations of approaches to diversifying diets. Several posters reported on studies determining the vitamin A content of indigenous foods that were reported as rarely consumed or exploring adaptations of recipes using locally available ingredients to enrich the nutrient content of diets. Examples were presented from Burkina Faso (W3, W4), Western Pacific (W5), Arctic Canada (W10), and Kenya (W14). Interventions using red palm oil were reported from Colombia (W12), and Cameroon (W16). Reports of work done in the United States described the difference in bioavailability of three types of carrots (W17) and the carotenoid content of green rice (W21). The retention of beta-carotene in boiled orange-fleshed sweet potato was reported in a study from Brazil (W18).

### Fortification

Dr. Martha Elizabeth van Stuijvenberg, of the Medical Research Council, in Cape Town, South Africa, described a long-term study of South African schoolchildren consuming beta-carotene-fortified biscuits providing 50% of the RDA. The efficacy of these biscuits in reducing the prevalence of VAD has been described previously in a 24-month longitudinal study. This presentation reported cross-sectional findings after 45 months of the intervention. Children received the biscuits each school day but not on weekends or during the long summer

vacation. Dramatic annual increases in mean serum retinol concentration were noted. After the summer vacation, the prevalence of VAD rose above 45%, but by the end of each school year it was reduced to about 20%. The authors of the report concluded that the beta-carotene supplied by the biscuit was adequate to maintain serum retinol concentration day to day, but not sufficient to replenish stores. Given that meals at home contributed only 10% of the RDA, the authors concluded that this intervention requires complementary strategies such as nutrition education and home-based production of beta-carotene-rich foods. In discussion following the presentation, one participant suggested that the increases in serum retinol concentration might not represent a real improvement in vitamin A status but rather reflect the recent consumption of the vitamin A in the fortified biscuit.

Responding to the findings from South Africa, Mrs. Luz Candelaria, of the Food and Nutrition Research Institute, in Manila, Philippines, presented the results of a six-month trial of vitamin A-fortified oil in 4- to 6-year-old Filipino children (W57). The children's serum retinol concentration increased substantially in the experimental groups, but increases were also noted in the control groups. It is difficult to draw any firm conclusions from these observations, because factors other than the consumption of fortified oil are likely to have increased retinol levels in all groups.

Ms. Maudé de Hoop, of the Department of Health, in Pretoria, South Africa, presented an overview of the development of the National Food Fortification Programme in South Africa (W58). The program began after a national survey in 1994 established that VAD was a significant public health problem in the country. The following year the government launched its Integrated Nutrition Program (INP), which specified reductions in the prevalence of micronutrient deficiencies as one of seven focus areas. Fortification joined supplementation and dietary diversity as program strategies. Planning for this national program was thorough and systematic and included multiple components:

- Formation of a multisectoral Food Fortification Task Group
- Collection and analysis of comprehensive food consumption data and information on food availability and expenditures

- The decision to pursue mandatory fortification of several staples, with additional voluntary fortification encouraged
- Assessment of the stability and the organoleptic characteristics of recommended fortificant levels for each staple
- Analysis of production, distribution, marketing, and costs of fortifying staples to support rational policy decision making and fine-tuning of implementation strategies
- Legislation — feedback invited on draft regulations is currently under review, and regulations will become law six months after publication of the final version
- Communication among key stakeholders and the target populations, which has already included media advocacy and consumer research

Ms. de Hoop concluded by enumerating the lessons learned from the South African experience. Dr. Philip Harvey, affiliated with MOST, the USAID Micronutrient Program, in Arlington, Virginia (USA), and with Johns Hopkins Bloomberg School of Public Health, in Baltimore, Maryland (USA), responding to this presentation, described it as almost the “ideal fortification planning model” and endorsed the opportunity it presented other countries to learn from the experiences reported. Dr. Harvey focused his presentation first on the process of establishing fortification levels, arguing that the experience reported suggests that levels in staples should be based on the results of organoleptic assessments (i.e., food science) rather than on the recommendations emerging from detailed dietary data and designed to fill a theoretical “nutrition gap.” Evaluation of food consumption patterns remains important in determining the likely impact of fortification in population groups (W34), but not in determining recommended fortification levels of staples and commodities. Dr. Harvey then used dietary data from young Filipino children to demonstrate the importance of adjusting single-day food intake data to represent usual intake (W6). Finally, he drew attention to the often underappreciated benefits that vitamin A fortification of staples offers breast-feeding infants by increasing retinol concentrations in breast milk.

Mrs. Carolina Martinez (W59), of the Institute of Nutrition of Central America and Panama (INCAP), in Guatemala City, Guatemala, and Dr. Omar Dary, of MOST, the USAID Micronutrient Program, in Arlington, Virginia (USA), summarized the extensive Central American experience of sugar fortification (W60). Field trials carried out in the 1970s demonstrated that the approach was efficacious and effective. Vitamin A added to sugar was readily bioavailable, and the serum retinol concentration of preschoolers, the concentration of retinol in breast milk, and retinol reserves in the livers of persons who had died accidentally all increased within six months of the program’s start. Dr. Judy Ribaya-Mercado, of the U.S. Department of Agriculture’s Human Nutrition Research Center, in Boston, Massachusetts (USA), and colleagues (W36) presented a poster on a study confirming that consumption of fortified sugar increases total retinol reserves in the body, even when serum retinol concentration was normal ( $>0.70 \mu\text{mol/L}$ ) at the beginning of the experiment. Despite some initial uncertainty, the program has functioned without interruption since 1987 in Guatemala, 1993 in Honduras, 1995 in El Salvador, and 2000 in Nicaragua.

The program has been monitored through quality control/quality assurance at the sugar mills, inspection by governmental food control authorities, and surveillance at the household level by technical institutions, including INCAP, national universities, and UNICEF. In 2001, household monitoring indicated that the desirable minimum vitamin A content of sugar (3.5 mg/kg) was present in 93%, 77%, 60%, and 35%, of households in El Salvador, Guatemala, Honduras, and Nicaragua, respectively. This minimum represents an average content of 7–10 mg/kg and, combined with daily sugar consumption of 20–120 g/day, provides 35%–150% of the Recommended Nutrient Intakes (RNI) for vitamin A. Despite the program’s long history of success, its sustainability and quality are threatened by the leakage of non-fortified sugar (smuggled or intended for industrial use) to households. Government capacity to control this situation is weak, making household-level monitoring imperative to maintaining the quality of the programs.

Sugar samples have usually been obtained from households by attaching collection to expenditure or health surveys. In the past, objectives have been restricted to monitor-



ing. INCAP carried out a study to determine whether schoolchildren could gather reliable information about sugar consumption and related habits to be used for evaluation purposes. Mrs. Martinez (W59) presented the results of the study, showing that with proper instruction, schoolchildren were able to collect samples allowing reliable and valid estimates of utilization and coverage. Further fine-tuning of the program resulted from the development of a fast, easy-to-use, low-cost qualitative assay to identify sugar samples with vitamin A levels at selected cutoff points (W35). This assay was used during the 2001 monitoring cycle in Guatemala to screen sugar samples obtained from schools in order to identify those with a vitamin A content below 3.5 mg/kg, the desirable minimum, and to exclude them from quantitative determination of vitamin A. Individual samples with acceptable levels are combined in groups of ten to form composite samples, which are analyzed using a quantitative spectrophotometric method. Screening out samples with unacceptable levels has improved the accuracy of the information reported. The “cutoff assay” costs US\$0.09 per sample, including personnel, reagents, and equipment, and allows analysis of 100 samples a day. The spectrophotometric method costs US\$3.00 per sample, and a single technician can handle only 38 samples a day.

Several poster presentations described qualitative assays similar to the one described above for determining the presence of acceptable levels of vitamin A in fortified sugar. All are based on the well-known Carr-Price reaction, in which retinol is converted in a retinyl anhydride, which has a characteristic transient blue color in organic solution. The method has been used for vitamin A–fortified maize-meal (W33), oil and fats (W24), salt, and wheat flour, and it can be adjusted to produce quantitative results (W31).

Using oil and fats as carriers of vitamin A has garnered increasing attention and was described in several presentations at this IVACG meeting. Prof. Mohamed Rahmani discussed in the Inaugural Session results of a study on the stability, during storage and cooking, of retinyl palmitate added to soybean oil (W26). Studies were conducted on the stability of vitamin A added at two levels to soybean oil, under different light and temperature storage conditions, after three and six months, and during cooking. Stability was more affected by exposure to

light (32% retention at six months) than by darkness (70% retention at six months), highlighting the need for opaque packaging. Temperature had little effect. Stability was reduced by repeated frying (about 30% lost after five rounds of frying), by common boiling (45% lost after 40 minutes) and, to a lesser extent, by pressure cooking (25% lost after 30 minutes). Similar findings were reported by Dr. Saraswati Bulusu, of the Micronutrient Initiative, in New Delhi, India, for fortified unrefined and refined vegetable oils in India. Retention of vitamin A after four frying cycles ranged from 40% to 70% and was affected adversely by higher food moisture content. Losses were greater than expected with longer periods of frying. Addition of the antioxidant TBHQ reduced losses in unrefined mustard oil, but not in unrefined groundnut, refined palmolein, or hydrogenated vegetable oil. Likewise, Dr. Tajammal Hussain, of NWFP Agricultural University, Peshawar, Pakistan, and colleagues (W29) reported that vitamin A retention in fortified banaspati ghee and edible oil in Pakistan was 70% in shallow frying, 50% in curry making, and 40% in deep-frying. Despite losses during storage, distribution, and use, oil fortification appears to be an attractive intervention, because the cost is very low and sufficient amounts can be added to compensate for any losses. The cost of fortifying one metric ton of oil to 12 mg/kg is about US\$2, one-fifth the cost of sugar fortification and half to one-third that of wheat flour fortification.

### **Communication and behavior change**

Communication and behavior change are essential components of effective health interventions. For supplementation programs to work, the support of health staff and volunteers must be enlisted and their commitment and enthusiasm cultivated and maintained. Communities must be made aware of when and where supplementation capsules will be distributed and which children are eligible. The communications challenges facing dietary diversification programs are arguably greater. Even fortification, often billed as an intervention requiring little behavior change on the part of consumers, depends heavily on advocacy and persuasive communication leading to behavior change in the public and private sectors.

Program accomplishments in communications and behavior change figured prominently at the meeting. The presentation mentioned earlier by Ms. Esi Amoafu, of the Ghana Health Service, on Ghana's non-NIDs supplementation programs stressed that communication and advocacy were crucial in generating the commitment of policy makers and increasing caregivers' demand for capsules (M2). Along with demonstrating consistently high coverage, survey data charted evolving community knowledge about the benefits of vitamin A supplements, which served as an important motivator for policy makers and health staff. Also in Ghana, a pilot study showed that women who had been exposed to promotional materials in mother-to-mother support groups had improved knowledge of dietary sources of vitamin A and were more likely to deliberately include these foods into children's diets (W43). The program in Niger attributed its success to targeted, evidence-based advocacy as well as careful attention to training and social mobilization (M7). Communications activities have also played valuable roles in the national programs in the Philippines and Indonesia, particularly in recent years as both programs faced challenges associated with decentralization (T18, T26, W61, W62). In both countries, strong efforts were undertaken at the national level to promote distribution and to publicize the importance of bringing children for vitamin A and other services. New district and local government unit management was also targeted for advocacy to establish and maintain the local commitment essential for program success and sustainability. In 2002, Indonesia initiated a multichannel mass media campaign and distributed print promotional materials to health clinics nationwide. In the Philippines, communications activities were implemented to address identified program weaknesses. Efforts were concentrated on increasing the priority status of the nutrition program among local government units, gaining local support for health workers and improving caregiver and community knowledge of the benefits of micronutrients.

Several innovative pilot programs, mainly food based, also owe much of their success to communication and behavior change activities. A communications project in Uganda effectively encouraged the farming and consumption of orange-fleshed sweet potatoes by developing client-focused messages for farmers and heads of households (W65). Extensive research identifying

the needs and preferences of the target groups guided the development of materials for multichannel communication.

Another pilot study focused on the social promotion of red palm oil for consumption by women and children in Burkina Faso (W64). After 24 months, nearly 50% of participants reported red palm oil consumption in the past week, and the prevalence of low serum retinol concentration among participant women was reduced by about half. Researchers concluded that the social marketing of red palm oil by home economists was an effective strategy for improving the vitamin A status of women, particularly those whose baseline vitamin A status was poor. The main challenges for these smaller food- and education-based interventions will be to scale up the programs and document their impact.

## Science underlying the programs

### *Biochemistry, physiology, and nutrient interactions*

Prof. Clive West, of Wageningen University, in Wageningen, the Netherlands, highlighted recent advances in vitamin A research in three areas: the role of a cleavage enzyme in determining vitamin A status, the role of vitamin A in preventing anemia, and the role of retinoic acids in embryogenesis and the immune response (T55). The pathway by which beta-carotene from plant foods is converted to retinol is regulated by the enzyme beta-carotene 15,15'-dioxygenase. Understanding the mechanism of this enzyme is thus of pivotal importance, because most people living in areas where there is VAD rely on plant foods for their supply of vitamin A. West reviewed what is known about the properties of the enzyme and the future directions research is likely to take. The most common form of the human enzyme acts by a central cleavage of the beta-carotene molecule and hence produces two molecules of retinal for each molecule of beta-carotene. However, an excentric-cleaving enzyme producing only one molecule of retinal from each molecule of beta-carotene has also been identified. The central-cleaving enzyme has been reported to require iron for activity, but there is evidence that it is also activated by zinc. This may help explain the higher-than-expected prevalence of VAD in some poor populations that appear to consume

amounts of plant foods that provide adequate amounts of carotenoids but inadequate amounts of zinc. Zinc may well also be involved at other steps of beta-carotene metabolism.

Dr. West noted several studies confirming that vitamin A plays an important role in correcting anemia caused by iron deficiency. Evidence suggests that this effect is mediated by favoring synthesis of transferrin and transferrin receptors and hence improving iron mobilization and iron uptake by erythropoietic tissues. Whether vitamin A improves iron absorption in the human intestine remains uncertain.

The role of vitamin A in embryogenesis is beginning to be elucidated. Dr. West identified specific, time-sensitive developmental processes for which vitamin A is thought to be required, for example, creating reference points for cephalic and caudal regions 2–4 weeks after fertilization and the primordial heart tube 4–5 weeks after fertilization. Vitamin A improves functioning in various parts of the immune system, but the mechanisms at the molecular level are not clear. Retinoic acid receptors (RAR and RXR) are now being shown to play a major role.

Dr. Marjoleine Dijkhuizen, of Wageningen University, in Amsterdam, the Netherlands, described the positive impact of adding beta-carotene and/or zinc to the standard iron folate supplements given during pregnancy (T58). Zinc (30 mg/day) given with beta-carotene (4.8 mg/day) increased serum retinol concentration both in mothers and in infants six months after birth. Zinc and beta-carotene given together also increased breast milk retinol content and plasma beta-carotene levels, but these effects were absent when zinc or beta-carotene was given alone. The results suggest that zinc is necessary for both the bioconversion of beta-carotene to retinol and the mobilization of beta-carotene in the human body.

Dr. Machteld van Lieshout, of Wageningen University, in Wageningen, the Netherlands, illustrated the use of an isotopic tracer technique in measuring the conversion of beta-carotene to retinol (W19). Her results suggest that 20  $\mu\text{g}$  beta-carotene was required to produce 1  $\mu\text{g}$  retinol. This is a lower conversion factor than the 12:1 accepted by the Institute of Medicine of the National Academies of Science in the United States, and much lower than the previously

accepted conversion factor of 6:1. It should be noted, however, that the study did not determine the zinc status of participants or otherwise address the role of zinc in vitamin A bioefficacy.

The role of vitamin A in reducing iron deficiency anemia was demonstrated in a clinical trial described by Dr. Hassan Abdelwahid (T56), of Suez Canal University, in Ismailia, Egypt. One hundred fifty anemic Egyptian children aged 6–12 years were given antihelminthic treatment and randomly assigned to treatment groups. The groups received one of five treatments over a two-month period: vitamin A (7,500  $\mu\text{g}$  retinol equivalent [RE] every 2 days), ferrous sulfate (3 mg iron/kg daily), both vitamin A and iron, a multivitamin and mineral supplement, or nothing. The prevalence of anemia declined 7% in the control group, 33% in the vitamin A group, 70% in the ferrous sulfate group, and 100% in the groups that received iron and vitamin A or multiple micronutrients. Ferritin levels rose in the multivitamin group and in all of the groups treated with iron. As expected, serum retinol concentration increased in the groups treated with vitamin A and multivitamins.

Two studies investigated the impact of iron and/or zinc supplementation on vitamin A status. Dr. Frank Wieringa, of Wageningen University, Amsterdam, the Netherlands, described a study with Indonesian infants indicating that iron, with or without zinc, reduced serum retinol concentration but increased liver stores of retinol (T57). This implies a redistribution of retinol after iron supplementation that results in a reduction of circulating retinol in the blood. On the other hand, Dr. Parul Christian, of the Johns Hopkins Bloomberg School of Public Health, in Baltimore, Maryland (USA), found that serum retinol concentration in pregnant Nepali women increased after supplementation with iron plus folic acid, and with iron plus zinc and combinations of other micronutrients (T59). The impact on serum retinol concentration was attenuated in the group that received supplements of iron plus zinc. Although these results are seemingly inconsistent at first glance, one must remember they come from different population groups and age groups. Further research will be critical in the development of our understanding of micronutrient interactions and the implications for public health programs.

### **Dosing schedules, safety, and biological impact of supplementation for infants and mothers**

Dr. Rosemary Ayah, of the Kenya Medical Research Institute, in Nairobi, Kenya, described a study in Western Kenya designed to test the safety and impact of higher maternal and infant doses of vitamin A than those recommended by IVACG and WHO before 2001 (T46). The randomized, double-blind trial had a factorial design allowing the impact of maternal and infant supplementation to be determined both together and separately. Mothers received a single dose of 400,000 IU vitamin A after delivery, and their infants received a single dose of 50,000 IU at 14 weeks. The primary outcome measures were retinol concentrations in serum and breast milk in mothers and serum retinol concentration and modified relative dose response (MRDR) in infants.

When baseline measurements were made at 36 weeks' gestation, the proportion of mothers in the intervention group with low serum retinol concentration was larger than that in the control group (31% versus 20%). At 14 and 26 weeks after delivery, mothers in the two groups had similar prevalences of low serum retinol concentration. Milk retinol concentrations were higher in mothers who received supplementation than in those in the control group at 4, 14, and 26 weeks, but after adjusting for the fat content of the milk, only the increase at four weeks remained statistically significant. No impact on infant serum retinol concentration was noted from either maternal or infant supplementation. However, infant supplementation did have a positive effect on vitamin A stores as assessed by MRDR at six months. Dr. Ayah concluded that the impact of the higher levels of supplementation was modest. Discussants noted that the study treatment was not consistent with the new recommendations and hence should not be viewed as an assessment of them. It was also noted that the relatively low prevalence of VAD at baseline in infants studied would likely have masked the potential impact of the intervention. Baseline differences in vitamin A status of

mothers between the treatment groups raised further concerns.

Dr. Dietreich Hornig, of Roche Vitamins Ltd., in Basel, Switzerland, presented findings from a study of exposure to vitamin A and its metabolites after consumption of retinol palmitate at doses of 4,000, 10,000, and 30,000 IU, both as a one-time dose and repeated daily over 21 days. Exposure was assessed by standard pharmacokinetic parameters used to predict teratogenic potential. All subjects reported tolerating the treatment well, and no adverse effects were observed. Concern about the teratogenic effects of retinyl esters prompted both the U.S. Institute of Medicine<sup>2</sup> and WHO<sup>3</sup> to establish 10,000 IU as the upper limit. Dr. Hornig and colleagues found that repeated dosing caused on average a 22% accumulation of retinyl esters. Maximum concentrations of 13-cis retinoic acid occurred two to four hours after dosing, and, at intakes of 10,000 and 30,000 IU, elimination half-life was 21 hours and 28 hours, respectively. The results confirm the safety of daily oral doses up to 10,000 IU and suggest that the current Upper Limit of 10,000 IU may be unnecessarily low.

Dr. Jean Humphrey, of the Zimbabwe Vitamin A for Mothers and Babies Project (ZVITAMBO), in Harare, Zimbabwe, described the implementation and preliminary results of the ZVITAMBO trial. Initiated in Zimbabwe in 1997, ZVITAMBO was designed to determine whether vitamin A supplementation to mothers and/or infants at delivery would reduce infant mortality, mother-to-child-transmission of HIV during breast-feeding, or new HIV infections in postpartum women. Over 14,000 mother-baby pairs were recruited into the study at 11 maternity clinics in greater Harare and randomly assigned to one of four groups in a factorial design. Mothers received either a single dose of 400,000 IU or placebo, and at delivery their infants received either 50,000 IU or placebo. Enormous effort was invested in following up subjects to determine vital and HIV status of mothers and children to 24 months of age.

Preliminary results from the study were presented at this meeting. Maternal HIV

<sup>2</sup> Dietary reference intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc. Washington, DC: National Academy Press; 2001.

<sup>3</sup> Safe vitamin A dosage during pregnancy and lactation. Geneva: WHO; 1998.



infection was the overwhelming determinant of infant mortality. The mortality risk of infants of HIV-positive mothers was 8.5 times higher than that of infants of non-infected mothers. Overall infant mortality was not affected significantly by maternal or neonatal vitamin A supplementation regardless of maternal HIV status. Risk of mother-to-child transmission of HIV also was unaffected by vitamin A supplementation. Dr. Humphrey described analyses in progress to identify determinants of maternal HIV seroconversion after delivery. Marital status and changes in marital status were identified as major determinants of seroconversion, but supplementation had no significant impact. Preliminary results indicate that the impact of supplementation may differ among subgroups of the sample, and further analyses are under way.

Dr. Humphrey concluded that her preliminary findings provide little support for encouraging postpartum or neonatal dosing with vitamin A as a strategy for reducing mother-to-child transmission of HIV and new infections in women. However, postpartum dosing continues to be an important strategy for improving the vitamin A content of breast milk and hence for building infants' vitamin A stores. Dr. Humphrey stressed that these findings raised no concerns about ongoing child vitamin A supplementation programs beginning at age six months in HIV endemic areas.

Dr. James Tielsch, of the Johns Hopkins Bloomberg School of Public Health, in Baltimore, Maryland (USA), reported on a study from Madurai, India, on the role of vitamin A supplementation in case-fatality from common childhood illnesses (T49). A 21% reduction in mortality was previously reported for infants receiving 24,000 IU vitamin A on each of the first two days of life. Morbidity status was recorded every two weeks until six months of age, and growth was measured at six months. Supplementation was unrelated to the incidence or duration of common illnesses, but was associated with lower case-fatality rates from diarrhea and fever. No effect on growth was noted. In addition to supporting dosing of newborns as an effective program option for reducing mortality, this study is important in providing strong evidence in support of the hypothesis that vitamin A reduces child mortality by reducing the severity of infections.

Two presentations described biological interactions between vitamin A supplementation and vaccines. The precise mechanisms by which vitamin A reduces mortality have not yet been elucidated. Dr. Christine Stabell Benn, of the Statens Serum Institute, in Copenhagen, Denmark, hypothesized that they involve amplification of the commonly observed non-specific positive effects of vaccines (T50). Dr. Benn presented findings from a number of supplementation and vaccine studies in African and Asian countries to support this intriguing hypothesis. Dr. Hamam Hadi, of the University of Gadjah Mada, in Yogyakarta, Indonesia, reported the results of a study investigating the specific effects of vitamin A supplementation on the immune response to measles vaccine (T51). Children were randomly assigned to receive 100,000 IU vitamin A one week before vaccination, three months before the vaccination, or not to receive a supplement. IgG titers measured one month after measles vaccination showed that vitamin A enhanced the immune response to the vaccine substantially. The greatest response was observed in infants who received supplementation one week before the vaccine.

Ms. Kristina Penniston (T41), of the University of Wisconsin in Madison, Wisconsin (USA), presented a poster on the effects of large doses of vitamin A in lactating sows. Sows provide a good model for human vitamin A metabolism because the digestive system is similar and normal concentrations of serum and milk retinol are close to those of humans. Sows were provided with the equivalent in body weight to 200,000 IU and twice that amount, as is recommended for postpartum women. Serum retinol concentration peaked two hours after treatment and returned to normal levels after 48 hours. Retinyl esters followed a similar pattern, and fell to near-baseline by 24 hours. Retinoic acid showed a peak after eight hours, but also returned to normal after another eight hours. Both retinyl- and retinoil-beta-glucuronide behaved in a similar way. At both dosages, milk vitamin A was elevated for only 48 hours, and retinol was stored in the liver in amounts proportional to intake. The study concluded that dietary vitamin A may be the most important contributor to milk retinol and that liver stores are mobilized primarily to maintain serum levels. If true, this means that frequent small doses of vitamin A more effectively increase the vitamin A content of

breast milk than the less frequent administration of larger doses. The programmatic implications of this finding are significant.

### **Assessment technologies**

The search continues for valid and reliable VADD measures that can be obtained through simple, practical, inexpensive methods. This IVACG meeting focused attention on efforts using changes in ocular physiology caused by VAD. Dr. Nathan Congdon, of the Johns Hopkins University, in Baltimore, Maryland (USA), and Dr. Marjorie Haskell, of the University of California, Davis, California (USA), summarized information gathered in Nepal, Tanzania, Kenya, Yemen, and Haiti during the past two years with the pupillary dark adaptation technique (T52, T53). This method measures the speed of response in the right-eye pupil to increasingly intense stimulation of the left eye. The eyes are first “bleached” by exposure to a standard photography flash. VAD reduces the number of visual pigment molecules in the eye, resulting in a slower response. Pupillary dark adaptometry is an objective and rapid means of identifying night blindness, but because of high intra-individual variation, it is more useful in assessing the status of populations than of individuals. Study results revealed that pupillary dark adaptometry is well accepted by 2- to 6-year-old children and is highly correlated with functional parameters such as night blindness and biochemical parameters such as relative dose response (RDR). It is also sensitive to changes in vitamin A status from supplementation. Nevertheless, several factors may confound results, and these need to be carefully considered. Because sun exposure impairs the pupillary dark adaptation response and waiting in darkness improves it, standardized results are assured only when children wait for about 10 minutes in a room with artificial light. Also, the machine must be calibrated frequently. Moreover, concerns remain about the reliability of the method in areas where night blindness is uncommon as well as for older children.

The poster presented by Dr. Haskell reported on the use of pupillary dark adaptometry together with plasma retinol levels to evaluate six different treatments for night-blind Nepali women (W7). Treatments were given six days a week over a period of six weeks. Pupillary response was improved

in all groups, but only consumption of liver (850  $\mu\text{g RE/day}$ ) and a vitamin A supplement of 2,000  $\mu\text{g RE/day}$  raised plasma retinol levels. The other four treatments (supplementation and consumption of carrot, green leafy vegetables, or ultra-rice), designed to provide the same amount of retinol as the liver, did not increase plasma retinol levels but did improve pupillary dark adaptation response. This finding suggests that the plasma retinol level is less sensitive than pupillary dark adaptation to changes in vitamin A status. For validity determinations, pupillary dark adaptation techniques should be tested against retinol stores as measured by RDR, MRDR, or total body vitamin A stores (W36).

Dr. Douglas Taren, of the University of Arizona, in Tucson, Arizona (USA), described a method based on visual perception in dim light called the Night Vision Threshold Test (T54). In a study of pregnant women in Nepal, this test was a more sensitive and specific measure of low serum retinol concentration than self-reported night blindness. A larger proportion of the population was classified as deficient according to results of the Night Vision Threshold Test than according to low serum retinol concentration, which suggests that the new technique may be better correlated with vitamin A reserves (RDR) than with serum retinol concentration. Both the Night Vision Threshold Test and pupillary dark adaptometry require the use of an appropriate location for dark adaptation. Prof. Larry Medlin, of the University of Arizona, Tucson, and collaborators have designed a portable darkroom for this purpose and have successfully field-tested it (T6). The room can be assembled in 30 minutes and weighs 200 kg, making it portable even by horseback or yak.

In summary, both pupillary dark adaptation and the Night Vision Threshold Test have the potential to become practical and reliable tests for identifying VADD in populations. Studies using these methods could be conducted with smaller sample sizes, since pupillary dark adaptometry and Night Vision Threshold Testing can detect VADD with a high degree of precision. Several components of the methods require further development; for example, standardized, practical equipment is needed, as well as an adequate environment in which to prepare for and carry out the test. Further research is needed on the effects of potentially confounding factors.

Although methods based on dark adaptometry are becoming more widely known, serum retinol concentration remains the most common parameter associated with VADD. Several posters related progress in making the assessment of serum retinol concentrations easier and more practical. Dr. Jürgen Erhardt, of Hohenheim University, in Stuttgart, Germany, described a single-extraction procedure for HPLC assay that uses a plasma sample of only 20  $\mu\text{L}$ , allowing a capillary finger-prick to be used in place of venipuncture (T2). The assay demonstrated high analytical sensitivity (0.1  $\mu\text{mol/L}$ ) and good interassay variability (3–5%). Dr. Erhardt also reported advances in the development of an assay to determine retinol concentration from dried blood spot samples (T3). The technique requires very sensitive equipment and the additional determination of sodium to estimate plasma volume, which is necessary for the calibration of results. The dried blood spot method has substantial advantages over other methods for collecting blood samples in the field, but the precision and reproducibility of its results are inferior to those obtained from the standard venous samples. Furthermore, the dried blood spot method still needs serum samples for the calculation of a correction or calibration factor, and it is more expensive than the standard method. Therefore, at this time, the standard method remains preferable in situations where venous blood samples can be obtained.

At several points during presentations and discussions at the meeting, change in serum retinol concentration was noted to be a poor indicator of the effects of interventions. For example, pupillary dark adaptation (T52 and W7) was more responsive than serum retinol concentration in identifying improvement in visual performance after treatment with vitamin A in individuals affected with night blindness. Similarly, the impact of consuming sugar fortified with vitamin A was revealed by an increase in retinol stores, measured by total-body technique, in school-age children in Nicaragua who were classified as vitamin A sufficient by the criterion of a serum retinol concentration exceeding 0.70  $\mu\text{mol/L}$  (W36). On the other hand, using a cutoff point of 0.70  $\mu\text{mol/L}$  may mask important effects. This was suggested by Dr. Dijkhuizen's study measuring the vitamin A status of infants born to mothers who received supplementation with zinc, beta-carotene, and iron with folic acid (T58). Despite considerable increases in serum retinol concentrations, in a large

proportion of infants the levels remained below 0.70  $\mu\text{mol/L}$  (41% versus 73–74% in the groups that did not receive zinc supplementation). Perhaps a lower cutoff would be more appropriate for infants, and using one could clarify the effects of vitamin A supplementation on deficiency in infants (T8). At a minimum, these findings suggest that describing the distribution of plasma retinol levels is of greater use than simply estimating the proportion below a cutoff value.

Retinol-binding protein (RBP) carries retinol in the blood and is present in an almost equivalent molar relationship with it. Measuring the concentration of RBP thus allows an estimate of the retinol concentration, as has been demonstrated previously in several studies using different assay techniques. Results were presented from a survey in Cambodia using the enzyme immunoassay (EIA) to measure RBP (T4). The method was demonstrated to be an acceptably sensitive (70%) and specific (93%) measure of serum retinol concentration adequacy when a serum retinol concentration of 0.70  $\mu\text{mol/L}$  was used as the criterion for deficiency. RBP determined by EIA was lower than the retinol content at levels above 0.8  $\mu\text{mol/L}$ , and this reduced the accuracy of the method over the range of normal retinol levels. In future applications of the method, accuracy over this range could be improved through adjustments. The EIA method is much simpler and less expensive than HPLC retinol analysis. Studies are planned to confirm that the monoclonal antibody currently used with this method produces the equivalent results in different populations. A version of this promising technology for samples collected as dried blood spots is being developed simultaneously.

Dr. Christine Northrop-Clewes, of the U.S. Centers for Disease Control and Prevention, in Atlanta, Georgia (USA), and Dr. David Thurnham, of the University of Ulster, Coleraine, Ireland (UK), presented posters demonstrating the usefulness of serum carotenoids as indicators of dietary intake of vegetable sources of provitamin A (T8, T10). The ratio between serum levels of alpha- and beta-carotene is 0.16 in the United Kingdom, but 1.0 in infants from Gambia. The number in Gambia likely reflects the consumption of red palm oil, which has a composition of carotenoids in that ratio. Mangoes are rich in beta-carotene, and during the mango season in June the level of beta-carotene increased substantially while



the level of alpha-carotene remained essentially stable. Retinol levels were largely unchanged throughout these changes in diet, even after supplementation with 50,000 IU vitamin A. The measurement of these two carotenoids in serum was determined to be a sensitive means of evaluating intake of provitamin A carotenoids. Thurnham also proposed using lutein in breast milk as a biomarker for green vegetable consumption in populations for which these constitute the major dietary source of vitamin A (T10). Lutein is present in green vegetables in concentrations similar to those of beta-carotene, but as a non-provitamin A carotenoid, it does not undergo conversion to retinol as beta-carotene does. Lutein breast milk concentration is well correlated with dietary lutein intake and thus will provide a precise measure of change in intake of green vegetables. This method can provide a strong evaluation tool for interventions promoting consumption of green vegetables.

Clinical and biochemical measures are not always the most relevant indicators for programs, especially those operating or planning to operate on a smaller scale. Programs that measurably improve peoples' dietary and care-giving behaviors or knowledge are successes in their own right, even when they have not changed biochemical parameters, especially over shorter periods. The meeting offered numerous examples of the effective use of dietary data for a variety of purposes. Many countries reported results from seven-day food frequency questionnaires, in many cases using the method developed by Helen Keller International, which measures adequacy of intake of vitamin A-rich foods at the community level (M4, T1, T32, W43). Others used 24-hour recall (T31, W6, W8, W38). The national survey in Malawi used a "fortification rapid appraisal tool" to assess consumption patterns of two potential vehicles, centrally processed sugar and oil (T30).

Dietary data were critical to several small-scale interventions. In Burkina Faso, an intervention designed to increase red palm oil consumption by children contributed to a significant reduction in the prevalence of low serum retinol concentration (W64). Infrequent consumption of carotene-rich foods by children of the Bhil tribe in India was reported and the promotion of these foods was identified as a potential intervention (T32). In Gujarat, even non-vegetarian families, who might be presumed less likely

to have diets low in vitamin A, reported infrequent consumption of animal foods (T32).

### **Present and future challenges**

Two panelists from the NGO and bilateral organization communities and one from the North Africa region were invited to offer their perspectives on the present and future challenges facing those seeking to improve the vitamin A status of populations. Dr. Shawn Baker, of Helen Keller International, in Abidjan, Ivory Coast, representing NGOs, described political, institutional, and programmatic challenges. Dr. Baker noted that vitamin A deficiency is often perceived as a marginal issue. He stressed the importance of effective advocacy to position it as a central development issue. With an estimated 640,000 deaths attributed annually to VAD in the sub-Saharan region alone, getting vitamin A on the development agenda should not be difficult. The Poverty Reduction Strategy Papers, New Partnerships for African Development, and established regional economic development associations constitute opportunities to advocate for vitamin A in development work. On the institutional front, Dr. Baker remarked on the need for vitamin A to have a place at the government decision-making table. Nutrition and vitamin A need to be more fully integrated into public health services. Vitamin A is often poorly presented in training curricula, fails to appear on essential drug lists, and is absent from supervision protocols and health information systems. As noted earlier in the meeting, regional economic structures play an important role in creating the favorable economic climate needed for fortification to succeed. Dr. Baker reviewed what he saw as opportunities for supplementation, fortification, and other food-based approaches and emphasized the key roles of assessment, monitoring, and evaluation in achieving success. He endorsed the sustainable elimination of vitamin A deficiency by 2010 as a goal that is attainable in Africa.

Dr. Hans Schoeneberger, of the German Agency for Technical Cooperation, in Bonn, Germany, described the constraints to finding support for micronutrient programs within his agency. He pointed out that health and food security were but two of ten priority issues, and micronutrient programs are not currently an essential part of Germany's bilateral development cooperation programs. Dr. Schoeneberger articulated

clearly the context underlying this state of affairs. Nutrition programs in general have the disadvantage of requiring strong multisectoral approaches, and the coordination needed for effective interventions is often seen as difficult, time-consuming, and accompanied by a risk of having unclear responsibilities. That micronutrient deficiencies are not as visible or acute as other health issues, that their consequences are not fully recognized, and that knowledge of the cost-effective solutions is not widespread only compound the constraints. In concluding, Dr. Schoeneberger recommended a series of activities designed to increase awareness among development professionals, policy makers, and the general public. He suggested identifying synergies with other programs, disseminating stories of successful, cost-effective programs, building closer cooperation between donors and agencies working on micronutrient issues, linking programs to the development mainstream (such as Poverty Reduction Strategy Papers), and promoting public-private partnerships.

Dr. Najat Mokhtar, of the International Atomic Energy Agency, in Vienna, Austria, presented the country and regional perspective. She highlighted results from the recently released 2002 WHO World Health Report, identifying the prominent contribution of undernutrition and micronutrient deficiencies to the burden of disease of developing countries. Given the availability of cost-effective interventions to reduce micronutrient deficiencies and the high cost of inaction, she urged governments to give top priority to implementing appropriate policies and programs. She noted opportunities for eliminating hunger and reducing health and social inequities through economic development and globalization.

### **Concluding remarks**

Prof. Fatima-Zohra Squali-Houssani, of the Faculté de Sciences, in Fez, Morocco, thanked participants for attending. She was pleased to note that although the objectives of the meeting were multiple and diverse, the discussions had remained focused. This focus would strengthen partnerships and collaborations, which contribute to reductions in vitamin A deficiency and ultimately a better world.

Dr. Sommer offered concluding remarks. He suggested that there would be broad agreement that this had been one of the most productive IVACG meetings in memory. The

oral reports, poster presentations, and discussion had been of a very high caliber, as had the work that underlay them. Reflecting on more than a quarter century of IVACG's work, he noted that the vitamin A community had indeed reached the position described by Dr. Gillespie on the first day of the conference as our "tipping point."

Dr. Sommer pointed to highlights of the meeting, first in the biological sciences and then in programmatic issues. For advancing child health and survival, the benefits and cost-effectiveness of reducing vitamin A deficiency are well established. However, there remains an important agenda for biological vitamin A research. This includes clarifying the importance of maternal deficiency and working towards its control, and determining the mechanisms of vitamin A action, particularly for the immune system. Dr. Sommer suggested that the next phase of biological inquiry will be more complex, because the mechanisms themselves are complex and operate within highly variable, multifactorial environments. Two issues discussed at this meeting illustrated these complexities: first, the importance of understanding the processes by which vitamin A affects, perhaps differentially, resistance to HIV and the virulence of infection; and second, interactions between micronutrients. Dr. Sommer emphasized that we should remain mindful of identifying the approaches that will best enhance public health and to recognize that these may differ across populations or population subgroups. He warned against the simplistic, unsupported notion advanced in well-fed populations that combining micronutrients into a single "one-a-day" pill would improve health outcomes.

This IVACG meeting offered much to celebrate in what we have learned about intervention programs. Dr. Sommer recalled the concern expressed during the past few meetings about the "looming calamity" of the post-NIDs era and remarked, "These past few days have assured us that there are successful national models for distributing vitamin A supplements at reasonable cost that don't depend upon national immunization days. As NIDs wane further from the scene, we can expect that many more such successful substitutes will be forthcoming." He went on to note that policy makers and program builders had mounted effective responses to recent biological evidence that a traditional vegetable diet alone is insufficient to normalize the vitamin A status of

very young children. Progress in food-based approaches was highlighted by reports of the development and distribution of beta-carotene-rich cultivars, popularizing vegetable products high in provitamin A, and increasing the availability of animal food products for poor populations in cost-effective, sustainable ways. Dr. Sommer noted that fortification is making rapid technological strides, but its reach continues to be limited by industrial and trade concerns. These food-based approaches promise to reduce the severity of vitamin A deficiency, if not to eliminate it entirely.

In concluding, Dr. Sommer observed that every IVACG meeting was an opportunity to celebrate. “Twenty meetings ago, when 30 people participated, we celebrated our common concern. Today, with over 600 participants, we can celebrate our collective accomplishments. Despite population growth, fewer children are being blinded or dying of vitamin A deficiency today than there were 30 years ago, because of our collective research and the translation of that research into effective programs.” IVACG

sustains a global movement, and the “IVACG meeting continues its tradition as a great marketplace for exchanging information, knowledge, and expertise.”

Dr. Sommer noted that after the first day’s discussions about the latest IVACG recommendations, Dr. Mohammed Braikat, of the Ministry of Health, in Rabat, Morocco, pledged that Morocco would incorporate vitamin A distribution into its immunization program, which should increase coverage from 40% to more than 80% by 2004.

He thanked attendees for their active participation and encouraged them in their continuing efforts. Finally he asked that participants begin to consider their contributions to the next IVACG meeting, to be held in 2004, and invited participation in the INACG and IZiNCG meetings that were to be held over the following two days.

Dr. Sommer declared the 21st IVACG meeting closed.

## Appendix

### Presentations Listed by Country

Country	Abstract Number or Author Name
Bangladesh	M1, M3, T12, T37, W54
Benin	T29
Brazil	T16, T35, W18
Burkina Faso	W3, W4, W23, W47, W64
Cambodia	M6, T4, T11, W49, W54
Cameroon	T29, W16
China	D. Jamison
Colombia	W12
DR Congo	T28, W46, W48
East Timor	M6
Egypt	A. Verster, T56, W8
The Gambia	T8, T29
Ghana	M2, T13, T44, W43
Guatemala	W35, W41, W45, W59, W60
Guinea-Bissau	T50, W23
Haiti	T52
India	T19, T20, T21, T24, T31, T32, T49, W25, W37, W40, W63
Indonesia	M1, M6, T14, T17, T51, T57, T58, W15, W62
Iran	A. Verster, W9
Jordan	A. Verster, T39
Kenya	T46, T52, W14
Madagascar	T29
Malawi	T30
Mali	T22, W23, W39
Federated States of Micronesia	T43, W5
Mongolia	M6
Morocco	M. Rahmani, A. Zerrari, T1, T33, T40, T42, W1, W26, W50, W51
Mozambique	M4, T36
Nepal	M1, T27, T34, T38, T44, T52, T53, T54, W7, W42, W54
Nicaragua	M1, W36, W60
Niger	M1, M7, W23
Nigeria	M5
Oman	A. Verster
Pakistan	A. Verster, T5, T10, W29
Papua New Guinea	M6
Peru	W38
Philippines	M1, M6, T18, T26, W6, W27, W34, W44, W57, W61
Saudi Arabia	A. Verster
Senegal	T15, W52
South Africa	T23, W20, W32, W33, W56, W58
Sudan	A. Verster
Syria	A. Verster
Tanzania	T25, T26, T29, T52, W53
Uganda	T29, W65
Vietnam	M6, T45, W11
Yemen	A. Verster, T52
Zambia	M1, T29, T44, W30
Zimbabwe	T48



# ABSTRACTS







- M1 PLANNING FOR VITAMIN A SUPPLEMENTATION AFTER NIDS: ALTERNATIVE SERVICE DELIVERY MODELS THAT WORK.** R Harvey, R Miller. MOST/USAID. **Background:** Since the 1990s, most countries classified as at risk of vitamin A deficiency have adopted vitamin A supplementation as national policy and have implemented programs. In many countries, vitamin A has been integrated with National Immunization Days (NIDs) and has fairly quickly achieved high coverage. Sustaining this achievement, however, has proven a more difficult challenge. Since many countries are phasing out of NIDs, national programs need alternative mechanisms to deliver supplements to the target population. **Aim:** To explore the options for delivery of vitamin A supplements beyond NIDs-type campaigns and regular clinic-based immunization services, the two program models most commonly considered. **Method:** This paper analyzes program experience in countries with long-term success. Alternative delivery models identified and discussed include: specific vitamin A days held twice a year; vitamin A given as part of a package of child health services during twice-yearly child health weeks; vitamin A distribution twice a year in communities where services are provided during monthly health/nutrition outreach events; or combining one of these methods with routine immunization services (e.g., vitamin A with measles). All of these approaches involve caregivers bringing children to the distribution site; none involve a special campaign with house-to-house services and mop-ups—a common approach with NIDs. In this analysis, key elements of the approaches are summarized in a framework to assist decision makers in post-NIDS planning for supplementation programs. **Conclusion:** These alternative delivery mechanisms all feature an active promotional component, are repeated periodically, and become a routine function carried out by the health sector. Evidence from programs indicates that these approaches can achieve and maintain high coverage over a period of many years.
- M2 EVALUATION OF THREE YEARS OF NON-NIDS VITAMIN A SUPPLEMENTATION; EXPERIENCES AND LESSONS FROM GHANA.** E. Amoahful, R. Agble, A. Nyaku. Nutrition Unit, Ghana Health service, Ghana; USAID/MOST, Ghana. **Background:** The Ghana Vitamin A Supplementation Programme was initially carried out mostly via annual National Immunization Days (NIDs). To ensure that target children received at least two capsules a year; a stand-alone distribution was established since 2000 to provide second doses. Mini-surveys are undertaken after each round to assess the effectiveness of the implementation in the absence of NIDs infrastructure. **Aim:** To independently validate coverage, assess awareness levels and the implementation process. **Methods:** Communities selected were representative of entire districts using population proportionate sampling to ensure that all communities had equal likelihood of being selected. Households were then randomly selected from community clusters. Caregivers and providers were interviewed using pre-tested questionnaires to study key processes including training, logistics management, coverage and demand creation. **Results:** The tallied national coverage improved from 89% in 2000 to 100% in May 2002 whilst the mini-survey results showed national coverage of 81% in 2000 and 89% in 2002 respectively, indicating that the non-NIDs supplementations were successful. Knowledge on benefits of vitamin A has improved from 44% in 2000, 51% in 2001 to 67% in 2002. Gong gong and town criers remain the major sources of information although radio as a source has increased to 34% in 2002. Programme management has improved with successive training making capsules more accessible. **Conclusion:** Successful non-NIDS supplementations were implemented and this needs to be sustained with continuous communication and community mobilization. Systematic planning and training is crucial for improved logistics management and provider-caregiver interactions. The recommendation is to strengthen efforts at institutionalizing the twice-yearly distribution by integrating into other services. This will make it more cost effective, attractive to caregivers and sustainable in the post-NIDS era.
- M3 VITAMIN A SUPPLEMENTATION PROGRAM FOR CHILDREN IN BANGLADESH: STRATEGIC CHANGES IN DISTRIBUTION AND ITS EXPERIENCES.** S Begum, M Rashid, M Shahjahan. UNICEF, Dhaka, Institute of Public Health Nutrition (IPHN), Dhaka, The Micronutrient Initiative (MI), Dhaka, Bangladesh. Vitamin A deficiency has been identified as a major public health problem in Bangladesh since 1973 and high potency VAC supplementation program is in place since then. So far, Bangladesh has experienced various strategic shifts in VAC distribution. Since 1973, doorstep distribution of VAC over a month-long period was the key strategy. During 1991, the strategy has been changed to center-based administration during EPI contacts for under-1 children. For children aged 1-5 years, VAC was administered during NID for polio during 1995. This was a campaign-based administration at NID centers. Encouraged by the success of VAC administration with NID, the GOB initiated a National Vitamin A Week (NVAW) for the following VAC distribution, which was also a big success. Since then, VAC administration during NID and NVAW became the regular strategies. The key changes in supplementation strategy were shift from door-step distribution to center-based administration, month-long distribution to day/week long administration along with mass campaign, sound recording and reporting system as adopted from EPI experiences, highest level commitment and support. According to national surveys during 1982-83 and 1989, the coverage rates were between 35-45 percent. Since the changed strategies been adopted during 1995, the coverage rates increased to above 80%, and that level has sustained since then. According to the national survey done by HKI/IPHN/ UNICEF during 1997-98, the night blindness rate was 0.66 percent among the under-five children compared to 3.76 percent during 1982-83. Recent changes includes to continue VAC administration with NID and replacing national VA week by innovative campaign based strategies such as sub-NIDs during 2002 and in near future rough National Child Health & Nutrition Week. The remaining challenges would be to reach other age groups for VAC supplementation, and to establish medium-term and longer-term strategies like food fortification and dietary diversification.
- M4 ENSURING VITAMIN A SUPPLEMENTATION THROUGH ROUTINE HEALTH SERVICES IN MOZAMBIQUE.** S Khan, C Ismael, V Van Steirtighem, and S Meershoek. Ministry of Health (CI, SK), UNICEF (VVS), and Helen Keller International (SM). In Mozambique, high-potency vitamin A supplementation of children is justified by the high under-five mortality rate (201/1000 live births) and the low intake of vitamin A rich foods revealed by a survey conducted in 1998 in four provinces. In 1999, the Ministry of Health began massive vitamin A supplementation of children 6-59 months old. In the first year, vitamin A supplements were distributed during National Immunization Days (NIDs) for polio eradication. Supplementation coverage attained 100% of the target group (children 6-59 months old). NIDS were phased out in 2000 after Mozambique had achieved a coverage of over 90 % during two subsequent years and developed a surveillance system for AFP (Acute Flacid Paralysis). An alternative strategy to sustain the delivery of vitamin A to young children was then tested. Vitamin A supplements were distributed during Mother and Child Health Campaign. Vitamin A supplementation coverage attained 79% in 2000 and 91% in 2001. These campaigns put too high a demand on the Ministry's scarce human and financial resources, without reaching the objective of a bi-annual supplementation. The Ministry of Health decided to discontinue the campaigns and integrate vitamin A supplementation into routine child health services so as to ensure vitamin A supplementation of children bi-annually. Moreover, in May 2002, a pilot project started in Maputo City to test the delivery of vitamin A supplements to women in the immediate post-partum period. Posters, leaflets, and radio spots have been developed. They are being used to create demand in the population for vitamin A supplementation services in health facilities and mobile clinics. Systems are being developed to monitor program implementation. First results show 32% coverage for the April-July 2002 for children. At the time of the IVACG Meeting, complete results of the first period of program implementation will be presented. These findings, will inform policy development for the effective control of vitamin A deficiency in children and women in Mozambique.



**M5 USING COMMUNITY DIRECTED TREATMENT WITH IVERMECTIN (CDTI) AS A VEHICLE FOR VITAMIN A SUPPLEMENTATION IN NIGERIA.** MA Obadiah, SK Baker, VM Aguayo, S Ogiri, A Nyam, and D Almustafa, and B Oguntona. Helen Keller International-Nigeria (MAO, OS AN), Helen Keller International-Africa Region (SKB, VMA), and UNICEF-Bauchi (DA), and University of Agriculture/Abeokuta (OB).

**Background:** In Nigeria maternal and child mortality rates are among the highest in West Africa. Vitamin A deficiency (VAD) is believed to be the underlying cause of 25% of child mortality in the country. The situation is grimmer in the northeastern part of Nigeria where onchocerciasis (river blindness) is also endemic. For the past three years, HKI has successfully facilitated the delivery of mebendazole tablets through Community Directed Treatment with Ivermectin (CDTI) systems for onchocerciasis control<sup>1</sup>. **Aim:** To test the integration of vitamin A capsule distribution into CDTI systems so as to ensure at least a 70% vitamin A supplementation coverage of children 6-59 months and mothers in early post-partum. **Methods:** CDTI systems have been used as a vehicle for vitamin A supplementation in the northeastern states of Adamawa and Borno (population of 1.65 million people with over 300,000 children under five years of age and 83,000 women in early post-partum). CDTI systems have strengthened the existing health systems in partnership with the onchocerciasis endemic communities. **Results:** In the years 2001 & 2002 the integration of vitamin A supplementation into CDTI systems resulted into the successful vitamin A supplementation of 284,673 children 6-59 months (97.4% of the target population) and 65,644 mothers in early post-partum (81.2% of the target population). **Conclusion:** Integration of vitamin A capsule distribution into CDTI systems appears to be a sustainable approach for ensuring the periodic delivery of vitamin A supplements to population groups at risk of VAD. This approach could be replicated in other community-based intervention programs such as trachoma and Guinea worm control programs. At the XXI IVACG Meeting, a complete 2-year implementation report will be presented. Its findings, will inform policy development and program design and implementation for the effective control of vitamin A deficiency in Nigeria.

<sup>1</sup> In Africa, 19 onchocerciasis endemic countries have adopted the CDTI approach for river blindness control in the next fifteen years. The approach involves partnerships among the endemic communities, governments, the African Programme for Onchocerciasis Control (APOC), and organizations like HKI.

**M7 MAINTAINING HIGH VITAMIN A SUPPLEMENTATION COVERAGE IN A RESOURCE-POOR ENVIRONNEMENT. LESSONS FROM NIGER.** H Hamani, X Crespin, A Mamadoultabou, MB Tidjani, SK Baker, and VM Aguayo. Helen Keller International-Niger, MOPH, and Helen Keller International-Africa Region.

**Background:** In Niger, child mortality and malnutrition rates, including vitamin A deficiency (VAD) are very high. Facility-based responses to nutritional deficiencies are ineffective because of low access to health services. If VAD in children is to be controlled, innovative high impact, cost-effective interventions need to be identified. **Objectives:** In 1999, the objective was to ensure that over 80% of children 6-59 months old receive a high-potency vitamin A capsule bi-annually and that at least 75% of women in early post-partum receive a high-potency vitamin A capsule in the 40 days after delivery. **Methods:** The first challenge (1997) was to integrate vitamin A supplementation into National Immunization Days to reach these children. The second challenge (1998) was to ensure that all children 6-59 months old receive a second high-potency vitamin A capsule every year and that women in early postpartum receive vitamin A capsule. **Results:** Since 1998, all vitamin A supplementation rounds in Niger have ensured over 85% coverage of children 6-59 months old. The current supplementation coverage of women in early post-partum is slightly over 50%. **Conclusion:** The experience in Niger proves that sub-Saharan countries can successfully deliver high-potency vitamin A supplements to children. As NIDS are scaled down and phased out, new approaches are being developed in order to maintain the high supplementation coverage attained between in 1998-2001. At the IVACG 2003 Meeting, we will present the lessons learned in the process of implementing nation-level vitamin A supplementation programs and how these lessons are informing the development of new potentially high impact, cost-effective approaches to maintain high vitamin A supplementation coverage in sub-Saharan Africa.

**M6 IS THERE LIFE AFTER NIDS?: NON-NIDS DISTRIBUTION OF VITAMIN A.**

K. Codling, S. Atwood. UNICEF Regional Office for East Asia and the Pacific

**Background:** Since 1997 the supplementation of children under 5 with high-dose vitamin A capsules, as an effective strategy to reduce vitamin A deficiency, has been recommended by agencies such as UNICEF and WHO. Today almost seventy countries have taken up that challenge and are supplementing children nationwide. In 2000 forty-four countries reached over 70% of children with at least one dose of vitamin A (preliminary data). The vast majority of countries have achieved such coverage by linking vitamin A supplementation with National Immunization Days for Polio. In 2000 however, WHO declared the Western Pacific Region as polio-free and countries are ceasing National Immunization Days. What is to become of vitamin A supplementation?

This paper will review the experience of the East Asia and Pacific Region in finding alternative ways to distribute vitamin A. It will illustrate how linking vitamin A to NIDS resulted in rapid increases in coverage and how cessation of NIDS and the adoption of alternative distribution strategies led to disappointing falls in coverage in some countries but maintenance of high coverage in others. This paper will describe the distribution mechanisms used, discuss why they were chosen and the variation in results that have been achieved. The paper will also look forward and anticipate the future of vitamin A supplementation in the region – to what extent can we expect vitamin A supplementation to be continued and how, if ever, will it become a routine primary health care service.

**Conclusion:** Vitamin A supplementation and the achievement of high coverage need not die with the elimination of polio and the ending of NIDS. Proven commitment and mechanisms for distribution exist in the East Asia and Pacific region to continue vitamin A supplementation and indeed, in some countries, other essential child health and nutrition services have been linked to vitamin A, in the same way that vitamin A was originally linked with polio.

- T1 Vitamin A deficiency among children living in the Kingdom of Morocco: comparison of ophthalmologic and biochemical assessments.** Berraho A., Refass L., Chekii H., Rjimati E., Mokhtar N., Schlossman N., Zerrari A., Tyane M.  
**Background:** The Kingdom of Morocco (KOM) was the first country in North Africa to conduct a national vitamin A deficiency (VAD) assessment in July 1996, to determine the extent of the problem and develop the most appropriate solution. **Aims:** To assess the prevalence of VAD by 1) biochemical criteria, 2) vitamin A consumption and 3) clinical ophthalmologic criteria. **Methods:** Randomly selected, regionally-representative cluster survey, including 1470 children 6 through 71 months of age, stratified by 3 eco-geographic regions, urban/rural distribution and population size; 49 clusters of 30 households each with one eligible child per household. Clinical VAD status was assessed by vitamin A concentration in blood samples using HPLC method and presence of ophthalmologic signs. VAD-risk was assessed using the Helen Keller International (HKI) food frequency score for estimating consumption of vitamin A-rich foods. **Results:** 41% of children had retinol concentration <200µg/L, which is twice the WHO cutoff for determining severe VAD public-health problems. The children had low vitamin A food frequency scores, indicating low vitamin A intake, with evidence of poor dietary quality. But the ophthalmologic exams did not reveal such high evidence of severe VAD; in fact, the prevalences of ocular symptoms were far lower than the WHO cutoff for public health VAD problems: XN (Night blindness): 0.1% (WHO cutoff: >1%); X1A (Conjunctival xerosis): 0.2% (WHO >0.5%); X1B (Bitot's spots): 0% (WHO >0.5%); X2 (Corneal ulcers (localized): < 1/3 of corneal surface): 0.1% (WHO >0.01%); X3A (Corneal ulcers generalized: >1/3 of corneal surface or keratomalacia): 0% (WHO >0.01%); X3B: 0% (WHO >0.01%). These results confirm that in Morocco, in comparison with review of literature and WHO criteria, VAD is mainly subclinical. **Conclusion:** In the KOM, VAD ophthalmologic symptoms are rare, whereas the low serum vitamin A levels and low food scores suggest that it is a significant public health problem. Similar patterns of subclinical VAD are found in many countries. Subclinical VAD is associated with increased morbidity among children and reproductive-age women and with non-ocular aspects of vitamin A metabolism. The KOM was a pioneer in its assessment of VAD in North Africa. As a result, supplementation of children, especially of those in poor, rural areas, was instituted through its public health services, along with a multi-sectoral program to fortify flour, sugar, and/or oil with vitamin A to reach the general public. Other ocular studies using paraclinical exams, such as vision restoration time or scotopic vision tester; should be conducted to confirm the low prevalence of clinical VAD ophthalmologic symptoms and to better understand early ophthalmologic changes that occur with subclinical VAD in the KOM. This will be especially revealing since the VAD program has been in effect for several years.
- T2 MEASUREMENT OF VITAMIN A STATUS USING A SINGLE-TUBE EXTRACTION METHOD AND IMPROVED HPLC SEPARATION.** JG Erhardt, H.K. Biesalski and N.E. Craft. Hohenheim University, Institute of Biological Chemistry and Nutrition, Stuttgart, Germany and Craft Technologies, Wilson NC, USA.  
**Background:** Plasma retinol is the most widely accepted indicator for the detection of vitamin A deficiency (VAD). HPLC analysis of plasma retinol is the methodology used most frequently. Currently available extraction methods are laborious since they require several solvent transfers, extractions and manipulations prior to injection. In addition, the chromatographic separation, especially for the MRDR test, is less than ideal. The aim of this study was to implement a single-tube extraction of retinol (from sample distribution to injection) and improve the chromatographic separation by optimizing the mobile phase and column.  
**Methods:** A 20µL-aliquot of plasma was deproteinated with 100µL ethanol/acetonitrile (50:50, containing retinol acetate as internal standard and 5 mg/mL BHT as antioxidant) directly in conical polypropylene autosampler vial. Samples were mixed and centrifuged in the autosampler vials prior to direct injection of the supernatant into the HPLC. The mobile phase was acetonitrile/water (85:15) and the column was a Prism RP18 (3µm, 150 x 3 mm, Thermo Hypersil). The total run time was 5 min.  
**Results:** The method yielded good intra and interassay variability (5% and 6%, resp), sufficiently high sensitivity (detection limit 0.1 µmol/L) and good recovery. By changing the mobile phase from the popular methanol/water system to acetonitrile/water and applying an efficient, selective column, the separation of retinol from the internal standard retinol acetate and dehydroretinol was excellent. In addition the sensitivity of the MRDR assay was improved.  
**Conclusion:** These improvements make the method more practical for rapid screening of low volume plasma samples. Likewise, it can be applied to the MRDR with greater sensitivity for a better evaluation of vitamin A status.
- T3 COMBINED MEASUREMENT OF RETINOL AND STFR IN ONE DRIED BLOOD SPOT (DBS) STORED AT ROOM TEMPERATURE.** JG Erhardt, HK Biesalski and NE Craft. Institute of Biological Chemistry and Nutrition, Hohenheim University, Stuttgart, Germany and Crafttechnologies, Wilson, NC, USA  
**Background:** Iron and Vitamin A deficiency are worldwide the most important nutritional deficiencies. Therefore a simple and cost effective measurement of these deficiencies is of high priority. **Aims:** The objectives of this study were 1. to establish a simple and inexpensive ELISA for sTFR, 2. to adapt an already existing measurement of retinol in DBS to measure the Vitamin A and iron status together in one DBS and 3. to measure the sodium content of the DBS to get a reliable value for the plasma content of a DBS with unknown content of blood.  
**Methods:** Retinol and s-TFR in a DBS were extracted with water and sonication. A small part of this solution was used for the determination of sTFR and sodium. sTFR was measured by a sandwich ELISA and sodium by using a sodium sensitive electrode. The leftover was used to extract retinol and to measure it by normal phase HPLC.  
**Results:** The CV of sTFR in DBS was < 5% with a good linearity ( $r^2 = 0.99$ ). A good correlation ( $r^2 = 0.95$ ) was found with a commercially available Kit method. The measurement of retinol in DBS was not negatively influenced by this combined procedure. The sodium content was highly correlated with the plasma content of a dried blood spot.  
**Conclusion:** This methods enables the reliable and cost effective determination of Vitamin A and iron status in DBS without venous blood sampling, centrifugation or cold chain which is especially useful for remote areas in developing countries.
- T4 VALIDATION OF A RAPID ENZYME IMMUNOASSAY FOR THE QUANTITATION OF RETINOL BINDING PROTEIN (RBP-EIA).** J Hix, P Racsa, J Morgan, S Denna, D Panagides, M Tam, A Shankar. Program for Appropriate Technology in Health (PATH), Seattle, WA; National Institute of Public Health, Phnom Penh, Kingdom of Cambodia; Helen Keller International-Asia/Pacific, Jakarta, Indonesia; Johns Hopkins University School of Public Health, Baltimore, MD.  
**Background:** Determining changes in the vitamin A status of populations is required to assess vitamin A deficiency (VAD) control efforts. Current methods to determine vitamin A levels range from high-pressure liquid chromatography (HPLC) to whole blood fluorescence. The former is considered to be reliable and accurate but is expensive and technical, while the latter is simple but lacks specificity. New tools are needed that permit rapid, simple, specific, inexpensive assessment of vitamin A status. We have developed a quantitative competitive enzyme immunoassay (EIA) to detect retinol binding protein (RBP), a surrogate marker for retinol. Validation of this assay is required prior to widespread field use. **Aims:** To determine the accuracy and reliability of the RBP-EIA vis-à-vis HPLC in assessing the vitamin A status of a subgroup of Cambodian children. **Methods:** Sera from 383 children were randomly selected from specimens archived at -72°C during the recent Cambodian national VAD survey. Retinol levels were assessed by HPLC using a one-step extraction procedure. Both NIST standards and predefined sera were used to assess accuracy for each batch of analyses. Samples were subsequently analyzed using the RBP-EIA to determine serum RBP concentrations. **Results:** HPLC analysis indicated a moderate to severe VAD prevalence of 20.4% (95% CI: 16.3-24.4%), and the RBP-EIA indicated a VAD prevalence of 20.2% (95% CI: 16.2-24.1%). The linear correlation coefficient ( $R^2$ ) was 0.88 and the ROC curve value was 0.93 with a specificity of 92%. Using a batch size of 40 samples, the time and reagent costs required for the HPLC procedure were ~16 minutes and ~US\$15.00 per determination, while the EIA required ~1-2 minutes and <US\$1.00 per determination. **Conclusion:** We found no significant difference between the results of the RBP-EIA compared to HPLC serum retinol. The speed, cost, and simplicity of the EIA could enable public health authorities to assess VAD and monitor control programs.

**T5 THE ROLE OF DISTRICT OPHTHALMOLOGISTS IN SURVEILLANCE OF BLINDING XEROPHTHALMIA IN NORTH WEST FRONTIER PROVINCE OF PAKISTAN.** Dr. Mohammad Aman Khan, Prof. M.Daud Khan, Dr. M. Babar Qureshi. Pakistan Institute of Community Ophthalmology, Peshawar, Pakistan.

**Background:** Pakistan has been classified as a country with severe sub-clinical cases of vitamin A deficiency. Very little has been reported regarding clinical cases of vitamin A deficiency from Pakistan, although cases of xerophthalmia have been reported from the neighboring countries with similar socio-economic and demographic conditions. Cases of blinding xerophthalmia were diagnosed and treated in one of the tertiary eye care centers. **Aims:** To record whether cases of blinding xerophthalmia occur and present to district ophthalmologists in North West Frontier Province, Pakistan. Will this surveillance system identify the high risk communities having vitamin A deficiency in the province? **Methods:** a record form for children age 0-72 months with blinding xerophthalmia was designed with the help of international Centre for Eye Health London and field tested. All the ophthalmologist working in districts / agencies and few from teaching hospitals were invited to a workshop on "Vitamin A deficiency and its consequences" at Lady Reading Hospital Peshawar Pakistan through the office of the Director General Health Services of the Province in October 1996. Slides of different stages of xerophthalmia were shown to the participants. Cases of xerophthalmia were called for follow up on the same day to show it to the participants. The ophthalmologists were asked to fill the record form for each child with blinding xerophthalmia and send the records in a stamped and printed addressed envelope to the researcher every month. Those ophthalmologist who could not attend the workshop, were visited in person by the researcher and were shown the slides of xerophthalmia. Ophthalmologists were asked to have a close liaison with paediatrician to include all possible cases at district level. **Results:** over a period of one year from November 1996- October 1997 a total of 76 children of blinding xerophthalmia were recorded from 19 districts and agencies of NWFP, 2 children were recorded from within side Afghanistan and one from Punjab province. Using the number of Children with blinding xerophthalmia identified as numerator and the estimated number of children 0-6 years in each district as the denominator, District Swabi had the highest prevalence of blinding xerophthalmia (80 per million aged 0-6 years). **Conclusions:** blinding xerophthalmia is likely to occur in all districts of NWFP and FATA with different incidence rates. The surveillance system of involving district ophthalmologist with some re-training in diagnosing children with blinding xerophthalmia can assist to identify high-risk communities with vitamin A deficiency.

**T7 APPLICATION OF ISOTOPE TECHNIQUES IN ASSESSING AND MONITORING VITAMIN A NUTRITION INTERVENTIONS.** N MOKHTAR, V IYENGAR, B MIRANDA-da-CRUZ.

Serum concentrations of vitamin A are homeostatically controlled and do not generally decline appreciably until, liver reserves reach an extremely low level. Therefore, monitoring vitamin A status is not an easy procedure and method of assessment needs refining. Since 1995, the International Atomic Energy Agency (IAEA) is actively involved with member states and other United Nations Organisations in developing and improving isotopic techniques for measuring the whole body retinol. A recent initiative by WHO/IAEA is planning to use isotope dilution techniques using <sup>13</sup>C-retinyl acetate to assess the efficacy of the new supplementation dosages of Vitamin A for post-partum mothers in Ghana. IAEA is also involved in addressing carotenoid bioconversion and bioavailability issues, wherein stable isotope techniques appear to have shown promise for use in humans for providing reliable data to estimate bioefficacy of dietary carotenoids. The IAEA's had the experience of using a 3-day deuterated-retinol-dilution procedure in school children in the Philippines with low serum retinol concentration who showed significant improvement in total body VA stores following intake of carotene-rich foods. The stable isotope techniques could also be employed to quantify the effect of several other factors that could influence the absorption of carotenoids. The IAEA's project in Indonesia uses isotope techniques to assess the effect of dietary fat and zinc status on beta-carotenes bioavailability and bioconversion into vitamin A in children and lactating women. Isotope dilution techniques therefore have potential to evaluate the impact of vitamin A/retinol and provitamin A/carotenoids intervention programs. It is suggested that further application of isotopic techniques for national monitoring programmes and evaluation should be considered and developed as an alternative reliable method of assessment of vitamin A.

**T6 A PORTABLE DARK ROOM (PDR) FOR DARK ADAPTATION AND TO ASSESS NIGHT BLINDNESS.** L Medlin, D Taren B Campbell, S Gibson, D Araiza, B Duncan. University of Arizona, Tucson, Arizona, EIDE Industries, Cerritos, California.

**Background.** A direct assessment of night blindness (XN) is often not possible because a location for dark adaptation (DA) does not exist. **Aim.** To create a Portable Dark Room (PDR) that can be used for DA and to assess XN. **Methods.** A team of vitamin A researchers, architects, and contractors designed and manufactured an opaque tensile fabric structure that can be set up outdoors. Design and construction were developed through an interactive sequence of steps between the research team and EIDE Industries, a tent manufacturer. A conceptual model of the PDR was developed and full fabrication drawings were prepared. A full-size test structure was set up and analyzed for construction and its serviceability for DA and XN testing. Using criteria established in these evaluations, design refinements were made. **Results.** A foundation-bearing/anchorage PDR was designed for quick set-up with 3-weight bearing posts and an arch to support outer shading and rain protection. The arch is configured to suspend another membrane to form two rooms within the PDR. One room is for DA and the other room for assessing XN. A series of overlapping zippers and velcro prevents light from entering the PDR from entrance and exit doors. A small attic built into the PDR can be opened up after testing subjects to allow hot air to escape from the PDR. The PDR is designed to be set-up within 30 min. The estimated weight for the PDR is about 200 kg and is packaged in such a way that it can be transported using a small pick-up truck or broken down to smaller components and transported by horseback or yak. The arch allows the PDR to be set up so a sloping side can be ideally oriented to have a laminated thin-film solar photovoltaic element facing the sun. **Conclusions.** A two-chambered PDR prototype suitable for production has been developed to expand studies on XN in locations that were previously unavailable. The U.S CDC and Task Force Sight and Life provided financial support for this project.

**T8 USEFULNESS OF PLASMA  $\alpha$ -CAROTENE FOR ASSESSING DIETARY RED PALM OIL INTAKE.** CA Northrop-Clewes, ASW Mburu, R Hynes, G Morgan, A Prentice, DI Thurnham. Northern Ireland Centre for Diet and Health, University of Ulster, Coleraine, UK and MRC Nutrition Unit, Keneba, The Gambia, London School of Tropical Medicine, London.

**Background:** The vitamin A (VA) status in Gambian infants is determined by maternal VA status and intake of complementary weaning foods. The principal dietary factors affecting maternal VA status are seasonally available red palm oil (RPO) and mangoes. RPO is a rich source of both  $\alpha$ - and  $\beta$ -carotene. **Objective:** The aim of this communication is to demonstrate the usefulness of plasma  $\alpha$ -carotene as a marker of RPO intake. **Design:** As part of a double-blind placebo-controlled vitamin A (VA) intervention study, plasma retinol and carotenoids were measured in 97 apparently-healthy infants, 6-12 months old. Infants were recruited from 5 rural villages in the West Kiang District of The Gambia and received 50 000 IU VA or placebo in groundnut oil in November and December 1999. The carotenoids and retinol were measured by HPLC and the results logged. **Results:** The overall median (25, 75%) plasma retinol was 0.93 (0.74, 1.15)  $\mu$ mol/L and there was no difference due to treatment or village. Table: Plasma concentrations are expressed as geometric means ( $\mu$ mol/L)

Month	Nov	Dec	Jan	Mar	June
$\alpha$ -carotene	0.17*	0.17*	0.16*	0.23#	0.37+
$\beta$ -carotene	0.15*	0.15*	0.13*	0.20#	0.87+
$\alpha$ : $\beta$ ratio	1.19*	1.21*	1.28*	1.22*	0.49+

Unlike superscripts significant difference by month (ANOVA P<0.05). High  $\alpha$ : $\beta$  ratios indicate the months where RPO was the major form of dietary VA. **Conclusions:** Ratios of plasma  $\alpha$ : $\beta$ -carotene were ~1.0 at all time-points except June, suggesting RPO is the dietary source of both  $\alpha$ - and  $\beta$ -carotene. Mangoes contain small amounts of  $\alpha$ -carotene but are rich in  $\beta$ -carotene and the drop in  $\alpha$ : $\beta$  ratio in June reflect their seasonal intake. Neither the VA supplements nor the large intake of  $\alpha$ - and  $\beta$ -carotene had any impact on plasma retinol.  $\alpha$ - and  $\beta$ -carotene concentrations were strongly seasonal and high  $\alpha$ : $\beta$  ratios reflect an unusually high  $\alpha$ -carotene concentration from RPO intake.



- T9 A SMALL PHYSIOLOGICAL DOSE OF VITAMIN A (17.5 μMOL) TAKES 4 YEARS TO “DISAPPEAR” IN HEALTHY INDIVIDUALS.** SA Tanumihardjo. Dept. Nutritional Sciences, UW-Madison, Madison, WI.

**Background:** In an effort to improve vitamin A status globally, large doses of supplemental vitamin A are administered periodically to preschool age children (210 micromoles) and postnatally to lactating women (up to 410 micromoles). Stable isotope dilution testing is a very powerful method to assess vitamin A status and trace supplemental vitamin A. **Aims:** To determine vitamin A status using a new method in humans and determine the length of time a small physiological dose of vitamin A remains in the body of a healthy adult female. **Methods:** After a baseline blood sample (10 mL) was taken, a healthy adult female ingested 13C4-retinyl acetate (17.5 micromoles) dissolved in corn oil. Thereafter, blood samples were obtained on days 2, 4, 8, 16, 24, 32, 64, 128 and 256 days and 1.2, 2, 3 and 4 years. Two-mL serum samples were extracted and the retinol purified twice with reversed-phase HPLC before analysis with gas chromatography isotope ratio mass spectrometry (GCCIRMS). **Results:** In the human volunteer, the synthetic labeled retinol was absorbed very well and the enrichment of the serum retinol with 13C4-retinol began to plateau in as little as 8 days. The calculated liver reserves for this female from the day 24 data were 0.29 micromole vitamin A/g, which is a normal value for a healthy American not taking supplements. The enrichment in the serum did not return to baseline until 4 years post-dosing. **Conclusions:** Isotope dilution testing with 13C-retinol and GCCIRMS is very sensitive. Small doses of supplemental retinol remain in the body for 4 y in healthy individuals of adequate vitamin A status.

- T10 USEFULNESS OF PLASMA LUTEIN AS A BIOMARKER IN BREAST MILK.** DI Thurnham, CA Northrop-Clewes, L McDermott, FSW McCullough, PI Paracha. Northern Ireland Centre for Diet and Health, University of Ulster, Coleraine, UK and Department of Human Nutrition, Agricultural University of Peshawar, North West Frontier Province, Pakistan.

**Background:** Lutein, a non-provitamin A carotenoid, is present in green vegetables in similar concentrations to β-carotene, and may be a useful marker of vitamin A (VA) status in developing countries where green vegetables are the main source of dietary VA. Previously, we reported an increase in plasma retinol in Pakistani infants (men age 12 months) over a 3 month period was correlated with an increase in plasma lutein. The improvement in VA status was attributed to the intake of breast milk and it was argued that the parallel increase in the two plasma nutrients indicated an increase in availability of green vegetables. **Objective:** To measure retinol and carotenoids in breast milk samples from a developing and developed country. **Design:** Milk samples were collected from rural Pakistani and Irish mothers. Milk was saponified at room temperature, extracted and then analyzed by HPLC. Aliquots were centrifuged to provide a creatocrit. Irish mothers completed a 24-hour dietary recall questionnaire to provide data on intake of retinol, lutein and β-carotene. Comparable Pakistani data was not available. **Results:** The median concentrations of retinol (40.6, 57.8 nmol/g milk fat) and lutein (4.8, 3.7 nmol/g milk fat) for the Pakistani and Irish groups respectively did not differ. Dietary lutein was correlated with milk lutein in the Irish samples ( $r = 0.68, P < 0.001, n = 20$ ) but neither retinol nor β-carotene correlated with dietary intake. There was a strong correlation between retinol and lutein in the Pakistani milk samples ( $r = 0.8, P < 0.0001, n = 20$ ) but no correlation in the Irish samples. No β-carotene was detectable in the Pakistani milk. **Conclusions:** In Irish women pre-formed VA is a more important determinant of VA status therefore breast milk retinol was not correlated with vegetable (lutein or β-carotene) intake. However dietary lutein correlated with milk lutein. In the Pakistani women there is little pre-formed retinol in the diet therefore pro-VA carotenoids are the main source of VA and all the β-carotene absorbed appears to be converted to retinol since there was none in the milk. Newly absorbed retinol and carotenoids appear quickly in the blood following absorption and would be available for transfer to milk hence the strong correlation between lutein and retinol previously seen in the Pakistani infants.

- T11 IMPROVEMENT IN VITAMIN A CAPSULE COVERAGE IN CAMBODIA: THE SUCCESS OF VILLAGE HEALTH VOLUNTEERS AS SOCIAL MOBILIZERS.** O Tokmoh, N Simoneau, D Panagides, S de Pee, O Poly, MW Bloem. Helen Keller International, Cambodia and Asia-Pacific Regional Office, and National Nutrition Department/Ministry of Health/Cambodia.

**Background:** In 2000, Helen Keller International (HKI) conducted the first Cambodia National Micronutrient Survey which revealed that vitamin A capsule (VAC) coverage is still very low among children 6-59 months of age (10-55%) and postpartum women (1-13%). In 1998, the National Vitamin A Program was integrated with the National Immunization Program. VACs are supposed to be delivered twice a year, during the months of March and November, through health center outreach activities. However, it was found that health center staff have received little training on VAC distribution and are unfamiliar with the National Vitamin A Policy. In September 2001, HKI and the Ministry of Health initiated a pilot project to test a strategy to improve VAC distribution. **Objectives:** To increase VAC coverage among children 6-59 months of age and postpartum women within 8 weeks of delivery. **Methods:** The pilot project was conducted in three operational districts and included: social mobilization, training and supervision of health center staff and village health volunteers (VHV), and support for logistics and activities of health center outreach. In December 2001 and in April 2002, a post-VAC distribution survey was conducted to assess people's knowledge of VAC, the channels through which they heard about VAC distribution, and VAC coverage during the November 2001 and March 2002 distributions. **Results:** A significant increase in coverage was found for both November 2001 and March 2002 distribution rounds. Coverage in the pilot areas ranging from 22-47% in March 2001 distribution (baseline data) increased to 82-97% in the November 2001 and 85-98% in March 2002. There was little difference among child age groups. Almost 70% of mothers reported hearing about the VAC distribution from VHVs, who also played an important role in mobilizing the target groups. **Conclusion:** These results show that with minimal inputs and the involvement of VHVs, significant increases in VAC coverage can be achieved. A subsequent component of the pilot project will be to determine what motivates VHVs to do their work and how their continued involvement can be assured.

- T12 NIGHT BLINDNESS AMONG WOMEN IS A GOOD INDICATOR OF VITAMIN A DEFICIENCY IN A POPULATION EXPERIENCING CRISIS.** H. Torlesse<sup>1</sup>, H. Moestue<sup>1</sup>, L. Kiess<sup>2</sup>, A. Throne-Lyman<sup>1</sup>, S. de Pee<sup>2</sup>, M.W. Bloem<sup>2</sup>. Helen Keller International, <sup>1</sup>Bangladesh, <sup>2</sup>Asia-Pacific, Indonesia.

**Background.** Criteria for assessing the public health significance of vitamin A deficiency in a population include a prevalence of night blindness that exceeds 1% in children aged 18-59 months and 5% in women during a previous pregnancy in the last 3 years. These indicators have limitations because children are often the targets of vitamin A capsule (VAC) distribution programs and the indicator for women does not reflect recent or current vitamin A status. **Aim.** To examine the impact of the 1998 flood on nightblindness in children and mothers in rural Bangladesh. **Methods.** The analysis used data collected on 119,560 children aged 18-59 months and 136,034 mothers of children aged 6-59 months by the Nutritional Surveillance Project during 18 bi-monthly rounds of data collection between February 1998 and December 2000 in rural Bangladesh. **Results.** Following the onset of the flood in mid-July 1998, there was a sharp increase in the percentage of nightblind children and mothers in the 3 severely flood-affected sub-districts, but not in 21 comparison sub-districts. Between August and October 1998 the percentage of night blindness in the severely flood-affected sub-districts increased from 0.3% to 2.0% in children and from 1.9% to 5.6% in mothers, and remained above the thresholds for a problem of public health significance until December 1998. **Conclusion.** The findings suggest that the prevalence of night blindness in all mothers, irrespective of pregnancy status, is a useful indicator of vitamin A deficiency in a population in times of crises that have a profound impact on household food security. Strategies are needed to improve the vitamin A status of mother following disasters, as mothers cannot safely take a high dose VAC unless they have given birth within the previous 6 weeks and they are rarely the specific targets of food assistance unless they are pregnant.

- T13 THE ROLE OF VITAMIN A AND OTHER ANTIOXIDANTS IN THE INCORPORATION OF CALCIUM INTO THE LATTICE STRUCTURE OF BONE.** S. AMEYAW, D. ASIAMA, A. ANDREWS, M. NYARKO, HEALTH AND LIFE GHANA, I. OSEI, HOLY FAMILY HOSPITAL NKAWKAW, S. AWELIGBA-TAMALE TEACHING HOSPITAL-TAMALE GHANA. **BACKGROUND:** Severe vitamin A deficiency has been found to be associated with soft, gelatinous / thin and fragile bones. It is thought to modulate the activity of osteoclasts responsible for the resorption of bone. **AIM:** The aim of this study was to assess the effectiveness of simultaneous vitamins A and E, zinc and calcium with/without vitamin D supplementation in increasing bone density, as compared to plain calcium particularly in post menopausal women who could neither tolerate nor afford oestrogen replacement. **METHOD:** Patients reporting with chronic neck, upper dorsal, back and waist pains without any infectious or malignant condition had x-rays of their spine taken in two perpendicular planes, to look out for the density of the spondyles, the width of the intervertebral disc spaces and the presence or absence of growing buds of osteophytes. Where considerable radiographic evidence of loss of bone mass and density existed, plain calcium or vitamin A and calcium with / without vitamin D was administered alongside zinc and vitamin E for a period ranging from at least thirty to ninety days. This was followed by check x-rays to re-assess the density of the spine bones / spondyles. 196 patients were involved. **RESULT:** Following a period during which there was arrest of further loss of bone density, considerable increase in bone densities were observed in all cases after various durations of therapy depending on the individual patients, with spontaneous loss of back pain in some but not all cases, in a mean x, of 90 days on calcium only and 30 on vitamins A and E, zinc and Calcium. **CONCLUSION:** The study showed that simultaneous vitamins A and E, zinc and calcium supplementation increases bone density faster by enhancing the incorporation/deposition of calcium into the lattice structure of bones, than giving plain calcium, and can be used to treat osteoporosis and to prevent bone loss in women who are at risk.
- T14 LOW AND HIGH VITAMIN A – IRON DOSE RATIOS: ITS EFFECTS ON THE MICRONUTRIENT STATUS OF ADOLESCENT GIRLS.** Imelda Angeles-Agdeppa-Food and Nutrition Research Institute, Department of Science and Technology, Werner Schultink-UNICEF, New York, Soemilah Sastroamidjojo-SEAMEO-TROPED, University of Indonesia, Jakarta. **Background:** Vitamin A and other micronutrients have been recommended in combination with iron to improve iron status. At present, there is a scarcity of information on the different amounts of iron to be combined with vitamin A to gain more beneficial effects. **Aim:** To determine the effective dose combination of a weekly low or high dose ratio of vitamin A to iron on the vitamin A and iron status of adolescent girls. **Methods:** At start, the girls were randomly allocated into 3 groups and each was given once weekly treatments on a doubly masked manner for 12 weeks. Group 1 received the low dose ratio of 6000 µg retinol, 60 mg Fe, 500 mg folic acid, and 60 mg vitamin C (100 µg retinol:1mg Fe); Group 2 received the high dose ratio of 6000 µg retinol, 120 mg Fe, and the same amount of the other micronutrients as the first group (50 µg retinol:1mg Fe); Group 3 received placebos. All subjects were dewormed prior to giving the treatments. Blood samples were collected at baseline, after 8 and 12 weeks supplementation. **Results:** Basal Hb, ferritin, and retinol levels between the three groups were similar. After 8-week supplementation, Hb, ferritin and retinol concentrations had significantly increased in both supplemented groups, however, between group difference was not observed in all the parameters. The placebo group had decreased Hb and ferritin levels but significant increase in retinol level. After 12 weeks, the low dose ratio had no further significant increase in Hb and retinol levels but ferritin level increased significantly. The high dose ratio had no further significant increase in Hb but further increases in ferritin and retinol levels. However, no significant between group differences in Hb, ferritin, and retinol levels was observed. The Placebo group had further decreased levels of these three parameters. **Conclusion:** The weekly low and high dose ratios of Vitamin A-iron supplements had similar beneficial effects on improving the vitamin A and iron status of adolescents. Considering that any added amount of micronutrient in a pill corresponds to a higher cost, the weekly low dose ratio of vitamin A-iron supplements (100 µg retinol:1 mg Fe) is more economical in the prevention of vitamin A and iron deficiencies among adolescents.
- T15 DAILY LOW DOSES OF VITAMIN A COMPARED WITH SINGLE HIGH DOSE IMPROVES SURVIVAL OF MALNOURISHED CHILDREN IN SENEGAL.** Ph Donnen, A Sylla, M Dramaix, G Sall, N Kuakivi, Ph Hennart. School of Public Health, Department of Epidemiology and Preventive Medicine, Université Libre de Bruxelles, Belgium and Hôpital Le Dantec, Dakar, Senegal. **Background:** Vitamin A (VA) deficiency is widely prevalent in hospitalized malnourished children in less-developed countries and mortality rates are high. Recommendation to give high doses of VA to children suffering from severe malnutrition is not sustained by results of research. Small doses of VA given regularly during hospitalization might be a better strategy to improve mortality and morbidity. **Aims:** To assess the effect of daily low doses of vitamin A on hospitalized malnourished children's mortality and morbidity. **Methods:** We did a double-blind, randomized trial in 604 and 610 senegalese hospitalized children. The first mentioned batch received a high dose VA supplement (200.000 IU) on admission, the second a daily low dose VA supplement (5.000 IU per day) during hospitalization. Children were followed up until discharged. All cases of mortality were recorded and data on all-causes morbidity were collected daily. **Results:** Children of both groups were similar at baseline in terms of age and nutritional status. Low serum retinol concentrations were found in more than 75% of the study sample. Mortality was 9.7% (59 deaths) in the low doses group and 11.1% (67 deaths) in the high dose group (NS). In children without edema on admission, mortality was similar in both treatment groups. In children with edema on admission, mortality was significantly lower in the low doses group (Adjusted odds ratio : 0.21 ; 95% CI : 0.05-0.99). The proportion of children who never presented acute respiratory infection during hospitalization was significantly higher in the low doses group (83.5 vs 77.8, p=0.043) whereas the proportion of children who never presented diarrhea was not significantly different among the two groups. Median percent time ill for acute respiratory infection and diarrhea were not significantly different in the two groups. **Conclusions:** In hospitalized severely malnourished children, daily low doses of VA improved mortality better than a single high dose.
- T16 EFFECT OF A COMBINED SUPPLEMENTATION OF VITAMIN A AND ZINC IN THE PREVENTION OF VITAMIN A DEFICIENCY: A CONTROLLED RANDOMISED TRIAL.** MMF Lola; ML Barreto; AS Diniz; RS Oliveira; SMM Silva, P Kolsteren. Federal University of Paraiba, Federal University of Bahia, Federal University of Pernambuco, Brazil; Prince Leopold Institute of Tropical Medicine, Belgium. **Background:** Vitamin A and zinc seem to interact in various metabolic processes in the organism. **Aims:** To evaluate the effect of a combined supplementation of zinc and vitamin A in children with Vitamin A Deficiency (VAD). **Methods:** A randomised, double blind, controlled clinical trial was carried out in Brazilian children. From a total of 927, a sample of 260 children with serum retinol levels < 0.70 µmol/l was selected and allocated into two treatment groups: 130 children received vitamin A (200.000 IU, in the first day) + zinc (25 mg zinc sulfate, daily), during 30 days; the other 130 children received vitamin A (200.000 IU, in the first day) + placebo zinc. The treatment groups were monitored during 6 months and evaluated before supplementation, and 1, 3, 4.5 and 6 months after supplementation, by serum retinol, serum alkaline phosphatase, hair zinc and anthropometry. **Results:** The prevalence of VAD was 30.7% and zinc deficiency 65.5%. There was no correlation between VAD and zinc deficiency, nor with the anthropometric indices. Zinc deficiency did not correlate to low weight (p>0.05), stunting (p>0.05), or wasting (p>0.05). Vitamin A supplementation increased significantly serum retinol levels (1.4 µmol/l) one month after supplementation (p< 0.05), keeping them in this plateau 6 months. Zinc + vitamin A did not increase serum retinol levels nor the time protection against VAD. This non-effect was sustained after adjusting for the co-variables sex, age, alkaline phosphatase, hair zinc, anthropometry and serum retinol basal levels. **Conclusion:** The absence of a synergetic effect between the two micronutrients could be related to the posology used for the zinc supplement and/or the duration of the intervention, which could be insufficient to have a positive effect in a population with such high levels of zinc deficiency.

- T17 COMPLIANCE WITH PERIODIC VITAMIN A CAPSULE SUPPLEMENTATION - A PROGRAM FOR PREVENTION OF VITAMIN A DEFICIENCY IN INDONESIA.** R Pangaribuan, JG Erhardt, V Scherbaum, HK Biesalski. SEAMEO-TROPED RCCN, Jakarta, Indonesia and Inst of Bio Chem and Nutr, Univ. Hohenheim, Germany.

Background: Vitamin A deficiency continues to be a public health problem in Indonesia despite periodic supplementation of vitamin A capsules (in February and August) since two decades ago. Integrated health service posts (Posyandu) are the main delivery mechanism for vitamin A capsules. It can also be obtained from community health centers (Puskesmas) or community midwives. Data on community factors influencing coverage of supplementation program are largely unknown. Aims: To describe compliance of program participants in Central Java. Methods: Fourteen villages as classic rural areas were randomly chosen from 5 sub-districts and 1 ward from 1 sub-district as typical middle class sub-urban area was included in the study. The subjects were 738 children aged 12-60 mo. Structured questionnaire was used to obtain information from the caretakers on demographic factors, socioeconomic conditions, current dietary practices and health-care-seeking attitudes for common childhood illnesses, previous breast-feeding experience and their knowledge about vitamin A. All questions were asked after the capsule distribution including the respondents' compliance and frequency of participating VAC program. Results: Caretakers who had lack understanding about the health benefit of vitamin A, >1 preschool children in households and households with older children (>36 months) were associated with decreased likelihood of regularly participating the program with odd ratios (P<0.01) of 0.38, 0.55 and 0.95 respectively. The percentage of caretakers who utilized Posyandu, Puskesmas or midwives' practices in rural areas was significantly higher (86.8%, P<0.001) than in sub-urban areas (62.8%). Living in rural location was associated with increased compliance to participate the program regularly with odd ratio (P<0.01) of 1.99. Conclusions: To increase compliance in the supplementation program nutrition communication and private health care practices need to be included in the program.

- T19 VITAMIN A SUPPLEMENTATION AT BIRTH AND 6-MONTH INFANT MORTALITY AMONG CHILDREN OF MOTHERS WITH NIGHT BLINDNESS IN SOUTH INDIA- THE VASIN STUDY.** S.Sheeladevi, L.Rahmathullah, K. Prakash, P.K. Nirmalan, J.Katz, J.M. Tielsch. Aravind Center for Women, Children and Community Health, Madurai, India and Dept. of International Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

**Background:** Night blindness (XN) during pregnancy is common in south Asia; however, few studies have looked at the effects of XN on infant mortality.

**Objective:** To determine the effect on 6-month infant mortality of Vitamin A supplementation to children of mothers with XN during pregnancy

**Methodology:** Pregnant women were enrolled and randomized to have their children receive either vitamin A supplementation (48,000 IU) or a placebo (Tocopherol 5 mg/dl) as two doses within 48 hours of delivery as part of a population based randomized placebo controlled double blind clinical trial. Besides demographic and socioeconomic details, a history of XN during the pregnancy was elicited from participants. All children were followed for a period of six months after delivery. **Results:** XN during the current pregnancy was present for 687 (5.2%) of 13173 women enrolled in the study. XN among mothers was not significant for overall mortality (RR 0.82, 95%CI: 0.60, 1.12). A 24% (RR=0.76) reduction of mortality after supplementing with vitamin A was achieved among children of mothers who did not have XN, and 13% (RR=0.87) among children of mothers with XN. **Conclusion:** The comparatively lower reduction of mortality for children whose mothers had XN suggests the possibility of these children probably requiring higher doses of supplementation due to their more undernourished state. Further studies will be required to explore this.

- T18 THE IMPACT OF THE NATIONAL VITAMIN A SUPPLEMENTATION PROGRAM ON SUBCLINICAL VITAMIN A DEFICIENCY IN PRE-SCHOOL CHILDREN IN THE PHILIPPINES.** MRA Pedro, JR Madiaga, CVC Barba, RCF Habito, AE Gana, M Deitchler, JB Mason. Food and Nutrition Research Institute-Department of Science and Technology, Metro Manila, Philippines; University of the Philippines at Los Banos, Laguna, Philippines; Tulane University School of Public Health and Tropical Medicine, New Orleans LA, USA.

VAD (<20 mcg/dl) in 1-5 y old children in the Philippines rose from 35% in 1993 to 38% in 1998, despite a 2x-yearly vitamin A capsule (VAC) distribution program reaching 80-90% coverage. The Philippine 1998 National Nutrition Survey, with one-time serum retinol (SR) measurements from 11,640 1-5 y old children, collected over an 8-mo period, 1 mo to more than 6 mo after VAC distribution, was an opportunity to examine program impact on the children's vitamin A status, using post-hoc analysis. Data were disaggregated by rural and highly urban cities, 2-3 month-bands after receipt of VAC, and period of data collection. Descriptive and linear regression analyses were carried out. Results were distinguished by the three main geographic areas: Luzon, Visayas, Mindanao. Overall, a detectable impact of VAC on SR was limited, mainly to groups with highest deficiency. First, in highly urban cities in Visayas, where very high prevalences of severe deficiency (<10 mcg/dl) are found, the prevalence was reduced from 27% to 9% at 1-2 mo after VAC to 16% at 3-4 mo, hence tapering further. Second, in Mindanao, a generally significant reduction was seen in mild-moderate deficiency (<20 mcg/dl) 1-4 mo after VAC, from 38% to 32%. Third, although there was no overall reduction in prevalence of deficient SR in Luzon, a significant interaction with stunting was determined, such that among stunted children the prevalence of SR<20 mcg/dl was reduced from 48% to 32% at 1-2 mo after VAC, then rising again. Otherwise, average effects on SR were minor and not significant: in Luzon the mean stayed around 25 mcg/dl; in Mindanao it rose marginally at 1-2 mo after VAC from 23 to 27 mcg/dl; in Visayas, from 20 to 23 mcg/dl at 1-4 mo after; the level returned to pre-dose value after 4 mo or less. Policy implication includes a shift in resources from low VAD prevalence areas, where VAC distribution may shift to a targeted scheme, to high VAD prevalence areas where a 3x-yearly schedule is warranted.

- T20 THE EFFECT OF A MULTIPLE MICRONUTRIENT FOOD SUPPLEMENT ON THE NUTRITIONAL STATUS OF PRESCHOOL CHILDREN.** MRS. MALAVIKA VINODKUMAR, SUNDAR SERENDIPITY FOUNDATION, 6-G, CENTURY PLAZA, 560-562, ANNA SALAI, TEYNAMPET, CHENNAI-600018, INDIA. PHONE: +91-44-434 9230, FAX: +91-44-434 9352 EMAIL: malavika@giasmd01.vsnl.net.in
- Background: The clinical trial was carried out to test the efficacy of a unique method of micronutrient delivery- supplementation through the food route.

**Aim:** The clinical trial involved the study of the nutritional status and health of children in the age group 2 to 5 who attended feeding centers of schools and consumed a noon meal at these centers.

**Methods:** 66 children in the control school and 114 children in the experimental school took part in the study. The children in the experimental school received the noon meal, to which a multiple micronutrient food supplement containing Vitamin A, B1, B2, B6, B12, Calcium Pantothenate, Niacin, Folic Acid, Iron and Calcium, had been added while there was no addition of multiple micronutrient food supplement in the control schools. Study lasted for 6 months. Weight of children and clinical examinations for vitamin deficiencies included basal recording, monthly recordings and final recording. Biochemical estimation of serum vitamin A, serum Albumin and Hemoglobin was done before the study and after 6 months at the end of the study in a subsample.

**Results:** 1. In age group 2-5 years, 11% more weight gain in experimental group compared to control. 2. Clinical examinations showed decrease of Vitamin B deficiencies, Xerophthalmia and anemia in experimental group, but not so in the control. 3. Serum vitamin A increased 255% from initial value for the study group of children, but increased only 92% over initial level in control. Serum Albumin had increased by 18% in experimental group, but decreased by 1% in control group. Hemoglobin remained at 10gms / dl in experimental group throughout the study, but decreased to 9.3 gms/dl in control.

**Conclusions:** Thus, multiple micronutrient food supplement improved the nutritional and health status of preschool children and supplementation through the food route is an effective way of delivery of micronutrients especially vitamin A.



**T21 COSTING TOWARDS SUSTAINABILITY FOR VITAMIN A SUPPLEMENTATION PROGRAMME.** S Bhandari, ADustagheer, R Sinha, G Singh, S Nirupam, R Nair, F Saiyed, M Singh, S Jacob and V Agarwal

**The Problem:** National programme for combating VAD in India is on-going since 1970 - Vitamin A supplementation (VAS) is the short-term and dietary improvement is the long-term strategy. VAS is part of the routine immunisation activity in the state, however the coverage being as low as 17% among children aged 12-35 months as evident from NFHS2 (1998), requires the need for special efforts on a periodic basis. 15 states have been supported in India in this endeavour by UNICEF with funding support from CIDA and MI. The experience reveals that the average cost to the donor is 3 US cents against an international experience of 7. **Objective:** To plan for reduction in cost to the donor by integrating in the routine system and utilise donor contribution for systems strengthening. **Conceptual Framework:** The framework for the programme is based on four pillars, namely, Vitamin A supplementation, dietary diversity, food fortification and public health measures. Scope of this paper is limited to supplementation. **Programme design:** the programme design is based on the strengths of implementing states. In some states, MOH is the nodal agency whereas in others the Women and Child Welfare Department takes the lead role. The nature of support is dependent on the state needs, for example some states needed support on supplies whereas others needed support on capacity building and IEC materials to strengthen the programme. **Outcome/Results:** The results bring out the varying costs per child. These outcomes will be closely monitored this year and detailed analysis will be presented for 7 states capturing different programme strategies. **Programme implication:** The planning for costs will enable the state to be self-reliant on supplies and invest minor incremental costs to maintain the quality of service. The donor funding should be planned to be utilised for systems strengthening and improving demand at all levels. Such activities will also incorporate a clear strategy for sustainability.

**T23 IMPLEMENTATION OF VITAMIN A SUPPLEMENTATION IN SOUTH AFRICA.** ME de Hoop. National Department of Health, A Goga. National Department of Health, N Mazibuko. National Department of Health, J Matji. UNICEF, SK Baker. Helen Keller International, C MacArthur. Helen Keller International, Z Sifr. Helen Keller International.

**Background:** The 1994 SAVACG survey, showed that vitamin A deficiency is a severe public health problem in 8 provinces in SA. Furthermore, the 1999 National Food Consumption Survey showed that 55-68% of children 1-9 years consumed 50% of their Vitamin A RDA. **Aim:** The Department of Health aims to reduce and prevent vitamin A deficiency through integrated strategies: food fortification, vitamin A supplementation, dietary diversification and public health programmes. **Program Design:** The national policy includes routine high-dose supplementation to children 6–60 months and to all mothers 6–8 weeks post delivery. Additional vitamin A is provided to children 0–60 months with severe undernutrition, persistent diarrhoea, measles or xerophthalmia. **Activities:** The Department of Health, Helen Keller International and UNICEF, designed a vitamin A supplementation strategy. This entailed distributing donated capsules, training over 400 health workers - who cascaded the training within districts – and adapting the Integrated Management of Childhood Illness Strategy (IMCI) to include vitamin A. Communication materials, including a training manual, reference materials, poster for health workers and a pamphlet for caregivers were developed. Four indicators for monitoring supplementation coverage have been included in the District Health Information System. **Results:** An assessment of the Vitamin A supplementation programme was done in 36 clinics (September 2002). In addition health workers from 18 districts and 9 provinces were interviewed. Preliminary results show that training on Vitamin A was successful, and IMCI, EPI and Nutrition collaborate well and deliver consistent messages. Some challenges are that some clinics only offer Vitamin A supplementation on certain days, procurement and distribution of Vitamin A needs to be strengthened, and communication materials for caretakers are urgently needed.

**T22 REGIONAL MICRONUTRIENT DAYS IN MALI.** A Cissé, D Koné, M Bore, K N'Diaye, SI Bamba, KZ Waltensperger, VM Aguayo. Helen Keller International (HKI)-Mali (AC, DK, KZW), Ministry of Health and Social Affairs (MB, KN, SIB), Helen Keller International-Africa Region (VMA).

**Background:** Approximately 17,000 Malian children 6-59 months die each year as a consequence of vitamin A deficiency. Prevention requires 2 annual administrations of 200,000 IU, with an interval of six months between doses. Since 1998, distribution of the first dose has been integrated into the second round of National Immunization Days (NIDs). To achieve bi-annual coverage of over 80% children, 5 of 9 regions have successfully organized Regional Micronutrient Days (RMDs). **Objective:** To improve the status of nutrition among children 6-59 months and pregnant and postpartum women through large-scale distribution of vitamin A and iron. **Methods:** RMDs are organized by Ministry of Health regional directorates, with assistance from UNICEF and HKI, other government structures, and local NGOs. Community mobilization is supported through information dissemination using local radio, traditional entertainment (e.g., village theatre), and the distribution of accessories. Micronutrients are administered by trained agents at fixed centers and by mobile teams at community outreach sites. **Results and discussion:** The Region of Koulikoro, having had 3 years experience with RMDs, has attained coverage of about 100% for children 6-59 months. In Mopti Region, 100% of children from 6-11 months, and 78% of children 12-59 months, received vitamin A during the first campaign that took place in August 2001. The Region of Gao attained 99% coverage in its first year's experience with RMDs. **Implications:** When NIDs are phased out, RMDs will be scaled up to ensure full coverage of target populations. Routine administration through fixed health structures must also be enhanced through training, supervision, and quality assurance.

**T24 Impact of Vitamin A Supplementation Delivered with Oral Polio Vaccine as part of the Immunization Campaign in Orissa, India.** Jonathan Gorstein<sup>1</sup>, P. Bhaskaram<sup>2</sup>, Sultana Khanum<sup>3</sup>, Reza Hossaini<sup>4</sup>, Patrice Engle<sup>5</sup>, Bruno de Benoist<sup>6</sup>, Tracey S. Goodman<sup>7</sup>. <sup>1</sup> Department of Epidemiology, School of Public Health, University of Michigan, <sup>2</sup> Deputy Director, National Institute of Nutrition, Hyderabad India, <sup>3</sup> Medical Officer, Focal Point for Nutrition in Emergencies, Low Birth Weight, Maternal Nutrition, Management of Malnutrition, Department of Nutrition for Health and Development, WHO Geneva, <sup>4</sup> Technical Officer, Polio, Vaccines and Biologicals, Regional Office for South East Asia (SEARO), New Delhi-India, <sup>5</sup> Senior Advisor, Early Childhood Development, UNICEF, New York, <sup>6</sup> Medical Officer, Focal Point for Micronutrients, Department of Nutrition for Health and Development, WHO Geneva, <sup>7</sup> Technical Officer, EPI, Department of Vaccines and Biologicals, WHO Geneva.

**Objective:** A study was carried out in Orissa, India at the request of the State Government to evaluate the impact of vitamin A (VA) supplementation integrated with an immunization campaign on vitamin A status. **Methods:** Data were collected from a representative sample of 1,811 children, aged 12 to 48 months, at baseline and then four and sixteen weeks following VA implementation. Primary outcome indicator was Serum Retinol. **Findings:** Coverage of VA supplementation was 97%. There was a significant decline in the prevalence of Bitot's spots from 2.9% to 1.9% at four weeks, but increased to 3.6% by sixteen weeks. There was a significant improvement in SR levels by the four week follow-up ( $0.62 \pm 0.32 \mu\text{mol/l}$  to  $0.73 \pm 0.23 \mu\text{mol/l}$ ), while mean SR declined between four weeks and sixteen weeks to a level below that observed at baseline. The greatest increase in SR from baseline to four week follow-up was among children with lowest baseline SR and children with X1B at baseline and remained above baseline levels by the sixteen week follow-up for both of these sub-groups. **Conclusion:** This study demonstrates the short-term benefits of vitamin A supplementation to be significant, especially for those whose status is most compromised. At the same time, the benefit of VA supplementation in this population was transient due to severe food deprivation, exacerbated by natural calamities. The positive impact of VA could not be sustained for the full 16 weeks in the study population. Appropriate measures to improve VA intake, such as decreasing the interval between VA supplementation dosages, reducing factors responsible for the decline in VA status, and taking more aggressive efforts to increase dietary intake of vitamin A should be put in place as part of a comprehensive VAD control strategy. The study demonstrates the feasibility of integrating VA supplementation with immunization campaigns.



**T25 VITAMIN A SUPPLEMENTATION DELIVERY SYSTEM FOR CHILDREN AND WOMEN IN TANZANIA.** J. K. L. Mugyabuso, G. Mulokozi, F. T. Modaha and G.D. Ndossi. Tanzania Food and Nutrition Centre (TFNC), Dar es Salaam.

**Issue addressed:** Vitamin A Deficiency (VAD) is a problem of public health significance in Tanzania. 24% of children aged 6-71 months had serum retinol levels below 20 micrograms/dL in 1997. Due to low utilization of vitamin A capsules (VACs) in primary health facilities, vitamin A supplementation (VAS) was integrated in Expanded Programme on Immunization (EPI). Low coverage in routine EPI led to incorporation of VAS in Sub-National Measles Immunization Days (SNMD), Day of African Child (DAC) and World AIDS Day (WAD). **Objectives:** To supplement children 6-60 months old and women within 4 weeks after delivery with VACs. **Conceptual Framework:** Multiple VAS approaches may increase coverage of the population at risk of VAD. **Program description:** VAS through routine EPI coverage children aged 9, 15 and 21 months, and postnatal women since 1997. VAS was integrated in SNMD in 30 and 52 of 113 districts of Mainland Tanzania in 1999 and 2000, respectively. The government opted for 2 doses of VACs annually to all children aged 6-60 months during DAC and WAD since 2001. **Process evaluation:** VAS is monitored through National Health Management Information System. VAS coverage for children at age 9 months was 55%, 69% and 79% in 1999, 2000 and 2001, respectively. 25% and 15% of children were correspondingly supplemented at age 15 and 21 months in 2000. Percentage of postnatal women supplemented between 1999 and 2001 increased from 45 to 53. During SNMD, 94% and 99% of children 6-60 months old were supplemented in 1999 and 2000, respectively. Coverage during DAC and WAD ranged from 80% to 91%. **Implications:** VAS is reaching many children at risk of VAD. A strategy will be developed to improve VAS of postnatal women and sustain DAC and WAD. **Supported by the Micronutrient Initiative, UNICEF, USAID, WHO, DFID, JICA, DANIDA, Rotary International and CDC.**

**T26 INSTITUTIONALIZING TWO-DOSE VITAMIN A SUPPLEMENTATION: FROM NATIONAL IMMUNIZATION DAYS TO CHILD HEALTH DAYS- EXAMPLES FROM TANZANIA AND THE PHILIPPINES.** Shekar, M; Mlay, B. (UNICEF Tanzania) and Aranas, C. (UNICEF Philippines).

**Background:** Annual Vitamin A supplementation for under-fives is now the practice in most countries, though few countries have programs to support 2 doses. Coverage data on routine supplementation are scarce and where available, are low. Most countries that introduced the first dose piggybacked this on to NIDs. With the winding down of NIDs, and the shift in NID target ages, the future of Vit-A supplementation is endangered, and no impact on under-five mortality is to be expected. **Programmatic implications:** To maximize the potential impact of Vit-A supplementation on mortality, where appropriate, countries need to be guided to think beyond NIDs. They need to introduce the 2nd dose, and examples of successful alternative strategies need to be widely disseminated. This paper attempts to do just that with examples from 2 countries. In the Philippines, high coverage was sustained through national micronutrient days for 1 dose. The 2nd dose was delivered through NIDs, but with the near-achievement of the polio goals these were scaled down to sub-NIDs. Vit-A supplementation was at-risk. A hasty decision was made to start child health days and other interventions were added. In Tanzania routine coverage has been low; NIDs are now sub-national, and measles campaigns are targeted at a different age group. Supplementation through NIDs has achieved >90% coverage but only in selected districts and with the phasing-out of NIDs, is unsustainable. In 2001 supplementation was included in the nation-wide activities linked to the Day of the African Child in June, and the World Aids Day in December. In 2002, other interventions are being added. Coverage rates in Tanzania were 80% and 91% for the 1st and 2nd doses respectively in 2001. In the Philippines, coverage was close to 80%. Both country examples have lessons for sustaining 2-dose supplementation and impact on mortality needs to be documented.

**T27 When Will Vitamin A Supplementation Be Taken Seriously?** Ram Shrestha, Sanjay Singh - NTAG; Sharada Pandey - MOH; Dr. Penny Dawson - JSI; Steve LeClerq - NNIPS; Kyoko Okamura, P.O. Blomquist, Pragyan Mathema - UNICEF

The periodic supplementation of high-dose vitamin A capsules (VAC - 200,000 IU) has shown that it can reduce childhood mortality by at least 23%. Despite the fact that no other single intervention has an equivalent impact on child survival, there is a common notion that vitamin A supplementation should be piggybacked on other public health interventions. Over the past years, VAC supplementation has been conducted in conjunction with National Immunization Days (NIDs). However, the NID is usually conducted once a year and will eventually phase out. These limitations of NID have also brought forth the possibility of inter-linking the VAC supplementation with the Routine Immunization Program. However, Routine Immunizations, promoted as the primary strategy for the post NID period only target children during their first 9 months thereby encompassing not even a quarter of the child's vital first 5-year period.

Thus the question arises on the rationale of either combining the VAC supplementation Program with other public health programs or to set up an individual intervention which will bring about a significant reduction in childhood mortality. Thus at this backdrop, an individual public health intervention is necessary to have a significant impact on child-hood mortality. Nepal's National Vitamin A Program (NVAP) is one such example of an individual intervention, which has brought vitamin A deficiency to a level that no longer constitutes a public health problem. The program is decentralized and builds on a community-based distribution system using more than 40,000 Female Community Health Volunteers trained by the Ministry of Health with initial one-year training support from Nepali Technical Assistance Group (NTAG). The program, initiated in 1993, has been implemented in 73 out of 75 districts, thereby reaching more than 3 million children bi-annually. Excellent coverage, above 80% has been achieved and documented by multiple sources. In addition, in 1998 the National Micronutrient Status Survey showed that the prevalence of Bitot's spots has been significantly reduced to only 0.37% compared to 3.1% during the program inception stage. The cost of bi-annual dose per child is estimated to be only 63 cents. The coverage rate is equally high in both 'new' and 'old' districts which no longer receive initial intensive external support. Thus these facts reveal sustainability and cost-effectiveness of this community-based system for VAC supplementation. This infrastructure built by the NVAP has enabled implementation of deworming at almost no extra implementation cost. The biannual deworming of children 2-5 years of age was integrated into the NVAP in 1999 and to date has covered 49 districts maintaining a similar high coverage of 88 - 91%. The deworming program is expected to be expanded in all the districts by 2004. Comparing deworming and non-deworming districts, VAC supplementation coverage is maintained high in both groups, indicating that inclusion of deworming has not disturbed the achievement of VAC supplementation. Similarly the 'Mini-surveys' conducted after each round of VAC supplementation round has incorporated monitoring of deworming, salt iodisation and iron supplementation.

The Nepali model of VITAMINA PLUS is a cost-effective and sustainable mechanism to, not only achieve high coverage of biannual vitamin A supplementation, but also to provide additional public health services to preschool age children. Appropriately designed and implemented vitamin A supplementation programs can serve as the engine for public health interventions instead of acting as the caboose.

**T28 SECOND DOSE OF VITAMIN A NATIONWIDE IN DR CONGO.** CLN Sita, MC Yandju, TN Tusuku, TK Ntambwe, and B Makambo. UNICEF, PRONANUT, USAID, Kinshasa, DRC.

**Issue:** A survey in 2001 showed that only 11.5% of children were adequately covered with vitamin A. Children were supplemented once a year during national immunization days (NIDs). There was little commitment to ensure a second dose. **Objective:** To implicate government and organizations to supplement 60% of children 6 months after NIDs. **Conceptual framework:** Infant and child mortality rate is 207 per 1000. In 1998, a national survey showed 61 % of serum retinol levels below 0,70µmol/l. Supplementing children in endemic areas can reduce infant and child mortality rates. Before 1997, vitamin A was associated with campaigns against measles, in 1997 with local immunizations days, and since 1998 with NIDs. **Description:** February 2002 was planned for a mass campaign. UNICEF, PRONANUT, USAID, health districts and communication experts prepared one project document, one guide and standardized tools. Selected health centers, parishes were used as supplementation sites. Video and audiotapes distributed over the country broadcast messages. Call - boys played a crucial role in mobilization. Vitamin A capsules, guides, tally sheets and reporting forms were made available. Supervision was important in initiating activities and in gathering data. Due to the complexity of the logistics, the initial 4-week period extended to April. Costs included posters, guides, broadcasting fees, management tools, launching ceremonies, fuel, distribution, briefing, supervision, and incentives. **Results:** Activities were implemented in 267 out of 321 (83%) health districts; 5,481,561 children supplemented represented a coverage of 61.7% in the planned districts and 52% nationwide. **Program implications:** In addition to routine activities, a mass campaign in a specific period, with reinforced logistics and supervision, is helpful in increasing adequate coverage rate among 6 to 59 months old children. Joint planning and common project documents are important for cost sharing and extensive coverage.

**T29 THE POTENTIAL CONTRIBUTION OF VITAMIN A DEFICIENCY CONTROL TO CHILD SURVIVAL IN SUB-SAHARAN AFRICA.** VM Aguayo and SK Baker. Helen Keller International (VMA, SKB) Africa Region.

**Background.** In 1998, vitamin A deficiency (VAD) prevalence estimates were developed to bring policy attention to VAD in countries with no VAD survey data. While these estimates have been critical in advancing VAD control policies in the last five years, we hypothesize that they significantly underestimate the prevalence of children at risk of VAD in SSA and underplay the contribution of VAD to child mortality in this region. **Aim:** To estimate the current prevalence of children at risk of VAD in SSA and to quantify the potential child survival benefits of policies and programs aiming at sustaining the delivery of vitamin A to children in this region. **Methods.** We estimated the average (weighted) observed and predicted VAD prevalence and observed/predicted VAD prevalence ratio in countries in SSA where a national VAD survey was conducted in the last five years. This ratio was used to estimate an adjusted prevalence of children at risk of VAD in SSA. The contribution of VAD to child mortality was then estimated combining the adjusted VAD prevalence and the observed child mortality effects of VAD. **Findings.** Nationally representative surveys conducted in 8 countries in SSA over the last five years show that the average (weighted) observed VAD prevalence is 2.2 times higher than that predicted in 1998. In SSA, an estimated 42.4% of under-fives (43.2 million children) are currently at risk of VAD. Effective VAD control can reduce child mortality by 25.1% from 1995 levels. **Interpretation.** VAD control has the promise to be one of the most cost-effective and high-impact child survival interventions in SSA. This analysis will be a powerful evidence-based advocacy tool to raise policy awareness of the need for strategies to sustain the delivery of vitamin A to children and of the potential child survival benefits of such policy and program action.

**T31 VITAMIN A NUTRITURE AMONGST PREGNANT WOMEN IN THREE URBAN SLUM COMMUNITIES OF DELHI: A PILOT STUDY.** Umesh Kapil, Priyali Pathak and Preeti Singh. Human Nutrition Unit, All India Institute of Medical Sciences, New Delhi, India

**Background:** Night blindness (NB) is widespread in South East Asia affecting 10-50% of pregnant women (PW). Its deficiency has been documented to play a significant role in the morbidity and mortality of the PW and the fetal outcome. **Aims:** Study was conducted to assess the nutriture of Vitamin A amongst PW and to assess the dietary intake of Vitamin A. **Methods:** All consecutive PW in the age of group of 17-40 years were included in the study. Eight hundred and twenty nine PW of II and III trimester attending antenatal clinic at an urban hospital catering to three slums communities in New Delhi constituted the study subjects. VAD was assessed by the presence of clinical symptoms of NB. A pre-tested semi-structured questionnaire was administered for assessing the presence of NB. The subjects with symptoms of NB were identified as suffering from VAD. Dietary intake of 10% subjects randomly selected was also assessed utilizing the 24 hour dietary recall methodology. Recommended dietary allowances suggested by the Indian Council of Medical Research for PW (sedentary worker) were utilized to assess the adequacy of vitamin A intake by the subjects. **Results:** Fifty four percent (n = 448) of the women were in II and 46% (n = 381) in III trimester. Prevalence of VAD amongst PW was 4.8 percent. Nearly 2.7% of PW reported NB also during their previous pregnancy. Results on dietary intake showed that 57% of the PW were consuming less than 50% of Vitamin A as compared to their RDA. Studies from Bangladesh and Nepal have also reported the prevalence of NB in 15-20% of PW. **Conclusion:** The present study highlighted VAD as a public health problem amongst PW of urban slum communities of New Delhi. There is a need of undertaking multicentric studies in different regions of the country.

**T30 VITAMIN ASITUATIONASSESSMENT IN MALAWI: RESULTS FROM THE NATIONAL MICRONUTRIENT SURVEY.** EA Bobrow1, HJ Mdebwe2, F Chimtolo2, D Butao2, T Banda2, D Thompson1, CH Buxton1, A Timmer1, R Chinula3, A Kalimbira4, D Chilima4, J Knowles1, K Sullivan1, I Parvanta1, L Grummer-Strawn1, and J Ortiz-Iruri4. 1Centers for Disease Control and Prevention, USA, 2Ministry of Health and Population, Malawi, 3National Statistics Office, Malawi, 4Bunda College, Malawi, 5UNICEF, Malawi.

**Background:** Through a CDC-UNICEF cooperative agreement, a national household and school-based micronutrient survey in Malawi was undertaken in September-October 2001. Objectives were to determine the prevalence of vitamin A deficiency, and to estimate levels of consumption of centrally processed sugar and oil to validate their use as vehicles for vitamin A fortification. **Methods:** All subjects (children 6-36mos, children 6-12y, women 15-45y, men 20-55y) were assessed for serum retinol on capillary blood samples collected into microtainers. Cut-offs for vitamin A deficiency were <20mcg/dL for children and <30 mcg/dL for adults. A targeted 24-hour recall assessed consumption patterns of centrally processed sugar and oil. **Results:** Vitamin A deficiency was found in 59.2% of young children, 38.3% of school children, 89.9% of non-pregnant women, and 81.8% of men. Overall, 64.4% of young children who had ver received a vitamin A supplement had one dose in the last six months. Only 34.9% of women received a vitamin A supplement within two-months of their last delivery. Half the women interviewed usually cook with oil and 61.2% usually have sugar in the house. Sugar use the previous day was 45.9% for children, 37.2% for women and 44.1% for men. Consumption of cooking oil the previous day varied by group (26.8% children, 36.8% women, 45.3% men). When consumed average amounts were similar for children, women and men. **Conclusion:** Vitamin A deficiency is a widespread problem, affecting all groups in Malawi. Sugar and oil are potentially good vehicles for fortification with vitamin A.

**T32 MICRONUTRIENT CONSUMPTION IN TRIBAL POPULATIONS :CASE STUDY ON BHIL TRIBE OF DANG DISTRICT, GUJARAT, INDIA.** L.Bhattacharjee\*, G.Kothari\*\*, V.Ramaswamy\*, H.Kuhnlein\*\*\*, B.K. Nandi\*, FAO Regional Office for Asia and the Pacific, Bangkok\*, Child Eye Care Charitable Trust, Mumbai, India\*\*, McGill University, Canada\*\*\*.

The food consumption pattern of 30 mothers and 42 preschool children from 187 tribal households showed foods mainly obtained from the jungle and local harvesting. Ninety-seven foods were identified - meat, poultry and fish being the most common foods, followed by pulses and green leafy vegetables. Twenty-nine foods were procured from the jungle, 26 foods were cultivated and 14 types of food were hunted. Rice was commonly consumed, while ragi (millet) was popular amongst lower income households. Fish was consumed by 27%, meat and poultry by 19% of households. While most foods were consumed throughout the year, six varieties of seafood and 5 types of green leafy vegetables were consumed during the monsoons. Frequency of intakes of micronutrient rich foods showed that both mothers and children took them about once or twice a week. Inter-relationships between the top ten foods rich in carotene, iron and Vitamin C taken from the traditional food list and consumption pattern of the study group was analysed. Carotene rich food sources like drumstick and fenugreek leaves were eaten by only 1%, while fruits and other vegetables were consumed by 3-6%. Among iron rich food sources, green leafy vegetables showed a consumption pattern of 0-2% while seafood showed a 3-6% consumption pattern. Amongst the Vitamin C rich foods, fruits showed a 1-2% consumption pattern while tomato showed 6% of families consuming them. As a move towards women's empowerment, the 'Vavli system' of land ownership and use is being promoted. These efforts need to be optimized towards improving the nutritional status of vulnerable members in the Bhil households.

- T33 NATIONAL SURVEY ON VITAMIN A ACTIVITIES MOROCCO 2000.** E Rjimat, Mr. Azelmat, A. Saad, R. El Aouad, A. Zerrari, H. Chekli, K. Loudghiri, Mr. Aljem, A. El Gandassi. Ministry Of Health

Following the survey on vitamin A deficiency carried out in 1996 by the Ministry of health which showed that 41 % of the children from 6 to 72 months suffer of this deficiency, a national strategy of prevention was started in 1998. This strategy is based on supplementation of children by vitamin A and promotion of consumption of foods rich with vitamin A. Three years after the starting of this activity, a National survey on supplementation of children by vitamin A was carried out by the Ministry of Health. The objective of this study is to determine the cover rate of the children by vitamin A. The sample size of this investigation was estimated at 2500 households (1404 in urban and 1096 in rural area). These households are divided into 104 clusters (55 in urban and 49 in rural area). This sample is sufficient to have significant results to 95 % and representative of area (urban or rural).

The analysis of the data of this investigation shows that: The proportion of the children less than 48 months having received at least one dose of vitamin A is 41. This proportion decreases with age. In urban area approximately half of children from 6 to 48 months received at least one dose of vitamin A. This proportion is about one child out of three in rural area. The proportion of the children from 6 to 48 months which received vitamin A in six months preceded the survey is more significant in urban area than rural area: 59.8% against 40.2%. The distribution of children from 6 to 48 months according to the place where they received the last dose of vitamin A shows that practically three children out of four have received it in the health center. The National Days of Vaccination contribute to this distribution by about 20%. In conclusion, the cover rate of the children by vitamin remains weak in Morocco. Training of the professionals of health were undertaken this year (2002).

- T35 VITAMIN A DEFICIENCY AND ANEMIA IN PRE-SCHOOL CHILDREN FROM SERGIPE, NORTHEAST BRAZIL.** MC Martins, LMP Santos, AMO Assis.

Vitamin A deficiency (VAD) and iron deficiency anemia (IDA) are among the most significant child health problems in Northeast Brazil, despite public policies in effect for many years. A state wide survey was conducted in Sergipe, Northeast Brazil, studying a sample of 598 children under five. Multiple stage cluster sampling was used to select a representative sample of households in the urban and rural areas of the state. The household visits were conducted by a team of trained health professionals, including nutritionists, who collected the dietary and anthropometric data. Height and weight figures were analyzed by the software Epi-Nut, with the NCHS growth curves as a standard, considering as inadequate indices below -2.0 standard deviations. Venous blood was collected by nurse aids and hemoglobin levels were determined by portable Hemocue instruments. Serum samples for retinol determination were immediately frozen and transported to the laboratory where the standard HPLC procedure was employed. The prevalence of VAD was 32.3% (serum retinol levels < 0.70 micromol/l) and of IDA 31.6% (Hemoglobin < 11.0 g/dl). Stunting (inadequate height for age) occurred in 11.6% of children and the prevalence of underweight (inadequate weight for age) was 9.9%. There was no statistically significant correlation between vitamin A deficiency, anemia and growth retardation for the whole group. However, among the stunted as well as the underweight children there was a significant overlap of these two micronutrient deficiencies. Of the non anemic underweight children only 36.1% presented VAD whereas 69.6% of the anemic underweight group had this deficiency. Among the non anemic stunted preschoolers 28.6% were vitamin A deficient but among the anemic ones 59.3% had VAD. Health planners and decision makers should be aware of the possibility of these deficiencies occurring simultaneously and take this into consideration when implementing public health policies directed towards this group.

- T34 THE MORTALITY RESPONSE TO THE VITAMIN A DISTRIBUTION PROGRAM IN NEPAL.** S Rutstein and P Govindasamy, ORC Macro, Calverton, MD

During the 1990s a vitamin A supplement distribution program for young children was progressively initiated in the 75 districts of Nepal. In the latter part of the 1990s, vitamin A supplements also began to be distributed nationally during the National Immunization Days. The purpose of the current analysis is to evaluate the impact of the distribution of vitamin A supplements on infant and child mortality. The 2001 DHS survey will supply the necessary data. 1. The unit of analysis will be a one-year period within each district for the 10 years preceding the DHS. Thus there are up to 750 cases, 10 for each of the 75 districts.

The dependent variables are the following mortality rates, calculated for each case: 6 to 11 months, 12-23 months, 24-59 months, and 6 to 59 months. The independent variables are a. the number of years since program began in the district, with -1 for times before program and districts without program, 0 for the year the program started, 1 for the year after the program began, and so on. (Assumes effect of program may increase over time); b. the recode of the above where all years 1+ after the program began are grouped into one. (Assumes effect of program constant over time); c. the dichotomous variable if year coincides with vitamin A NIDS; and d. the interaction between b and c.

The analysis utilizes the following as control variables: percent urban, region, percent of women with primary education or more, percent of women literate the mean wealth index value for the district, and time (calendar date) to adjust for an overall trend in mortality.

The program is considered to have effect if there is a significant difference in independent variable coefficients for periods before and after program start.

- T36 VITAMIN A DEFICIENCY AND ANEMIA IN CHILDREN AND WOMEN: FINDINGS FROM A NATION-LEVEL SURVEY IN MOZAMBIQUE.** R Thompson, S Khan, C Ismael, V Van Steirtighem, A Assante, S Meershoek. Ministry of Health (RT, SK, CI), UNICEF (VVS), WHO (AA), and Helen Keller International (SM).

Background: Previous studies have shown high risk of vitamin A deficiency and high prevalences of anemia in several parts of Mozambique. Yet no nation-level representative data are available about the extent and distribution of anemia and vitamin A deficiency in Mozambique. Such data are necessary to mobilize resources, design cost-effective interventions, and assess the impact of vitamin A deficiency and anemia control policies and programs including supplementation, food fortification, and dietary diversification. Objectives: The objective of this nationally representative survey was to determine the prevalence of vitamin A deficiency, anemia, and malaria infection in preschool-age children and their mothers. Methods: A nationally representative survey was conducted using a 2-step proportional-to-population size sampling method. The sample included 719 children 6-59 months old and their mothers. Serum retinol concentration and serum transferrin saturation capacity were measured using the 'dried blood spot' method (DBS). DBS was used as among the population strong resistance exist against taking venous blood. It was also very difficult to create proper conditions to treat and preserve venous blood in field settings in rural Mozambique. Samples were analyzed using high performance liquid chromatography (HPLC). Blood hemoglobin concentration was measured in capillary blood using the HemoCue™ portable hemoglobinometer. Malaria parasite prevalence and density was estimated by parasite counting on Giemsa stained blood smears. Results and Conclusions: Data are currently being analyzed. The most salient findings of this first ever nationally representative survey on vitamin A deficiency and anemia will be presented at the 2003-IVACG Meeting. These findings will inform policy development and accelerate the design and implementation of cost-effective programs for the control of vitamin A deficiency and anemia in preschool-age children and women of reproductive age.



- T37** COEXISTENCE OF VITAMIN A DEFICIENCY AND ANEMIA AMONG CHILDREN LIVING IN URBAN SLUMS IN DHAKA CITY, BANGLADESH. M A Wahed, K Kongsbak and S H Thilsted. ICDDR, B: Centre for Health & Population Research, Dhaka and Research Department of Human Nutrition, The Royal Veterinary and Agricultural University, Denmark. Background: Vitamin A deficiency (VAD) and anemia are important, high priority health problems among children in developing countries. Vitamin A supplementation has been practiced for several years to prevent VAD among preschool children. Aim: As a prelude to a randomized dietary trial of fish curry rich in vitamin A among marginally VAD children (3-7 yrs), this study aimed to determine the occurrence of VAD and anemia. Methods: We mapped 553 households from 4 urban slums in Dhaka city. We identified 673 apparently healthy children who had not received vitamin A or mineral supplementation during the past 6 months. To identify VAD children, blood was collected and the serum retinol estimated in 579 children using HPLC technique. Hemoglobin (Hb) was also measured in 403 of these children using Hb-kit from Sigma. Serum retinol levels <0.35  $\mu\text{mol/L}$  and 0.35 to 0.70  $\mu\text{mol/L}$  were categorized as severe and marginal VAD, respectively. A Hb level <11 g/dl was considered anemic. Results: The mean serum retinol was significantly ( $p < 0.03$ ) lower in boys ( $0.82 \pm 0.3 \mu\text{mol/L}$ ) than girls ( $0.87 \pm 1.3 \mu\text{mol/L}$ ). Marginal VAD was significantly ( $X^2 = 7.49$ ,  $p < 0.01$ ) higher among boys (36.5%) than girls (25.8%). One-half of the children tested (53%) were anemic. The mean Hb level was ( $10.8 \pm 1.3$ ) in preschool children (3-5 yrs) was significantly lower ( $p < 0.001$ ) than that of older children ( $11.2 \pm 1.1$ ). Anemia was more prevalent among preschool-aged children (67%). There was a high correlation ( $r = 0.3$ ,  $p < 0.005$ ) between the occurrence of anemia and VAD. Conclusion: The prevalence of anemia and VAD remains high among children. Male children appear to be at higher risk of marginal VAD and younger children for anemia. Intervention strategies should be planned taking into consideration the likely coexistence of VAD and anemia. (Thrasher Research Fund).

- T38** VITAMIN A DEFICIENCY AND PROTEIN-ENERGY MALNUTRITION ARE THE ANTECEDENT RISK FACTORS FOR MATERNAL NIGHT BLINDNESS. T Jiang, KP West, Jr., L Wu, P Christian, SK Khatri, M Dreyfuss, A Sommer. Maternal night blindness (MNB), attributed to vitamin A (VA) deficiency, affects 10-20% of pregnant women in many developing countries, usually occurring in the latter half of pregnancy. It is associated with a high risk of maternal morbidity and mortality. Beyond VA deficiency, protein-energy malnutrition (PEM) may act as antecedent cause of MNB. Using placebo group data from a community-based, maternal VA supplementation trial in Nepal, we compared antecedent mid-gestational (mean = 21 wk) biochemical and anthropometric status of women who later developed MNB to the status of pregnant women who never developed MNB. Cases had lower antecedent, mid-gestational serum levels of retinol:  $0.84 \pm 0.41$  (mean  $\pm$  SD) ( $n = 43$ ) vs.  $1.15 \pm 0.36$   $\mu\text{mol/L}$  ( $n = 84$ ) ( $p < 0.0001$ ). The lower the serum retinol, the sooner MNB subsequently occurred. Night-blind women also had lower serum retinol binding protein (RBP) ( $1.07 \pm 0.32$  vs.  $1.33 \pm 0.42$   $\mu\text{mol/L}$ ,  $p < 0.001$ ) and transthyretin (TTR) ( $3.45 \pm 0.76$  vs.  $4.05 \pm 1.03$   $\mu\text{mol/L}$ ,  $p < 0.0004$ ) than controls. Serum retinol and TTR were correlated in both cases ( $r = 0.57$ ,  $p < 0.0001$ ) and controls ( $r = 0.26$ ,  $p < 0.02$ ). Moreover, women who developed NB in later pregnancy had a smaller antecedent mid-upper arm circumference (MUAC) ( $-0.5$  cm,  $p = 0.08$ ), lower weight ( $-1.9$  kg,  $p = 0.08$ ), and shorter height ( $-2$  cm,  $p = 0.08$ ) than control. Thus, PEM as well as VA deficiency precede the incidence of MNB in rural Nepalese pregnant women. (Funding: by the USAID Ofc of Health and Nutrition, Sight and Life Research Institute, and the Bill & Melinda Gates Foundation).
- T39** POVERTY-LINKED VITAMIN A DEFICIENCY (VAD) IN JORDAN IS ENDEMIC AND COUPLED WITH COMPROMISED VITAMIN E STATUS. IMD Khatib and SS Hijazi. Department of Community Medicine, Medical School, Jordan University of Science & Technology, Irbid - Jordan. Background: This two part-survey was meant to check the reliability of a preceding finding that prevalences of subclinical VAD and anemia of young Jordanian children in poor areas reached 22% and 19%, respectively. Aims: To explore the problem-dimensions of VAD in poorer children and test the efficacy of interventional approaches. Methods: In the survey baseline part, 468 young school children aged 6-9 years were randomly selected from eight rural districts and had their serum retinol (SRC) and alpha-tocopherol (STC) concentrations measured along with basic hematological parameters. Anthropometry and dietary assessment were performed. Then, 136 children from one study-area were divided into three matching groups: G1 (study group) children received, over the whole 6 month-study period, a mid-morning snack foods providing 25 % of the basic nutritional needs. G1 and G2 (control) were supplemented with a single VA-capsule of 200,000 i.u., one month before the final assessment. G3 (VA-reference) received no supplement. All groups were exposed to an intensive nutrition education activity. Results: Baseline VAD and anemia prevalences were 32.9 %, and 19.9 % respectively. Mean SRC was  $222$  ( $\text{sd} \pm 56$ )  $\mu\text{g/l}$ , and STC  $8.2$  ( $\text{sd} \pm 1.8$ )  $\text{mg/l}$ . SRC correlated strongly with STC ( $r = .32$ ;  $p < .001$ ). 91% of subjects had their SRC < 300  $\mu\text{g/l}$ . Normal and VAD children had different ( $p < .001$ ) vitamin E statuses. SRC was a determinant of serum ferritin level ( $p < .5$ ). Final SRC was greater for G1 [ $241$  ( $\pm 57$ )  $\mu\text{g/l}$ ] compared with G2 [ $214$  ( $\pm 50$ )  $\mu\text{g/l}$ ], ( $p < .05$ ), and G3 [ $203$  ( $\pm 36$ )  $\mu\text{g/l}$ ], ( $p < .001$ ); no difference between G2 and G3 could be detected. The snack foods enhanced capsule-supplementation impact in boosting up SRC. Conclusion: The 32.9% VAD-prevalence in a Middle Eastern community is profoundly alarming; it indicates a worse problem among the under 5 y-children. In such a situation, it is a national health priority to phase in a VA-Program that recognizes the problem dimensions and its relevant interventional options.

**T40 INTERACTION BETWEEN VITAMIN A AND IRON STATUS EVALUATION OF VITAMIN A SUPPLEMENTATION STRATEGY IN MOROCCO.**

R.Lourhaoui and R.Belahsen.

**Background:** Nutritional anaemia constitutes a real problem of public health the world over, particularly in developing countries, children are more touched by this pathology. **Aims :** The aim of this study was to evaluate the effect of strategy of supplementation with vitamin A on anaemic states in a population of children from El Jadida province of Morocco. **Methods:** A sample of 300 preschool children are sampled from the rural and urban areas of El Jadida province. The status of iron was determined by biochemical indicators of iron metabolism and the estimation of dietary iron intake using the 24 hours dietary recall. Socioeconomic data questionnaires and anthropometric measurements are also examined. **Results:** the results show that anaemia (haemoglobin (12g/dl) is prevalent in approximately 78% of children and that among the anaemic children only 37% have not received vitamin A supplementation. **Conclusion:** these results show that anaemia persists after supplementation in vitamin A in at least 63% of the population studied.

**T41 ENHANCED VITAMIN A IN SERUM, LIVER, AND MILK IN LACTATING SOWS FOLLOWING A DOSE OF PREFORMED VITAMIN A.** KL Penniston and SA Tanumihardjo. UW-Madison, Dept. of Nutritional Sciences, Madison, WI, USA.

**Background:** Vitamin A deficiency is endemic in developing countries, particularly in lactating women and infants. The efficacy of high retinyl ester dose interventions to lactating women has been inadequately studied. **Aim:** Determine the time course of retinol, retinyl esters, retinoic acid, and vitamin A glucuronides in serum and the effect of the dose on liver and milk vitamin A concentrations. **Methods:** Lactating sows were provided 300 or 600 mg retinyl ester (comparable to amounts/BW given to women in Africa). Blood and milk was collected over 48 h and analyzed by HPLC. Livers were collected from each dose group and analyzed. **Results:** Total serum vitamin A peaked at 1 h (2.0 micromole/L) and 2 h (4.0 micromole/L) in the lower dose (LD) and higher dose (HD) groups, respectively, up from 0.45 micromole/L at baseline, and returned to baseline by 48 h for both groups. Serum retinol, which did not change significantly during the time period, accounted for approximately 80% of serum vitamin A at baseline but only 22% and 13% of total vitamin A at peak times for LD and HD groups. The glucuronides rose significantly in both dose groups at peak time points ( $P=0.0006$  and  $P=0.02$  for HD and LD groups, respectively) but returned to baseline by 48 h. An increase in retinoic acid was not observed. Hepatic vitamin A for control (C) animals and the two dose groups in micromole/g wet tissue were: 1.1 and 1.8 (C),  $2.7 \pm 1.2$  (LD), and  $4.8 \pm 0.52$  (HD). Liver histology suggested no toxicity in dosed animals. Milk vitamin A showed a significant treatment ( $P=0.0019$ ) and time effect ( $P=0.0001$ ) but no difference between dose groups. Milk vitamin A peaked between 12 and 24 h to 9X baseline but fell to 4X by 48 h. **Conclusions:** If timed to minimize potential teratogenicity, 200,000 or 400,000 IU vitamin A provided to lactating women appears effective in enhancing liver stores and may provide non-dietary vitamin A for milk synthesis via enhanced serum vitamin A, but only for 48 h.

**T42 ANTIOXIDANT PROTECTION AND PROOXIDANT STRESS IN MALNUTRITION.** F-Z Squali Houssaïni, MR Iraqi, J Arnaud, A Favier. Laboratoire de Biochimie, Faculté des Sciences Dhar Mehraz, BP 1796, Atlas Fès Morocco.

**Background:** Protein-calorie malnutrition is commonly associated with inadequate vitamin A status. In Morocco, malnutrition is a public health problem. Indeed 25% of 6- to 60 month old children suffer from malnutrition. These children show a higher mortality rate and a higher incidence of severe infection than do vitamin A sufficient children. Vitamin A is an antioxidant protection factor. **Aims:** To identify imbalance between antioxidant protection and prooxidant stress in malnourished children. **Methods:** Blood antioxidant vitamins (retinol,  $\alpha$ -tocopherol and carotenoids), trace elements (serum zinc, copper and selenium) and enzymes (erythrocyte Se glutathione peroxidase and Cu-Zn superoxide dismutase) as well as blood oxidative stress index [ferritin, thiobarbituric-acid reactants (TBARS)], in 21 children suffering from severe malnutrition, 15 children suffering from mild malnutrition and in 20 healthy control children, were determined. **Results:** Selenium, retinol,  $\alpha$ -tocopherol and carotenoids were significantly decreased in malnourished children. These decreases were related to severity of malnutrition. Moreover, the percentage of vitamin and trace element concentrations under deficient cutoff were high in malnourished children. On the contrary, TBARS, ferritin and prognostic inflammatory and nutritional index (PINI) were significantly increased in malnourished children. On the other hand, blood retinol,  $\alpha$ -tocopherol,  $\beta$ -carotene and selenium were negatively related to  $\alpha$ -acid glycoprotein. Blood  $\beta$ -cryptoxanthin, lycopene, carotenes and copper were positively related to weight. Finally, blood lutein/zeaxanthin and copper were positively related to height. **Conclusion:** These results confirm the imbalance between antioxidant protective factors and oxidative stress index in malnourished children. Moreover, the decrease in antioxidant protective factors is related to inflammation or stature. These results suggest that antioxidant micronutrient supplementation of the refeeding diet could be required in the nutritional rehabilitation of malnourished children.

**T43 VITAMIN A DEFICIENCY AND RISK FACTORS AMONG PRESCHOOL AGED CHILDREN IN POHNPEI, FEDERATED STATES OF MICRONESIA.** CM Yamamura, KS Sullivan, F van der Haar, SB Auerbach, AL Sowell. Emory University School of Public Health, Atlanta Health Resources and Services Administration, New York, Centers for Disease Control and Prevention, Atlanta, USA.

**Background:** Studies during 1987-92 revealed clinical vitamin A deficiency (VAD) and reported >50% of children aged 24-48 months with deficient serum retinol ( $\leq 20 \mu\text{g/dL}$ ) in Chuuk, one of four FSM States. In 1993, the FSM Department of Health conducted a population-based stratified random vitamin A survey in Pohnpei, including 355 children aged 24-48 months. The present study reports on associations between VAD and risk factors among the children surveyed. **Objectives:** Determine VAD prevalence and explore VAD risk factors among preschool children in Pohnpei. **Methods:** Data were collected from a range of demographic, dietary and socioeconomic variables related to the child. Simple frequencies and two-by-two tables were created of each variable with VAD (yes/no). Significant variables were entered in logistic regression analysis, VAD being the dependent variable. **Results:** The serum retinol concentration was  $19.4 \pm 7.5 \mu\text{g/dL}$  (mean  $\pm$  SD), and the VAD prevalence among children surveyed was 53.1%. Independent risk factors identified were: Mother's work at home, sibling < 2 years older, rural household located on the main island, improper breast feeding, and child anemia ( $\text{Hb} < 11.0 \text{ g/dL}$ ), controlling for pipe water and electricity in the household. Compared to a U.S. reference of apparently healthy preschoolers of similar age, the entire distribution of serum retinol among the Pohnpei preschoolers was significantly shifted to lower levels. **Conclusion:** With the majority of children in Pohnpei affected by VAD, conventional risk factor analysis is limited for guiding an intervention design. **Recommendations:** We conclude that eliminating the pervasive VAD problem in Pohnpei would require a multi-pronged tactical approach that combines dietary improvement strategies with the ongoing supplementation effort.

**T44 COST ANALYSIS OF THE NATIONAL VITAMIN A SUPPLEMENTATION PROGRAMS IN GHANA, ZAMBIA AND NEPAL: SYNTHESIS OF THREE STUDIES.** Bechir Rassas. Micronutrient Opportunities, Strategies and Technologies (MOST) Project, Arlington, Virginia, USA

**Background:** A variety of vitamin A supplementation programs have been implemented in developing countries, but little is known about their costs. **Objective:** Provide researchers and policymakers with cost information on vitamin A supplementation. **Methods:** This paper is based on three recent studies on the cost of three national vitamin A supplementation programs. Each program is based on a form of periodic distribution to all children 6 to 59 months of age. Effective promotion of the special events surrounding the distribution has led to high coverage in the three countries. Analysis in the three studies was performed using data collected from primary and secondary sources. The methodology used to estimate costs combined two common approaches to cost analysis, the expenditure approach and the ingredients approach. The paper describes the main characteristics of the three programs and analyzes their cost structure. **Results:** Costs were divided into three categories: program-specific, personnel and capital costs. It was found that personnel costs (including volunteers) were highest and capital costs lowest. Analysis of cost per child covered and cost per death averted suggests that vitamin A supplementation is highly cost-effective. **Conclusion:** When costs are considered, Vitamin A supplementation compares favorably with other primary health care interventions.

**T46 HIGH-DOSE MATERNAL AND INFANT VITAMIN A SUPPLEMENTATION IN RURAL KENYA.** R Ayah,<sup>1,2,3</sup> A Tedstone,<sup>1</sup> T Marshall,<sup>1</sup> H Friis,<sup>2</sup> KF Michaelsen,<sup>2</sup> DL Mwaniki.<sup>3</sup> <sup>1</sup>London School of Hygiene & Tropical Medicine, U.K., <sup>2</sup>Kenyan-Danish Health Research Project, and <sup>3</sup>Kenya Medical Research Institute, Nairobi, Kenya.

**Background:** Vitamin A (VA) supplementation (VAS) has been recommended by WHO as a cost-effective strategy to control VA deficiency (VAD). Recent consultations have led to an increase in the recommended VA doses for both lactating women and infants living in VAD regions. These new proposed doses have not been tested. **Aim:** To assess the adequacy of high dose maternal (400,000 IU) and infant VAS (100,000 IU) to improve VA status 6-months postpartum. **Methods:** A 2x2 factorial randomised double-blind placebo controlled trial. Pregnant women were followed up to delivery. Mothers of singletons were immediately randomised to 400,000 IU VA or placebo, and the infants to 100,000 IU or placebo with DPT/OPV immunization at age 14 weeks. Maternal serum and breast milk retinol; infant serum retinol and MRDR ratios were assessed at weeks 14 and 26. **Results:** Mean s-retinol concentration of mothers at baseline was 0.81µmol/L (95% CI: 0.79; 0.93) and of infants at week 14 was 0.91µmol/L (CI: 0.89; 0.93). The corresponding proportion of mothers and infants with low s-retinol was 33.3% (CI: 29.1; 37.4) and 16.2% (CI: 11.1; 21.3) respectively. Maternal VAS increased milk retinol over 6-months, when expressed as volume [0.07µmol/L, CI: 0.004; 0.140 at week 4; 0.08µmol/L, CI: 0.03; 0.13 at week 14, and 0.05µmol/L, CI: 0.003; 0.100 at week 26]. However when milk retinol was corrected for fat content, there was a significant increase only at week 4 (0.006µmol/g, CI: 0.001; 0.010). Infant VAS improved liver retinol stores (decrease in MRDR ratio) at week 26 (-0.01, CI: -0.020; -0.005). **Conclusion:** The new higher doses demonstrated significant benefits to lactating mothers and their infants, which are likely to be of public health significance. VAS did not however correct underlying VAD during early lactation. The benefits of these proposed higher doses should be examined in other populations where VAD continues to be of public health concern. **Funding Acknowledgement:** Danish International Development Assistance Agency (DANIDA).

**T45 COST-EFFECTIVENESS OF DELIVERING LOW DOSE VITAMIN A INTEGRATED WITH OTHER COMMUNITY HEALTH ACTIVITIES IN VIETNAM.** T Tuan, VTM Dung, TD Thach, NX Ninh, HV Thang, NC Khan, E Boy, J Cervinskas. Center for Research and Training on Community Development, Hanoi, National Institute of Nutrition, Hanoi, Vietnam and Micronutrient Initiative, Canada. **Purpose:** To assess the cost-effectiveness of monthly vitamin A supplementation integrated with other community health interventions to reduce the burden of vitamin A deficiency (VAD) among children in rural Vietnam. **Methods:** A community-based RCT was conducted in a district of northern Vietnam (population 79,000). In ten intervention communes, monthly administration of 50000 IU vitamin A for children 6-35 months and biannual administration of 200,000 IU for women post partum took place during 12 months as part of routine immunization (EPI) and in combination with iron supplementation for women of child-bearing age. Ten control communes were subject to normal public health interventions (biannual vitamin A supplementation for children, routine EPI, iron supplementation to targeted groups of women and children). Baseline, mid-term, and final assessment of serum and breast milk retinol were carried out with representative samples. HPLC was used to measure serum and breast milk retinol. All costs incurred during project implementation for either type of communes were recorded. **Results:** After one year of intervention, prevalence of children with serum retinol below 0.7µmol/L decreased from 15% to 1.5% in the intervention group, compared with 16.7% and 9.9% in the control (P=0.0029). Coverage rates for VA supplementation among children at the intervention and control communes were 98% and 97%, respectively. Prevalence of women with breast milk retinol <1.05µmol/L dropped from 63% to 31.9% in the intervention, and from 58% to 39% in the control. Coverage rates for VA supplementation among women at intervention and control communes were 86% and 50%, respectively. The project cost per person in whom vitamin A deficiency was prevented was US\$19.15 for children and \$8.28 for women (average \$14.42). The project cost for delivering one-year-low dose vitamin A to children 6-35 months is \$3.44. The cost of monthly vitamin A supplementation after 6 months of running the integrated model consisted of supplements (41%), supervision (36%), and administration (23%). When the monthly vitamin A supplementation became fully integrated into the commune health system, the cost for a child 6-35 months to receive a full year schedule of monthly doses of 50000IU vitamin A capsules was US\$0.57, compared with US\$0.31 for the biannual supplementation in the control group. The estimated cost per life saved with the monthly vs biannual supplementation schedules were \$2.58 (when fully integrated) and \$3.06, respectively. **Conclusions:** At a cost of \$0.57 per child per year, the Vietnamese model of monthly supplementation integrated with other community health activities is more effective in reducing the prevalence of VAD among children from moderate to a level where it no longer is a public health problem. However, notwithstanding coverage rates of 50% and 86%, supplementation was not as effective in reducing the prevalence of vitamin A deficiency from its currently severe level in this group as assessed by breast milk retinol.

**T47 PHARMACOKINETICS OF VITAMIN A IN NON-PREGNANT WOMEN AND IMPACT ON SAFETY.** D Hornig, S Hartmann, D Hartmann, J Bausch, D Bienz, U Wiegand, R Blomhoff. Roche Vitamins Ltd, Basel, Switzerland and Department of Clinical Nutrition, University of Oslo, Oslo, Norway.

**Background:** Excessive vitamin A intake like vitamin A deficiency, causes birth defects in animals and possibly in humans. Data available on incidence of malformations in humans are insufficient to define a reliable estimate of the upper safe intake during human pregnancy. **Aim:** Evaluate the plasma concentration time curves of retinol, retinyl esters, and their metabolites in non-pregnant females at 3 doses of vitamin A and its impact on safety. **Methods:** In a study with 3 parallel groups (each n=12), non-pregnant females (18-40 yrs) received a daily supplement of vitamin A palmitate (4000, 10000 and 30000 IU) for 21 days. Dietary vitamin A intake was controlled at 1 RDA. Plasma concentration time curves were established at d -3 (baseline), d 1 (single dose) and d 21 (repeated doses). The AUC<sub>24h</sub> was used as indicator for exposure. **Results:** Plasma retinol concentrations were not altered. Dose-concentration response was linear for retinyl esters. All-trans-retinoic acid (all-trans RA) exhibited a diurnal-like concentration-time profile with C<sub>max</sub> at 3h and C<sub>min</sub> below pre-dose concentrations at 8h. The maximum temporary increase in exposure to all-trans-RA acid 24h was 33 % (single dose) and 19% (repeated doses) above baseline. Due to the 'undershooting' below pre-dose concentrations, the overall exposure AUC<sub>24h</sub> to all-trans RA after single and repeated doses remained unaltered with all doses. 13-cis RA and 13-cis-4-oxo-RA AUC<sub>24h</sub> increased linearly with dose. Accumulation of repeated doses was max. 25% for 13-cis RA and on average 70% for 13-cis-4-oxo RA. **Conclusion:** Repeated oral daily intakes by non-pregnant females of up to 30000 IU of supplemental vitamin A over 3 weeks resulted in plasma concentrations of all-trans RA and metabolites, earlier shown to be without increased risk of teratogenicity. The results indicate that the potential teratogenic intake of vitamin A is considerably higher than 10000 IU/day, as has been suggested earlier from epidemiological studies.



**T48 IMPACT OF VAS OF MOTHERS AND BABIES ON INFANT MORTALITY, HIV MTCT AND NEW MATERNAL HIV INFECTIONS.** J. Humphrey, ZVITAMBO Study Group. Univ of Zimbabwe (Harare), Harare City Health Dept, Ctr for Human Nutr (Johns Hopkins Bloomberg School of Public Health, Baltimore, MD), and Montreal General Hospital Research Institute (Canada).

Two trials documented substantial reductions in infant mortality following vitamin A supplementation (VAS) of neonates during the first couple days of life. Several studies have suggested that maternal VA deficiency is a risk factor for mother to child transmission (MTCT) of HIV, but 3 trials of daily VAS to pregnant and post partum HIV positive (pos) women found no benefit, and one observed a significant adverse effect. Finally, animal data and limited human data indicate that vaginal epithelium is sensitive to the earliest stages of VA deficiency: the tissue cornifies and loses integrity but quickly responds to VAS.

The ZVITAMBO trial enrolled 14,110 mother-infant pairs within 72 hrs of delivery. Multiple births, babies <1500 g, babies and mothers with acutely life threatening conditions, and those unavailable for follow up were excluded. Pairs were randomized to 1 of 4 groups (maternal dose=400,000 IU; infant dose=50,000 IU): mother-VA and baby-VA, mother-VA and baby-placebo, mother-placebo and baby-VA, both placebo. All mothers were tested for HIV at delivery. Pairs were followed at 6 wk, 3 mo, and then 3 monthly for 12 to 24 mo. Similar to national statistics, 32.5% of the mothers were HIV pos at delivery. A further ~300 (some indeterminate samples await PCR confirmation) mothers seroconverted during the two years post partum. 1098 infants died, 898 born to HIV pos mothers and 200 born to HIV neg mothers. PCR analysis of infant samples is on-going and will be completed before the end of 2002. The 3 major outcomes of the trial will be presented: infant mortality, post-partum MTCT, and incident HIV infection among post partum women. Funded by Canadian International Development Agency, United States Agency for International Development, Rockefeller Foundation, Linkages Project (AED).

**T50 VITAMIN A SUPPLEMENTATION AND CHILDHOOD MORTALITY: AMPLIFICATION OF THE NON-SPECIFIC EFFECTS OF VACCINES?** C Benn, Balé C, Sommerfelt H, Friis H, Aaby P. Projecto de Saude de Bandim, Guinea-Bissau, Department of Epidemiology Research, Statens Serum Institut, Denmark, Centre for International Health, University of Bergen, Norway, Research Department of Human Nutrition, Royal Veterinary and Agricultural University, Denmark.

The literature on vitamin A supplementation and mortality in developing countries involves a paradox: supplementation at birth and after 6 months of age is associated with marked reductions in mortality, whereas supplementation between 1 and 5 months of age has no effect on mortality. The current interpretation that the effect of vitamin A supplementation is due mainly to the prevention of vitamin A deficiency is not able to explain this paradox.

The mortality age pattern following vitamin A supplementation is similar to the mortality pattern observed for routine vaccinations, with a larger than expected reduction in mortality after Bacille Calmette Guérin (BCG) vaccine given at birth and measles vaccine given at 6 to 9 months of age, but not the expected reduction in mortality after diphtheria-tetanus-pertussis (DTP) vaccine given between 1 and 5 months of age. Vitamin A enhances cellular and humoral immune responses. We suggest that the effect of vitamin A supplementation is partly due to vitamin A amplifying the non-specific effects of vaccines given during infancy.

This hypothesis would explain not only the contradictory mortality age pattern, but also solve several enigmas in the current literature on the effect of vitamin A supplementation on infant mortality in developing countries. It could for instance explain why a small dose of vitamin A may be better than a large one, and why normal birth weight children but not low birth weight children seem to benefit. Furthermore, we reanalyzed data from a trial in Guinea-Bissau and found that the mortality effect of vitamin A supplementation was significantly dependent on the type of vaccine that was given at the time of vitamin A supplementation ( $p=0.02$ ).

If the effect of vitamin A supplementation depends on enhancing the non-specific effects of vaccines, it has implications for vaccination-linked vitamin A supplementation programs in developing countries.

**T49 IMPACT OF NEWBORN VITAMIN A DOSING ON CASE-FATALITY FROM COMMON CHILDHOOD ILLNESSES.** JM Tielsch, L Rahmathullah, RD Thulasiraj, J Katz, S Devi, C Coles, Rajesh, Kartik. Dept. of International Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD and Aravind Centre for Women and Children, Madurai, India.

Background: Vitamin A supplementation reduces mortality of young children, but has little impact on the attack rates of common childhood illnesses. We assume that vitamin A acts to decrease severity and lower case-fatality. Most studies have not been designed to directly assess this claim. Aims: To compare the case-fatality for episodes of diarrhea and ARI between newborn infants randomized to receive either 48,000 IU vitamin A or placebo in the first 2 days after birth. Methods: A community-based randomized trial was conducted Tamil Nadu, India. Newborn infants were randomized to receive either oral doses of 24,000 IU vitamin A or placebo on each of days 1 and 2 following birth. Infants were followed every 2 weeks until 6 months of age at which time they were given 100,000 IU vitamin A and discharged. Morbidity was assessed by asking the mother about signs and symptoms of illness for each day in the prior 2 weeks. Episodes of diarrhea and ARI were constructed from the daily reports for each child. Mortality was examined for infants with episodes of illness and the case-fatality calculated separately by treatment group. We also compared the case-fatality between treatment groups by the number and duration of episodes of illness and by time since episode. Results: 13,173 deliveries were completed resulting in 13,294 infants. 23 refused, 1027 infants migrated and 625 were stillborn or died prior to enrollment. This left 11,619 live-born infants enrolled and followed, 5833 (50.2%) in the placebo group and 5786 (49.8%) in the vitamin A group. Early infant mortality was reduced by 21% ( $p<0.05$ ), but there was no impact of vitamin A on the incidence or duration of morbid episodes. There was a significant reduction in case-fatality in the vitamin A group compared with the placebo group. Case-fatality by treatment groups for varying time lags between the onset of the episode of illness will be presented.

**T51 THE EFFECT OF VITAMIN A SUPPLEMENTATION ON IGG TITER: A STUDY FROM CENTRAL JAVA, INDONESIA.** A Pratiwi, H. Hadi, and MH Soesatyo, Department of Public Health, and Department of Cell Biology, Faculty of Medicine, Gadjah Mada University, Yogyakarta, Indonesia.

Background: Although the Universal Child Immunization (UCI) has been reached in most of Indonesian area, measles outbreaks still exist. In Central Java with measles immunization coverage of 96%, measles is still prevalent. This might be due to low IgG titer following measles immunization. Aims: To examine the effect of vitamin A supplementation on IgG titer of the babies immunized with measles vaccine. Methods: This study was a non-equivalent control group design and was carried out in Central Java. Subjects of this study were 104 babies aged 9-11 months. A half of the babies ( $n=52$ ) received 100,000 IU of vitamin A 3 months ( $n=26$ ) or 1 week before measles immunization ( $n=26$ ). The other half ( $n=52$ ) of the babies received no vitamin A. The serum IgG titer was determined by ELISA Technique 1 month after immunization. Results: Overall, the IgG titer was  $44.3 \pm 20.4$  g/L (mean  $\pm$  SD) in children receiving vitamin A compared to  $7.9 \pm 13.5$  g/L in children receiving no vitamin A before measles immunization. Children receiving vitamin A 3 months before measles immunization had  $26.9$  g/L (95% CI=  $19.3$  g/L;  $34.5$  g/L) higher in IgG titer than those children receiving no vitamin A. Children receiving vitamin A 1 week before measles immunization had  $46.0$  g/L (95% CI=  $38.4$  g/L ;  $53.6$  g/L) higher in IgG titer than those children receiving no vitamin A and they had  $19.0$  g/L (95% CI=  $8.9$  g/L ;  $29.1$  g/L) higher than those children receiving vitamin A 3 months before immunization. Conclusions: Vitamin A supplementation before measles immunization increases the IgG titer. Vitamin A supplementation 1 week before immunization is more powerful to increase the IgG titer than vitamin A supplementation 3 months before immunization.

**T52 PUPILLARY DARKADAPTOMETRY: AN OVERVIEW.** N. Congdon, H. Lai, E. Schweitz, Dana Center, Johns Hopkins School of Medicine, Baltimore, MD, C. Neumann, UCLA School of Public Health, Department of Community Health Sciences, Los Angeles, CA.

**Background:** The pupillary threshold has been proposed as an index of dark adaptation (DA) for population assessment of vitamin A (VA) status. An overview of the technique is offered based on recent studies in Haiti, Nepal, Yemen, Kenya and Tanzania. **Methods:** Subjects consisted of pre-school (Tanzania) and school-age (Kenya) children and pregnant or lactating women (Nepal, Yemen, Haiti) in VA deficient areas. All subjects underwent a partial retinal bleach followed by 10 minutes of dark adaptation. Pupillary threshold was measured as previously described (AJCN 61:1076-1082): light from a hand-held device placed over the left eye was incremented until a pupillary response could be visualized in the dark-adapted fellow eye using a loupe and oblique illumination. **Results:** Except where VA status was not in the deficient range (Yemen) or the sample size small (Haiti), a significant correlation was observed between pupillary DA and other measures of VA status (Kenya, Tanzania). A significant response to VA dosing was also seen (Nepal). However, population DA thresholds, ranging from  $-0.10$  to  $-1.51$  log cd/m<sup>2</sup>, did not always vary as predicted by VA status. All investigators were trained by a single trainer (NGC), and another investigator (ES) was involved in field standardization in several studies. Machines were calibrated before and after use. Ambient light conditions prior to DA was a significant predictor of DA threshold (Kenya). Thus, it appears likely that variations in ambient light rather than lack of standardization between observers or machine error explains the unexpected variation. **Conclusion:** Standardization of ambient light conditions prior to dark adaptation may be an important method to further improve accuracy of this technique. A more complete retinal bleach or full 30 minute dark adaptation are alternatives, but might decrease the practicality of the technique.

**T54 REPORTED NIGHT BLINDNESS, THE NIGHT VISION THRESHOLD TEST AND SERUM RETINOL CONCENTRATIONS AS INDICATORS OF VITAMIN A DEFICIENCY.** B. Duncan, D. Genaro-Wolf, K. Shrestha, N. Shrestha, R. Schleicher, C. Pfeiffer, A. Sowell, J. Greivenkamp, D. Taren. University of Arizona, Tucson Arizona, Tribhuvan University, Kathmandu Nepal, National Eye Hospital, Kathmandu Nepal, U.S. Centers for Disease Control and Prevention (US CDC), Atlanta Georgia.

**Background.** Reported night blindness is used to determine if vitamin A deficiency (VAD) is a significant public health problem. **Aim.** To compare the classification of pregnant women as VAD using three methods: reported night blindness, the Night Vision Threshold Test (NVTT), and serum vitamin A concentrations (SVA). **Methods.** A total of 1401 pregnant women were screened for night blindness (XN) using the NVTT in the antenatal clinic of the Nepal National Maternity Hospital. Before taking the NVTT each woman reported if they currently had problems seeing at dusk or in the dark, and reported XN was determined. When a woman failed the NVTT (as defined by not seeing the dimmest light) another woman passing the NVTT was matched as a control, based on age, week of gestation, and parity. Blood samples were drawn from 174 case and 177 control subjects for SVA. Blood samples were analyzed at the US CDC. **Results.** In the total sample 6% were classified with reported XN and 16% failed the NVTT. Of the women with SVA < 10ug/dl, only 25% had reported XN while 100% failed the NVTT. Of the women with SVA < 20ug/dl, only 19% had reported XN while 73% failed the NVTT. A sensitivity (SE) and specificity (SP) analysis using the STATA ROCTAB command indicated that the NVTT had greater SE (73) and less SP (51) compared with reported XN (SE = 19 and SP = 87) when classifying SVA < 20ug/dl. The NVTT also had greater SE (100) and equivalent SP (50) compared with reported XN (SE = 73 and SP = 51) when classifying SVA < 10ug/dl. **Conclusion.** The NVTT is a better test for classifying pregnant women with very low SVA compared with reported XN. Furthermore, the NVTT uses several cut-points to estimate VAD giving a better probability algorithm to estimate the prevalence of VAD than reported XN that is dichotomous by definition.

**T53 RELATIONSHIPS AMONG INDICATORS OF VITAMIN A STATUS IN NIGHTBLIND AND NON-NIGHTBLIND PREGNANT NEPALI WOMEN:** KH Brown, MJ Haskell, JM Peerson, P Pandey, JM Graham, and RK Shrestha. Prog in Int'l Nutrition, Dept of Nutrition, Univ of California-Davis, USA and Nepali Technical Assistance Group, Kathmandu, Nepal.

**Background:** Information on relationships among clinical and biochemical indicators of vitamin A status is needed to better understand their usefulness for assessing vitamin A status and changes in response to supplementation. **Aims:** To compare self-reported nightblindness, pupillary response threshold and plasma retinol concentration as indicators of vitamin A status in pregnant Nepali women. **Methods:** The vitamin A status of XN, pregnant women was assessed at baseline and following 6 wks of daily supplementation (6 day/wk) with 0.850 mg RE/d as either preformed retinol or provitamin A carotenoids from foods, or 0.850 or 2.0 mg RE/d as vitamin A capsules, and compared with the vitamin A status of non-XN pregnant women. Among women initially reporting nightblindness, plasma retinol concentration was measured before and after the 6-wk intervention; self-reported nightblindness and pupillary thresholds were assessed weekly. The vitamin A status of a comparison group of non-XN, pregnant women was assessed at a single timepoint using the same indicators. **Results:** Plasma retinol concentration did not differ between women initially reporting or not reporting nightblindness ( $0.96 \pm 0.02$  vs  $1.01 \pm 0.03$   $\mu\text{mol/L}$ ,  $p=0.11$ ). Pupillary threshold was higher in women initially reporting nightblindness than in those not reporting nightblindness ( $-0.66 \pm 0.04$  vs  $-1.37 \pm 0.06$  log cd/m<sup>2</sup>,  $p<0.0001$ ). In all women, initial plasma retinol and pupillary threshold were correlated ( $r=-0.13$ ,  $p<0.005$ ). Among treated XN women, change in plasma retinol was related to change in pupillary threshold ( $r=-0.16$ ,  $p<0.005$ ). **Conclusions:** Reported nightblindness is a valid indicator of dark adaptation, as measured objectively using pupillary threshold. Reported nightblindness is not strongly related to plasma retinol, suggesting that either nightblindness or plasma retinol does not reflect whole body vitamin A status. All three indicators respond to supplementation with vitamin A or vitamin A-containing foods. The degree of improvement in pupillary threshold is correlated with the change in plasma retinol concentration following supplementation with vitamin A.

**T55 RECENT ADVANCES IN VITAMIN A RESEARCH.** CE West, FT Wieringa, S. Kersten. Division of Human Nutrition and Epidemiology, Wageningen University, Wageningen, The Netherlands.

Advances in vitamin A metabolism are discussed. **Metabolism:** By altering DNA transcription, retinoic acids play a role in cell differentiation, cell proliferation, and nutrient homeostasis. Transcriptional regulation by retinoic acids is mediated by 2 types of transcription factors: retinoic acid receptors (RARs), which bind and are activated by all-*trans* and 9-*cis* retinoic acids, and retinoid X receptors (RXRs), which bind 9-*cis* but not all-*trans* retinoic acid. RXRs also bind and are activated by fatty acids. Whereas RAR binds to DNA exclusively as a heterodimer with RXRs, RXRs forms heterodimers with various nuclear hormone receptors. **Interactions:** Vitamin A enhances metabolic utilization of iron. Supplementation trials provide evidence that vitamin A deficiency can cause anemia independently of iron deficiency. Supplementation with iron alone reduces plasma retinol concentrations in infants and increases liver stores. Mechanisms involved are unknown. **Bioefficacy** of provitamin A carotenoids is the efficiency ingested carotenoids are absorbed and converted to retinol, and is a product of bioavailability and bioconversion. Bioavailability is affected by food matrix (influenced by food processing), amount of dietary fat and intestinal parasites. Bioconversion of dietary carotenoids is less than previously thought. Using data from western countries, the US Institute of Medicine (2001) revised conversion factors to retinol for  $\beta$ -carotene and other provitamin A carotenoids to 1:12 and 1:24 respectively. The factors are based on old data on conversion of  $\beta$ -carotene in oil to retinol, and on recent data on absorption of  $\beta$ -carotene from plant foods. Research suggests the factors overstate bioefficacy of carotenoids from plant foods, especially in developing countries. **Host defense:** Vitamin A affects the integrity of the epithelial mucosa, the production of antigens by epithelial cells, non-specific immune responses, cellular immunity, and humoral immunity.

**T56** THE EFFECT OF TREATMENT WITH VITAMIN A ALONE OR IN COMBINATION WITH IRON IN IRON DEFICIENT ANEMIC CHILDREN IN ISMAILIA CITY. H Abdelwahid. Family Medicine Department, Faculty of Medicine, Suez Canal University, Ismailia, Egypt

**Background:** Vitamin A deficiency (VAD) and nutritional anemia are among the major nutritional deficiencies in developing countries, especially among pregnant women and children. **Aims:** to study the role of vitamin A in treatment of iron deficiency anemia (IDA). **Methods:** This randomized controlled trial that included 150 school children with IDA who were randomly allocated into 5 groups after deworming them. Groups A, B, C and D received oral vitamin A (25000IU/other day), oral iron (3 mg/kg/D), oral iron + vit.A in the same doses, and multivitamin preparation (5ml/D) with iron (3mg/kg/D) respectively. Group E (the control group) received nothing. The duration of the intervention was 2 months. **Results:** VAD was highly prevalent among the anemic children. Hemoglobin levels were increased significantly, after the intervention, in group A (7.7 g/dL), group B (11.8 g/dL), group C (16.2 g/dl) and group D (15.4 g/dL) and insignificantly in the control group (2.1 g/dL). Group C children (vitamin A + iron group) had the highest increase in hemoglobin levels followed by the Multivitamin group. Serum retinol levels were significantly increased in those children who received vitamin A (either alone or in combination with iron) and multivitamin. The whole number of anemic children who received vitamin A in combination with iron (Group C, n=30) and multivitamin (Group D, n=30) became non-anemic after the intervention. On the other hand, 33% and 70 % of children who received vit.A alone and iron alone, respectively, became non-anemic after the intervention. **Conclusion:** Vit.A in combination with iron is more effective than oral iron alone or vit.A alone in improving hemoglobin and serum retinol levels.

**T58** ZINC SUPPLEMENTATION ENHANCES THE CONVERSION OF  $\beta$ -CAROTENE TO VITAMIN A. MA Dijkhuizen, FT Wieringa, CE West, Muhilal. Division of Human Nutrition and Epidemiology, Wageningen University, Netherlands; Nutrition Research and Development Centre, Bogor, Indonesia.

**Background:** Deficiencies of vitamin A, iron and zinc are prevalent in women and their infants in many developing countries. Iron+folate supplementation during pregnancy is already implemented in many countries, but data is lacking on supplementation with other micronutrients. **Aims:** To investigate the efficacy of adding  $\beta$ -carotene and/or zinc to the standard iron+folate supplements during pregnancy in improving pregnancy outcome and vitamin A and zinc status of mothers and infants 6 months post-partum. **Methods:** Pregnant women (229) with a gestational age of <20 weeks were supplemented daily until delivery with iron+folate, in combination with zinc(30 mg) and/or  $\beta$ -carotene(4.8 mg) or neither. After delivery, women and newborn were followed for 6 mo. **Results:** Supplementation during pregnancy with  $\beta$ -carotene+zinc significantly increased plasma retinol concentrations of both mothers and infants 6 months post-partum, and reduced the prevalence of vitamin A deficiency in the infants by more than 30% (41% in the  $\beta$ -carotene+zinc group vs. 73-74% in the other groups,  $P<0.01$ ). Breast milk concentrations of  $\beta$ -carotene were increased in all women receiving  $\beta$ -carotene, but breast milk retinol concentrations were increased only in women who had also received zinc.  $\beta$ -Carotene supplementation during pregnancy without the addition of zinc did not improve vitamin A status in neither mothers or infants. **Conclusion:**  $\beta$ -Carotene supplementation during pregnancy significantly improved vitamin A status of mothers and infants, but only in combination with zinc. This points to a specific role of zinc in the conversion of  $\beta$ -carotene to retinol. Impaired bioconversion of  $\beta$ -carotene in zinc deficiency could explain the high prevalence of vitamin A deficiency in the presence of abundant dietary carotenoids as encountered in many developing countries. The addition of  $\beta$ -carotene and zinc to iron supplements could be an effective way to improve health of mothers and infants.

**T57** IRON SUPPLEMENTATION IN INFANTS INDUCES A REDISTRIBUTION OF VITAMIN A. FT Wieringa, MA Dijkhuizen, CE West, DI Thurnham, Muhilal. Division of Human Nutrition and Epidemiology, Wageningen University, Netherlands; Northern Ireland Centre of Diet and Health, University of Ulster, UK; Nutrition Research and Development Centre, Bogor, Indonesia.

**Background:** Vitamin A and iron deficiency are prevalent worldwide. Single micronutrient supplementation is widely used to combat these deficiencies. However, micronutrient deficiencies often occur concurrently, and many interactions between micronutrients have been described. For example vitamin A has a synergistic effect on iron supplementation in reducing anemia prevalence. **Aims:** To investigate interactions among 3 important micronutrients: vitamin A, iron and zinc, when supplemented in infants. **Methods:** In a randomised, double-blind, placebo-controlled supplementation trial, 387 Indonesian infants, aged 4 mo, were supplemented 5 days/week for 6 mo with iron(10 mg), zinc(10 mg),  $\beta$ -carotene(2.4 mg), iron+zinc(10 mg each), zinc+ $\beta$ -carotene(10 mg +2.4 mg) or placebo. Complete data on micronutrient status was available from 256 infants at the end of the study. **Results:** Iron supplemented infants had significantly lower plasma retinol concentrations (mean concentration 0.59 vs. 0.74 in the placebo group), and a significantly higher prevalence of vitamin A deficiency as defined by plasma retinol concentrations <0.70  $\mu\text{mol/L}$  (53% in the placebo group vs. 70% and 75% in the iron and iron-zinc groups). In contrast, the MRDR of the iron supplemented infants indicated higher vitamin A liver stores. Furthermore, iron supplementation improved iron status while zinc supplementation improved zinc status. There was a trend towards improved vitamin A status after  $\beta$ -carotene supplementation (39% deficiency in the  $\beta$ -carotene groups). **Conclusion:** Iron supplementation of infants with marginal vitamin A status led to lower plasma vitamin A concentrations and simultaneously to higher vitamin A liver stores. This implies a redistribution of retinol after iron supplementation, possibly inducing vitamin A deficiency. Therefore, supplementation of infants with iron should be accompanied by measures to improve vitamin A status, especially in populations with marginal vitamin A status.

**T59** EFFECT OF MATERNAL MICRONUTRIENT SUPPLEMENTATION ON VITAMIN A STATUS DURING PREGNANCY. P Christian, JB Shrestha, SB Shrestha, T Jiang, T Wagner, SC LeClerq, SK Khatri, KP West Jr. Ctr for Human Nutrition, Bloomberg School of Public Health, Baltimore MD & The Society for Prevention of Blindness, Kathmandu Nepal.

**Background:** Two recent trials of iron and zinc supplementation had opposing effects on vitamin A status in children. One, in Mexico, showed that daily iron increased plasma retinol concentrations among iron deficient preschool children. In contrast, iron given daily to Indonesian infants lowered serum retinol concentration. Data are lacking regarding the impact of micronutrients such as folic acid, iron or zinc on vitamin A status of pregnant women. **Aims:** To assess the effect of micronutrient supplementation over and above that of vitamin A in reducing incidence of night blindness and improving serum retinol during pregnancy. **Methods:** We conducted a cluster-randomized, controlled trial in rural southeastern Nepal to look at the impact of folic acid (FA), folic acid + iron (FAFe), folic acid+ iron+zinc (FAFeZn), and a multiple 13-micronutrient supplement (MN), all containing an RDA of vitamin A versus vitamin A alone (as the control, VA) on reproductive health outcomes, including maternal vitamin A status. Women who had a live birth were asked at the end of pregnancy if they had developed night blindness using the local term and further probing to confirm the history. In a 20% subsample of women, baseline (n=1161) and third trimester (n=775) venous blood draws were done to assess Hb and serum concentrations of different micronutrients. **Results:** The incidence of night blindness during pregnancy ranged between 2.3-3.2% across the 5 treatment group, yielding relative risks of 1.0. Mean change in serum retinol concentration at followup did not differ by treatment arm, although it was slightly higher (+0.05  $\mu\text{mol/L}$ , NS) among FAFe vs. VA recipients. Prevalence of serum retinol < 0.875  $\mu\text{mol/L}$  was significantly lower (3.2 vs 11.6%, RR=0.27, 95% CL: 0.09, 0.78) in the FAFe group vs. VA. Adding zinc to iron attenuated the impact of iron on serum retinol while MN may have overcome, to a degree, this inhibitory effect. **Conclusion:** Adding iron or other micronutrients to vitamin A had no effect on the incidence of maternal night blindness. Adding iron (with folic acid) to vitamin A appeared to shift to the right the lower tail of the distribution of serum retinol concentration in pregnancy.



**W1 FEEDING OF CHILDREN FROM 0 TO 59 MONTHS.** I. Barakat \*, A. Chaoui \*, A. Bettache \*, J Daoudi \*, Mr. Boulgana \*, Mr. Bahadi , Mr. Ghayour , L. Sila A. Zerrari \*\*, H. Chekli \*\*, E Rjimiati \*\*

The survey on feeding of children from 0 to 59 months was carried out by the Ministry of Health in 1996 showed that the consumption of food rich with vitamin A is insufficient. To know the evolution of this situation we propose to carry out an investigation about this category of population. It will be held in four centers of health : two in Marrakech and two in Azilal. The sample of this study is 160 children divided equally into four age groups ( 0-6 month; 7-12 month, 13-24 month and 25-59mois). These children are randomly selected. The objective of this study is to compare the children food intake to the recommended daily allowance (RDA) particularly caloric intake, Iron and vitamin A. This investigation will have in October 2002. The results will be available in November of the same year. The awaited results will be great utility to contribute to establish IEC strategy and appropriate messages for promotion of vitamin A rich food consumption and iron. They will be presented in the next IVACG/INACG.

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**W2 STUDIES ON BIOAVAILABILITY AND BIOCONVERSION OF PAPAYA (CARICA PAPAYA) CAROTENOIDS.** U. G. Chandrika, E. R. Jansz, S. M. D. N. Wickramasinghe and N. D. Warnasuriya, Faculty of Medical Sciences, University of Sri Jayewardenepura, Gangodawila, Nugegoda.

**Background:** One of the main fruits, which has been recommended for prevention of vitamin A deficiency in Sri Lanka is Papaya (*Carica papaya* L.). Recent studies showed red-fleshed papaya fruits contain a higher mean calculated retinol equivalent (281.5 RE/100g) than yellow-fleshed fruits (151.6 RE/100g) **Aim:** To study *in vivo* bioavailability of major varieties of red and yellow-fleshed papaya incorporated with and without to standard diet on Wistar rats.

**Methods:** *In vivo* bioavailability studies were carried out using healthy male Wistar rats as the experimental model. Rats were randomly divided into three groups (6 rats each). Two experiments were carried out and in the first study papaya (red-fleshed and yellow-fleshed) was incorporated into the standard WHO rat feed. In the second study while being maintained on the standard rat feed papaya was given orally (10 g/day) to rats in the morning. After 4 weeks 300 µl of blood was drawn under anesthesia for the estimation of Vitamin A levels by RP-HPLC. **Results:** Among the three rat groups the serum vitamin A levels were significantly ( $p < 0.0001$ ) higher for groups given yellow-fleshed and red-fleshed papaya incorporated to standard diet  $12.0 \pm 1.8$  µg/dL and  $14.3 \pm 2.8$  µg/d respectively, compared to control ( $4.8 \pm 1.4$  µg/dL). There was no significant difference between yellow-fleshed ( $5.8 \pm 2.0$  µg/dL) and red-fleshed papaya ( $6.2 \pm 1.6$  µg/dL) given separately and control as only standard diet ( $6.4 \pm 1.2$  µg/dL). **Conclusion:** Bioavailability of pro-vitamin A is greater when the papaya is incorporated into the standard diet, than when the two are given separately. It may be due to fats and oil in the diet, which enhance bioavailability of pro-vitamin A carotenoids. This would tend to suggest that in humans papaya taken as a dessert soon after a main meal is more likely to increase vitamin A bioavailability rather than when it is taken separately.

**W3 IMPROVEMENT OF BURKINABE DIET WITH CAROTENOID-RICH FOODS.** K Ayassou<sup>1</sup>, M Ouedraogo<sup>1</sup>, C Mathieu-Daudé<sup>2</sup>, A Bambara<sup>1</sup>, Ph Chevalier<sup>2</sup>. <sup>1</sup> IRD, BP 182, Ouagadougou, Burkina Faso; <sup>2</sup>-IRD, UR024, BP 64501, 34394 Montpellier Cedex 5.

**Introduction:** In Burkina Faso (BF), the diet is constituted of a thick cereal porridge ("tô") with a sauce based on fresh or dried leaves and vegetables. The sauce is the unique source of vitamin A and the way to increase the carotene content of meals prepared in the households. **Methods:** A food-based intervention has been conducted during the dearth season in a rural area of BF. Households were sampled among those volunteers for a 2-month supplementation. Thirty families received red palm oil (RPO) from Togo, 60 received locally-produced dark green leaves (DGL) (sorrel leaves: *Hibiscus Sabdariffa*) and 60 were controls. All components of meals were weighed before and during the last week of supplementation and the carotene supplies calculated for all households. Consumption frequency of the main sauces and their retinol equivalent content (µg RE/100 g sauce) were computed for the 2-month period. **Results:** The sauce prepared with dry okra (*Abelmoschus esculentus*) was the most frequently consumed (45-55%) by all households, despite its very low RE level (17 µg RE/100g). The RE content of the sorrel sauce was 280 and the consumption frequencies were 15% and 29%, respectively for controls and DGL groups ( $p < 0.05$ ). The RE level of RPO supplemented sauces was 350. On the 2-month period, the average RE intakes were 72, 110 and 253 respectively for controls, DGL and RPO groups. **Conclusion:** DGL and RPO groups presented higher RE but only the RPO group met the basal requirements for children because of low amounts of sauces consumed. The consumption of DGL must be increased and sauces with dried products such as okra must be systematically supplemented with RPO.

**W4 GUIDEBOOK OF LOCAL CAROTENE-RICH FOODS TO IMPROVE THE CAROTENE CONTENT OF SAHELIAN DIETS.** Ph Chevalier, C Mathieu-Daudé. IRD, Health Department, UR024, BP 64501, 34394 Montpellier Cedex 5.

**Background:** The staple food of Sahelian people is composed of cereals with a sauce. In Burkina Faso, the main food pattern is a thick millet porridge ("tô") with a sauce based on dried leaves or vegetables. The carotene content of this diet is very low and partly explains the high prevalence of night blindness and other signs of vitamin A deficiency (VAD). Local carotene-rich foods are available but the lack of knowledge about the food origin of VAD brakes the food-based approaches.

**Objective:** To provide to agricultural and health workers of the Sahelian area a better knowledge on local carotene-rich products.

**Contents:** this guidebook underlines the importance of VAD, explains its food origin and presents 26 carotene-rich products (leaves, fruits and vegetables). The products mentioned have been chosen to their ecologic or economic availability. Most of them are pure products of the sahelian zone, whereas the others come from the southern part of the area but are available in the markets of the whole area. For each product, botanical description, ecology and exploitation, uses as food, carotene content and quantities required are given and some photos illustrate the descriptions. A glossary of scientific and vernacular names, a table of food-composition and a harvesting calendar are added and some local recipes given.

**W5 SOURCES OF PROVITAMINA CAROTENOIDS IN MICRONESIA: BANANA, TARO, BREADFRUIT, AND PANDANUS.** L Englberger<sup>1</sup>, GC Marks<sup>1</sup>, MH Fitzgerald<sup>2</sup>, JP Schierle<sup>3</sup>, W Aalbersberg<sup>4</sup>, J Elymore<sup>5</sup>. <sup>1</sup>University of Queensland, Brisbane, Australia, <sup>2</sup>University of Sydney, Sydney, Australia, <sup>3</sup>Roche Vitamins Ltd, Basel, Switzerland, <sup>4</sup>University of the South Pacific, Suva, Fiji, <sup>5</sup> FSM Dept of Health, Pohnpei, Federated States of Micronesia (FSM).

**Background:** Vitamin A deficiency (VAD) is prevalent in the Federated States of Micronesia (FSM) and some other Pacific countries. Commonly recommended plant sources of provitamin A, such as dark green leafy vegetables and ripe papaya are not acceptable for many people in FSM. Locally grown, culturally acceptable foods rich in provitamin A carotenoids are important for a sustainable food-based VAD prevention strategy. **Aims:** To identify locally grown, culturally acceptable Micronesia foods high in provitamin A carotenoids. **Methods:** Local foods with potential to be effectively promoted to alleviate VAD were identified using an ethnographic approach that included key informant interviews and observation. Raw and cooked samples were analyzed by HPLC by two laboratories. **Results:** The results showed:

	# of cultivars	Ranges of carotenoids (µg/100g)	
		β-carotene	α-carotene
Banana	12	30-6110	10-1209
Giant swamp taro	13	50-2040	20-830
Breadfruit, seeded/unseeded	10	10-867	<10-142
Pandanus	5	19-392	<2-190

**Conclusion:** There is a great range in provitamin A carotenoid content in FSM banana and taro cultivars, eight banana cultivars contain 25 times the level of β-carotene in common bananas. Banana is a well-liked infant and young child food, and giant swamp taro is especially important on atoll islands. Seeded breadfruit contain moderate amounts and may protect against VAD in some areas due to quantities of breadfruit eaten. Pandanus cultivars vary greatly in provitamin A content, some containing moderate amounts. These culturally acceptable staples may play a role in vitamin A programs in the Pacific. In particular, those cultivars with higher carotenoid content should be promoted for their health benefits. This paper also suggests that similar work in other countries with comparable resources would be valuable. (Acknowledgements: SIGHT AND LIFE, Thrasher Research Fund, and Centers for Disease Control and Prevention for funding support.)

**W6 ESTIMATING USUAL DIETARY INTAKE FROM SINGLE 24-HOUR RECALLS OF CHILDREN IN THE PHILIPPINES.** P Harvey<sup>1</sup>, T Taylor<sup>2</sup>, C Lopez<sup>3</sup>, R Klemm<sup>1</sup>. MOST, the USAID Micronutrient Program, JHU<sup>1</sup>/ISTI<sup>2</sup>/HKI<sup>3</sup>, Arlington, VA, and Manila, Philippines. **Background:** In estimating the extent to which food fortification will reduce inadequate intake of vitamin A, it is important to use dietary methods that account for individuals' large day-to-day differences in intake. **Aim:** With data on within-individual variation of intake from the Philippines, demonstrate a method of adjusting a single day's consumption to represent 'usual intake,' and evaluate the change in prevalence of inadequate intakes that results. **Methods:** Three independent 24-hour recalls of food consumed by 168 schoolchildren in a randomized controlled trial were analyzed to partition the within- and between-individual variation in vitamin A intake. Following procedures recommended by the US National Research Council\* with an additional bias correction, these results were used to adjust one-day intake data from a population-based survey of 1208 children aged 1-3 years from the three major island groups in the Philippines. We then calculated the proportions of children with intakes below the US RDA (300 ugRE/day). Lastly, we applied an approach that uses distinct probabilities of adequacy at levels of intake to predict the proportion of children whose needs were not being met. **Results:** Compared to one-day intakes, usual intakes were distributed more normally, with higher minimum and lower maximum values. Usual intakes had a mean similar to one-day intakes (324 vs. 319 ugRE) and a higher median (306 vs. 209 ugRE). Approximately 66% of children had one-day intakes below the RDA, and 48% had usual intakes less than this value. Using the probability approach, 50% of children had inadequate one-day intakes, and 25% had inadequate usual intakes. Successful fortification of staples in the Philippines will shift the distribution of vitamin A intakes to the right and increase the difference in prevalence of inadequate intakes resulting from considering usual intake rather than one-day intake. **Conclusion:** The methods for adjusting consumption data from a single day to estimate usual intake are relatively straightforward and yield a more realistic description of actual nutrient intakes of populations upon which to base policy decisions and evaluate the outcome of food-based programs.\*National Research Council (1986). Nutrient adequacy: Assessment using food consumption surveys. National Academy Press, Washington DC.

**W7 RECOVERY FROM IMPAIRED DARKADAPTATION DOES NOT DIFFER AMONG NIGHTBLIND PREGNANT NEPALI WOMEN WHO RECEIVE SMALL DAILY DOSES OF VITAMIN A AS EITHER LIVER, VITAMIN A-FORTIFIED ULTRA-RICE™, GREEN LEAFY VEGETABLES, CARROTS, OR VITAMIN A CAPSULES.** MJ Haskell, P Pandey, JM Graham, JM Peerson, RK Shrestha, KH Brown. Prog in Int'l Nutrition, Dept of Nutrition, Univ of California-Davis, USA and Nepali Technical Assistance Group, Kathmandu, Nepal.

**Background:** Supplementation of pregnant, Nepali women with 7 mg RE/wk of vitamin A as synthetic retinyl palmitate or β-carotene reduces the incidence of nightblindness and maternal mortality (Christian, 2000). These data suggest that small daily doses of vitamin A from food may be effective in treating nightblindness during pregnancy. **Aims:** To determine the effect of daily supplementation with small doses of vitamin A (0.850 or 2.0 mg RE/d) as preformed retinol or β-carotene from food sources or as vitamin A capsules on dark adaptation and plasma retinol concentrations in pregnant nightblind (XN) women. **Methods:** Nightblind pregnant women were randomly assigned to 1 of 6 treatment groups to receive 6 days/wk for a period of six weeks either 0.850 mg RE/d as: 1) vitamin A capsule, 2) vitamin A-fortified Ultra-rice™, 3) liver 4) green leafy vegetables, 5) carrots, or 2.0 mg RE/d as 6) vitamin A capsule. Plasma retinol and carotenoid concentrations were measured before and after the 6 wk intervention period. Nightblindness and dark adaptation were assessed weekly by self-report and by measurement of the pupillary response threshold. These outcomes were also measured in a comparison group of non-nightblind, pregnant women. **Results:** The mean initial and final plasma retinol concentrations of XN women were 0.96 ± 0.02 µmol/L and 1.06 ± 0.05 µmol/L (p<0.0001), respectively. The final mean plasma retinol concentration in the liver group was significantly higher than in the other groups that received 0.850 mg RE/d of vitamin A (P<0.03), and did not differ from the group that received 2.0 mg RE/d. The mean initial and final pupillary thresholds of XN women were -0.66 log cd/m<sup>2</sup> and -1.45 log cd/m<sup>2</sup>, respectively (p<0.0001). Their final mean pupillary threshold was similar to the value for the comparison group and US women (-1.37 and -1.35 log cd/m<sup>2</sup>). **Conclusion:** Recovery from nightblindness did not differ among women who received 0.850 mg RE/d as liver, Ultra-rice™, green leafy vegetables, carrots or as a vitamin A capsule.

**W8 VITAMIN A INTAKE AND FACTORS AFFECTING THE BIOEFFICACY IN EGYPT**  
**NA. Ibrahim , Laila D. El-Mahdy , Zahra S. Ahmed. Food Technology Research Institute. ARC and Food Technology. Nutrition Div. NRC. Egypt**

**Background:** Given the potential consequences of vitamin A deficiency determination of vitamin A intake is a useful strategy for assessing the adequacy of the diet to meet vitamin A requirements. **Aim:** To determine the mean consumption of vitamin A-rich foods among the Egyptian population. Also, to study the factors known to influence the bioefficacy of vitamin A in the Egyptian diet. **Methods:** A continuing survey of food intake by individuals was used to drive summary statistics on the intake level of vitamin A. Data for this study were taken from the first and second round of a planned long-term monitoring system for food consumption and related variables by the Food Technology Research Institute, Egyptian Ministry of Agriculture in collaboration with UCLA school of public health. Quantitative 24-hr recalls of food intake were collected for the adult female survey respondent and for a child between two and six years of age, approximately 10,000 households. Recall data were converted to estimate nutrient intakes utilizing the modified Food Intake Analysis System (FIAS). Two dietary evaluation methods were calculated, vitamin A intake as percent of RDA and Nutrition Adequacy Ratio NAR. **Results:** Significant differences were observed in vitamin A intake by age, sex, place of residence, and other socio demographic factors. A substantial proportion of women (about 40%) and children (about one third) had diets which were low, relative to recommended intakes of vitamin A. however, vitamin A intakes of children were relatively higher than those of women in relation to their requirements for vitamin A. One fourth of the vegetables and one third of fruits were yellow-orange. Twenty seven percent of urban women and 45% of rural women consume diet with less than 20% energy as fat, as do 23% of urban children and 37% of rural children. **Conclusion:** Urban women and children had better quality diets than rural residents. The energy intake as fat of less than 20% is very low. This seems to add to the problem because it may cause a low efficacy and bioavailability of carotenoids. Moreover the high fiber content of the traditional Egyptian diet, especially in rural area, might also exacerbate the situation. Promoting the vegetable and fruits consumption would improve the quality of diet and vitamin A status.



**W9 MEETING VITAMINA REQUIREMENTS THROUGH LOCAL FOODS IN AN IRANIAN PROVINCE: A SEMI-THEORETICAL CALCULATION.**

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**Background:** Meeting vitamin A requirements is possible through diverse types of diet in the world. While preformed vitamin A comprises over two-thirds of the dietary vitamin A in the U.S. and Europe, provitamin A sources dominate in many other countries including Iran. The issue of food volume and energy density in meeting the vitamin A needs through fruits and vegetables have been raised in the past. **Objectives:** This study was carried out, therefore, to examine different provincial dietary patterns and to see how they compare with the RDA, especially with the new suggested carotenoids bioefficacy factor of one-twelfth and to devise practical remedies by capitalizing on common available local foods. In this communication, the results on one typical province of the country is being reported. **Methods:** Consumption of carotene – rich fruits and vegetables were taken from the national food survey data. Based on all the information a pattern of intake conducive to optimal supply of vitamin A was explored. **Results:** The results showed mean consumption of vegetables, fruits, eggs, butter, liver and milk to be 328, 215, 14, 3.3, 0.7 and 26 grams per day respectively. Preformed vitamin A consisted 22.5% of the intake and the rest came from provitamin A sources. Looking at the individual food items fruits especially cantaloupes (Table) which are part of the dietary habits of the people seemed to be the best potential source.

**Table-possible ways of covering vitamin A deficit**

Food item	g	Energy (Kcal)	Retinol/energy ratio (µg/kcal)
Cantaloupes	70	25	9
2 apricots	60	35	5.5
Tangerines	220	90	2.2
Watermelons	600	240	1
10 dried prunes	100	230	0.9

**Conclusion:** While recommending to add rich carotenoid food sources depending on local availability seems to be effective way of combating vitamin A deficiency, further studies on the actual bioefficacy in the real setting is necessary.

**W10 INDIGENOUS PEOPLES' TRADITIONAL FOOD SYSTEMS ARE SOURCES FOR VITAMIN A AND OTHER MICRONUTRIENTS.**

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**Background:** As populations often the most disadvantaged within nations, Indigenous Peoples (IP) residing in rural areas can be seriously at risk for food insecurity and nutritional status for micronutrients. Understanding their diet means knowing their unique food species and methods of processing that then requires knowledge of their traditional food system (TFS). **Aim:** To develop a method for documenting Vitamin A and other micronutrients in TFS, and how these contribute to nutritional status. Overall goal is to use TFS to improve health of IP. **Methods:** Participatory research methods with IP in Arctic Canada and Asia included: community workshops to crate TFS lists of species, food composition research for micronutrients, interviews for cultural contexts and food use, dietary evaluation and intervention planning. **Results:** IP communities retain knowledge of 100 or more TF species. Many of these do not have scientific identification or nutrient composition data. However, unique foods with excellent micronutrient contents have been identified. Examples of these include fish oil (*Thaleichthys pacificus*) with (mean ± SD/100g) 2400 ± 1200 µg retinol; narwhal (*Monodon monoceros*) mattak with 31.5 ± 7.0 mg ascorbate and 8 ± 1.5 mg zinc; narwhal blubber with 1900 ± 1780 µg retinol and 8922 ± 11,200 µg tocopherol; amaranth (*Amaranthus sp*) with 11,029 µg β carotene, 19.1 mg iron and 22.0 mg ascorbate; betel leaf (*Piper betel*) with 5760 µg β carotene and 10.6 mg iron). Extent of inclusion of these items in current and prospective diets to improve nutrition resulting from interventions are important considerations. **Conclusions:** TFS of IP are excellent sources of vitamin A and other micronutrients that should be maximized to improve health status of IP. Methods to identify and document these foods including their cultural specificity, require special consideration and field techniques.

**W11 Natural β-carotene crystals isolated from GAC fruit rich in Carotenoids (Provitamin A) for prevention Vitamin A deficiency in Viet Nam.**

Bui Minh Duc<sup>1</sup>, Nguyen Cong Khan<sup>1</sup>, Tu Ngu<sup>1</sup>, Bui Hoang Anh<sup>2</sup>, Lam Xuan Thanh<sup>2</sup>, Do Hoa Vien<sup>2</sup> et al. <sup>1</sup>National Institute of Nutrition(NIN), <sup>2</sup>Institute of biological and food technology-Hanoi University of technology(HUT). **Background:** Carotenoids in plants play many biological functions in process of growth, taste, hearing, appetite, vision, increasing information in cell culture, immune response, prevention and treatment of chronic diseases including cancer and HIV-AIDS. Gac Fruit (*Momordica cochinchinensis* (Lour.)) is a king among Vietnamese precious tropical fruits, has been cultivated widely throughout the country. Carotenoids in red pulp of seed membrane Gac fruit, especially in extracted *Momordica oleum* is the most important of provitamin A antioxidants and distributed in plants always together chlorophyll. **Aims:** A study was conducted to extract natural crystalline β-carotene from Gac fruit according to Vietnamese Pharmacopeia. Otherwise the need to analyse, estimate and compare the content of Carotenoids in Gac fruit ripened on the tree and fruit over 1kg collected early and storing at 5°C over one month before let ripening for use. **Methods:** Samples Gac fruit over 1kg in weight, collected from ripe fruit and not ripened in the same stem and plant, detach red pulp seed membrane and dried at 60-70°C, then grinded to achieve a dried pulp Gac powder. Extracted *Momordica oleum* with petroleum ether. Crystallisation β-carotene by use chloroform & Carbondisulfide. Test melting point. Loss on drying. Residue on ignition according to AOAC 1990 & FCC- USA 1996. Provitamin A is analysed by HPLC & expressed in mcg as β-caroten and carotenoids. **Results:** From 20 kg Gac fruit collected 900-1000g dried Gac seed membrane pulp powder (4.5-5%) and use 100g for extracted Gac oleum (30-34ml) with density at 15°C: 0.9151-0.9156, refraction index at 20°C 1.481-1.4685 which contain 1185.080mg% carotenoids and 227.900mg% β-carotene. Then crystallize and extract 180-200mg β-carotene crystals. Test of purity by melting point 182°C. Loss on drying and residue on ignition not more than 2%. At the same tree, the content of carotenoids in Gac fruit powder (ripened in tree, or collected green over 30 days early and store at 5°C before ripening) are not very different, yet the content on carotenoids and β-carotene of fruit not ripened in the tree are higher than ripened fruit 15-16% respectively. From red dried pulp, are produced Gac jam, yoghurt soybean less antitrypsin, special candy, wafers and others rich in β-carotene. **Conclusion:** Gac fruit as precious and good food nutritious ingredients of functional food for the prevention in deficiency of vitamin A for mothers and infants, good results of prevention and therapy treatment for human cancer and HIV-AIDS. The need to establish the international co-operation on expanse exploitation agriculture, analyse bioactive substances of Gac fruit, isolated β-carotene crystals and the wide use for export and produced Gac food products to the nutrition sustainable health and prevent chronic diseases.

**W12 CRUDE PALM OIL: PREVENTION AND TREATMENT OF AVITAMINOSIS**

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**Background:** Vitamin A deficiency is a public health problem present worldwide. Crude palm oil (CPO) obtained from the oil palm fruit is the richest natural source of carotenoids. CPO extracted from the Colombian *Elaeis guineensis* Jacq. oil palm has a carotenoids concentration of 1000 ppm (90% as alpha and beta carotenes). Colombia is the fifth world producer of palm oil but its production goes to domestic consumption as products with low carotenes contents, which are lost during the refining process. It is estimated that 11% of the Colombian preschool Children has moderate vitamin A deficiency. Controlled studies carried out in Asia and Central America have demonstrated that food fortification with CPO improves significantly the nutritional status through increase plasmatic retinol and lower rate of morbidity. Currently a control-case study is carrying out with 95 Colombian children aged 2-4 y. **Aims:** to identify the effect of CPO fortified food consumption on the retinol status and lipid profile among Colombian preschool children. **Design:** The first part of the project consisted in developing two kinds of cookies: one prepared with CPO, which carotenoids content provides 50% of vitamin A RDA for children aged 2-4 (195 ER / unit); and the other nonfortified prepared with refined palm oil. The second part (nutritional intervention) has began with parasitism tests to determinate whether or not children need to be treated with worming drug before the intervention begins.. Then, during a 10 weeks period, the children will receive daily, in school days, the respective fortified (study group n=48) or the nonfortified (control group n=47) cookies. Food frequency, vitamin A, hemoglobin, lipid profile and anthropometric status will tested before and after cookies consumption, and 6 months later for assessing vitamin A stores. We expected to rise and to keep adequate serum retinol levels without affecting negatively the lipid profile.

- W13 EFFECT OF EMERGING INDUSTRIAL TECHNOLOGIES ON THE BIOAVAILABILITY OF B-CRYPTOXANTHIN IN HUMANS.** Olmedilla, B; Granado, F; Cano1, P; Herrero, C; Blanco, I; de Ancos1, B; Martín-Belloso 2, O. Unidad de Vitaminas. Hospital Universitario Puerta de Hierro, 28035-Madrid (Spain). 1Instituto del Frío, CSIC. 28035-Madrid (Spain). 2 Escuela Técnica de Ingenieros Agrónomos, Lérida (Spain).

**Background:** B-cryptoxanthin is a provitamin A xanthophyll widely present in fruits frequently consumed in developed and developing countries. Some evidences suggest that b-cryptoxanthin (usually present in esterified form) may be more efficient in increasing serum levels of retinol in undernourished children. In addition, emerging technologies are being used in the food industry which may affect both retention and bioavailability of provitamin A carotenoids (i.e. b-cryptoxanthin) contained in commercially available food products. **Objective:** To assess the effect of different industrial processes on the bioavailability of b-cryptoxanthin (absorption and conversion into retinol) in control subjects. **Methods:** In a cross-over study, six apparently healthy subjects (aged 20-30) consumed orange juice (250 ml x 2, ingested with meals) processed differently ("minimally processed", "high-pressure", "electric pulses" and "freshly prepared orange juice") during four periods of 14 days with 1-month washout in between. Blood samples were collected at baseline (during 8 hours) and on day 7 and 14 for HPLC analysis of carotenoids and retinol. **Results:** Serum b-cryptoxanthin increased at 7 and 14 days of juice consumption and the increments were similar with refrigerated and high-pressure juices. Conversion into retinol during post-prandial metabolism and serum responses using natural juice and electric pulses are being evaluated. **Conclusions:** The effect of these new emerging industrial processes on the absorption and bioconversion into retinol is being evaluated. This work was granted by Comunidad de Madrid (CAM 07G/0041/2000)

- W14 HIGH  $\beta$ -CAROTENE SWEETPOTATO PROCESSING FOR INCREASED VITAMIN A INTAKE: GENDER IMPLICATIONS AND POTENTIAL FOR SUSTAINABLE TECHNOLOGY ADOPTION IN SIAYA DISTRICT, KENYA.** M.A. Oyunga-Ogubi, N.M. Ng'ang'a and J.A. Olayo. Kenya Agriculture Research Institute and Ministry of Agriculture, Kenya.

**Background.** In Siaya district of Western Kenya, where vitamin A deficiency is common and the white sweetpotato is an important secondary staple, high  $\beta$ -carotene (orange-fleshed) sweetpotatoes were introduced and their adoption was evaluated. **Aim:** To investigate the adoption of an intervention technology for increasing vitamin A (VA) intake through the use of high  $\beta$ -carotene sweetpotatoes. **Methodology:** A survey was conducted to qualitatively determine VA and sweetpotato production and processing status in Karemo division, Siaya district. Four women groups (100 farmers-including men) participated. All the groups received 3 intervention technologies developed earlier; i.e. 4 high  $\beta$ -carotene sweetpotato varieties, a nutrition education package, and training on sweetpotato processing for high retention of  $\beta$ -carotene. An ex-ante evaluation by gender was done to identify barriers to use. **Results.** Knowledge about VA was found to be very poor. Except in female-headed (28.9%) households all land was under the control of men. Women and children (both genders) have access to and manage more than 80% of small sweetpotato plots. Both genders prefer the new varieties due to higher yields (18-30 t/ha) exceeding yields of (5-10 t/ha) popular existing farmer's varieties. Men selected the new varieties for market value while women valued them highly for home consumption, processing and marketing. Women indicated that if men picked on the new varieties then in terms of production resources and cash benefits, men would have greater control and access. Taste preferences were not significantly different from the farmers' variety. Women indicated that the low dry matter varieties were suitable for preparing different weaning foods, requiring less fuel and time for cooking. In 67% of cases, women compared to about 5% men in sweetpotato post harvest activities. Women along with children participated in another 15% of cases, while in 6% of cases women worked alongside men. This represents 91% participation by women in sweetpotato production and post harvest activities. Sweetpotato processing in Siaya is insignificant. **Conclusions:** Knowledge on VA and importance was found to be very poor among the participating households-there is need for nutrition education. Both genders prefer the new varieties due to higher yields but have different post harvest interests. There is some indication that if the new sweetpotato varieties prove popular and lucrative may be taken over by men since they control most of the production resources. There is insignificant sweetpotato processing in Siaya but there is potential for adoption of this technology particularly by women. Adoption of the new varieties and direct cash benefits to women may be hampered because of men's control over or because of limited access to ploughing resources and increased production. Women and children do most of sweetpotato activities therefore in the absence of other constraints they stand to benefit from the technology adoption.

- W15 VITAMIN A CONTENT IN KATUK LEAVES (*SAUROPOUS ANDROGYNUS L. MERR*) AND ITS EFFECT IN ENHANCING THE PERFORMANCE OF LAYING HENS.** Wiranda G. Piliang, A. Suprayogi, N. Kusumorini. Center for Life Sciences Study, Bogor Agricultural University. M. Hasanah, S. Yuliani and Risfaheri. Research Institute for Spice and Medicinal Crops.

**Background:** Katuk leaves (*Sauropus androgynus* L. Merr) has been used for many years as a medicinal plant and has a capability to increase milk secretion in Indonesia as well as in other Asian Countries such as Malaysia, China and Taiwan. Farmers have been using katuk leaves as feed supplement for dairy cattle as to increase milk production. So far, there is no report as to whether katuk leaves have been used in laying hens' ration. **Aims:** To study the effect of Katuk leaves supplementation in the diet on the performance of laying hens. **Methods:** One hundred eighty local pullets starting at the age of 20 weeks old were used as experimental animals, divided into 4 treatment groups with 3 replications and 15 pullets in each replicate. Four treatment diets were 0%, 3%, 6%, and 9% of katuk leaves supplementation in the diet. The parameters observed were age at maturity, lutein, retinol, alpha-tocopherol, gamma-tocopherol, cholesterol content in eggs, liver and carcass. Egg yolk color intensity, feed consumption and feed conversion were also measured. **Results:** The result of the experiment showed that the laying hens fed 9% katuk leaves supplementation matured at 26 weeks of age, followed by the groups fed 6%, 3% and 0% katuk leaves that matured at 27.3, 27.7 and 29 weeks of age respectively. The highest katuk leaves supplementation in the diet (9%) gave the highest content of lutein, retinol, alpha-tocopherol, gamma-tocopherol in the eggs, liver and carcass of laying hens. The lutein content in the eggs, liver and carcass from hens fed 9% katuk leaves supplementation were 3.45; 4.99; and 4.12 micrograms/gr respectively - the retinol content were 2.11; 43.37; and 2.49 micrograms/gr respectively - the highest alpha-tocopherol content were 30.19; 167.88; and 11.70 micrograms/gr respectively - the highest gamma-tocopherol content were 4.83; 136.89; and 4.34 micrograms/gr respectively. The cholesterol content in the egg yolk, liver and carcass were found the lowest when 9% of katuk leaves was supplemented in the diets; the cholesterol content were 0.606, 1.055 and 0.099 mg/dl respectively which were equal to 0.37, 0.59% and 0.70% respectively of the cholesterol content in the control group. The egg yolk color intensity, measured by using "yolk color fan from Roche", was found to be the highest when hens were supplemented with 9% katuk leaves in the diet. The egg yolk color score was 11.5. When the groups of hens were supplemented with 6%, 3% and 0% katuk leaves, the egg yolk score were 6, 5 and 1 respectively. Egg yolk color score 11.5 gave orange color of the egg yolk, while score 1 gave a very pale color of the egg yolk. **Conclusion:** This research proved that katuk leaves gave many beneficial important properties, not only for lactating mothers or animals in increasing milk production but also for laying hens' products which eventually consumed by human beings, besides its property as a medicinal plant.

- W16 BLEACHED RED PALM OIL AND VITAMIN A STATUS OF CAMEROONIAN CHILDREN.** D. Sibetcheu, M. Nankap, J.N. Tata, A.A. Ntonga, B. Kollo, M.M. Gimou, and N.J. Haselow. Ministry of Public Health/Cameroon, Centre Pasteur/Cameroon, and Helen Keller International/Cameroon.

**Background:** The 2000-National Vitamin A Survey showed that 38.8% of Cameroonian children 1-5 years old were vitamin A deficient (serum retinol levels < 20 mg/dl) despite wide availability of vitamin A rich foods, particularly red palm oil (RPO). **Objectives:** To assess 1) the contribution of RPO to the vitamin A status of Cameroonian children 1-5 years old and 2) the role that bleaching RPO plays in the vitamin A status of such children. **Methodology:** For sampling purposes, the country was divided into five zones: the Sahelian zone; the grass fields; the forested zone; the coastal zone, and the two major cities. HPLC was used to measure serum retinol (SR) levels in children. The Helen Keller International Food Frequency Method was used to assess children's consumption of foods rich in vitamin A, protein, fats, and oil. Correlations between SR and different food items/categories were calculated. Special attention was paid to the relationship between SR levels and the consumption of bleached/non bleached RPO. **Results:** 4954 interviews were conducted and 2375 blood samples collected. 51.8% of children in the sample consumed RPO daily. Children's average frequency consumption of RPO was over 4 days a week in 4 of the 5 sampling zones (6.5-7 days a week in the coastal and grass zones) whereas in the Sahelian zone average frequency consumption of RPO was less than once a week. Of those children who consumed RPO (n=3800), 15.2% had bleached RPO every time they consumed it. Only 29% of caregivers whose child consumed RPO claimed to never bleach the RPO during food preparation. Mean SR in children who never consumed RPO was 20.52  $\mu$ g/dl whereas mean SR in children who consumed RPO 4-7 days per week was 23.93  $\mu$ g/dl (p<0.0001). Among those children who consumed RPO, mean SR in children who consumed non-bleached RPO was 24.73  $\mu$ g/dl whereas in children who consumed bleached RPO 4-7 times a week mean SR was 23.26  $\mu$ g/dl (p<0.05). **Conclusions:** RPO is the main food source of vitamin A in Cameroon. Yet, the increasingly common practice of bleaching RPO before consumption contributes to lower levels of SR in Cameroonian children. Strategies to control VAD should promote the consumption of non-bleached red palm oil.

- W17** THE DIFFERENCE IN BIOAVAILABILITY OF BETA-CAROTENE FROM THREE TYPES OF CARROTS. SA Tanumihardjo, MA Horvitz, and PW Simon, Departments of Nutritional Sciences and Horticulture, UW-Madison, WI, USA.
- Background: A sustainable intervention to improve vitamin A status may be the promotion of common vegetables that have enhanced beta-carotene concentrations. In nature, carrots may have up to a 5-fold difference in beta-carotene concentrations. Aim: To assess the difference in beta-carotene serum concentrations of young adults fed 3 different carrot types with time. Subjects and Methods: Young adult volunteers (n = 10, 50% female, 27.5 +/- 4.4 y of age, BMI of 23.0 +/- 2.7 kg/m<sup>2</sup>) were randomized to three treatments in a 3X3 crossover experiment to either white, low beta-carotene or high beta-carotene carrots. Carrots were incorporated into "identical" muffins and fed at breakfast for 11 days with a 10-day washout period in between muffin types. Blood samples were obtained at baseline, 1, 3, 5, 7, 9, 11, 13 and 15 days and analyzed for carotenoids and retinol for each study period. Results: The serum carotenoid response in the white carrot group was always significantly lower than either orange carrot. While the response of the high beta-carotene group was significantly higher than the low beta-carotene group in the first period of the study (P = 0.01) this effect did not remain after completion of all three periods in all individuals. Interestingly, serum retinol decreased between the first period of the study and periods 2 and 3 (P = 0.02). Conclusions: Assessment of dietary intervention trials with beta-carotene from foods is complicated by the fact that it can be bioconverted to retinol. Factors that affected response in this study included sequence of the treatments (P = 0.038) and potentially BMI (P = 0.08).
- W18** EVALUATION OF THE RETENTION OF  $\beta$ -CAROTENE IN BOILED, MASHED ORANGE-FLESHED SWEET POTATO. PJ van Jaarsveld, De Wet Marais, E Harmse and DB Rodriguez-Amaya. Nutritional Intervention Research Unit, Medical Research Council, Parow, South Africa 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 orange-fleshed sweet potato (OFSP) in improving the vitamin A status of children is being assessed in South Africa. Complementary to this trial, the retention of  $\beta$ -carotene ( $\beta$ car) in boiled OFSP must be known. Aim: To determine the retention of  $\beta$ car in boiled, mashed OFSP. Methods: The  $\beta$ car-rich Resisto variety was chosen for the efficacy trial and present work. Preliminary studies were done to establish and evaluate the analytical procedure and to assess the natural variability of the  $\beta$ car content of OFSP. For each of the retention studies: five OFSP were quartered longitudinally, two opposite sections from each OFSP were combined, chopped, grated and mixed for the analysis of the raw sample; the other opposite sections were combined, boiled and mashed; triplicate raw and cooked samples were submitted to HPLC analyses. True retention was calculated as follows: %TR = (carotenoid content per g of cooked food x g of food after cooking) / (carotenoid content per g of raw food x g of food before cooking) x 100. Results: Compared with chloroform:methanol (2:1), acetone, and tetrahydrofuran, tetrahydrofuran:methanol (1:1) was more efficient in extracting the carotenoids of both raw and cooked OFSP, thus the preferred extracting solvent. The method established showed good reproducibility. No loss of  $\beta$ car occurred when chopped/grated raw OFSP was allowed to stand for 4 h, indicating that Resisto was not prone to enzymatic oxidation. The  $\beta$ car content of medium-sized OFSP taken from the same harvest batch ranged from 132 to 194  $\mu$ g/g. The TR was 92% when medium-sized OFSP covered with water was boiled for 20 min in a pot with lid; without the lid, boiling took 30 min and TR was 88%. When OFSP of different sizes were boiled 30 min, covered with water, in closed pot, TR was 70 to 80%. The mean  $\beta$ car content of boiled and mashed OFSP sampled on three consecutive days, five times during the efficacy trial ranged from 83 to 114  $\mu$ g/g. Conclusion: The %TR varies with cooking conditions. Although some degradation occurs during cooking, the  $\beta$ car content of the boiled and mashed OFSP is still substantial.
- W19** ISOTOPIC TRACERS FOR STUDYING CAROTENOID BIOEFFICACY.. Machteld van Lieshout, Clive E West, Richard B van Breemen. Division of Human Nutrition and Epidemiology, Wageningen University, Wageningen, The Netherlands and Department of Medicinal Chemistry and Pharmacognosy, University of Illinois at Chicago, USA.
- Provitamin A carotenoids in fruit and vegetables are the major source of vitamin A for a large proportion of the world's population. However, the contribution of plant foods to vitamin A nutrition depends upon consumption, content and bioefficacy of the provitamin A compounds. With respect to provitamin A carotenoids, the term bioefficacy is defined as the product of the fraction of an ingested amount which is absorbed (bioavailability) and the fraction of that which is converted to retinol in the body (bioconversion). Since the 1940s, efforts to estimate or quantify the bioefficacy of dietary carotenoids in humans have included animal models, depletion-repletion techniques, oral-fecal balance techniques, serum/plasma or chylomicron response, and the use of isotopic tracers. Since techniques using isotopic tracers can provide the most accurate and precise data on bioavailability, bioconversion and bioefficacy of dietary carotenoids, these will be discussed in detail. Since 1990, 12 studies have been published using compounds labeled with stable isotopes for studying carotenoid bioavailability and/or bioefficacy in humans. Five studies provide only qualitative information while 7 provide quantitative data. Here we will discuss how tracer techniques can be applied to obtain reliable and representative data. A step-by-step discussion of considerations that need to be taken into account in the design of isotopic tracer techniques will be provided including the design of studies, isotopic tracers, dosing regimen, collection of samples, chemical analysis of samples, and method of analysis of data. Thus far, the only reliable data available are estimates of the bioefficacy of  $\beta$ -carotene in oil. LC-MS using APCI has emerged as the most effective and convenient method of analysis for large numbers of samples arising from studies with adequate power. Considerable progress has been made in the past decade enabling carotenoid bioefficacy to be studied using isotope techniques.
- W20** ADDRESSING VITAMIN A DEFICIENCY THROUGH DIET DIVERSIFICATION, A FIRST IN MPUMALANGA PROVINCE, SOUTH AFRICA. L.Viljoen, C.MacArthur, Z.Sifiri. Department of Health Mpumalanga South-Africa, Helen Keller International.
- Issue:** The control of micro-nutrient deficiencies in South Africa, in particular Vitamin A deficiency, is one of the focus areas of the Integrated Nutrition Programme (INP) of Department of Health in South-Africa. Sub-clinical Vitamin A Deficiency is a problem of public health significance in the country. Findings in the 1994 SAVACG study proved that the range of Vitamin A deficiencies are 18,5 to 43,5% of which Mpumalanga is one of the three highest Provinces. Statistics for Mpumalanga show that children between 1–3 years have only approximately 15% RDA intake of Vitamin A. **Objectives:** The provincial intervention in Mpumalanga aims to address the Vitamin A deficiencies through diet diversification and an education programme in addition to the National Supplementation Programme. **Framework:** 58% of Mpumalanga consists of deep rural communities of whom approximately 80% are severely poverty stricken. The 1999 Food Consumption survey showed that the Vitamin A intake of 69% of the children do not meet two-thirds of the recommended dietary allowance. This is of particular concern among the rural children who average only approximately 10% of the recommended Vitamin A dietary intake (RDA). Diet diversification and awareness are used as entry point for household security interventions in the rural areas of the province. **Description of implementation:** A provincial food diversification strategy through a food production program and a nutrition education program in vitamin A, starting in primary schools as an entry point to communities. **Process evaluation methods:** Environmental management: social impact study on community behavior change due to diet diversification. **Implications:** Since the dietary approach is most sustainable, there is a need to ensure actual household food security that is addressed at the same time.



- W21** CAROTENOID VALUE OF GREEN-RICE. L. Vuong, United States Department of Agriculture - Western Human Nutrition Research Center, University of California, Davis, CA 95616.

Polished rice, staple food of many populations, contains effectively no carotenoids, however, carotenes are present in the ripening rice grain. This study was aimed to identify and quantify carotenoids in roasted young hulled rice. Glutinous rice (*Oryza sativa* L.) was harvested immaturely when the seed coat and pericarp of the grain are still green and soft. The harvest was processed into a diet called Green-Rice. Identification and quantification of carotenoids in Green-Rice were performed using HPLC and UV/visible spectroscopy, matrix assisted laser desorption/ionization (MALDI) mass spectrometry, and one dimensional <sup>1</sup>H NMR spectroscopy. Total carotenoid content in Green-Rice was calculated as 4.03 ug/g; lutein accounted for 2/3 of the total carotene, and beta-carotene was quantified as 1.09 ug/g. Post-harvest processing of Green-Rice is much simpler than the process to produce polished rice. Further research efforts can be focused in improving availability and consumption of Green-Rice in addition to polished rice (containing no beta-carotene) in regions where vitamin A deficient disorders exist.

- W22** OPTIMIZING VITAMIN A RETENTION IN CONSUMER PACKAGED FORTIFIED VEGETABLE OILS. V. Abraham, Y. Kakuda, H. Smadi, L. Laleye. Caravelle Foods, Brampton, ON, Canada. Department of Food Science, University of Guelph, Guelph, ON, Canada. The Micronutrient Initiative, Ottawa, ON, Canada.

Vitamin A deficiency is the most common and preventable cause of childhood blindness throughout the developing world. Fortification of appropriate foods with this vitamin is an effective way of increasing the vitamin A intake and thereby reducing the incidence of vitamin A deficiency. Many foods have been fortified with vitamin A but vegetable oils appear to be well suited for fortification due to its several special advantages. However, the fortification critics have argued that vitamin A retention in oil is quite low during storage and cooking. Therefore there is a need to study and optimize conditions and packaging materials to maximize vitamin A retention in fortified oils. Light exposure has been shown to be a critical factor affecting the stability of vitamin A in fortified vegetable oils. The use of packaging materials (plastics and tins) with appropriate barrier properties can be an effective means of improving its stability. The containers investigated were clear polyethylene terephthalate (Clear PET), brown polyethylene terephthalate (Brown PET), opaque high density polyethylene (Opaque HDPE), brown high density polyethylene (Brown HDPE), clear polyvinyl chloride (Clear PVC) and metal tins. The soybean oil was fortified with 175 IU/gm of vitamin A and then transferred to their respective containers. The samples were stored under florescent light and at five temperatures. For light conditions, bottles were placed upright on the floor of the chamber and fully exposed to light. Samples were taken every week and analyzed for vitamin A by HPLC. The stability of vitamin A in PET brown bottles was much better than clear PET bottles when exposed to light conditions. When stored in PET clear bottles, the vitamin A retention was 28% after 30 days compared to 80% for PET brown bottles stored for the same length of time. The vitamin A retention was much better in HDPE brown bottles than in opaque HDPE bottles when stored under light conditions. The PVC clear bottle did not protect vitamin A when exposed to light. The samples packaged in tins were very stable for more than 24 weeks. This would be the best packaging option if the criteria was to prevent the vitamin A degradation during storage. Taking into account of all the variables (light conditions, type of containers, pigmentation, temperature) the highest vitamin A retention was observed in metal cans and the lowest in PVC clear bottles.

- W23** FOOD FORTIFICATION VEHICLES FOR THE CONTROL OF VITAMIN A DEFICIENCY IN WEST AFRICAN WOMEN AND CHILDREN. FINDINGS FROM A MULTI-COUNTRY STUDY IN BURKINA FASO, GUINEA, MALI, AND NIGER. VM Aguayo, Noel M. Zagr , Mohamed Ag Bendeche, Ambroise Nanema, Andr  Ouedraogo, and Shawn K. Baker. Helen Keller International-Africa Region (VMA, NZ, MB, SKB) and WHO-AFRO (AN, AO).

**Background:** Poor dietary quality is a major determinant of inadequate vitamin A status in West African women and children. Improving the quality of the diets through food fortification could be a major step forward in the control of vitamin A deficiency in West African women and children. **Objectives:** To identify the most appropriate food fortification vehicles for the control of vitamin A deficiency in women of reproductive age and preschool-age children in Burkina Faso, Guinea, Mali, and Niger. **Methods:** The FRAT (Fortification Rapid Assessment Tool) methodology was used to collect information on women and children's usual dietary intake and consumption patterns. In each country, one independent sampling area was identified for every region where differences in consumption of the potential vehicles could exist. In each independent sampling area, 30 clusters were randomly selected using a probability-proportionate-to-size sample selection method. In each cluster seven households with at least a woman of reproductive age and a preschool-age child were randomly selected. **Results and discussion:** The analysis of national food processing and consumption data identified four available, widely accepted, and increasingly consumed food items: sugar, oil, cereal flour, and bouillon cube. Systematic information on usual intake and consumption patterns of these four potential food fortification vehicles was collected in 3375 women of reproductive age and 3003 preschool-age children. All four food items were consumed by over 40-50% of children and women on a regular basis and all four were consumed by significantly higher proportion of women and children in urban areas than in rural areas. At the IVACG Meeting results will be presented on the extent to which vitamin A fortification of these potential food fortification vehicles can contribute to the control of vitamin A deficiency in women and children in West Africa.

**W24 RAPID SEMI-QUANTITATIVE CHEMICAL ASSAY KIT FOR VITAMIN A IN FATS AND OILS.** C Ngo-Duy, P Angers, J Arul and V Abraham. Dept of Food Science and Nutr, Université Laval, Québec, PQ and CF Champion Foods Brampton, ON, Canada

**Background:** Fortification of widely consumed fats and oils with vitamin A can be a valuable strategy to ensure the intake of vitamin A, and alleviation of the diseases related to its deficiency in developing countries. This strategy would be meaningful only if properly executed. **Objectives:** to develop a rapid semi-quantitative chemical assay kit for vit. A in fats and oils for use by plant personnel in developing countries. **Methods:** The methodology involved identification of a reagent to reveal vit. A by coloration selectively, selection of a test format (solid support or solution), and development of a comparator color chart in the vit. A concentration range of 0-800 IU. Operator repeatability and reliability of the tests were also evaluated against spectrophotometry analysis. **Results:** Carl-Price reagent (antimony trichloride solution, 22% v/v) was found most suitable for revealing vit.A selectively in various oils among the 8 reagents tested. The test is best performed in solution using a test tube than ceramic spot plate. Solution color was stable for 30 sec to 2 min., the stability increasing with vit.A concentration in oil. Although the color stability was longer on solid support, the coloration was not uniform. **Conclusion:** the test is repeatable with a reliability of  $\pm$  10-20 IU, with vit. A concentrations of up to 300 IU. The rapidity and simplicity of the test suggests easy adaptability to the conditions prevailing in the fats and oils processing plants in developing countries.

**W25 STABILITY OF VITAMIN A AND  $\beta$ -CAROTENE IN FORTIFIED VEGETABLE OILS:** KK Bhat, VD Sattigeri, MR Asha, JA Satyabodha, BS Ramesh and S Bulusu, Central Food Technological Research Institute, Mysore and The Micronutrient Initiative, India.

**Background:** One feasible approach for combating vitamin A deficiency in India is through fortification of vegetable oils. In the cooking practices prevalent in India, oil is subjected to considerable heat abuse. Loss of vitamin A under such conditions is a critical factor that determines its availability to the consumer. Unrefined vegetable oils account for 55-60% of edible oils consumed in the country, but very little is known about vitamin A stability in them during cooking, frying and storage. **Aims:** Estimation of loss of vitamin A and  $\beta$ -carotene in fortified unrefined/refined and hydrogenated vegetable oil during (a) preparation of foods and (b) storage under ambient and accelerated conditions. **Methods:** Unrefined groundnut and mustard oils, refined palmolein and hydrogenated vegetable oil were fortified at three levels of vitamin A and two levels of  $\beta$ -carotene. Losses in fortificants were estimated during (a) 4 fryings of 4 snacks having low, medium and high moisture contents, (b) preparation of wet and dry vegetable curries and (c) storage of oils in open or closed bottles kept at ambient (27°C, 65%RH) and accelerated (37°C, 92% RH) conditions. Effect of antioxidant (TBHQ) was studied in another set of fortified oils. **Results:** At the end of 4 fryings loss in vitamin A ranged between 28 & 60% depending on the type of food being fried, with similar patterns observed in all oils: shorter duration frying for low/medium moisture content foods produced a 28-39% loss; longer duration frying for high moisture content foods produced 42-60% loss. Maximum destruction of  $\beta$ -carotene occurred (60-68%) during frying of samosa (a food with high moisture content). Addition of antioxidant TBHQ did not slow down the losses except in the case of mustard oil. Compared to frying, curry preparation resulted in lower range of losses in vitamin A (10-25%) and  $\beta$ -carotene (12-20%). At the end of one month of storage all the fortified samples under ambient and accelerated conditions showed very little loss of fortificants. **Conclusion:** Type of food and duration of frying influenced the loss of vitamin A and  $\beta$ -carotene added to vegetable oils. Curry preparation caused less destruction than frying. TBHQ did not exhibit protective effect except in mustard oil.

**W26 EFFECT OF TEMPERATURE AND LIGHT EXPOSURE ON VITAMIN A STABILITY IN FORTIFIED SOYBEAN OIL.** L.BORGHOS<sup>1</sup>, M.RAHMANI<sup>2</sup>, K.EL KARI<sup>1</sup>, N.MOKHTAR<sup>1</sup>, H.AGUENAOU<sup>1</sup>

1. Université Ibn Tofail, Faculté des Sciences / Kénitra, Laboratoire de Nutrition et Alimentation.
2. Institut Agronomique et Vétérinaire Hassan II / Rabat, Département des Sciences Alimentaires et Nutritionnelles, Laboratoire de Chimie et Technologie des Corps Gras.

**Background :** Vitamin A deficiency (VAD) is the single most important cause of childhood blindness in developing countries. Among the strategies adopted to alleviate VAD, food fortification is regarded as the most effective long-term approach. **Aims :** Prevalence of VAD in Moroccan preschool children was found to be 40.9 %, therefore the Department of Health has recently initiated vegetable oil fortification with retinyl palmitate. For this purpose, a feasibility study was carried out to determine the stability of vitamin A in fortified soybean oil as a function of temperature, exposure to light, and level of fortification. **Methods :** The experimental design included 2 levels of fortification (33.3 and 66.6 IU/g), 2 temperatures (ambient and 42°C), and 2 levels of light (darkness and diffuse day-light). The storage period was extended over 6 months period, and all replicate samples were packaged in PET packaging material. The concentrations of vitamin A were determined by a laboratory developed HPLC method. **Results :** The statistical interpretation of the results, according to a 3 way ANOVA analysis, concluded a very high significant effect ( $p < 0.1\%$ ) of all three parameters investigated : level of fortification, temperature, and exposure to diffuse day-light. Since vitamin A degradation was dependent on the level of fortification (33.3 or 66.6 IU/g), its kinetics followed a first order reaction. Temperature had a minimal effect on degradation of vitamin A in oil samples stored in darkness; the rate constants were 0.054 (month)<sup>-1</sup> and 0.058 (month)<sup>-1</sup>; respectively at ambient temperature and 42 °C. Day-light, however showed a more pronounced effect. After six months of storage in diffuse day-light at ambient temperature, the levels of vitamin A degradation in oil samples ranged from 67.5 % to 69.0 %. Those same samples retained 70.5% to 75.0 % of the vitamin A when stored in darkness. **Conclusion :** It can be concluded that vegetable oil is an effective carrier for vitamin A and will retain its potency when protected from light.

**W27 Building a public-private partnership for fortifying staples in the Philippines.** Maria Evelyn P. Carpio, Hector Maglalang, Philip Harvey, Roy Miller, Adelisa C. Ramos.

**Background.** Governments cannot develop fortification programs without the active involvement of the commercial sector. Philippine legislation mandates fortification of flour with vitamin A and iron, oil and sugar with vitamin A and rice with iron from November 2004. But the government is not in a strong position to enforce mandatory fortification on industries that generate substantial employment, influence and taxes. The Philippine Fortification Program has focused on building a viable partnership between the public and the commercial sectors that will minimize the enforcement burden. **Methodology.** Food industry stakeholders (Chamber of Food Associations for flour, rice, sugar and oil) were involved early in the development and implementation of the fortification initiative. They were afforded key positions in the various committees that comprise the policy setting and management structure of the fortification program. Food industry representatives participated in developing the following: a) Implementing Rules and Regulations that provide the framework for enforcement of the legislation; b) Communications Plan for food fortification and c) proposal for funding by GAIN. **Results.** Regular and open dialogues take place at the staple specific sub-committee meetings and this has been effective in promoting understanding between the sectors. Food manufacturers expressed a need for technical, industry-specific information and this need was addressed with a Newsletter and internet-accessible technical data. Joint public-private-NGOs communication activities were conducted to generate awareness of fortified foods and create demand. Working with the industry associations has been difficult where the major markets are for "unbranded" products (sugar, oil and rice). Recovering the cost of fortification where the industries are unable to capture market share by promoting fortified brands is a major challenge as well as monitoring unbranded products. These were the private sectors' major concerns as expressed during the dialogues. Options from public-private-NGO joint undertakings are being done to address these concerns. **Conclusions.** The most important outcome of the building process has been giving all partners a common understanding of the direction of the fortification project and providing a foundation upon which to build trust and cooperation.



- W28 VITAMIN A FORTIFICATION OF SALT.** L.L.Diosady, University of Toronto, Toronto, ON, Canada, L.Laleye, The Micronutrient Initiative, Ottawa ON, Canada.  
Salt is an ideal carrier for micronutrients, since it is ingested by all segments of the population. The daily salt intake is similar within a society, and it is independent of gender or social status. Salt iodization is now widespread, and has been very effective in reducing the incidence of iodine deficiency diseases. The infrastructure developed for salt iodization could be readily adapted to the delivery of other micronutrients such as iron and Vitamin A.  
We have been developing appropriate technology for double fortification of salt with iodine and iron, and expanded this work to salt fortified with iodine and Vitamin A and triple fortification with iodine, iron and Vitamin A. In the present study we report on the development and testing of the stability of a large number of salt premixes containing these micronutrients at high temperature and humidity typical of tropical developing countries.  
We agglomerated one, two or all three of the micronutrients to produce particles which have particle-size distributions similar to normal table salt. The particles were microencapsulated, and mixed with salt to provide the daily iodine requirement and 30-50% of the daily iron and Vitamin A requirements. In all cases the premixes containing all three micronutrients represented less than 1% of the salt. Vitamin A stability was greatly reduced by the presence of iron, unless both iron and Vitamin A were encapsulated with a high-quality continuous film coating. The best results were obtained when Vitamin A was encapsulated on its own, or with potassium iodide. Vitamin A stability was enhanced by antioxidants in the capsule coating. Triple fortified salt formulations stable for three months at high temperature and humidity were developed, and tested on a pilot scale.
- W29 Vitamin A Content in Banaspati Ghee and Edible Oil Produced in Pakistan and Stability of Vitamin A During Cooking.** T.Hussain and N A Khan .NWFP Agriculture University Peshawar. The Micronutrient Initiative Islamabad. **Background** In Pakistan ghee (hydrogenated vegetable oil) is consumed in cooking by all segments of population .As it is widely used, the country has legislation demanding the addition of 9.9ug/g of vitamin A in ghee/edible oil to provide at least 1/3 of RDA. However there is a poor compliance, as manufacturers claim vitamin A as extremely unstable. **Aim** To determine the level of vitamin A fortification and to test the stability of vitamin A during cooking. **Methods** 80 samples of banaspati ghee and edible oil were randomly collected from local markets and their vitamin A content determined by HPLC technique. Retention and stability of vitamin A was tested after exposure to light and different methods of cooking, deep, shallow and repeated frying and cooking. **Results** None of the 80 samples of ghee/oil had the required level of vitamin A fortification (9.9ug/g ghee and oil produced) 40% of the samples were found to have a maximum of 50% fortification while 60% even less than half of the recommended level .With per capita consumption of 30g of the ghee/oil per day and an average availability of 4.0 ug/g vitamin A from ghee and oil ,the infants, children, pregnant women would be receiving 30% ,24% and 15% of RDA. It was noted that processing/refining of crude palm oil results in significant loss of b-carotene .Similarly in deep frying 60% ,shallow frying 30% and in currying 50% of total vitamin A is lost. Moreover it was observed that 50% of the total vitamin A is lost during 4 weeks of exposure to air and light. **Conclusion** Despite proper legislation of ghee/oil fortification with vitamin A, there is poor compliance .Vitamin A is light unstable but cooking stable .Even in worse frying condition substantial level of vitamin A remain in ghee/oil. A comprehensive approach is needed to encourage manufacturers to fortify their product with recommended level of vitamin A fortification. **Acknowledgement.** Unicef and Micronutrient Initiative.
- W30 EFFECT OF COOKING PACKAGING AND STORAGE ON VITAMIN A STABILITY IN FORTIFIED MAIZE MEAL.** MT Kaputo and GC Kabaghe, Food Technology Research Unit, National Institute for Scientific and Industrial Research. Lusaka, Zambia.  
**Background:** Micronutrient malnutrition is widespread in Zambia particularly amongst the peri-urban and rural communities as evidence by high prevalence of vitamin A and Iron deficiency disorders. In order to combat the micronutrient malnutrition problem one Zambian strategy has been to fortify domestic sugar with vitamin A. To complement this intervention maize meal has been selected as an attractive choice for the desired micronutrient fortification. This choice is based on the fact that maize meal is widely consumed (>90% of the population) in large quantities (>220g per person per day) and it is milled both by industries (60%) and small scale hammermills (40%). The small scale millers service over 60% of peri-urban and rural communities. Thus a trial was conducted to assess the feasibility of fortifying maize meal at community level. In order to evaluate the benefits to be derived from consuming fortified maize meal, the retention of micronutrients were assessed during cooking and storage through vitamin A determinations. **Aim:** To evaluate the effect of cooking and storage on the nutritive value (vitamin A) of fortified maize meal. **Methods:** Multi-vitamin-mineral fortified hammermilled maize meals were cooked as porridges or nshima or packed in polyethylene or polypropylene bags and kept at room temperature for 14 weeks. Vitamin A concentration in samples was determined by the Carr-Price reference method. **Results:** Vitamin A losses occurred to a largest extent during cooking than storage. The losses for the former were 37.9% and 49.3% for the porridges and nshima respectively. During storage for a month about 15% loss of vitamin A occurred. **Conclusion:** As much as the benefits accrued from consuming micronutrient fortified maize meal are obvious and pertain to the overall improvement in nutrition, it is important to increase the initial micronutrient concentration to add to maize meal during fortifying in order to compensate for the high losses observed in this study.
- W31 COMPARISON OF THE CARR-PRICE ASSAY FOR VITAMIN A DETERMINATION IN FORTIFIED OIL, SUGAR, SALT AND FLOUR WITH THE STANDARD HPLC METHOD.** Y. Kakuda<sup>a</sup>, F. Jahaniyal<sup>a</sup>, V. Abraham<sup>b</sup>, L. Laleye<sup>c</sup>. <sup>a</sup>Department of Food Science, University of Guelph, Guelph, ON, Canada. N1G 2W1. <sup>b</sup>Caravelle Foods, Brampton, ON, Canada. <sup>c</sup>The Micronutrient Initiative, Ottawa, ON Canada.  
Vitamin A deficiency is a serious public health problem in many developing countries. The fortification of foods is technologically feasible and can be a cost effective means of supplying vitamin A to high risk groups. To be effective, the fortified foods must have a standardized level of vitamin A and must be monitored by government labs for regulatory purposes and by the manufacturer for quality assurance auditing. The method of choice for vitamin A determination is high performance liquid chromatography (HPLC). However not all labs can afford the HPLC equipment and must rely on less sophisticated methods. A major concern with these alternative methods is their accuracy and precision. The objective of this study was to compare the reliability and accuracy of the Carr-Price colorimetric method and two semi-quantitative procedures to the HPLC method. The samples were vitamin A fortified oil, sugar, salt, and flour. The HPLC procedure was based on Thompson et al. (1980). The Carr-Price procedure was based on the AOAC Official Methods of Analysis (974.29). The fortified oil samples were diluted in chloroform for Carr-Price analysis and for HPLC analysis. The solid samples were dissolved in water and extracted with chloroform to remove vitamin A. The colorimetric assays were difficult to perform due to the transient nature of the blue chromophore that is produced with antimony trichloride, trichloroacetic acid or trifluoroacetic acid. The color begins fading immediately after mixing and absorbance readings must be taken within 5 s. The limit of detection for the colorimetric assays was approximately 10 IU/g. The HPLC procedure could accurately detect this level and gave results close to the label declarations.

- W32 VITAMIN A IN MAIZE AND FLOUR: AN INTER-LABORATORY EXERCISE.** D Labadarios<sup>1</sup>, IM Moodie<sup>1</sup>, M Kent<sup>3</sup>, H-L Robertson<sup>2</sup>, R Parkhurst<sup>3</sup>. <sup>1</sup>Department of Human Nutrition, University of Stellenbosch, <sup>2</sup>Vitamin Information Centre, <sup>3</sup>Roche Vitamins, South Africa.  
Background: The forthcoming food fortification programme in South Africa and the necessity for the monitoring thereof mandate the development of standardised methodology for the determination of vitamin A levels in commercially produced fortified maize meal and wheat flour. Aim: The aim of this study was to determine the degree of agreement for the determination of vitamin A in fortified food staples, which were obtained by two independent laboratories using in-house HPLC methods. Methods: Both laboratories employed methodologies, which included sample saponification, "Extrelut column clean up", elution of the vitamin A with hexane and solvent evaporation prior to analysis. Results: The reported mean vitamin A concentration from the respective laboratories varied significantly in all samples of staples tested, viz 537, 616, 794, 985, 502, 831 and 523 IU/100gm from laboratory A and, for the same samples, 250, 383, 584, 567, 267, 433 and 250 IU/100gm from Laboratory B. The declared vitamin A concentration in the samples tested was 694 IU/100 gm. In order to determine whether differences existed between the individual samples supplied to each laboratory, those originally supplied to Laboratory A were analysed by Laboratory B to give the following results 384, 584, 483, 464, 300, 367 and 234 IU/100gm. These results showed a better agreement with those from samples originally analysed by Laboratory B, viz 250, 383, 584, 567, 267, 433 and 250 IU/100gm. Conclusion: These findings would imply that the observed discrepancies could be assigned firstly to in-house methodological differences as well as an apparent lack of homogeneity of the test samples supplied. It would, therefore, appear that, for the purpose of successful monitoring, the available analytical methodologies as well as the fortification process in the country are in urgent need of standardization. Footnote: Financial assistance from Sight and Life is acknowledged.
- W33 RAPID TEST FOR VITAMIN A LEVELS IN MAIZE MEAL.** D Labadarios<sup>1</sup>, IM Moodie<sup>1</sup>, H-L Robertson<sup>2</sup>, R Parkhurst<sup>3</sup>. <sup>1</sup>Department of Human Nutrition, University of Stellenbosch, <sup>2</sup>Vitamin Information Centre, <sup>3</sup>Roche Vitamins, South Africa.  
Background: There is an urgent need for a field test, which is both simple and rapid, for assessing qualitatively the presence of vitamin A in maize meal. Such a test is required by cereal producers, who fortify their products with vitamin A, as a quasi-quality control procedure and by the appropriate authority to monitor these products at retail outlets. Aim: To develop such a test in the form of a readily transportable kit. Methods: The methodology involves aliquots of two solutions, which are added consecutively to a small sample (1gm) of vitamin A fortified maize meal taken from the bulk material, which has been appropriately and adequately mixed. On addition of the second solution, a blue colour develops. The intensity of the colour is indicative of the presence of the vitamin A level in the maize and allows for the semi-quantitative assessment of the vitamin A level in the test material against the colour intensity of preformed standards, which are also provided in the kit. Results: Experimentally fortified maize meal at approximately 400 IU/100gm shows marked blue colour in solution; this colour can be observed with diminishing intensity at levels down to a lower limit of approximately 200 IU/100gm. The entire process is rapid being completed in approximately 1 - 2 minutes, since the method provides the necessary solutions ready mixed, and does not involve the use of any instrumentation. Conclusion: This rapid test is useful in the detection of vitamin A at a range of vitamin A levels usually found in fortified maize meal. Footnote: Financial assistance from Sight and Life is acknowledged.

- W34 FOOD CONSUMPTION DATA STRENGTHENS PLANNING IN A FOOD FORTIFICATION PROGRAM.** H Maglalang, C Lopez, P Harvey, T Redaniel. MOST/USAID, HKI/Philippines, JHU, University of the Philippines.  
Background: Micronutrient deficiencies remain a significant public health problem in the Philippines and the government is responding with programs to reduce these deficiencies. An understanding of what people eat, how they produce or purchase it, and prepare it should strengthen the development and implementation of food-based interventions. In 1997, an OMNI/USAID food consumption survey was used to compare the cost-effectiveness of supplementation with fortifying flour with vitamin A. The results of this study contributed to a strong rationale for implementing a fortification program that consists of both mandatory fortification of selected staples and voluntary fortification of other foods. The data, however, were not used further in policy or program development. Aim: To demonstrate how food consumption data can contribute to the design, implementation, and evaluation of a fortification program. Methods: Quantified 24-hour food recall data were collected on 2000 children aged 6-59 months and 2000 mothers aged 15-49 years randomly selected from the three major island groups of the country and Metro Manila. Food models were used to assist in estimating quantities consumed. Information also included frequency of consuming selected foods in the last week, food source, brands of processed foods consumed, preparation and storage practices, breast-feeding, and use of dietary supplements. Food brands enable fortified foods to be identified. Nutrient intakes were computed from the Philippines food composition tables and fortification specifications from food manufacturers. Results: The intake of food fortified voluntarily increased intake of vitamin A of children by 4.0% and of mothers by 2.6%. Simulations of the intakes contributed by each fortified staple will allow planners to estimate the proportions of population segments that may remain with inadequate intakes and also with intakes that might be excessive. Information concerning the type of sugar and rice consumed in different locations; the purchase, usage, and storage of oil; and the common practice of double washing of rice are examples of data that are relevant to strengthening the implementation of the program. Conclusion: Food consumption data, while somewhat expensive and time consuming to collect, can play a critical role in the development, implementation, and evaluation of fortification programs.
- W35 A CUT-OFF POINT METHOD TO DETERMINE VITAMIN A IN SUGAR AND OTHER FOODS FOR FAST SCREENING IN MONITORING PROGRAMS.** R. Calzia<sup>1</sup>, C. Martínez<sup>1</sup>, P. Domínguez<sup>2</sup> and O. Dary<sup>3</sup>. <sup>1</sup>Institute of Nutrition of Central America and Panama (INCAP/PAHO), <sup>2</sup>Universidad de San Carlos de Guatemala, <sup>3</sup>INCAP/PAHO, now in MOST/the USAID micronutrient program. Background: In Guatemala, monitoring of the sugar fortification program includes the sampling of approximately 6,000 samples a year obtained through public health schools. In the past, with the purpose of reducing the amount of samples to be analyzed, ten samples were mixed to constitute a composite sample. Thus, 600 samples were prepared, two from each of the participating schools. This system provided an acceptable estimation of the average vitamin A content, as well as that of the program's quality for the whole country. However, nonfortified samples were hidden because their combination with well-fortified samples, and therefore "coverage" (proportion of samples with desirable vitamin A levels) might be overestimated. With the purpose to overcome this limitation, the Nutritional Biochemistry laboratory of INCAP decided to develop a qualitative method to determine the presence of vitamin A in fortified sugar. The method was designed to test positive for the 3.5-mg retinol/kg cut-off point; this level provides 25 to 50% of the RDI for vitamin A, using the typical sugar consumption in the country: 30 g/day (children) and 70 g/day (adults). Aims: To develop a rapid and reliable qualitative method for determining vitamin A presence in sugar. Methods: 423 sugar samples were taken at households and schools from Escuintla (one of the 22 territorial divisions in which the country is divided). All samples were analyzed using the cut-off point method, under assessment, and the spectrophotometric quantitative methods with hexane extraction (reference method). The cut-off method consists in mixing about half a teaspoon of sugar in a test tube with hot water. Then the reactive chromogen is added and a light blue color indicates the presence of vitamin A in sugar. The uncolored samples are taken as negatives. In order to characterize the method, an analysis of 2x2 contingency tables was used. The sensitivity and specificity were calculated against the reference method. Results: The method's sensitivity (identification of samples with less than 3.5-mg/kg) was 73% and the specificity (identification of samples with a retinol content equal or larger than 3.5 mg/kg) was 97%. The low sensitivity obtained, as compared with the specificity, is attributed to a small proportion of negative samples in the study. The performance of the method is adequate to screen individual samples to be excluded for the constitution of composite samples to be analyzed through the quantitative assay. The method is also examined on flour and oil fortified with vitamin A. With the cut-off method, about 200 samples can be analyzed daily, and the cost of the reagents is around US\$0.25 per sample. Conclusion: The cut-off method with a 3.5 mg/kg discriminative limit is a reliable and practical screening assay to be used in surveillance systems for sugar fortified with vitamin A. The potential usefulness of the method in other applications will also be discussed.

**W36 SEQUENTIAL APPLICATION OF TWO FORMS OF DEUTERIUM-LABELED RETINYL ESTER WHOLE-BODY-DILUTION TRACERS TO MONITOR THE IMPACT OF ONE-YEAR OF SUGAR FORTIFICATION WITH VITAMIN A ON VITAMIN A STATUS OF NICARAGUAN SCHOOLCHILDREN.** JD Ribaya-Mercado, NW Solomons, Y Medrano, J Bulux, GG Dolnikowski, RM Russell, CB Wallace. Tufts University/USDA HNRC, Boston, Massachusetts, USA; CeSSIAM, Guatemala City, Guatemala; and Universidad Nacional Autónoma de Nicaragua, Managua, Nicaragua.

**Background:** Nicaragua was the last of the five Central American republics to initiate vitamin A fortification of its table sugar for domestic use. With the *de novo* introduction of this public health measure with the 1999/2000 sugarcane harvest, the opportunity to document any impact of the program on vitamin A status became available. **Aim:** To determine any change in vitamin A status (i.e., total-body vitamin A stores, and plasma retinol concentration) in a cohort of children during the first year of the Nicaraguan national program of sugar fortification with vitamin A. **Methods:** Total-body vitamin A stores was assessed in 5-9-y-old schoolchildren (n=21) by using deuterated-retinol-dilution techniques: each child received 15.04 μmol of tetra-deuterated retinyl acetate in March, 2000 and 14.85 μmol of octadeuterated retinyl acetate in March, 2001. Plasma retinol isotopes at 21 d post-isotope-dosing were measured by GC-MS after extraction and separation of retinol from other plasma constituents by HPLC, and derivatization of retinol into trimethylsilyl compounds. The ratio of deuterated: non-deuterated retinol was used in a mathematical formula to obtain a numerical estimate of total-body vitamin A stores. Total retinol concentration in plasma was assessed by HPLC, and endogenous plasma retinol was calculated by subtracting the contribution of deuterated retinol from total retinol. **Results:** Total-body vitamin A stores increased from a median value of 0.33 mmol retinol at baseline to 0.72 mmol retinol 1 y later (P=0.0001); plasma retinol rose from 0.97 to 1.17 μmol/L (P=0.01). **Conclusion:** A marked improvement in the vitamin A reserves of school-aged children resulted during the year following initial vitamin A fortification of domestic sugar in Nicaragua; this was accompanied by a small increase in circulating retinol.

**W37 TECHNOLOGY FOR FORTIFYING LARGE CRYSTAL SIZE PLANTATION WHITE SUGAR WITH VITAMINA:** SS Sirohi and S Bulusu, Nutrition & Sugar Consultants, The Micronutrient Initiative, South Asia Regional Office, India.

**Background:** Vitamin A deficiency (VAD) is common in several parts of India, largely affecting women and children. Fortification of sugar has been an effective strategy to reduce VAD in Guatemala. Laboratory trials conducted on the stability and segregation of vitamin A beads in typical India sugar demonstrated the feasibility of sugar fortification in India. However, most Asian and African countries produce plantation white sugar with large crystal size (as compared to the small crystal sugar produced in most European and Latin American countries), requiring the development of a suitable fortification technology. **Aims:** To establish a Pilot Plant to study the feasibility of fortifying large crystal size white sugar with vitamin A at the factory level. **Methods:** The design of the plant was tailored to suit the fortification of sugar crystals having sized between 850 microns and 1.25 mm. The equipment needed to be configured so that it could be operated during production itself or to fortify previously produced sugar. Hence, the Pilot Plant was designed in India to fortify 1 ton sugar per hour. The flow rate of sugar is maintained on a food grade belt conveyor where premix is added through a dosing machine, which has also been improved by fixing an electronic eye to allow the flow of premix only when sugar flow is assured. A drier-cum-mixer has been designed to maintain a suitable temperature of sugar crystal for proper adherence of premix, duly fitted with a controlled supply of hot/cold air as desired. The fortified sugar is finally conveyed through a food grade belt conveyor to a bin for weighing and packing. **Results:** The Plant was commissioned in the year 2000 and the fortified sugar was found satisfactory in respect of vitamin A stability and segregation. In the Pilot Plant trials, optimization of plant capacity with minimum variation of vitamin A level in fortified sugar has been achieved, with the level of vitamin A maintained between 15-20 mcgs per gm. The fortified sugar is being tested for biological efficacy by the National Institute of Nutrition, India, the results of which will be available by early 2003. **Conclusions:** Feasibility of fortifying large crystal white plantation sugar has been established for the first time for the benefit of sugar mills producing this variety in India or elsewhere.

Integrated Approaches and Communication and Behavior Change

**W38 CONTROL OF SUBCLINICAL VITAMIN A DEFICIENCY (VAD) IN THE HUALLAGA VALLEY OF PERU.** LE Benavente, SE Contreras, KR Delgado and B Schwelthelm. Project HOPE, Millwood, Virginia and Universidad Peruana Cayetano Heredia, Lima Peru.

**Problem:** Five years ago, rural children under 3 years of age in the Hullaaga Valley of the Peruvian Amazon basin had high morbidity and malnutrition rates. **Objectives:** The Child Survival program's aim is to improve child nutrition and health. **Framework:** Nutrition status is the composite result of different interventions. Vitamin A (VA) status, which is affected by access to supplement s, diet and disease status, influences physical growth. **Program design:** Professional nurses, dietitians and technical nurses hired locally were trained to supervise 250 community health volunteers in remote rural villages. Interventions included: a) VA supplementation during immunization campaigns; b) exclusive breastfeeding promotion for the first 6m of age; c) nutrition education aimed at dietary diversification; and d) growth monitoring and promotion. Project HOPE also helped to procure VAsupplements and trained Ministry of Health partners in VA supplementation. **Evaluation design:** Household surveys using cluster sampling were conducted before (B) and after (A) the intervention, without a non-intervened group for comparison. All children in the sample (B = 307, A = 464) had serum retinol (High Performance Liquid Chromatography) and anthropometric measurements, while a subsample (B = 60, A = 79) also had quantitative dietary survey. **Results:** Until the program started, VA supplements had not been distributed in this area, and the target area had the highest prevalence of subclinical VAD ever reported in Peru. Due to the sample size used for dietary surveys, we cannot demonstrate an increase in dietary VA intake during this period. The increased coverage of VAsupplements and reduction in morbidity might explain the improved VA status in this area. Stunting rates, statistically associated with low serum retinol levels at baseline, decreased also significantly.

Results, outcomes [Confidence Interval]	B, 1997/8 [CI]	A, 2000 [CI]	p, X <sup>2</sup>
VA supplement in the previous year	0%	19.3% [10-28]	<10 <sup>-7</sup>
VA intake <90% recommended (including an estimate of breast milk intake)	39.7% [15-65]	37.7% [16-59]	0.80
Diarrhea in the previous two weeks	72.2% [58-87]	57.8% [47-69]	0.003
% with low serum retinol (<0.7 μmol/L)	71.7% [62-82]	11.5%[5-18]	< 10 <sup>-7</sup>
Stunting, height-for-age below -2Z.	55.4% [44-67]	39.4% [30-49]	0.00001

**Program implications:** VADeficiency is being controlled as a public health problem in this area. The project will continue integrating supplements with nutrition and health education, with the aim of achieving sustainable changes. Underregistration of VA doses will be reduced with improved design of immunization cards. [Funded in part by USAID, Project HOPE and Sight and Life]

**W39 MICRONUTRIENT HEALTH IN MALI: PRE-SERVICE TRAINING AND HEALTH WORKER PRACTICE.** A Cissé, A Coulibaly, F Ouattara, A Tely, KZ Waltensperger, and VM Aguayo. Helen Keller International (HKI) - Mali (AC, AC, FO, AT, KZW) and HKI - Africa Regional (VMA).

**Background:** Results of Mali's 2001 DHS support earlier studies pointing to micronutrient deficiencies as a major national public health problem. Mali's 10-year health sector development plan emphasizes preventive and curative protocols to improve the micronutrient status of pregnant women and children 6-59 months. In its technical assistance role to the MOH, HKI-Mali conducted two studies: 1) baseline assessment in 13 pre-service training institutions; 2) study of micronutrient availability and prescribing practices in health centers. **Aims:** 1) evaluate pre-service training in nutrition for health workers of various disciplines; 2) identify areas of weakness in compliance with national protocols for the curative and preventive supplementation of children 6-59 months and pregnant and post-partum women. **Methods:** a) curricula assessment; b) structured interviews; c) quantitative surveys; d) observations in randomly selected facilities in 4 regions; e) retrospective examination of health records. **Results and discussion:** Nutrition is commonly taught by non-specialists and emphasized scientific theory over practice in all 13 schools. Thanks to the integration of micronutrient supplementation with national and regional immunization days, 70% of postpartum women and 58% of children 6-59 months had received preventive vitamin A supplementation. However, only 7% of sick children were prescribed vitamin A by health agents, even though national policy calls for use of high-dose vitamin A supplementation in children with measles, clinical signs of vitamin A deficiency, chronic diarrhea, severe malnutrition, and respiratory infections. Half of health centers visited had experienced stock ruptures (of 20-365 days) for vitamin A and iron/folate, despite their being listed as essential medicines. Iron/folate was prescribed to 93.7% of pregnant women coming for pre-natal consultations. **Conclusions:** Current practice reflects inadequate pre-service training. Health agents would benefit from additional training and improved supervision to enhance compliance. The supply system needs to be examined to correct the causes of stock rupture.



**W40 RISK FACTORS FOR NIGHT BLINDNESS AMONG PREGNANT WOMEN IN SOUTH INDIA- THE VASIN STUDY.** P.K. Nirmalan, L. Rahmathullah, S.Sheeladevi, K.Prakash, J.Katz, J.M. Tielsch. Aravind Center for Women, Children and Community Health, Madurai, India and Dept. Of International Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA.

**Background:** Although night blindness (XN) is recognized as a common complication of pregnancy in south Asia, few studies have looked at the risk factors for XN in this population. **Objectives:** To identify risk factors for pregnancy related maternal XN in south India. **Methods:** Pregnant women were enrolled and randomized to have their children receive either vitamin A supplementation (48,000 IU) or a placebo (Tocopherol 5 mg/dl) as two doses within 48 hours of delivery as part of a population based randomized placebo controlled double blind clinical trial. Demographic and socioeconomic details, a history of XN during pregnancy, history of prior pregnancies, and morbidity were elicited from participants. Nutritional status was also assessed for mothers in the study. **Results:** Night blindness was present for 5.2% of all deliveries. After multivariate analysis, increasing years of maternal education (OR 0.91, p<0.001) and prior miscarriage (OR 0.54, p<0.001) were protective for XN while an increased risk was associated with occupation of head of the household –laborer (OR 1.20, p<0.05), Parity of 3-4 (OR 1.55, p<0.001) or 5 and more (OR 1.85, p<0.001) and multiple children in the same pregnancy (OR 3.3, p<0.001). Maternal age and age at first pregnancy were not significantly associated with XN in the multivariate model. **Conclusions:** Parity and multiplicity are more proximal risk factors for XN, although socioeconomic status also plays a role. Strategies aiming at improving family planning services and maternal education in addition to vitamin A supplementation are required in this population to further reduce the risk for XN during pregnancy.

**W41 THE CONTRIBUTION OF VITAMIN A FROM A MULTI-MICRONUTRIENT-FORTIFIED CONDIMENT SPREAD TO THE TOTAL DIETARY VITAMIN A FROM MAIN-DISH RECIPES OF URBAN AND RURAL LOW-INCOME GUATEMALAN HOUSEHOLDS.** M Orozco, NW Solomons, A Briand. CeSSIAM, Guatemala City, and ISTNA/CNAM, Paris, France.

**Background:** Finding potentially selective and targeted –but effective—ways to increase vitamin A intake in populations at risk of endemic hypovitaminosis A, may be a key to reduce this deficiency. **Aims:** To present low-income Guatemalan women with a high-density-nutrient spread (HDNS) in the form of a condiment seasoning, to determine how they would incorporate it into household cuisine; and to determine the distribution and inter-individual variance of extrinsic and total vit A from these main-meal dishes. **Methods:** A total of 30 main-meal recipes (15 rural; 15 urban) were collected from women presented with the condiment spread containing 20 mg of retinol per 100 g and the micronutrient values calculated by recipe and by portion consumed by family members. **Results:** A total of 30 main-meal recipes (15 rural; 15 urban) were collected. Meals were consumed by 2 to 11 persons (median: 5). The intrinsic vit A density of main meals ranged from 12.6 to 19095.5 RE/1000 kcal, with 11.4 to 28059.9 RE/meal, for an average individual consumption of 699.3 ± 1766.6 RE per consumer. This raised the total vit A consumption statistics for main-meals to 253.7 to 19234.1 RE/1000 kcal, with 468 to 28259.6 RE/meal, for 1292.3 ± 1731.1 RE per consumer, helping most consumers to meet or exceed their daily vitamin A intake recommendation for this meal alone. **Conclusions:** Vitamin A content of meals was increased by HDNS addition by 1 to 176.9 times, but inter-individual exposure varied widely. More than 100 % of the DRI-RDA vit A recommendation was achieved in the meals for 50% of women.

**W42 PERCEPTIONS OF NIGHTBLIND Pregnant WOMEN, THEIR FAMILIES AND COMMUNITY LEADERS ON CAUSES, TREATMENT AND STRATEGIES FOR COPING WITH NIGHTBLINDNESS DURING PREGNANCY.** Pooja Pandey, Rita Pradhan, Sanjay Singh, Ram K. Shrestha - Nepali Technical Assistance Group (NTAG), Kathmandu; Rakesh K. Thakur, District Public Health Officer, Saptari, Nepal.

**Background:** The prevalence of nightblindness (XN) during pregnancy is ~16% in the eastern rural Terai region of Nepal (Katz, 1995). Because nightblind (XN) pregnant women are at higher risk of maternal mortality (Christian, 2000), a public health intervention program to address this problem is needed in Nepal. Information on the perceptions and beliefs about XN during pregnancy among nightblind pregnant women, their families and community leaders is needed to develop a culturally-appropriate intervention program to address this problem in Nepal. **Aims:** To describe perceptions and beliefs regarding causes and treatment of XN, and strategies for coping with XN during pregnancy among pregnant XN Nepali women, their family members and community leaders (?). **Methods:** The study was conducted in the eastern Terai district of Saptari. Nightblind pregnant women (n=200) were identified by conducting a census in 60 village development committees of the district. Information on perceptions and beliefs about causes and treatment of XN during pregnancy, and coping strategies of nightblind women was obtained from pregnant XN women, their family members and community leaders using focus group discussions (n= 30) and in-depth interviews (n=100). **Results:** Women reported that XN occurs as a gradual process that starts with haziness at dusk and that their vision improves as the night progresses. Women believe that XN is a symptom of pregnancy and that it disappears when the baby is born. Although women are aware that “XN pills” (low-dose vitamin A tablets) are available for treatment of XN most do not purchase them because they do not believe that XN is a serious illness. However, women reported that their physical activity is restricted at dusk, which interferes with their household chores and childcare. Women use different coping strategies to manage XN, such as cooking earlier in the day, and calling someone from the maternal home to assist with cooking and childcare. **Conclusions:** XN is recognized as a problem during pregnancy, but nightblind pregnant women do not seek treatment because they and their families believe that the condition will disappear when the baby is born. Health and nutrition education is needed to increase awareness of the serious consequences XN during pregnancy and to encourage women to seek appropriate treatment.

**W43 MOTHER TO MOTHER SUPPORT GROUPS AS A CHANNEL FOR NUTRITIONAL EDUCATION.** J Petersen, S Sosi, S W Andersson.

**Background:** Improvement in dietary diversity to include vitamin A-rich foods is one of the main strategies suggested to address vitamin A deficiency. One of the problems faced is the dissemination of information to reach the grass roots in order to achieve behaviour change and improve vitamin A intake. **Aims:** To evaluate mother to mother support groups (MtMSG), within the Baby Friendly Hospital Initiative (BFHI), as a tool for delivering nutritional information on vitamin A to rural care-givers. **Methods:** A community intervention study of 154 randomly selected caregivers of children aged 6-59 months in two rural communities in Mfantseman District, Ghana. Intervention material was disseminated from the sub-district clinic nurses through the MtMSG to community women over a period of 10 weeks and was based on vitamin A promotion materials developed by the MoH with support from USAID/MOST/WHO. Pre- and post-intervention questionnaires probed for knowledge of vitamin A. A 7-day FFQ was used to estimate pre- and post intervention intake of vitamin A food sources. Pre-intervention interviews were conducted with 132 of the respondents representing the community as whole and 22 respondents representing the members of the MtMSG. **Results:** Pre-intervention results show that familiarity with the term “vitamin A” was low, only 59% pre- compared to 95% post intervention (n 132). Pre-intervention knowledge of food and breast milk as vitamin A sources were 32% and 16% respectively, compared to 81% and 24% post-intervention (n 132). The 7-day FFQ indicates a more deliberate choice of vitamin A rich foods, for example everyday usage of red palm oil increased from 4.5% to 22% post-intervention. **Conclusion:** MtMSG appear to be a possible channel for improving information dissemination on vitamin A sources and influencing behavioural change, and can thus be incorporated in programmes aimed at the prevention of micronutrient deficiencies.

- W44 IMPROVING VITAMINA COVERAGE (VAC) AMONG 6 MONTH TO 5-YEAR-OLD CHILDREN IN THE AUTONOMOUS REGION OF MUSLIM MINDANAO (ARMM), E Puertollano, E Villate, E Barquilla, D Reario, HKI Philippines; Asst. Sec. L Pandi, E Hampac, DOH-ARMM, Philippines.**

**Background.** The Autonomous Region of Muslim Mindanao (ARMM) is composed of 4 provinces (Maguindanao, Sulu; Tawi-Tawi, Lanao Sur) with a population of 2,412,159. Two provinces are in the mainland and the other 2 are composed of island municipalities. Ninety percent of the populations are Muslims and 10% are Christians. ARMM has its own centralized Department of Health (DOH). The 1998 FNRI Survey reveals that infant mortality rate of the region is 55 per 1000 and under five-mortality rate is 97.6 per 1000. VAD (deficient and low <20 ug/dl) is 40.5%. The 1998 NDHS survey shows that VAC coverage of ARMM among 6 mo to 5-year-old children was only 31.8%, the lowest among the 16 regions in the Philippines. **Objective.** In October 2000, HKI was commissioned by USAID to extend technical assistance to ARMM and 4 other regions with low VAC coverage with the aim of achieving 80% VAC coverage among 6 mo to 5-year-old children by 2001. **Implementation Strategy.** To improve VAC coverage in the 5 regions, HKI utilized the Preschoolers Health Week or Garantisadong Pambata. This is a weeklong event conducted twice a year (April and October) by the DOH that provides VAC to 12-59 mo old children, conducts weighing, routine immunization and deworming and promotes positive caregiving behaviors. HKI organized regional and provincial task forces and the technical assistance focused on improving the capability of the task forces to manage the project using the project management cycle. Activities conducted by the task forces were: 1) Provincial social mobilization planning workshop with situational analysis. "Out of the box" social mobilization activities were designed and implemented. 2) Development of IEC materials. 3) Technical updates on vitamin A for local health workers. 4) Monitoring activities before, during and after Preschoolers Health Week 5) Consultative/Planning Workshop to assess performance, identify problems and solutions, discuss lessons learned and plan for the next Preschoolers Health Week. **Evaluation.** In the two surveys conducted by the National DOH to evaluate the VAC coverage of the 5 regions, ARMM got 82% VAC coverage in the 2000 survey and 78.8% in 2001. The decrease of VAC coverage in 2001 was attributed to the unsafe situation in some parts of the region due to the presence of the lawless elements like the Abu Sayyaf. **Implication/Recommendation.** Social mobilization helps increase VAC coverage, to generate needed resources, encourage project ownership and sustenance. However, despite the increase of VAC coverage, it is still recommended to continue the project in ARMM to focus in areas where VAC coverage is low and to sustain VAC supplementation in the region.

- W46 PROXIMITY COMMUNICATION IN ORDER.** A. Saka Saka. BASICS II, Kinshasa, Democratic Republic of Congo.

Despite efforts, only 20% of children aged from 12 to 59 months in 2001 have been supplemented with a second dose of Vitamine A as part of Primary Health Care (PHC) program which provided to cover all children aged from 6 to 59 months in Kinshasa. The reason for this situation is that parents are automatically stopping going to Health Facilities once the "Vaccine Administration Schedule" ends up.

In order to increase preschool frequentations and supplement at least 80% of children aged between 12 and 59 months with Vitamine A, PRONANUT (National Nutrition Program), along with UNICEF and BASICS II decided to rely on the base community by engaging and selecting local Community Rally Groups; developing attractive messages to be used as posters and songs, to be diffused through regular broadcastings (Community radio and TV), regular field-work supervision of actors. This media-assisted Proximity Communication resulted in 87% coverage of Vitamine A supplementation for children aged from 12 to 59 months in February 2002. Results are worth being promoted in rural areas where there's been encouragement for Rally Groups.

- W45 INCREASING CHILDREN'S VITAMIN A INTAKE THROUGH DAY CARE PROGRAMS: AN EXAMPLE FROM GUATEMALA.** MT Ruel, IFPRI, Washington, D.C.

**Background:** The Guatemala Hogares Comunitarios Program (community day care program), a government-sponsored program, was originally designed as a non-traditional alternative to ensure the care of children of working parents in communities characterized by poverty and lack of access to other child care alternatives. The ultimate goal was to promote child development, health and nutrition.

**Program design:** A group of parents select a woman from their community and designate her as the caretaker mother. This woman then becomes responsible for receiving in her home and caring for up to 10 children 0-7 y, 5d/wk, 12h/d, and to provide them with care and affection, security and hygiene, early stimulation, and 2 meals and 2 snacks. The program provides approximately \$0.50/d/child for purchasing food for children and a small incentive for caretaker mothers (\$3/child/mo). Parents pay \$5/child/mo.

**Objectives of Evaluation:** To assess the program's impact on children's nutrient intakes, by comparing beneficiary children individually matched with controls of the same age, neighborhood, and whose mothers also work outside the home.

**Results:** Beneficiary children consumed on average 20% more energy, protein and iron, and 50% more vitamin A than matched controls. A greater proportion of the iron and vitamin A intake of beneficiary children was from animal products, and thus more bioavailable. Home diet of beneficiary children was also slightly more nutritious compared to control children and thus the net impact of the program on nutrient intake is positive and significant.

**Conclusions:** The government-sponsored day care program in Guatemala is an innovative approach that has great potential to promote increased vitamin A intake and dietary diversity among preschool children. The cost of the program is \$1.38/child/d, of which 80% is provided by the program and the remaining 20% by the parents.

- W47 DEVELOPING A COMMUNITY BASED APPROACH TO GARDENING IN BURKINA FASO: THE ROLE OF FEMALE VILLAGE SOCIAL WORKERS.** O Vebamba, F Guidetti, Z Sifri, M Ag Bendech. Helen Keller International-Burkina Faso (OV, ZS, MB) and UNICEF-Burkina Faso (FG).

Food insecurity is chronic in Fada N'Gourma, one of the most arid areas in the eastern region of Burkina Faso. In this region, intake of micronutrient-rich foods is very low. In 2000, Helen Keller International (HKI) and UNICEF implemented a gardening project in 16 villages. This gardening project has two components: a school garden component and a community garden component. The community garden component is managed by women's groups and followed-up by female village social workers. This paper will describe and analyze the role of female village social workers in the follow-up and sustainability of the production and consumption of vitamin A-rich foods. After a number of training sessions in market gardening techniques, communication for behavioral change, and nutrition, the social workers selected by the community in each of the project villages, organized the launching of gardening activities and follow-up of women's groups. One packet of pre-selected seeds was given to each women's group. Outreach follow-up helped to significantly improve the availability of vitamin A-rich foods at a period of the year when there is usually no vitamin A source except dried leaves. It has also helped to establish a fund for each women's group, using members' contributions after they have sold part of the produce in the village. The fund will serve for buying inputs and maintaining water points when the project is phased out. The evaluation of the first farming season has shown great improvement in the availability of vitamin A-rich garden products in the villages and the village funds are all replenished. For example, the number of home gardens increased from 41 to 127 gardens and carrot production from 0 to 27 tones. The social workers that all community actors like have fully played their role as advisers. Increasing availability of vitamin A rich foods is possible when there is water in the villages. To do so, it is very important to use a participatory approach and rely on community intermediaries like the female village social workers.



**W48 COMBATTING VITAMIN A DEFICIENCY BY INTEGRATING VITAMIN A SUPPLEMENTATION IN THE PRIMARY HEALTH CARE ACTIVITIES AND PROMOTING THE CONSUMPTION OF FOOD RICH IN VITAMIN A, KINSHASA, DR CONGO.** M.C Yandju D.L\*; Sita Claire\*\*; A. Sakasaka\*; Th. Kazadi\*\*\*; T. Tusuku\*\*\*\*; Th. Ntambwe\*\*\*\*; M. Othepa\*. \*BASICS II/USAID, \*\* UNICEF, \*\*\* MOST/USAID, \*\*\*\* PRONANUT.

The national wide scale survey conducted in 1998 shown that the vitamin A deficiency remains a major public health problem DR Congo. About 61.1% of children 6-59 months old were vitamin A deficient. Because of that, the MoH then, took the opportunity of National Immunization Days (NID) for polio eradication initiative to supplement vitamin A to all children aged 6-59 months.

In order to extend this intervention to breastfed women end to new cohorts entering the target age for vitamin A supplementation after the NID in one hand, and to keep the frequency of supplementation once every six months in the other hand, BASICS II project started a pilot study in 3 health zones of Kinshasa by integrating vitamin A supplementation in Primary Health Care (PHC) activities. This activity was put scale addressing the remaining health zones of Kinshasa. In addition to these supplementation activities MoH, BASICS and other partners are promoting the consumption of food rich in vitamin A.

The number of health facilities has already integrating vitamin A supplementation into PHC activities has increased from 59 in 2000 to 339 in 2002. The vitamin A supplementation coverage has been improved since: 132 % for 6-11 months of age, 86 % for the children 12-59 months old and 41 % among the breastfed women.

**W49 PARTNERSHIPS FOR SUSTAINABLE PREVENTION OF VITAMIN A DEFICIENCY IN CAMBODIA.** Y Yim, V Ly and DD Shaw. World Vision Cambodia.

**Issue:** Vitamin A deficiency (VAD) is a public health problem in parts of Cambodia. World Vision Cambodia (WVC) is implementing a project in Kompong Thom Province which has a high prevalence of night-blindness in children. Phase 1 (2000-2001) has been evaluated and Phase 2 (2002-2003) begun. **Objective:** To develop sustainable community-based interventions to prevent VAD. **Framework:** A multi-sectoral approach combining proven interventions with community participation and capacity building of partners. Where the project is working, WVC has long-term Area Development Programs (ADP)-a people-centered approach to development. **Program Design:** The multi-sectoral approach involves partners from the Ministries of Health, Education, Agriculture and Rural Development. Interventions are semi-annual Vitamin A capsule (VAC) distribution; post-partum VAC distributed by traditional birth attendants and Village Health Volunteers (VHV); promotion of optimal breast feeding; health and nutrition education; training for health staff, teachers and community leaders; and home and school gardens. **Results:** During Phase 1 the prevalence of night-blindness in children aged 18-59 months was reduced from 11% to 3%, exclusive breast-feeding for the first 6 months of life increased from 5.3% to 13.5%, mothers knowledge of two VA rich foods increased from 5% to 57% and families consuming a VA rich meal in the last 3 days increased from 55% to 94%. **Implications:** Recommendations for Phase 2 include: formal evaluation of materials used; review of home and school gardens; questions on VAD in school exams; enhanced measles immunization; and a focus on pregnant and lactating women. Successful interventions will be integrated into the ADP, the capacity of partners increased, community ownership attained and improved nutritional practices achieved through behaviour change.

**W50 INTEGRATED COMMUNITY DEVELOPMENT TO CONTROL VITAMIN A DEFICIENCY**  
Dr. F-Z Akalay, Pr. D. Bensaid, Helen Keller International-Morocco.

**Background.** According to the National Directorate of Statistics, more than 89% of rural women from the poorest regions in Morocco are illiterate. In 2001, a survey by the Ministry of Health and Helen Keller International Morocco revealed a strong correlation between illiteracy and micronutrient malnutrition, especially in women and children. Furthermore, results from recent studies conducted by Moroccan researchers on food and nutrition habits (Dr. Akalay, Pr. Bensaid), the socio-economic status of women (Pr. Harras), illiteracy (Pr. Ibaaqil), and poverty (Demographic Research and Study Center) reveal the complexity of problems linked to micronutrient malnutrition, particularly vitamin A (VA) deficiency. Sustainable improvement of VA status requires the implementation of a comprehensive strategy integrating economic, technical (agricultural), and cultural concerns. **Aims:** In 10 villages of Zagora, southern Morocco: 1) Ensuring a functional post-literacy cycle for 1,500 women; 2) Equipping ten market gardens so that they can produce diversified micronutrient and VA rich foods and generate income for women; 3) Developing post-literacy training modules on topics linked to micronutrient deficiencies focusing on VA deficiency; 4) Developing a database on the economic and nutritional status of families in the ten villages included in the project. **Results and discussion:** At the time of the XXI IVACG Meeting, results will be presented on 1) Knowledge and practices of the target population regarding VA/ VA deficiency; 2) Literacy and numeracy training for 1,500 women; 3) Three literacy modules on VA; 4) Endowment of women with economic and technical/agriculture skills; 5) Development of a community-friendly database on their economic and nutritional status; and 6) potential for project replication. It is expected that these findings will guide program expansion for the effective and sustainable control of vitamin A deficiency in Morocco.

**W51 MICRONUTRIENT DEFICIENCIES AND THEIR ECONOMIC IMPLICATIONS IN MOROCCO.** E. Rjmati, A. Zerrari, H. Chekli, Ministry of Health.

Micronutrient malnutrition affects the health and survival of more than 2 billion people worldwide. Women and children are most at risk. Micronutrient deficiencies "hidden hunger" remain a major concern in Morocco. Vitamin A Deficiency (VAD) is a public health problem. The prevalence in children from 6 to 72 months is 41% (Retinol < 200 µg/l). VAD is the most common cause of preventable blindness in children and leads to increased morbidity and risk of mortality. Iron Deficiency Anemia is most common among young children and women of reproductive age, especially among pregnant women. In Morocco (2000) the prevalence of anemia among children under 5 is 31.5%, women childbearing age is 33.0%, pregnant women is 37.2% and in men group is 18.0%. IDA increase the risk of poor pregnancy outcome including prematurity, low birth weight and maternal mortality. Iodine Deficiency Disorders (IDD) impairs physical and mental development, including intellectual capacity. The presence of goiter reflects significant iodine deficiency in population. A 1993 national prevalence survey found that the total goiter rate among children (6 to 12 years) was 22%. Our analysis suggests that the mean value of losses due to IDA is about 1.25% of gross domestic product (GDP), due to IDD is about 2.1% of GDP and due to VAD is about 0.7% of GDP.

**W52 A MODEL FOR INSTITUTIONALIZATION OF COMMUNITY-BASED VITAMIN A SUPPLEMENTATION IN SENEGAL.** G Sall, B Ndiaye, K Siekmans. Service National d'Alimentation et de la Nutrition, Ministry of Health, Senegal; World Vision Senegal; World Vision Canada

**Problem:** Vitamin A deficiency disorders (VAD) are a major public health problem in Senegal, affecting mothers and children (infant mortality estimated at 68‰). Vitamin A capsule (VAC) supplementation is the main strategy used to address VAD in developing countries. Due to insufficient health facilities and personnel, mass campaigns (e.g. National Immunization Days) are used for large-scale VAC supplementation. Yet mass campaigns are resource-intensive, require major organization coordination and are not sustainable in resource-scarce contexts. They target only children under five (U5), although mothers are also vulnerable to VAD. **Objective:** To demonstrate that incorporating VAC supplementation into routine community-based health services is a sustainable alternative to mass campaigns for large-scale VAC supplementation in Senegal. **Framework:** A community-based health service system, set up by non-government organizations in collaboration with Ministry of Health (MOH), acts as a vehicle for routine VAC distribution to postpartum women (PPW) and U5. **Program design:** The MICronutrient And Health (MICAHA) program advocated for a community-based VAC distribution pilot model, collaborating with MOH stakeholders from an early stage to ensure sustainability. Community health volunteers (CHV) were trained and supervised to routinely distribute VAC to PPW and U5. MICAHA facilitated the monitoring, evaluation and information sharing. Coverage was evaluated at baseline (1997) and follow-up (2000). **Outcomes:** VAC coverage increased from 1.6% to 51% among U5 and from 0.9% to 30.5% among PPW (all cases  $p < 0.05$ ). These results led to the use of CHV during mass campaigns and encouraged a shift in MOH plans toward implementing routine VAC distribution through existing community-based health services. **Implications:** Incorporating VAC supplementation within community-based health services is a sustainable strategy to achieve low-cost large-scale VAC supplementation coverage of U5 and PPW.

### Selected Oral Presentations

Wednesday, 5 February

**W53 CONTENT AND IN VITRO ACCESSIBILITY OF PROVITAMIN A CAROTENOIDS FROM FRUITS AND COOKED LEAFY VEGETABLES** Generose Mulokozi, Ellen Hedrén, and Ulf Svanberg. Tanzania Food and Nutrition Centre. Dar es Salaam, Tanzania. Department of Food Science, Chalmers University of Technology, Göteborg, Sweden. E-mail: gmx@fsc.chalmers.se

**Background:** Vitamin A deficiency is still prevalent among children in Tanzania and provitamin A carotenoids from fruits and vegetables constitute their major dietary source of vitamin A. **Aim:** To determine the content and *in vitro* accessibility of provitamin A carotenoids in selected fruits and vegetable dishes, and to estimate the amount of retinol equivalents (RE) provided by edible meal portions of these fruits and vegetables dishes. **Methods:** An *in vitro* digestion method that simulates human digestion was used to estimate the amount of bioaccessible provitamin A carotenoids from the fruits and vegetable dishes. The total content and *in vitro* accessibility of provitamin A carotenoids were quantified by HPLC method. To estimate the amount of RE provided by edible meal portions of the samples, the amount of *in vitro* accessible provitamin A carotenoids was assumed to be completely absorbed and converted to retinol according to factors set by FAO/WHO. The amount of provided RE was compared with the recommended daily safe intake level (RSDIL) of vitamin A for children. The portion sizes of cooked vegetables consumed by children in households were determined by weighing. **Results:** The all-trans- $\beta$ -carotene content in fruits and vegetables ranged from 191 to 5502  $\mu\text{g}/100\text{g}$  edible portion and 541 to 914  $\mu\text{g}/\text{g}$  d.m., respectively. In fruits  $\beta$ -cryptoxanthin was found in papaya, tree tomato and mabungo (*Treculia africana*) and ranged from 69-311  $\mu\text{g}/100\text{g}$  edible portion and  $\alpha$ -carotene was found only in mabungo (2832  $\mu\text{g}/100\text{g}$  edible portion). The *in vitro* accessible all-trans- $\beta$ -carotene in fruits varied between 7% and 100% whereas that from leafy vegetables cooked without oil ranged from 4-26%. Vegetables cooked with oil had 2 to 5 times higher amount of *in vitro* accessible all-trans- $\beta$ -carotene than vegetables cooked without oil. A median portion for children (84g) of such a relish then provided 88 to 477% of the RSDIL of vitamin A, while portions cooked without oil only provided between 23 and 46% of the RSDIL. A portion of fruit (150g) would provide between 27 and 216% of the RSDIL. **Conclusion:** Consumable portions of fruits with high content of bioaccessible  $\beta$ -carotene and vegetables cooked with oil may provide > 100% of the RSDIL of vitamin A for children.

**W54 INTEGRATION OF ANIMAL HUSBANDRY INTO HOME GARDENING PROGRAMS TO INCREASE VITAMIN A INTAKE FROM FOODS.** A Talukder<sup>1, 4</sup>, H Torlesse<sup>2</sup>, S de Pee<sup>4</sup>, A Taher<sup>2</sup>, T Chowdhury<sup>2</sup>, H Kroenun<sup>3</sup>, D Panagides<sup>3</sup>, L Kiess<sup>4</sup>, MW Bloem<sup>4</sup>. Helen Keller International, <sup>1</sup>Nepal, <sup>2</sup>Bangladesh, <sup>3</sup>Cambodia, <sup>4</sup>Asia-Pacific, Indonesia.

**Background:** Micronutrient deficiencies are prevalent in countries where the diet lacks diversity and is low in quality. To combat vitamin A deficiency (VAD), Helen Keller International (HKI) has been implementing home gardening programs during the last ten years in Bangladesh, Cambodia and Nepal covering over 900,000 households. However, bioavailability of vitamin A from plant foods is lower than previously assumed, and it is now recognized that interventions should also focus on increasing consumption of animal products. HKI has therefore started pilot projects in three countries to incorporate animal husbandry within home gardening programs. **Aims:** To examine the association between home gardening practices and consumption of micronutrient-rich foods and to assess the impact of the new pilot projects on the production and consumption of vitamin A-rich animal and plant foods. **Methods:** The analysis used data collected by the HKI Nutritional Surveillance Project (NSP) on 53,850 households in Bangladesh in 2000, and monitoring data from the new pilot projects in Bangladesh, Cambodia and Nepal in 2001-2. **Results:** Nationally representative NSP data showed that households with improved or developed gardens consumed a more diverse diet and consumed non-grain foods, including green leafy vegetables, yellow/orange vegetables or fruits, and eggs ( $p < 0.001$ ), more frequently than other households. Baseline data from the pilot projects revealed that dietary intake of vitamin A from animal sources was very low, and that few households consumed eggs although over 70% reared poultry. Income from garden produce was used to purchase high quality foods, including animal foods. Monitoring data on the pilot projects will be available at the IVACG meeting. **Conclusion:** Home gardening, particularly when practiced in an improved or developed garden, increases the quality of the household's diet. However, to be most effective against VAD and other micronutrient deficiencies, home gardening programs should include animal husbandry.

**W55 THE POTENTIAL IMPACT OF BETA-CAROTENE-RICH (BCR) SWEETPOTATOES ON VITAMIN A INTAKE IN SUB-SAHARAN AFRICA.** JW Low, TS Walker, R. Kapinga, R. Hijmans, D. Reynoso, P. Ewell and DP Zhang. Michigan State University, East Lansing, Michigan and the International Potato Center (CIP), Lima, Peru.

Background: Sweetpotato is grown extensively in Sub-Saharan Africa (SSA), but the common white-fleshed, high-dry matter varieties do not contain beta-carotene. Beta-carotene-rich (BCR), orange-fleshed materials initially released as part of the VITAA Partnership have low to medium dry matter content. Sufficient progress has recently been made via conventional breeding to produce beta-carotene rich clones with the high-dry matter content preferred by adult African consumers. Aim: Select new clones and estimate the potential impact on pro-vitamin A intake of replacing white-fleshed with orange-fleshed varieties. Method: Promising elite clones in the germplasm collection held at CIP were identified through station trials and farmer participatory evaluations. Consequently, the population has undergone intensive recurrent mass selection for five cycles.

A simple simulation model based on supply and demand assumptions was used to calculate the potential impact of substituting white-fleshed varieties with orange-fleshed. A geographic information system was used to evaluate the spatial distribution of per capita production. Results: In addition to the 31 BCR sweetpotato varieties already released SSA, forty new BCR clones with high dry matter content are ready for international distribution. Their meeting existing consumer preference and marketing standards enhance the potential sustainability of their introduction. Simulation results indicate that the potential contribution of BCR varieties to solving vitamin A deficiency is greatest in the Lake Victoria region of the East African highlands. The potential value of varietal replacement for young children in Burundi, Rwanda, and Uganda was equivalent to 35% of RDA. Nutritional benefits could also accrue to populations at risk in parts of Madagascar, southern Africa, and West Africa. The potential of BCR materials to leverage vitamin A outcomes is strongly conditioned by the seasonality of production. Conclusion: In many parts of SSA, there is sufficient per capita production of sweetpotato to warrant optimism about the positive nutritional consequences for Vitamin A deficient populations with the introduction and diffusion of BCR varieties.

**W56 LONG-TERM EFFECTIVENESS OF A  $\beta$ -CAROTENE FORTIFIED BISCUIT IN MAINTAINING IMPROVED VITAMIN A STATUS.** ME van Stuijvenberg, MA Dhansay, CM Smuts, CJ Lombard, AJS Benadé. Nutritional Intervention Research Unit and Biostatistics Unit, Medical Research Council, Cape Town, South Africa

Background: A biscuit fortified with  $\beta$ -carotene and given to primary school children as school feeding was effective in significantly improving the vitamin A status of 6-11-year-old children over a period of 12 months. Objective: The aim of this study was to evaluate the long-term effectiveness of this intervention in maintaining vitamin A status over a period of 45 months. Design: Children receiving the  $\beta$ -carotene fortified biscuit (supplying 50% of the RDA) were followed in a longitudinal study for 30 months (n=108); in addition, data from three subsequent cross-sectional surveys, conducted in the same school at 33, 42 and 45 months after the start of the original intervention, are reported. Biscuits were distributed daily during the school week; no intervention took place during school holidays, weekends or public holidays. Results: There was a significant improvement ( $P < 0.0001$ ) in serum retinol during the first 12 months of the biscuit intervention, and the prevalence of low serum retinol levels ( $< 20$  g/dL) decreased from 39% to 12%. However, when the schools reopened after the summer holidays serum retinol returned to pre-intervention levels. Retinol levels increased again during the next 9 months, but showed a significant drop in a subsequent cross-sectional survey carried out directly after the summer holidays; this pattern was repeated in two further cross-sectional surveys. Conclusion: This study has shown that fortification of a biscuit with  $\beta$ -carotene at a level of 50% of the RDA was enough to maintain serum retinol concentrations in primary school children from day to day, but not enough to sustain levels during long school holiday breaks. It is recommended that the biscuit programme is supplemented with other long-term strategies such as nutrition education and local home gardening programmes, which encourage the production and consumption of  $\beta$ -carotene rich foods.

**W57 THE EFFECT OF VITAMIN A-FORTIFIED COOKING OIL INTAKE ON THE SERUM RETINOL LEVEL OF 4 TO 6 YEARS OLD CHILDREN.** LV Candelaria, CR Magsadia, RE Velasco, CVC Barba, CC Tanchoco, MRA Pedro. Food and Nutrition Research Institute-Department of Science and Technology, Metro Manila, Philippines.

Food fortification is one of the strategies being carried out to address VAD in the Philippines. A 6-months intervention trial was conducted to determine the effect of vitamin A-fortified cooking oil on vitamin A status of 4-6y old children. 413 children from 9 barangays in 2 municipalities were randomly assigned to the experimental group, which received ration of vitamin A-fortified cooking oil, and to control-1 group which received ration of unfortified cooking oil. 129 other children from 1 barangay each in the 2 municipalities were assigned to the control-2 group that did not receive cooking oil rations. Mothers recorded children's intake of cooking oil and infections daily. Serum retinol, weight-for-age, weight-for-height and height-for-age z-scores, and frequency of intake of vitamin A-rich foods were measured around the 50th, 120th and 180th day of the study period. Other explanatory variables including cooking and eating practices, and energy, protein and vitamin C intakes were measured. Baseline measurements of all variables including socio-demographic characteristics and household food expenditure were also taken. Serum retinol of children in all study groups improved, but relative change from baseline to end of intervention was significantly higher among children in the experimental group than in control groups. Determinants of post-intervention serum retinol included baseline serum retinol ( $\beta=0.28$ ), caregiver's years of schooling ( $\beta=0.11$ ), receipt of high-dose vitamin A capsule ( $\beta=1.21$ ), and interaction terms between consumption of vitamin A-fortified cooking oil and consumption of other vitamin A-rich foods, and between purchase of cooking oil and household food expenditure. Vitamin A-fortified cooking oil combined with intake of vitamin A-rich foods was necessary to contribute to increasing serum retinol. Among children in the control-2 group, higher household food expenditure increased serum retinol.

**W58 OVERVIEW OF THE DEVELOPMENT OF THE NATIONAL FOOD FORTIFICATION PROGRAMME**

ME de Hoop<sup>1</sup>, J Matji<sup>2</sup>. <sup>1</sup>Department of Health, South Africa. <sup>2</sup>UNICEF (South Africa)

The National Food Fortification Programme (NFFP) which forms part of the Integrated Nutrition Programme (INP) of the Department of Health is one of the key strategies to reduce and prevent vitamin A and other micronutrient deficiencies in the country. In developing the NFFP, the Department of Health is assisted by a National Food Fortification Task Group comprising representatives from the Food Industry, Consumer Organisations, Professional Food and Nutrition Associations, Academics, the Department of Agriculture, Department of Trade and Industry and UNICEF. Ongoing technical support is also provided by the Micronutrient Initiative.

The paper will present the process and outcome of the key activities that were implemented in developing the NFFP, namely the National Food Consumption Survey, Industry Situation Analyses, a position paper on iron fortificants, stability tests and organoleptic evaluation of fortified maize meal and wheaten flour, advocacy and communication campaign, fortification standards, regulations and monitoring plan, the development of a database of small-scale millers and the training and capacity-building of small-scale millers and Environmental Health Practitioners. The major challenges in developing and implementing the programme will also be presented.

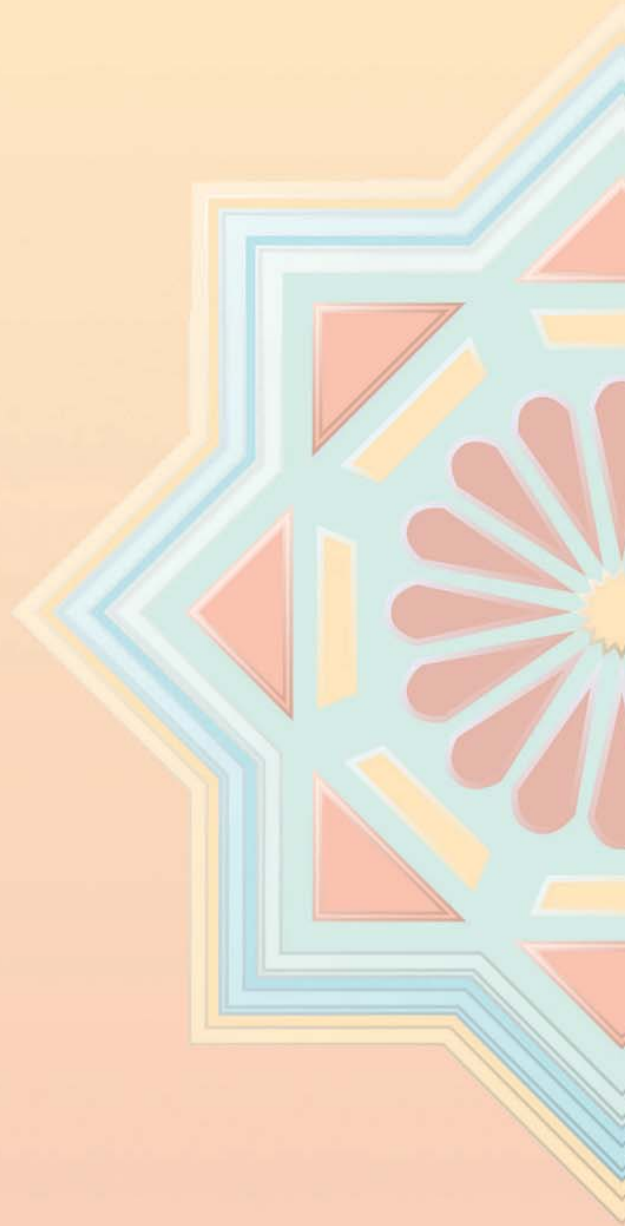
The draft regulations for the mandatory fortification of all maize meal and wheaten flour with vitamin A, thiamin, riboflavin, niacin, vitamin B6, folic acid, iron and zinc were published in the Government Gazette in October 2002 for public comment (three months). The final regulations will be published end of February 2003 and the regulations will come into effect after 6 months.



- W59** EVALUATION OF A SURVEILLANCE SYSTEM FOR THE PROGRAM OF SUGAR FORTIFICATION WITH VITAMIN A AT THE HOUSEHOLD LEVEL. P. Domínguez<sup>1</sup>, C. Martínez<sup>2</sup>, R. Molina<sup>3</sup> and O. Dary<sup>4</sup>. <sup>1</sup>Universidad de San Carlos de Guatemala, <sup>2</sup>Institute of Nutrition of Central America and Panama (INCAP/PAHO), <sup>3</sup>Universidad del Valle de Guatemala, and <sup>4</sup>INCAP/PAHO, now in MOST/the USAID micronutrient program.
- Background:** In Guatemala, a household surveillance system of the sugar fortification program has been carried out yearly since 1995. This program obtains sugar samples through students of rural public schools. This system was selected to ensure an annual sampling framework independent of home surveys that are costly and difficult to systematize. It was assumed that the information obtained from samples taken in schools reflects the situation at the household level, but it has not been proved. **Aims:** This study had the purpose to determine the equivalence between the information and sugar sample quality obtained through students in school that were gathered directly from households. **Methods:** A descriptive analytical study of cross-sectional design was conducted, using a cluster sampling in two phases, in which 10 elementary rural government schools and 187 schoolchildren of Escuintla (one of the 22 territorial divisions of the country) were selected. The study was carried out from July to September 2001. Information regarding family composition, sugar consumption and sugar samples were obtained from the children at schools and from their corresponding households. The same person made the home visits. Vitamin A content of samples obtained from schools and households was determined by a quantitative method. Data were analyzed using descriptive statistics, correlation, paired T-test, and Chi-squared test. **Results:** The correlation between households and schools results was acceptable. The average vitamin A level in households was 10.4±0.41 mg/kg, and 10.71±0.39mg/kg in schools. Both Chi-squared test and paired-t test indicate that the results were not significantly different, among samples provided by the children and those obtained directly from households. The most important finding was that the information given by the students is very reliable regarding the true households' circumstances. **Conclusion:** Based on the statistical analysis, it was confirmed that the information obtained through the sugar fortification program and through schoolchildren reflects the existent reality in their households. This project received financial support from MI, Canada.
- W60** QUALITY CONTROL (QC)/QUALITY ASSURANCE (QA) AND MONITORING SYSTEM OF THE SUGAR FORTIFICATION PROGRAM IN CENTRAL AMERICA. O. Dary<sup>1</sup>, C. Martínez<sup>2</sup>, C. Alfaro<sup>2</sup>, D. Chinchilla<sup>2</sup>, M. Lacayo<sup>2</sup>. <sup>1</sup>Institute of Nutrition of Central America and Panama (INCAP/PAHO), now with MOST/the USAID micronutrient program; <sup>2</sup>INCAP/PAHO.
- The four North Central American countries (El Salvador, Guatemala, Honduras and Nicaragua) have established a QC/QA and monitoring system to follow the annual adherence of food fortification programs. The system consists in ensuring that producers carry out systematic and daily QC/QA activities. Food control authorities confirm fulfillment of producer's responsibilities by inspection visits. Compliance of the fortification levels is checked in food samples taken from retail stores, either by local authorities or consumer associations. Finally, the overall quality of the program is estimated through food samples' analysis from households. For each of these steps, indicators, simple criteria of success and a methodical and uniform presentation of results have been developed. For each stage, three different sampling intensities have been adopted: relaxed, normal and demanding. The relaxed situation involves a consumer's risk, whereas the demanding situation represents a producer's risk. None of them is positive or negative; they simply respond to the current performance of the fortification process. Sampling is limited to fit the scarce amount of economical and human resources, reason by which the test receives the denomination of corroborating trials. A formal and statistical-base sampling framework is reserved only for evaluation of product conformity and for legal situations. This simple and low cost monitoring system has proven to be very effective. In 2001, it was found that 93, 77, 60 and 35% of sugar in El Salvador, Guatemala, Honduras and Nicaragua, respectively, contained the expected vitamin A biological minimum at the household level (3.5 mg/kg). The system enabled to discover that imported sugar was not being fortified in Guatemala, and hence the provinces that were receiving this sugar failed from the 70% minimum coverage goal; that the policy allowing production of nonfortified sugar only for industrial use was not working in Honduras; and that the control of non-fortified sugar coming from outside was very weak in Nicaragua. These results have supported technical and political recommendations to improve the outcome of the sugar fortification program in Central America. This project has received financial support from MI, Canada, during 2000-2002; from UNICEF in Guatemala, Honduras and Nicaragua during 1995-2002; and from USAID, through several projects, during 1992-1999.
- W61** THE PHILIPPINES' VITAMIN A SUPPLEMENTATION PROGRAM: INDICATIVE IMPACT, POLICY AND PROGRAM IMPLICATIONS. MRA Pedro, RL Cheong, JR Madriaga, CVC Barba. Food and Nutrition Research Institute – Department of Science and Technology, Metro Manila, Philippines
- The Philippine government addresses vitamin A deficiency with the implementation of a universal twice-yearly high-dose (200,000 IU) vitamin A supplementation (VAS) program for 1-5y old children. The program, which started in 1993, has been a centerpiece in the country's nutrition efforts. The paper reviews the vitamin A supplementation policies and program in the Philippines from the general guidelines, administrative documents and records of implementing and cooperating agencies such as the Department of Health (DOH) and Helen Keller International, and a cost-effectiveness analysis by a Philippine Cost-Effectiveness Study Team; as well as examines program impact from results of the 1993 and 1998 National Nutrition Surveys. The review drew significant program and policy implications. Among the programmatic changes was the shift from being centrally-managed by DOH to being a program devolved to local government units (LGUs). A declining coverage of target children after the early years reflected the lack of a smooth transfer of program ownership to LGUs. On the other hand, a preferential access to the program by children from poor households was apparent in some provinces. The 1993 and 1998 National Nutrition Survey results revealed indications of positive impact of the VAS program: a shift to the right in the distribution of plasma retinol among 0-5y old children between 1993 and 1998, and between children without and with vitamin A supplement in both years, higher mean plasma retinol and lower prevalence of deficient and deficient+low plasma retinol in 1998 among children who received vitamin A capsules from 1-4 months and 6 months after giving the dose. The potential waning effect of the supplement on serum retinol on the fifth month after administration of the dose may be due to a seasonality effect and presence of infections. Stunted children were likely to have benefited more significantly than not stunted children.
- W62** VITAMIN A PROGRAMS IN INDONESIA: SUPPORTING NATIONAL PROGRAM ACTIVITIES DURING THE ONGOING PROCESS OF DECENTRALIZATION. R Untoro, AL Rice, Sunarko, Atmarita, R Adirza, M Bloem. Ministry of Health/Government of Indonesia (MOH/GOI) and Helen Keller International Indonesia, Jakarta, Indonesia.
- Problem:** The Asian economic crisis that started in 1997 continues to compromise the nutritional status of Indonesian children and cases of clinical vitamin A deficiency (VAD) are still reported in some areas. The process of government decentralization that began in 2000 has also affected how public health programs are funded, managed, promoted, monitored and evaluated. In 2001 programmatic support and VA capsule coverage rates of children < 5 yr old varied widely across Indonesia.
- Objectives:** To continue supporting the national VA program during the governmental transition in order to raise awareness about the continuing importance of VAD as a public health problem and to increase activities to improve VA status among children < 5 yr old. **Conceptual framework:** A multi-agency team composed of the government, NGOs, national industry, international donors and other organizations works to support VA program activities including VA supplementation, food fortification, informal nutrition education and improved dietary intake.
- Implementation:** A variety of strategies were used in 2002. These include a national level mass media campaign to promote the VA distribution months of Feb and Aug; advocacy aimed at district level decision-makers and program managers, the distribution of guidelines for the detection and treatment of clinical VAD; and integrating VA capsule delivery into the national polio immunization day on September 12, 2002 in an effort to reach children who did not get VA during the August campaign month.
- Outcomes:** Data about VA coverage, prevalence of malnutrition, lessons learned from previous program activities, and adaptations to local autonomy and a decentralized government structure will be presented. **Program implications:** Partnerships forged prior to the process of decentralization will continue to assist the national VA program adapt to the new structure of health programming.



- W63 EVALUATION OF VITAMIN A SUPPLEMENTATION PROGRAM IN INDIA: WHAT AILS ROUTINE PROGRAMS?** NK Arora on behalf of IndiaCLEN Program Evaluation Network, Clinical Epidemiology Unit, AIIMS, New Delhi, India. **Problems:** Vitamin-A supplementation is currently distributed as part of Reproductive and Child Health (RCH) Program. Despite three decades of operations, the program coverage among target clients remained below 25% in most parts of the country and a large proportion of population has sub clinical Vitamin-A deficiency. **Objectives:** A process evaluation of Vitamin-A supplementation program was carried out to determine the strengths and limitations in program implementation and to identify determinants of client behaviour. **Methods:** Data was collected using Rapid Assessment Procedures in the form of 1529 in-depth interviews with all identified categories of stakeholders [program planners, managers, providers, facilitators (NGOs/leaders) and clients] and 60 focus group discussions with health workers and clients. The study was conducted in 15 states across India which represented good, intermediate and poor levels of health facilities. **Results:** High variability in the implementation reflected lack of clear understanding about program objectives, its delivery and the target groups among health workers, anganwadi workers and also providers at district level. This could be attributed to poor training imparted to the functionaries, which lead to loss or distortion of information. Passiveness and lack of proactive efforts to implement program were evidenced by statements like "Those who need it they come and those who do not need they do not come". There was no focus on 100% coverage. Vitamin-A supplements were available irregularly and in inadequate quantities. Supervision and monitoring was incidental with no definite task list and schedule for monitoring and was restricted to checking registers and reports. Integrated Child Development Scheme is under the Department of Social Welfare but involved in distribution of Vitamin-A supplements. Supplies were routed through health department. This interaction lacked coordination and at places was the reason for conflict and poor performance. Lack of awareness about program services was the most important reason for non-utilisation of services by community. However, quality of Vitamin-A supplements distributed in the program was acceptable to most of the clients. **Conclusions:** Vitamin-A supplementation program suffers from passiveness with lack of proactive efforts to reach clients and clear understanding of the implementation guidelines. This routine program can be improved with good quality training regarding implementation strategy, regular and adequate availability of supplements to the clients and establishing a mechanism of supportive and consistent supervision with feedback at all levels. Equally important is to mount an aggressive social mobilization campaign to tell clients about the program services and its benefits.
- W64 SOCIAL MARKETING OF RED PALM OIL IN RURAL BURKINA FASO: AN EFFECTIVE STRATEGY TO IMPROVE VITAMIN A STATUS OF WOMEN.** NM Zagré<sup>1,3</sup>, F Delpuch<sup>2</sup>, P Traissac<sup>2</sup> and H Delisle<sup>1</sup>. <sup>1</sup>Department of Nutrition, University of Montreal, Canada, <sup>2</sup>IRD, Montpellier, France, <sup>3</sup>Research Institute for Health Sciences, Ouagadougou, Burkina Faso **Background:** Vitamin A (VA) deficiency is still a major public health problem in Burkina-Faso. In addition to supplementation, food diversification strategies are required. A two year pilot project on the introduction of red palm oil (RPO) was undertaken in a non-consuming area. RPO was collected and sold by women's groups, and it was promoted by home economists as a food supplement for women and children of the test area using social marketing. **Aim of the study:** to demonstrate the effectiveness of the pilot project as measured by changes in dietary VA intakes and serum retinol in adult women. **Methods:** A pre-post, longitudinal design was used for evaluation on a random sample of 210 women (18-49 y.) from 7 out of the 11 pilot sites. VA intake was assessed by food frequency at baseline, 12 and 24 months later. Serum retinol was measured using HPLC at baseline and 24 months later. Regression models were used to assess changes in serum retinol and their determinants. **Results:** After 24 months, nearly 50% reported consuming RPO in the previous week. Mean VA intake increased from 235 ± 23 µg RE (n=210) at baseline to 571 ± 93 µg RE (n= 196) and 655 ± 144 µg RE (n=184) after 12 and 24 months (p<0.0001), respectively owing primarily to increasing RPO consumption. Mean serum retinol increase was +0.26 (95% CI 0.16-0.34), from 0.69±0.02 µmol/l at baseline to 0.95 ±0.04 µmol/l 24 months later (p=0.0001). The rate of serum retinol < 0.70 µmol/l decreased from 61.8 ± 8.0% to 28.2 ± 11.0%. Mothers with low serum retinol at baseline showed a marked increase (0.47 µmol/l to 0.88 µmol/l; p<0.0001), while there was no difference for those with normal initial serum retinol. **Conclusion:** The results suggest that the approach based on introducing RPO through a commercial channel was effective in improving the VA status of women in the surveyed sites, and particularly so in mothers whose VA status was poor. Promotion of RPO seems a feasible strategy to reduce VAD in rural Burkina-Faso. Scaling up is on-going to confirm the impact and to assess the cost-effectiveness.
- W65 CHANGING BEHAVIOUR: POPULARISING VITAMIN A-RICH FOODS.** C Pond, L Sserunjogi, A Karecki. **MOST.** **Background:** The Uganda Ministry of Agriculture, Animal Industry and Fisheries, with the support of MOST/USAID and CIP (The International Potato Centre) began a pilot project to encourage the farming and consumption of orange-fleshed sweet potatoes (OFSP), a rich dietary source of vitamin A. The project aims to reduce vitamin A deficiency in Uganda using various strategies. A simple, concise communication strategy designed to support the changes in key behaviours required by caregivers and others to acquire, prepare and feed the potatoes to their families and thus improve vitamin A status is an important component of the program. **Program design:** Formative communication research has guided the development of messages that are "client oriented" and not based on the goals, perceptions, and motivations of stakeholder organisations and the project management team. The messages developed are aimed at two primary target audiences: the farmer and the caregiver/household heads. Behaviours for change include the farmers adopting the new crop and the householders consuming the crop (and in particular feeding the crop to the children) rather than selling it. Materials developed are based on research findings that specifically identified and highlighted the needs and likes of the potential target audiences and included highly pictorial print materials and radio spots. Monitoring and Evaluation has been conducted to measure the process and impact of the communication and information dissemination strategy. **Outcome:** Results indicate that the use of multi-channel communication to popularise key behaviours has resulted in an acceptance of the OFSP as both a crop and food.



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