Controlling Vitamin A Deficiency – Nutrition policy discussion paper No. 14

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UNITED NATIONS

ADMINISTRATIVE COMMITTEE ON COORDINATION – SUBCOMMITTEE ON NUTRITION

(ACC/SCN)

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ADMINISTRATIVE COMMITTEE ON COORDINATION – SUBCOMMITTEE ON NUTRITION

ACC/SCN STATE–OF–THE–ART SERIES
NUTRITION POLICY DISCUSSION PAPER NO. 14

A Report based on the ACC/SCN Consultative Group Meeting on Strategies for the Control of Vitamin A Deficiency 28–30 July 1993, Ottawa, Canada

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January 1994

Information on the ACC/SCN State−of−the−Art Series, as well as additional copies of papers, can be obtained from the ACC/SCN Secretariat. Inquiries should be addressed to:

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FOREWORD

With the recent publication of "Effectiveness of Vitamin A Supplementation in the Control of Young Child Morbidity and Mortality in Developing Countries" as ACC/SCN Nutrition Policy Discussion Paper No. 13, we now know more about the type and degree of positive benefits of raising vitamin A status among deprived populations. The mortality−reduction effects among young child populations known to be vitamin A−deficient are clear, particularly with respect to mortality associated with measles and diarrhoeal disease. This meta−analysis concentrated on describing the likely benefits of raising vitamin A status that would accrue under given conditions. The policy implications of its findings were the subject of a further detailed comparative evaluation, which led to this publication.

After the findings of the meta−analysis became known in March 1993, work began on investigating the policy and programme implications. The SCN Secretariat was supported by the Canadian International Development Agency (CIDA) and the Micronutrients Initiative to prepare a review of existing evaluations of vitamin A deficiency control programmes. After an extensive search of the literature, both published and unpublished, a background paper was drafted that pulled together the results of 46 evaluations. Methods for deciding on an appropriate mix and sequencing of interventions under different conditions were also considered.

Following comments from a wide range of people, a second draft of this paper served as background to the Consultative Group Meeting on Strategies for the Control of Vitamin A Deficiency, in July 1993 hosted by the Micronutrients Initiative in Ottawa. Again, we are very grateful to CIDA and the Micronutrients Initiative for their support for this meeting. This meeting brought together individuals from 11 countries who were directly involved in vitamin A deficiency control activities along with representatives of the SCN member agencies and academics. The future potential of different control activities was considered from the dual perspective of past experience and the findings of the meta−analysis.

We hope that this document – which combines the output of this meeting with the original background paper – will serve to catalyse a better informed and invigorated drive to combat vitamin A deficiency and thus reduce its damaging and often fatal effects.

Dr Abraham Horwitz
Chairman, ACC Sub−Committee on Nutrition

PREFACE AND ACKNOWLEDGEMENTS

In 1986, the Advisory Group on Nutrition (AGN) of the ACC Sub−Committee on Nutrition (ACC/SCN) reviewed the study from Aceh, Indonesia (subsequently published as Sommer *et al.* 1986 [3]) on the impact of vitamin A supplementation on childhood mortality (ACC/SCN 1986)[1]. The Sub−Committee endorsed the AGN review and advised the ACC "that a reduction of childhood mortality may reasonably be expected from high dose vitamin A programmes". It continued "... confirmatory trials are in process, the results of which should be closely monitored to find out whether significant effects of vitamin A are to be found in populations of different patterns of morbidity and other conditioning factors, and where less severe deficiency of vitamin A exists".

[1] ACC/SCN 12th Session Report, see para 3 and Annex II.

By 1991, around ten such studies were nearing completion. The AGN in 1990 developed a proposal, approved by the SCN at its 18th Session (ACC/SCN 1991)[2], entitled "Assessment of the Research and Policy Implications of Recent Studies of Vitamin A and Morbidity and Mortality". The research and policy implications have been examined in two separate phases. In the first, a meta−analysis was done of the results of eight trials of effects of vitamin A supplementation on mortality, and 20 on morbidity. The results were introduced by the AGN in mid−1992 as an interim report on "Effectiveness of Vitamin A Supplementation in Control of Young Child Morbidity and Mortality in Developing Countries". These showed that "in populations exhibiting signs of general deprivation marked by a high prevalence of stunting, and exhibiting at least a low prevalence of xerophthalmia, on average a reduction of young child mortality by about 23% can be expected" when vitamin A status is improved. The mortality effect was pronounced for deaths due to diarrhoeal disease and measles, while little effect was found with respect to deaths due to respiratory infection. By design, the meta−analysis study did not seek to determine the policy implications of these findings, as this was to be the focus of this second phase, an outline of which was suggested at this time (AGN Report, September 1992)[3].

[2] ACC/SCN 18th Session Report, paras 21−23.

[3] AGN Report, September 1992. Annex: Vitamin A Mortality Control: Policy Considerations, page 9.

The final report of the meta−analysis was discussed at the SCN 20th Session in February 1993 (Beaton *et al.* 1992; ACC/SCN 1993[4]). The SCN proposed to draw to the attention of the ACC both a short statement on the mortality effect, and a longer statement giving detail. It also noted that discussion of the policy and programme implications would be arranged. In the meantime, funding was agreed with CIDA and Micronutrient Initiative, which led to the present study and the consultative group meeting, as the second phase.

[4] ACC/SCN 20th Session Summary Report, paras 33−36.

The SCN Secretariat began compiling information for this second phase investigation of the policy implications of the meta−analysis findings, in March 1993. The objectives of this study are described in full in Annex I. They include establishing criteria to be applied in deciding whether a vitamin A intervention is warranted as a means to reduce mortality; providing age−specific estimates of the magnitude of benefits expected when vitamin A status is improved; identifying and critiquing alternative strategies for improving vitamin A status, including considerations of their relative cost−effectiveness, acceptability, sustainability, and complementarity with other strategies; recommending which approaches may be favoured, under given circumstances, over other competing alternatives, and the means of sequencing and phasing appropriate strategies over time. In general, the aim was to provide guidance to the subsequent consultative group meeting, on methods for controlling vitamin A deficiency, under varying circumstances, with reduction in child mortality as one objective.

The process adopted for the comparative evaluation was as follows. From March to June 1993, a literature search for reports of evaluations of vitamin A deficiency control programmes, published or unpublished, was carried out. More than 60 letters were sent to various multilateral and bilateral agencies, NGOs, universities and relevant specialized institutions, requesting information on evaluations of control programmes or community intervention trials. In addition, several computerized searches were carried out to identify published material as far back as the early 1960s. These reports and articles were filed according to intervention type and country, and logged into an evaluation inventory (see Annex III).

The Consultative Group Meeting on Strategies for the Control of Vitamin A Deficiency (funded by CIDA and the Micronutrient Initiative) was held at the offices of the Micronutrient Initiative in Ottawa on 28−30 July 1993. The agenda and list of participants are provided in Annex VI and VII at the back of this paper. This meeting drew on an earlier version of the background paper and developed the discussion of 'what works, where' with respect to vitamin A deficiency control. Two sets of working group sessions were arranged that focused firstly on the pros and cons of different intervention types, and secondly on the mix and sequencing of interventions under differing typologies of conditions. A concluding statement was agreed on by the meeting participants and this is included here.

This paper is thus an expanded and modified version of the original background paper, that has been revised according to the meeting recommendations, in part by working groups at the meeting. The original background paper itself had benefitted from consultation with a wide range of people with experience in different aspects of vitamin A deficiency control. We are particularly indebted to the following, all of whom took

time to search for relevant evaluations, and/or read and prepare comments on the first draft: David Alnwick, Ken Bailey, John Barrows, George Beaton, Martin Bloem, Jenny Cervinskas, Nicholas Cohen, Jose Dutra de Oliveira, Ted Greiner, Marcia Griffiths, Richard Heyward, Abraham Horwitz, Jak Jervell, Urban Jonsson, Rolf Klemm, Harriet Kuhnlein, Mahshid Lotfi, Jose Marlines, Reynaldo Martorell, Judith McGuire, Penelope Nestel, James Olson, Roger Pearson, Robert Pratt, Sonya Rabeneck, Anne Ralte, Vinodini Reddy, Alfred Sommer, Timothy Stone, Suttilak Smitasiri, Rebecca Stoltzfus, Andrew Tomkins, Kraisid Tontisirin, James Tulloch, Barbara Underwood and Keith West.

S.R.G.
J.B.M.
January 1994

SUMMARY

An earlier version of this document[5] provided background for a meeting on methods for the control of vitamin A deficiency, which was the second phase in an "Assessment of the Research and Policy Implications of Recent Studies of Vitamin Morbidity and Mortality". The work followed the recommendations of the Advisory Group on Nutrition (AGN) in September 1992, which in turn derived from the conclusions of a meta–analysis of mortality effects of vitamin A supplementation, which showed an average of 23% reduction in mortality. The overall objectives of the meeting (funded by CIDA and the Micronutrient Initiative) were to provide guidance to policy makers on when vitamin A interventions are warranted, on choices of alternative methods for controlling vitamin A deficiency under different circumstances (usually expected to be a mix of interventions with appropriate sequencing), and the likely benefits.

[5] "Considerations in Deciding on Methods for the Control of Vitamin A Deficiency in Relation to Infant and Child Mortality", 12 July 1993.

The first step was to identify impact evaluations of trials and large–scale programmes for preventing vitamin A deficiency. Criteria for using results were whether impact on consumption of vitamin A, and/or vitamin A nutritional status, could be reasonably assessed. Programme types were defined as: supplementation; dietary modification; fortification; public health; breastfeeding promotion. Some of these are easier to evaluate than others, and it is important to distinguish differences in impact detection from programme effect. For example, the largest number of evaluations were of high–dose supplementation, but these were also probably the easiest to evaluate.

Three issues which influence policy are *not* addressed here, the first two requiring further research, and the third being largely resolved. The first concerns the possible impact of vitamin A deficiency and its control on children of less than six months. Further data is needed on this, and clearly breastfeeding practices have a crucial role. Second, there is some concern over relations between vitamin A status, supplementation, and acute respiratory infections, which is the subject of on–going research. Third, there is now considerable consensus on indicators for assessment of vitamin A status, as published by WHO and others, which it is suggested should be accepted without needing discussion at present.

The roles of each intervention type (including how, and when) and its pros and cons were first evaluated, with respect to different conditions. Differing conditions determine how the various potential interventions may be integrated and sequenced. First, the intervention types are looked at individually. One early and difficult set of considerations concerns the balance between interventions that are quick–acting versus longer–run attacks on underlying causes. It seems agreed that where it is feasible to have quick–acting solutions, through some use of supplements, these must be included to save lives sooner rather than later, but should not be the exclusive approach. The mix and sequencing of quick–acting (perhaps less sustainable) and longer–run interventions to secure sustained improvement are at the heart of the issue.

Supplementation Periodic (e.g. six monthly) high–dose supplements are the commonest, for practical reasons, although more frequent (e.g. weekly) lower doses are likely to be more effective. Twenty five evaluation studies of effects of supplementation on vitamin A status (usually clinical) were included; of these, 13 were pilot projects or trials under controlled conditions, and 12 were operational programmes. A general finding was that such programmes were effective when their coverage was adequate. Generally *universal* coverage was hard to sustain, and often not a practical approach. Interventions *targeted* by various means were likely to be more effective and sustainable. Supplementation has the advantages of potentially rapid and demonstrable impact on vitamin A deficiency. Disadvantages include both problems of sustainability (even for

targeted programmes), and risks of inhibiting the development of alternative programmes.

Dietary Modification Several approaches are included: i) behavioural change to improve consumption through communications, social marketing, or nutrition education (IEC); ii) home food provisioning – mainly home gardens but including potential animal and fish food sources; iii) food and price policies; iv) technology, e.g. food/nutrient preservation. Evaluations in this area are sparse. Communication programme evaluations often focus on assessing changes in knowledge, attitudes and practice (KAP) and not vitamin A status changes. There is a need for communication programmes to be evaluated more rigorously, particularly with respect to the links between changes in knowledge and attitude on the one hand, and consumption and biological outcomes on the other. Several existing IEC programme evaluations concluded that there was room for improvement, particularly through more sustained and appropriate inter–personal communications. This is consistent with IEC experience in other nutritional areas.

Dietary modification, using one or a combination of methods, is widely considered as an approach of choice. Successful promotion of behaviours that provide for adequate intake, together with ensuring availability of supply, is likely to be both sustainable and affordable. There are only a limited number of studies that demonstrate effects on vitamin A status. Certain prerequisites (such as land and time for home gardens) can be a considerable constraint; and other aspects, from pricing interventions to appropriate technology have not in fact yet been widely tried, or evaluated. With respect to vitamin A, such options are agreed to be very promising possibilities. As dietary modification has been successfully accomplished for other objectives, these techniques should now be more widely applied to vitamin A programmes.

Breastfeeding is critical for vitamin A status of infants. While non–breastfed infants in communities vulnerable to deficiency are at particularly grave risk, sub–optimal breastfeeding practices may also put infants at risk. Under such conditions, if full or exclusive breastfeeding is not nearly universal, breastfeeding promotion would be of top priority, using the well–defined activities for promotion. In areas where vitamin A deficiency is endemic, opportunities also exist for improving the vitamin A status of both women and breastfeeding infants through a single high dose of vitamin A delivered to the mother within four weeks of delivery.

Fortification The *potential* effectiveness of fortification is well–established. Trials in Chile, Indonesia, and the Philippines, and evaluation of a large–scale programme in Guatemala, have proved effects on vitamin A status. The preconditions for fortification however have proved hard to sustainably fulfil for any particular combination of technical, social, economic, or political circumstances. The food vehicle needs to be widely consumed by at–risk population groups, it needs to be accessible and affordable, and it should not be organoleptically affected by the fortification process. The technologies and financial support need to be in place, backed up by governmental commitment to bear the initial extra costs. Over time, consumer cost–sharing may be increasingly phased in. The challenge for many countries, with both a growing food industry and a vitamin A deficiency problem, is to move from feasibility trials with appropriate food vehicles, to large–scale programmes.

Public Health Interventions, such as oral rehydration therapy, intestinal parasite control, and treatment of acute respiratory infection, significantly affect vitamin A status, and may be regarded therefore as potential interventions to address the deficiency. Measles immunization is especially important in this context. In practical decision–making, public health interventions are probably seldom seen as *alternatives* to others aimed at vitamin A deficiency. Targeting of public health measures may be influenced by vitamin A considerations, however. Greater emphasis on certain public health measures may also be guided by concern for vitamin A deficiency – for example intestinal parasite control might rise in priority if vitamin A deficiency, to which malabsorption contributes, is seen as an urgent issue.

In terms of *cost–effectiveness* of programmes, a range of expenditures per participant per year can be estimated, which appear to be associated with some effect – this is between around $0.2 to $1 per participant per year, the median being around $0.5. Clearly the costs are not strictly comparable between different interventions, for example between costs of capsule distribution and nutrition education. Such costs can be compared with levels of health budgets (around $2 – $15 per head of population per year), costs of immunization ($10 – $15 per fully immunized child), etc. – and still appear rather good value.

Based on the review, the interventions most often likely to be effective, under suitable conditions, seemed to be:

> – dietary modification to make better use of what is available to the family or to enhance their ability to obtain foods to meet dietary needs is the fundamental point of departure for programmes in areas where vitamin A intake and status are not adequate. The approaches

include communications using social marketing techniques, home food provisioning, economic/food policies, technologies such as food preservation, plant breeding, etc.

– targeted capsule distribution, and their medical use, as a quick–acting intervention. Targeting may be passive through health contacts or active to mothers at delivery;

– promotion of breastfeeding, if the pattern is sub–optimal, and improving consumption of lactating women;

– fortification when feasible would be of high priority, however this as yet appears to apply primarily to middle–income countries with centrally–processed foods that are widely distributed.

Decisions on the appropriate *mix and sequencing of interventions* depend on deficiency and disease patterns and trends, and factors such as ecology, community organization, political support, access to health services, etc. The expected impact of vitamin A deficiency control may depend upon the extent of xerophthalmia in the population; general opinion is that prevention of sub–clinical deficiency would have an impact on mortality, and on severity of disease. Measles immunization may well affect the response, but anyway measles immunization is of high priority in its own right. Underlying trends of vitamin A deficiency may also affect strategies: in Asia, for example, frank deficiency (including nightblindness) is declining significantly (probably due both to control of infectious disease and improvement in diet) so design of interventions under these circumstances may come to focus on pockets of deficiency. The extent of breastfeeding, and maternal nutritional status, significantly affects vitamin A deficiency and its control. For example, where breastfeeding is extensive but mothers may be deficient, maternal supplementation just after birth is a promising approach.

Different types of situation are considered, leading to different methods for control. Examples of approaches taken in 11 countries in response to the nature of vitamin A deficiency problem and the feasibility of corrective actions were discussed at the meeting and are described here.

Rough estimates of lives potentially saved by preventing vitamin A deficiency go up to around 1.12 million children per year, equivalent to around six per 1000 covered among six to 24 month old children. Adjusting for likely incompleteness of coverage, perhaps nearer one life per 1000 could be saved, still amounting to about 250,000 per year.

This document combines material in the background document with the output of the meeting itself in which working groups closely examined individual interventions and strategies (see Introduction, page 6, for details). The overall conclusions, as agreed at the meeting and given in Chapter V, outline strategies for control of vitamin A deficiency.

CHAPTER I. INTRODUCTION

This paper concerns methods for controlling vitamin A deficiency in order to reduce mortality in young children. The problem being addressed is therefore vitamin A deficiency among children between either zero or six months and around 60 months of age, when this is contributing to elevated mortality.

It should be emphasized here that the mortality outcome itself is no longer the issue as the link between vitamin A status improvement among 6–59 month children and mortality reduction was already demonstrated in the first phase. No conclusive evidence was available regarding the under six month age group, nor for populations with sub–clinical deficiency but no clinical signs. Another major conclusion of the first phase was that the mortality–reducing effect of vitamin A is biological and not pharmacological – that is, it is a function of vitamin A status itself, and independent of the mode of administration of vitamin A. Low dose, frequent administration of vitamin A by capsule or via fortified foodstuffs was shown to be associated with mortality reduction among xerophthalmic child populations in the mortality trials. The outcome of concern for the second phase is thus vitamin A status, with the relative merits of a variety of interventions *for improving vitamin A status* primarily among young children being compared.

STRUCTURE OF THE PAPER

Chapter II concerns the definition of the problem of vitamin A deficiency, and the type of questions that need to be asked to delineate the aetiology and epidemiology of the problem. Risk factors for vitamin A deficiency,

and factors likely to cause differential mortality effects, are introduced.

Chapter III addresses the question "what has worked, where?", based on the lessons of past experience. It incorporates the outputs of the first set of working groups of the July 1993 Consultative Group Meeting. The characteristics of different intervention types – their pros and cons and the type of factors influencing their feasibility and potential impact under given conditions – are discussed. Other factors which may be considered in the choice of intervention or mix of interventions over time include cost–effectiveness, sustainability, acceptability, community involvement, complementarities with other strategies and additional benefits. The comparative evaluation is based on the findings of some 46 evaluations, listed in the summary table (Table A.I) and evaluation inventory (Annex III).

Chapter IV then moves on to try to integrate these lessons to provide guidance in deciding what mix of interventions and their sequencing over time, is likely to be appropriate under different conditions. This draws on the discussions and outputs of the second set of working group sessions at the July 1993 meeting. The factors that need to be taken into account in such decisions and the nature of their influence on the choice are outlined. Finally, processes by which a country may come to assess the problem of vitamin A deficiency, analyze its causes and design solutions to alleviate it, are put forward with some illustrative examples from selected countries.

There are seven annexes to this report. Annex I provides the full objectives of this study. In Annex II, the age–specific magnitude of benefit (in terms of childrens' lives saved) through large–scale vitamin A control programmes is estimated. For this, the findings of the Beaton *et al.* (1992) report were used in conjunction with 1989 demographic and mortality data for countries where vitamin A deficiency is a significant public health problem. (It should be noted though that this serves only to highlight the potential *maximum* mortality reduction as the assumptions regarding compliance and coverage for such nationwide programmes are unlikely to be met in practice). On a more practical level, the range of likely effects and the probabilities of their occurring in a future programme with realistic coverage levels, were assessed in a case–study illustration.

The evaluation inventory provided in Annex III and Annex V are intended to allow quick between–evaluation comparisons with respect to certain important characteristics, such as country, context, study design, inputs, measurements, outcome, and conclusions. Additional references are provided in Annex IV. (It should be noted here that a quoted reference that is included in the evaluation inventory will be followed by its specific inventory number in superscript e.g. Tielsch and West (1990)[2c]). Annex VI comprises the list of consultative group meeting participants.

The origins of the text are as follows. The background paper for the Consultative Group meeting, "Considerations in Deciding on Methods for the Control of Vitamin A Deficiency in Relation to Infant and Child Mortality", 12 July 1993, provided material for working groups in the meeting. The sections in Chapter III here were each examined carefully by individual working groups (as footnoted at the beginning of each section) and the text here represents the outcome of the discussions. The background paper did not include enough material on "Problem Definition", and Chapter II here includes new text prepared by a separate working group, chaired by Dr A. Sommer, Rapporteur Dr F. Trowbridge.

Chapter IV combines material from the background paper with considerations and conclusions from the second set of working groups. Chapter V contains the summary statement drafted at the meeting and agreed by the participants – it provides an overall summary of the conclusions on strategies for the control of vitamin A deficiency.

INITIAL CONSIDERATIONS

At the outset, it may be useful to recall that the meta–analysis of mortality effects (Beaton *et al.* 1992) showed that the relative impact of vitamin A supplementation was not apparently affected by most of the variables describing the population. It should be stressed that the effective sample size to assess this was the number of studies, i.e. eight, thus the lack of effect was not well–established. Nonetheless, the following variables were not found to influence the overall mortality reduction of vitamin A supplementation:

- Age (between 6–59 months)
- Sex
- Baseline (control group)[6] mortality rate
- Baseline xerophthalmia prevalence (for the range 1–14%)
- Degree of stunting or wasting

– Periodicity and magnitude of vitamin A dosage[7]

[6] The mortality rates seen in the control groups were often much lower than pre–existing population–based information, possibly due to a positive non–specific effect of the intervention, or other reasons.

[7] This refers to the fact that in two trials, in Tamil Nadu and Indonesia, low doses were used (weekly capsule delivery and daily via fortified monosodium glutamate respectively).

Relative effects, however, did differ according to attributed disease–specific causes of death (where reported). A greater mortality–reducing effect of vitamin A was observed where measles and diarrhoeal diseases were dominant causes of death, while vitamin A had little effect on reducing the rate of death due to respiratory disease. Malaria deaths may be unresponsive to vitamin A (according to unpublished data from Ghana). It should be noted that reduction in the mortality rate from vitamin A interventions may be less where measles has been controlled by immunization. Measles immunization therefore would usually be a top priority where adequate coverage has not yet been achieved, more than vitamin A deficiency control.

Another unknown from the mortality trials is whether an effect on mortality is to be expected in individuals or populations that do not have clinical signs of vitamin A deficiency, but do have sub–clinical deficiency. In all the mortality trials, xerophthalmia was present, and no differential mortality effect was found with xerophthalmia prevalences ranging from 1% to 14% (although the sample sizes and consequently discriminatory power was low). The question of whether a vitamin A intervention should be considered in the presence of biochemical evidence of depletion but absence of clinical evidence is highly important. There are three reasons pointing to an expected benefit in such circumstances:

i) *Mortality.* There is no direct evidence but some support from prior research, as although mortality studies were conducted in areas where there was at least some xerophthalmia, the studies did treat cases in treatment and control areas. In effect, these experiences could be said to have been conducted in non–xerophthalmic populations, particularly if treated cases are removed from the analysis. Still, one could argue that vitamin A supplementation prevented the development of xerophthalmia, and the consequent progression to deaths in susceptible individuals.

Another line of evidence is the continuity in mortality reduction across the spectrum of xerophthalmia prevalence (from 1% to 14%) in the prospective studies as summarized in the Beaton *et al.* 1992 meta–analysis. While the power is low due to the small number of studies, the results are consistent with mortality effects extending into populations with mild levels of deficiency.

ii) *Morbidity.* Evidence from several sources suggests the likelihood of morbidity effects of vitamin A supplementation in sub–clinical vitamin A deficient populations. The Brazil study (Barreto *et al.* 1993) indicates that vitamin A supplementation in non–xerophthalmic children reduced the severity of diarrhoeal disease. The Ghana study (Arthur *et al.* 1992) indicates reductions in clinic attendance and hospital admissions following vitamin A treatment. Although xerophthalmia occurred at very low rates in the study population, contact with the study children was frequent, and treatment for cases was routine. Thus, in all likelihood the study subjects represented non–xerophthalmic children.

iii) *Immunocompetence.* There is also evidence indicating that vitamin A treatment of children with low serum values improves immunocompetence, including the response to vaccines.

In conclusion, a benefit of mortality reduction is likely to result when vitamin A interventions are undertaken in populations with sub–clinical evidence of vitamin A depletion, but no clinical signs. Xerophthalmia is thus likely to be one indicator of the general vitamin A status of the population, and it is the latter which is thought to determine the potential mortality effect. There is a range of factors which could be used to predict the likelihood of benefit in non–xerophthalmic vitamin A deficient populations such as: high mortality levels, high diarrhoeal disease mortality and high rates of malnutrition.

ISSUES NOT ADDRESSED

Three important issues influencing policy are not specifically addressed in this report. These concern the following: the possible mortality–reduction impact of vitamin A deficiency control in children under six months, the relationship between vitamin A supplementation and acute respiratory infections, and indicators and assessment methods for vitamin A deficiency. In the first two cases, more definitive recommendations await the outcome of ongoing research, while in the third case, the issue has already been well–covered in existing publications e.g. WHO 1982 and 1988.

The possible impact of vitamin A deficiency, and its control, on children of less than six months is not conclusively resolved. Two studies, in Nepal (West 1993) and Tamil Nadu (Rahmathullah *et al.* 1990[10]), provided some evidence of a lack of impact of vitamin A supplementation in this age group. In both cases, the extent of breastfeeding in the population was thought to be high and – given the crucial role of breastfeeding in maintaining vitamin A status in children under six months – this is consistent with the lack of impact. What is not known is whether there is a likely impact in populations where breastfeeding is less extensive, or indeed possibly where deficiency amongst mothers is more severe.

A second issue which is the subject of considerable debate, and on which further research is ongoing, concerns the possibility of vitamin A supplementation causing an increase in acute respiratory infections (ARI). What is not clear is the extent to which this affects the symptoms – e.g. increased mucus secretion with vitamin A repletion – and to what extent it affects the actual severity and risk from ARI. This, it should be noted, is a different issue from those of pharmacological toxicity. Again, this is primarily important in children under six months; this topic is left for clarification elsewhere (see WHO 1993 and WHO/IVACG 1992).

CHAPTER II. PROBLEM DEFINITION

[8] *Working Group Chair.* A. Sommer; *Rapporteur:* F. Trowbridge.

Clearly, in deciding under specific circumstances the best approach to vitamin A deficiency control, an early step is to consider the aetiology and epidemiology of the problem – who is affected, where, when, and why. In this context, WHO/UNICEF and IVACG have provided guidance on indicators and assessments methods (IVACG 1989 and Underwood 1993). For the present exercise in providing more general guidance, it may be useful to elaborate on the general features of the problem.

The approaches to problem definition for vitamin A deficiency will vary from country to country, although they are likely to all involve a progression of steps which include initial assessment, epidemiological assessment, and an operational assessment, as summarised in Table 1 below:

Table 1: Stages of Problem Definition

	Key Issues/Objectives	**Practical Approaches**
Initial Assessment	– Is there likely to be a problem with vitamin A deficiency? – Is the problem getting better or worse? – What areas, populations, age groups are most likely to be at risk? – What other nutritional and health problems affect the population?	– Use existing data from surveys in–country or from similar populations – Conduct rapid assessments in suspected High–risk areas – Assess case reports, experiences of individuals working in the areas, community level perception of the problem, morbidity/mortality rates.
Epidemiological Assessment	– Identify possible underlying causes (inadequate intake, high infections, disease, malnutrition burden, socio–economic factors) – Quantify the severity of the problem on specific at–risk areas/groups	– Conduct sample surveys focused on high– risk areas – Include community level assessments of dietary patterns, seasonality of vitamin A–rich foods, access to markets, health services.

	– Identify potentially effective interventions	
Operational Assessment	– Assess potential for specific interventions	– More detailed dietary assessment, infant feeding habits – Assess consumption by target groups of potential vehicles for fortification – Assess coverage of PHC for supplementation as other interventions.

One approach to the initial and epidemiological assessments is to consider the life–cycle, and a second is to look at causal factors.

In considering the *life–cycle,* one point to emphasize is that concern for infant and young child vitamin A deficiency should begin before conception. The new born infant to a vitamin A–deficient mother will have lower vitamin A stores in the liver than an infant of a well–nourished mother. Moreover, supplementation of vitamin A during pregnancy is problematic, because of concerns for teratogenic effects. (There is also some evidence of a need for vitamin A for normal foetal development, but deficiency has not been implicated in congenital malformations). A second reason for an effect of deficiency during pregnancy is that the colostrum and breastmilk will also have lower levels of the vitamin when the mother is vitamin A–deficient. The importance of improving the diet of women of child–bearing age for this and many other reasons is thus very clear. During lactation, again adequate maternal intake of vitamin A is important for the infant. If the infant is breastfed – notably from a well nourished mother – then the risk of deficiency in the first few months of life is relatively small. Some time during the second half of the first year of life, initial liver stores and vitamin A supply from breastmilk may become more limiting, and the intake of vitamin A from complementary foods will become of increasing importance. Thus in the preschool child the complementary food and then the normal diet require an adequate vitamin A content in order to sustain adequate vitamin A status.

Causal factors of vitamin A deficiency illustrated in Table 2 have been found to be commonly associated with vitamin A deficiency. These have been categorized by level, as immediate, underlying and basic (following UNICEF 1990). The outcome or manifestation of the problem is high rates of xerophthalmia, with or without high mortality rates, among 6–59 month old children. At the immediate level of causation, dietary intake and disease factors may co–exist and interact in their influence on these outcomes, while at the underlying level, the three problem clusters of food, health and care are relevant. Finally, the basic causes will potentially include such broad factors as poverty, national–level resources, culture, ecology, and indeed the political system.

Table 2: Causes of Vitamin A Deficiency Among Young Children

	Causal Factors
Immediate	– Low vitamin A and fat dietary intake – High incidence of diarrhoeal disease and measles – Low birth weight – Maternal deficiency of vitamin A – Breastfeeding of short duration and non–exclusive in first six months – Inadequate complementary diet and feeding practices
Underlying	– Poor health infrastructure for services or programmes (incl. immunization) – Low production of vitamin A–rich foods – No kitchen garden – Poor marketing/distribution/storage/preservation of vitamin A–rich foods – Inadequate caring capacity (including maternal time) and practices – Intra–household food, health and care maldistribution – Maternal awareness/education/literacy
Basic	– Poverty with early childhood deprivation (e.g. marked by high prevalences of stunting) – Poor economic or physical access to markets – Little or no productive land – Seasonally of disease and food availability – Other environmental considerations

	– Other cultural considerations – Status of women – Other considerations on the political system

The relation of causality to intervention in vitamin A is somewhat simpler than for protein–energy malnutrition, and rather more similar to public health interventions. This is because there are a range of possible interventions that address the proximal causes, some of which are quick–acting and efficacious. Thus there is some parallel, with, for example, addressing polio – although the underlying causes of poor sanitation and crowded housing could be addressed, in practice immunization is the intervention of choice. Another parallel might be with malaria – where drug treatment and chemoprophylaxis have a clear and undisputed role, but longer run preventive measures such as insecticide–treated bednets, and indeed better drainage and environmental control, have a role to play. In contrast, because there are not quick–acting, widely–applicable, and efficacious methods of control for protein–energy malnutrition – supplementary feeding is expensive and often difficult –in this case the attention inevitably focuses more on basic causes and longer–term solutions.

CHAPTER III. A COMPARATIVE EVALUATION OF DIFFERENT INTERVENTIONS

In this section, results of a comparative evaluation of past experience with different interventions for the control of vitamin A deficiency are given, drawing on 46 individual evaluations. Two main types of evaluations were seen as relevant and are included: i) impact evaluations of large–scale control programmes, and ii) community–based field trials of the effectiveness of a vitamin A intervention in raising vitamin A status of defined population groups. The latter group includes those mortality and morbidity trials that included measurements of the changes in vitamin A status of study populations.

The main criterion for inclusion in the inventory, and hence the comparative analysis, was the measurement of outcome indicators of vitamin A status and studies of their association with the intervention. These included *at least one* of the following types: vitamin A or beta–carotene consumption; clinical eye signs of xerophthalmia, nightblindness; biochemical indices e.g. serum retinol, breastmilk retinol, modified and relative dose response. Complementary indicators in communication–based programmes included measures of (usually maternal) knowledge, attitude, practice (KAP). However, without a measure of changes in actual practice (usually vitamin A consumption), knowledge and attitude indicators were insufficient to qualify an evaluation for the comparative analysis.

The evaluation inventory (see Annex III) is organized according to five major intervention types – supplementation, dietary modification, fortification, public health[9], and breastfeeding promotion – each with various sub–categories. Following the compilation of the inventory, one–page summary sheets (see Annex V) were drawn up for each evaluation to condense the material and pull out the relevant findings under various headings, for later comparison by intervention type. These results are further summarized and tabulated in Table A.I of the annex for easy comparison. The checklist below gives the factors that were, as far as possible, considered for each evaluation in order to permit subsequent comparison and synthesis (not all evaluations however include information on all factors, so there are some gaps in the summary sheets).

[9] Public health services include here immunization, especially against measles, prevention and management of diarrhoeal disease, primary health care delivery, and hygiene and sanitation services.

Checklist of Evaluation Factors

Project/programme
Country
Year completed
Setting: Rural/urban, infant mortality rate, morbidity (extent of vitamin A deficiency), infrastructure (immunization coverage), vitamin A supply, population affected, health care utilization rates
Study design
Sample population
Age group/s
Input e.g. 200,000 IU vitamin A capsules, nutrition education.
Measurement of vitamin A status e.g. serum retinol (breast milk), eye signs, vitamin A consumption.

Vitamin A status at baseline
Coverage (%)
Compliance/acceptability
Effect on vitamin A status
Reported cost ($)
Cost/year protection/targeted individual
Sustainability
Community involvement
Potential confounding effects
Potential detrimental effects
Complementarity with other strategies (including criteria for establishing linkages)

Of the 46 evaluations detailed in the annexed summary table (Table A.I) and listed in the inventory, 25 were of supplementation interventions, 13 dietary modification, 4 fortification, 2 public health and 2 breastfeeding. Among these, there were two comparative evaluations of three approaches, in Nepal and the Philippines, and two evaluations of combined (supplementation and communications to improve consumption) interventions, in the Philippines and Haiti. These evaluations are cross–tabulated in Table 3 below according to whether they are evaluations of programmes, field trials of intervention efficacy, or "mortality trials", included in the meta–analysis, which also included pre and post–trial measurements of vitamin A status of individuals.

Clearly there are more eligible evaluations for supplementation than for other strategies, partly as a consequence of the longer history of attempts with this approach, and also because of its relative ease of evaluation (although priority consideration here should be given to evaluations of programmes rather than trials). Table 3 does also suggest that more evaluations of other approaches may need to be built into future programmes. In comparing evaluation across intervention types, when evaluations show a lack of effect for a particular type, it is important to consider whether this is due to specific difficulties in evaluation, or actual lack of effect.

Table 3: Types of Evaluations Included in Comparative Analysis

Intervention	**Programme?**	**Field trial?**	**Mortality trial?**
Supplementation	12*	9	4
Dietary modification	4**	9	0
Fortification	1	3	0
Public health	0	2	0
Breastfeeding	0	2	0

* *Includes 5 universal programmes, 4 age–group targeted through health services, 1 disease–targeted through health services, and 2 targeted through community–based health/nutrition programmes.*

** *Includes 3 communications/social marketing programmes to increase consumption of available foods and 1 home gardening programme.*

Comparison between supplementation and dietary modification evaluations is difficult for two main reasons. Firstly, these tend to measure different aspects of vitamin A deficiency – evaluators of dietary modification are interested in measuring behavioural change related to consumption, while evaluators of supplementation focus on the effects on clinical (and to a lesser extent) biochemical status. Thus, there are usually no comparative indicators. Secondly, the sample sizes of the dietary modification interventions are considerably smaller than those for supplementation evaluations. In particular, the supplementation–based mortality trials needed to have very large sample sizes to detect the mortality effect, so their "power" was high. As can be seen in Table A.I, the sample sizes of most of the programmes and trials were also large. The North–East Thailand project by Smitasiri *el al.* 1993[32] is the exception in both cases, as it measured change in target group biochemical and clinical status as well as dietary change; it also had a large sample size. More evaluations along such lines are needed to assess the relative effectiveness of dietary modification approaches compared to others, with respect to population vitamin A status.

In the following analysis, the essential preconditions, pros and cons, relative coverage and impact, and lessons learned for each intervention type, are examined, based on the empirical material reviewed. Table 4 summarizes the "how", "when" and pros and cons of the five intervention types for quick reference. This section has benefitted from the outputs of the first set of working groups at the Consultative Group Meeting, where the participants were directed to consider the pros and cons of specific intervention types. For each intervention type, the chairpersons and rapporteurs of the corresponding working group are footnoted.

Table 4: Summary of Preconditions, Pros and Cons of Various Vitamin A Deficiency Control Strategies

How	When	Pros/Cons
Supplementation: In general:	All countries (category I & II) are likely to have some use for capsules.	
Single–purpose door–to–door (universal) e.g. Bangladesh.	Not shown to be feasible, due to difficulties leading to inadequate coverage.	Pro: if could be done, high visibility impact. Con: infeasible so far; absorbs time and effort, detracts from other approaches.
Within regular health services, targeted to all in specified age group (targeted)e.g. Haiti.	When xerophthalmia in the area; when logistics, supervision, and specific training allow health workers adequate delivery.	Pro: relatively cheap. Con: casual contacts (passive) may miss the most vulnerable; demanding in terms of training module.
Within health services, for sick children, especially measles, also diarrhoea, ARI, PEM (disease–targeted) and for xerophthalmia cases (treatment)	With lower prevalence than above (or less supervision);? measles only. Always, if xerophthalmia in the area, must be treated.	Has to be done in vitamin A deficient areas.
Within health/nutrition services (e.g. *posyandu,* Indonesia; ICDS, India; Tanzania)	When health/nutrition services at village level are sustained.	Pro: effective, low marginal cost. Con: may detract from more sustainable interventions; puts load on workers.
Dietary Modification: Communications/social marketing	Vitamin A containing foods are available, and affordable (care: seasonality). Also that interpersonal communication can be achieved through local organizations.	Pro: should embed behavioural patterns that combat deficiency in the long–term. Con: none if the approach works.
Home food provisioning (often with communications social marketing)	Inputs including resource access, land and labour, can be made available; market access for part of produce.	Pro: eventually it should be cost–effective. Con: high start–up costs.
Economic and food policies	Vitamin A foods are not affordable or available.	Pro: complementarity with many other objectives.
Technology –e.g. preservation methods, plant breeding, etc.	E.g. when supply is seasonally adequate.	Pro: potentially cost–effective.
Fortification:	– Legislation and/or government and consumer awareness of	Pro: potentially feasible and cost–effective in middle income countries, although

Fortification of food commonly consumed by at−risk groups, with vitamin A.	benefits. − Suitable vehicle exists (accessible, affordable, widely consumed). − Process economically and technically feasible. − Political commitment to bear initial costs. − Population monitoring and advocacy feedback. − Policy for sustained financial support. − Not very dependent on prevalence.	difficulties in sustaining programmes has been experienced. For poorer countries many problems arise, and as yet there are not examples of successful programmes in these.
Prevention and Management of Disease: *Disease prevention:* Govt and NGO primary health services and community−based health care, including: environmental health (water, sanitation, safe complementary foods) EPI esp. measles, CDD, health education, personal hygiene, giardia control, MCH, growth monitoring, nutrition education, suppl. Feeding/rehab. Sometimes need to modify service pattern e.g. wider measles coverage rather than limited coverage by full−immunization.	Health services are ALWAYS needed, as a supporting action, not as alternative. To be strengthened if VAD prevalence and child mortality high (may already be disadvantaged in VAD areas). Severe resource limitations may suggest this change.	Pro: pre−existing, vitamin A−related benefits are further arguments for their strengthening. Multiple benefits. No separate delivery mechanism or programme necessary. Deals with environment which conditions risk of vitamin A deficiency. Less costly than separate programme. Con: Alone, may not be sufficient. May not be priority problem in face of others e.g. severe malaria or other endemics. At−risk populations may not yet be reached by services, or may not utilize them, (similar to health−service targeted strategy). Not specific to vitamin A.
Disease management: Early treatment of all infections (ORT, drugs etc). − Vitamin A supplements for all children <5 in known VAD area with measles and have not had VA supplement in last 3 months. (NB. need recording system for VAC).	Needed when effective general prevention measures (supplementation, fortification, dietary modification) not in place or inadequate.	Pro: Relatively low cost compared with supplementation of all under−fives Con: Lower coverage of most at−risk subjects. Low sustainability?
Breastfeeding Promotion: Through health service contacts, community−based programmes, clinics, hospitals, social marketing and communications.	In all situations as described, particularly where breastfeeding is not universal or practices are problematic.	Pro: As with 'public health', but more specific to vitamin A, as focuses on most at−risk age groups. Leads to long−term sustained behavioural change. Con: None if works. Depends on social marketing

preconditions if this route used.

SUPPLEMENTATION

[10] *Working Group Chair:* J.E. Dutra de Oliveira; *Rapporteur:* J. Cervinskas.

Within this section, a distinction needs to be made between universal and targeted supplementation. *Universal* delivery is defined here, following West and Sommer (1987), as single–purpose distribution of large doses of vitamin A to all children of defined age (and other designated groups) within communities in specified regions according to a pre–established time schedule. *Targeted* delivery refers to distribution of large doses of vitamin A through contacts between high–risk individuals and the existing health service infrastructure (including periodic mass immunization campaigns) and/or existing community–based health/nutrition programmes. There are three types of targeted supplementation, as shown in Table 4, including:

i) targeting to specific age groups through existing health service infrastructure;

ii) targeting to specific diseases in individuals through existing health services (may be called medical–targeting or disease–targeting or therapeutic). A further distinction may be made between therapeutic targeting solely to xerophthalmic cases on the one hand, and targeting to all individuals presenting with diseases such as chronic diarrhoea, measles, ARI and severe PEM, on the other;

iii) targeting to specific age groups and/or sick children through community–based health/nutrition interventions.

Of the 25 supplementation evaluations, 12 were of operational programmes, including evaluations of universal delivery programmes in Bangladesh, India (2), Philippines and El Salvador; and evaluations of targeted programmes in Haiti, Malawi, Indonesia, Philippines (2), India and Brazil. There were also evaluations of 9 field trials and 4 mortality trials.

Vitamin A capsules providing 200,000 IU were found to have at least 90% prophylactic efficacy for 4–6 months among recipient children against developing mild xerophthalmia and corneal disease (West and Sommer 1987, Tarwotjo *et al.* 1975[1], Vijayaraghavan *et al.* 1984[8]). For 6–59 month–old children, assuming 50% retention in hepatic stores, it is estimated that a 200,000 IU dose should confer protection from xerophthalmia for up to 8 months while the observed protective period against low serum retinol levels may be as little as 2 months (WHO 1982, West and Sommer 1987); this will vary with respect to factors such as protein–energy malnutrition and concurrent infection, which may reduce retention to 20% (Pant and Gopaldas 1986). The duration of protection against recurrent xerophthalmia has been shown to be shorter in children with severe protein–energy malnutrition (Sommer *et al.* 1982).

Supplementation generally was found to be low–cost, acceptable and clinically effective within the relatively short–term, *providing* coverage of the population is good. There was observed, on average, a 75–80% reduction in mild xerophthalmia prevalence among 1–4 year olds with at least 65% coverage (West and Sommer 1987) – a minimum target population coverage level suggested for universal supplementation programmes. With over 85% coverage, effectiveness with respect to severe corneal xerophthalmia may be as high as 90%, while there is unlikely to be an impact where coverage is less than 25%. A strong inverse association was found between coverage and subsequent nightblindness prevalence in Bangladesh (Cohen *et al.* 1987[4]).

In national universal supplementation programmes in India (before mid–1980s) and Bangladesh, and in the Indonesian programme targeted through community health posts, coverage rates had all fallen below the 65% threshold by the fourth distribution cycle (West and Sommer 1987) i.e. after 18 months of the programme's inception. Poor coverage was reported as being due to any combination of: lack of personnel, lack of health worker motivation, inadequate capsule supply, transport problems, inefficiency of distributor, lack of sustained administrative support and political motivation, programme fatigue, beneficiary disinterest, and lack of information–education–communication (IEC).

In two studies of factors affecting coverage in Indonesia (Hadi *et al.* 1993, Tarwotjo *et al.* 1993), maternal knowledge of xerophthalmia and the benefit of capsules was considered to improve coverage rates; in the latter study, the involvement of community organizations (particularly women's groups) in the promotion of

vitamin A activities was positively related to attendance at community–based health outposts *(posyandu).* Women's knowledge and awareness of vitamin A deficiency and the means to overcome it, is clearly a critical factor affecting programme coverage. Maternal educational level and literacy has also been shown to be closely related to risk of xerophthalmia in Bangladesh (Cohen *et al.* 1985) and Nepal (Tilden *et al.* 1993[13]) respectively. One of several problems reported with the Bangladesh Nutritional Blindness Prevention Programme (BRAC 1989[5]) was the fact that less than 4% mothers reported having had vitamin A–related discussions with health workers, and 90% mothers did not know about the target age and frequency of delivery of vitamin A capsules, nor the causes or potential remedies of nightblindness.

With universal supplementation programmes it has turned out to be very difficult to get adequate population coverage. Generally those children missed are thought to be at relatively greater xerophthalmic risk than those included. For example, the case study in Annex II uses data from the Bangladesh national programme (Greiner, pers. comm.), that shows that with approximately 50% target population coverage, the coverage of the high–risk target population will be only 25%. This tendency, for disproportionately missing the needy with declining coverage (see also Tarwotjo *et al.* 1987, Sommer and Zeger 1991) is related to the fact that vitamin A deficiency tends to cluster by family, community and geographical region (e.g. Cohen *et al.* 1985, Darnton–Hill 1988, Mele *et al.* 1991), and it is these problem "clusters" that are usually the most difficult to reach through existing delivery infrastructure. To get coverage rates of above the 65% minimum threshold, a programme's cost – both absolute and marginal – would rise considerably. It would involve a great emphasis on raising awareness of both the public and health workers regarding the benefit of supplementation – efforts which may arguably be better directed to raising awareness of beneficial dietary practices. Furthermore, if such an educational campaign were to succeed, it might paradoxically be more difficult to phase out supplementation later.

There is also the issue of unaccounted for or mistargeted capsules (Greiner 1991[5c]). In the 1989 evaluation of the Bangladesh Nutritional Blindness Prevention Programme (BRAC 1989[5a]), 25% infants received incorrect or multiple doses, potentially up to toxic levels of 200,000 IU, and 22 million capsules per year were unaccounted for (the numbers being ingested by pregnant women were thus unknown). A reasonable level of insurance against such mistargeting could further raise the costs of such a strategy, possibly to prohibitive levels. One other type of cost not generally considered is the opportunity cost involved with universal supplementation, which leads to the question: "does the existence of a universal programme detract from consideration by policy makers of other more sustainable, long–term approaches?" as has been suggested for Bangladesh (Greiner 1993).

In sum, based on past experience the case for universal supplementation is becoming less and less tenable. Where any type of supplementation is indicated, experience seems to suggest that it should be targeted.

Targeted supplementation is therefore now generally considered to be more sustainable, specific and efficient than universal distribution, particularly where there is high health service utilization. On the other hand, it is possibly less sensitive i.e. more vitamin A–deficient children may be missed. It has been estimated as about twice as cost–effective as universal distribution in delivering capsules to the target group (see cost–effectiveness section later). Targeting has been done through integrating supplementation into routine health delivery, including essential drugs programmes, immunization, diarrhoeal control programmes, as well as community–based nutrition and health programmes. Such targeting is often "passive", in that it entails selective distribution to eligible people who contact the health services; not actively seeking participants.

An early example of a successful health–service and medically–targeted programme came from Haiti (Toureau *et al.* 1979[19]) where the prevalence of new corneal scars was reduced by a factor of nine – from 0.8% to 0.09% between 1974 and 1979 (though some of this change may have been due to other factors). Targeting is usually directed to 1–5 year old children (e.g. Toureau *et al.* 1979[19], Barrows 1993), but is also possible (at least in trials) for lactating women within 1 month post partum e.g. Indonesia and Bangladesh (Stoltzfus *et al.* 1993[21], Roy *et al.* 1989[22]). Both of the latter two trials, in Indonesia and Bangladesh, demonstrated the efficacy of single dose supplementation of the mother after birth (in terms of both raised serum retinol and breast milk retinol levels). In addition, the Indonesian trial (Stoltzfus *et al.* 1993[21]) demonstrated raised serum retinol levels of the breastfeeding infant.

Capsule distribution at relevant dose levels and periodicity has been attached to the immunization schedule, and successfully targeted to infants over six months in trials in Indonesia and Brazil (Sutanto *et al.* 1993[20], Araujo *et al.* 1987[17]), although policy recommendations on this issue still await the results of ongoing research.

Disease–targeting – whereby children are targeted with xerophthalmia and/or severe PEM, measles or diarrhoea – is another option, which has been successful e.g. Philippines (Klemm *et al.* 1992[24]) and Tanzania (IVACG 1993). Training (particularly integration of capsule delivery into diarrhoea and measles case management protocols), supervision and supply factors were all seen as crucial factors.

As with universal distribution, coverage is crucial, and related to both health service accessibility and utilization rates. In Malawi, coverage at Under–Five clinics was found to be as low as 14% partially as a result of the lack of maternal knowledge of the benefits of capsules and the lack of priority attached to vitamin A deficiency control among knowledgeable mothers. Communications of such benefits are thus important.

The preconditions for successful targeted delivery, as demonstrated by the evaluations reviewed, include the following: high health service accessibility and utilization rates, particularly among at–risk population, an adequate system of regular supply, transport, logistics with accountability built in, specific vitamin A training and re–training of existing health workers, adequate supervision and monitoring, integration of vitamin A considerations into case management protocols for diarrhoea, acute respiratory infection, measles, and communications to create demand and motivate the population and leaders.

Another route for targeting capsules is through existing *community–based nutrition and health programmes* e.g. the Integrated Child Development Services (ICDS) in India and the community–based health and nutrition services *(posyandu)* in Indonesia (Hadi *et al.* 1993, Tarwotjo *et al.* 1993). An evaluation of the ICDS component (Gujral and Gopaldas 1991[11]) found that with targeting through ICDS, coverage of the national Indian capsule distribution programme increased from 21% to 47% and from 13% to 75% in two States between 1984 and 1989, with xerophthalmia rates dropping from 4% to 1% and 12% to 1% respectively. In contrast, an earlier integrated programme in the Philippines showed little additional effect of capsule distribution through a supplementary feeding scheme (American Foundation for the Overseas Blind, Inc 1976[23]), except for severe PEM cases – due probably to increases in dietary vitamin intake through consumption of the supplementary foods. Additional efforts were recommended to reach these severe cases.

In sum, if the problem is severe, stable or worsening, and confined to geographically distinct communities with accessible health services, targeted supplementation is likely to be warranted as an immediate and quick–acting measure, with the development of additional long–term approaches initiated concurrently. As the problem comes under control, new interventions may gradually increase in emphasis, that deal with more underlying levels of the problem, and supplementation may increasingly be disease–targeted (for which there will probably always be a role).

All countries are likely to have some use for supplementation. There are two dimensions of importance – delivery and selectivity. For example, with a universal, door–to–door, single–purpose delivery system, there is no beneficiary selection. With supplement delivery through existing health services (including immunization), selection is based on medical need, and sometimes on 'risk'. With delivery through other services (e.g. nutrition programmes, schools), only children in school will be selected. The latter two delivery means also have the advantage of convenience, unlike universal supplementation, but may not reach the highest priority groups.

The following are some guiding principles regarding the role of supplementation in vitamin A deficiency control.

> i) Supplementing with vitamin A should not inhibit attention/investment in other strategies. There is a need to push at least as hard for the underlying preventive approaches, as for supplementation. To date, there has been a relatively larger flow of resources into supplementation than to fortification or dietary approaches.
>
> ii) New vertical infrastructures should not be established as "single–purpose" delivery channels for vitamin A supplementation. Single–purpose machinery can be cost–effective where there is the possibility for eradication (which is not the case for vitamin A deficiency). There is thus a need to think in terms of integration within existing delivery systems including health and nutrition services e.g. well–baby clinics/services, etc. Supplementation possibilities have tended to be bounded by the traditionally–used delivery systems, which has limited opportunities. A full assessment of all available options including novel delivery systems needs to be explored. Hitherto unexploited possibilities may include Child–to–Child programmes, the formal school system, additional opportunity points in EPI (e.g. the rubella vaccine at around 15–18 months, as is currently being discussed in some countries), low dose supplements sold over–the–counter, a plastic pouch of 12 one–monthly doses.

Contacts where supplements are given (e.g. EPI) can also be used as an educational opportunity. Immunization contact points should be used to provide supplements of vitamin A to children over six months e.g. the 9 month contact for the measles vaccine, and at suitable points thereafter. It has been suggested that a new "immunization" contact should be established at around 18 months, with the express purpose of giving vitamin A. Childbirth presents an opportunity for maternal supplementation that may be used. Other means to improve women's vitamin A status during pregnancy and post–delivery should also be considered. A continuing issue of concern is how to reach those children who do not come into contact with the health services.

iii) An important consideration must be to minimize the risk of multiple–dosing, which necessitates adequate record–keeping of the use of high dose supplements. Where record–keeping is inadequate, reducing the frequency of supplementation contacts may be advisable.

iv) There are situations when a pharmacological dose is needed to reach a goal and a dietary approach would not be appropriate e.g. case management of disease (measles, protein–energy malnutrition, xerophthalmia). Supplements may also be indicated when food is just not adequately available, for example in refugee and emergency situations. Vitamin A supplementation should be further explored for the management of diarrhoeal disease, e.g. with diarrhoeal disease, more frequent and lower doses may be considered. For example, in Tanzania capsules of 50,000 IU were available, making it easier to prescribe at different dose levels.

DIETARY MODIFICATION

While dietary modification (as stated by Arroyave 1987) defines a goal not a strategy, programmes to reach this goal have employed strategies made up of four specific activities to improve the vitamin A (and sometimes fat) content of the diet of at–risk population groups:

i) nutrition education or communications, often using a social marketing approach, to improve practices related to the consumption of available vitamin A–rich food sources;

ii) horticultural interventions (or home food provisioning) e.g. home–gardening, that aim to increase availability of vitamin A–rich foods;

iii) economic/food policies affecting availability, price and effective demand for vitamin A–rich foods, and

iv) technological advances concerning food preservation, plant breeding, etc.

The scope of 'dietary modification' interventions is thus broad. A division can be made between those that aim to improve the *availability* of vitamin A–rich foods (that is (ii) – (iv)), and those that aim to improve the *consumption* of vitamin A–rich foods (including (i)).

Of the 13 dietary modification evaluations, 9 incorporated some education/communication project activities, 7 included home gardening (4 of which were combined with social marketing activities), and one study examined changes in consumption in response to naturally–occurring changes in prices and availability of vitamin A–rich foods. There were no evaluations of the impact of food preservation or plant breeding schemes. Most of the evaluations were of pilot projects or field trials.

Improving Consumption of Vitamin A–Rich Foods

[11] *Working Group Chair.* H. Kuhnlein; *Rapporteur:* S. Smitasiri.

Improving the consumption of vitamin A–rich foods, one of which is breast milk, assumes that such foods are available or could be made available but are not being consumed in adequate amounts by vulnerable groups. This implies the need for behavioural change. Behavioural change can be accomplished by a variety of

mechanisms which involve appropriate messages and their presentation within a receptive environment. There are a number of general principles of directed behavioral change, and one of these is the need to adapt to the local context and resources. Effective communication is only one part of the total task required to successfully change vitamin A–related behaviours. In general, what is needed for vitamin A–related dietary modification is a conceptual system for thinking through the problems of bringing about changes in the ideas or practices of the target populations as they relate to vitamin A. This system should aim at behavioural change through culturally appropriate information and the creation of an environment suitable for change. Social marketing is one example of such a behavioural change strategy. For sustainability, modified dietary habits need to become embedded in the culture; thus the process is one not only of behavioural change but also of cultural change.

Considering the evaluations, while there have been many communications projects implemented during the last 10–15 years, generally little emphasis was placed on evaluation of effects on vitamin A status (relative, for example, to supplementation programmes). There are two important factors related to evaluation of communications programmes. Firstly, behavioural change effects (usually increased consumption of vitamin A–rich food) have in the past been difficult to attribute conclusively to projects – largely as a consequence of the tendency of mass media–based strategies to "pollute" the control group. Secondly, consumption is difficult to measure, and often reliant on reported intakes which may be inaccurate.

Thus, the objective of many behaviour modification programmes, and particularly those using communications, is both difficult to measure and difficult to evaluate. There is thus a need for applying more attention and resources to measuring consumption effects. Biological indicators might also be used in small–scale, well–designed interventions. For general populations however, behaviour indicators should be sufficient provided the biological relationship has been previously established. Assessment techniques appropriate for this particular type of intervention should be further developed.

There was generally considered to be sufficient evidence to conclude that food–based approaches using pro–vitamin A sources, adequately implemented, are effective in the control of vitamin A deficiency, and contribute to alleviating the other usual accompanying nutritional deficits, e.g. of other micronutrients and protein. Evidence comes from vegetarian populations that do not show vitamin A deficiency; from small scale, community–based studies that have fed controlled amounts of carotene sources and demonstrated elimination of sub–clinical deficiency (e.g. Oey Khoen Lian *et al.* 1967, Venkataswamy *et al.* 1976, Sharma *et al.* 1993); and from clinic–based metabolic studies on absorption from different carotenoid sources (e.g. Lala and Reddy 1970, Hussein and El–Tohamy 1990). In certain cases where protein is limiting in the diet, beta–carotene consumption may be preferable to large doses of retinyl palmitate, since the carotenoids generate retinoids which are not protein–dependent for mobilization (Carlier *et al.* 1992). The availability of beta–carotene will also be significantly enhanced if fat is not limiting in the overall diet. Additional research to understand details of efficacy under field circumstances more quantitatively are warranted, but are not necessary before deciding on and implementing carotenoid–containing, food–based interventions.

Two projects that were able to demonstrate positive change (to varying degrees) in knowledge, attitude and practices (KAP) were in North–East Thailand (Smitasiri *et al.* 1993[32]) and West Sumatra (Pollard 1989[26]). The North–East Thailand trial was based on promoting consumption of one food – the ivy gourd. Significant increases in consumption where attributed to the project, as well as increased knowledge and attitudinal change. Whereas the most effect occurred with mothers of 24–72 month old children, the improvement extended also to a non–target group of over–fives. After three years, there were significant increases in dietary vitamin A and fat intakes of pregnant and lactating women; also (although less significantly) with preschool children. Regarding clinical and biochemical vitamin A status, while a lack of impact on serum retinol levels was attributed to delay in transport of samples to laboratory and high prevalence of hookworm, there was a significant decrease of nightblindness from 4.8% in 1989 to 1.4% in 1991 among preschool children. The West Sumatra trial demonstrated increased consumption of dark green leafy vegetables of between 10–33% for target groups and considerable positive attitudinal change after two years. The increased coverage of the existing capsule distribution programme during this period, from 35% to 58%, was partly attributed to demand creation via the project. However, the interpersonal communication component was weak due to a high drop–out of project communicators.

The Worldview International Foundation project (INFS 1990[30]) in Bangladesh showed increases of 40–60% in production, and consumption (by young children) of green leafy vegetables and yellow fruits, and increased awareness of nightblindness – its causes and potential remedies. Nightblindness prevalences among young children also dropped, although a further impact evaluation is awaited which will more conclusively determine what level of change can be attributed to the programme.

Not included specifically in this comparative evaluation were community–based projects that sought to promote appropriate complementary feeding practices. Several such projects (e.g. in Indonesia, the Philippines) demonstrated improvement in consumption practices in general. Inasmuch as these also improved the consumption of vitamin A–rich foods, and fat, they would also have benefited the vitamin A status of the children targeted (although no specific measures were taken to show this).

In general, where social marketing projects have successfully changed levels of knowledge and awareness of the benefits of consuming more vitamin A–rich foods, *sustained behavioural change* has been more difficult to demonstrate. This has been attributed to the need for more intensive interpersonal communications (to health workers and mothers), in addition to the mass media campaigns which characterize most projects (e.g. see Pollard 1989[26]; David 1990[27]; INFS 1990[30]; Mir Mahboob Ali *et al.* 1993[31]). A full complement of media should be optimally utilised. A pre–requisite for a strong interpersonal communication project component is a pre–existing reliable cadre of community–based health workers or another network of potential communicators (Favin and Griffiths 1991). Effective change in vitamin A consumption at the community level has the following additional requirements or preconditions:

– consideration of the context, which involves disaggregation or segmentation of the population into regional, community, household and finally, targeted individual by gender and age;

– community involvement in the decision–making process, allied to flexibility to encourage local initiatives;

– inclusion of related government officials and community leaders as the target audiences, not only the mothers and children in the community;

– interpretation of vitamin A issues that require a change in behaviour, so that they are perceived by policy and programme implementers, community practitioners, and also the vulnerable population, as relevant, beneficial and doable;

– consideration of the desired characteristics of the change agents who are going to operate the intervention;

– the availability and affordability of the foods being promoted. Interventions need to be linked to the increased production of green leafy and yellow vegetables and fruits where food availability is a concern (4 of the 9 communications interventions evaluated were linked to horticultural activities);

– the access of the target population, particularly women, to information;

– constant monitoring, regular retraining and supervision of workers.

– media and messages which are: i) based on a consideration of six questions – to whom, what, how, which, where and when, ii) based on a prior understanding of local knowledge, attitude and practices (KAP) and perceptions, including obstacles and resistance to change, of those individuals with the power to change behaviour. This can be gained through pre–intervention formative research; iii) specific[12]; iv) feasible, v) offer tangible rewards and provide motivation; vi) linked to health ("feeling good"); vii) credible and memorable; and viii) disseminated through multiple channels in contact with target group.

[12] There is some debate over the value of promoting one or more foods within social marketing projects. Favin and Griffiths (1991) state that promoting one food is more feasible and can still significantly improve a monotonous diet. In Bangladesh however, the Worldview project (INFS 1990) and HKI/AVRDC 1993 project were both based on promoting a range of vegetables and fruits to simultaneously combat other micronutrient deficiencies.

Communication/social marketing should be an essential component of all vitamin A intervention strategies because through appropriate communication at various levels in the system, awareness and innovative change can be facilitated. It is necessary to understand basic causal factors i.e. poverty, national level resources, culture, ecology and the political system, at least enough to create feasible changes.

Breastfeeding Promotion

[13] *Working Group Chair:* H. Kuhnlein; *Rapporteur:* S. Smitasiri (group combined with 'improving consumption' group).

Breastfed infants have been shown to be protected against vitamin A deficiency (Tarwotjo *et al.* 1982, West *et al.* 1986[46]), although breastfed infants of mothers with marginal vitamin A status may become vitamin A–deficient (Stoltzfus *et al.* 1993[21]). In Indonesia, Stoltzfus *et al.* (1993) demonstrated that high–dose supplementation of lactating mothers was an efficacious way of improving the vitamin A status of breastfeeding infants (the probability of low liver vitamin A stores at 6 months of age were reduced by two–thirds). Mother's breastmilk vitamin A levels were still elevated at 8 months post partum, at a time when complementary feeding is becoming increasingly important. As complementary foods may be low in vitamin A, the infant will still be dependent on vitamin A that is either available from accumulated liver stores, or still being ingested through breastfeeding.

There were two other evaluations of the effects of breastfeeding, in Bangladesh and Malawi, which both retrospectively demonstrated a significant protective effect for infants. In Bangladesh, breastfeeding was shown to confer a 74% reduction of risk of vitamin A deficiency on average for under–threes, while in Malawi, breastfeeding and complementary feeding practices were significantly inversely associated with xerophthalmia risk. Further discussion of the relation of breastfeeding and maternal nutrition to child vitamin A status is provided in Chapter IV.

Breastfeeding is the most important factor affecting vitamin A status of infants under six months of age, and is important for older infants too. Where breastfeeding rates are low or declining or practices are sub–optimal, stimulating breastfeeding initiation and better practices would be the top priority. Linked directly to this is a concern for the mother's nutritional status.

Improving Availability of Vitamin A–Rich Foods

[14] *Working Group Chair:* V. Reddy; *Rapporteur: C.* West.

Seven home gardening interventions, evaluated from a vitamin A perspective, were included in the analyses here (including 4 which were combined with social marketing activities). These all showed several indirect benefits, such as increasing female income and social status, which are likely to have positive spin–offs for vitamin A status of children. Only the Bangladesh project (HKI/AVRDC 1993) showed a positive effect on actual vitamin A status (in this case a slight improvement in reported nightblindness), although caloric intake increased by 15% and several positive economic changes were recorded. Previously in Bangladesh, analyses had shown that households without a home garden were much more likely to have a xerophthalmic child (Cohen *et al.* 1985).

In general, preconditions for successful home gardening interventions were found to be the following: land and water, relevant technologies, fences, fertilizer, high quality inexpensive seeds[15], labour time, investment capital, knowledge of optimum means of production in local conditions, including pest and disease control, and adequate marketing, storage and preservation.

[15] Poor quality seed can be especially harmful (Greiner, pers. comm.) when trying to promote home gardening among people not used to it. If the seed has a poor germination rate, the lack of visible results may lead to discouragement. Seeds should not be too expensive, as this may also be prohibitive for some households.

These preconditions are likely to be most difficult to achieve for those population groups with the highest risks of vitamin A deficiency. However, while one pre–requisite is land, vitamin A does have an advantage over most nutrients in that even landless households may cultivate vines that grow on roof–tops or papaya plants that grow alongside the walls of houses (e.g. INFS 1990[30]). For seasonally available vitamin A–rich vegetables and fruits, improved methods of preservation across seasons may be another important consideration (sun–drying of mangoes is one example); although sun–drying may destroy most of the vitamin A in the case of leaves.

Finally, a sub–category of economic/food policies has been included within this section, to investigate the effect of changes in economic policies (e.g. pricing) on the availability and consumption of vitamin A–rich foods. One study in the Philippines (Bouis 1991[38]) showed that vitamin A demand behaviour was quite different to that for calories, and consumers were not as aware of their requirements. Vitamin A intakes fluctuated widely with prices, even though daily requirements could have been met cheaply. Seasonality in availability and price of green leafy vegetables resulted in threefold shifts in consumption levels. While the poorest 20% of households on average consumed the recommended per caput allowance of vitamin A, there was a wide variation around this mean, with 34% households consuming below 80% of their allowance. Such findings illustrate the potential both for communications techniques to increase demand and extension programmes to increase production (particularly seasonally) of vitamin A–rich foods. While food policies may potentially have a large impact on micronutrient availability and demand, they are unlikely to be very influenced by vitamin A–specific objectives. Manipulating prices specifically to affect micronutrient intakes of at–risk households has not been demonstrated, although this does not mean that advocacy may not alter this situation in the future.

In sum, the availability of food sources rich in vitamin A and fat may be improved through a range of strategies. National household food security policies should incorporate considerations of availability and accessibility of vitamin A–containing foods particularly for those populations at risk of developing vitamin *A* deficiency. More data at national/regional/community/household levels may be required on production and consumption of foods other than staples. Quantitative indicators of vitamin A availability and consumption should be developed for the monitoring of actions with potential for improving the availability of vitamin A–rich foods.

FORTIFICATION

[16] *Working Group Chair.* O. Dary; *Rapporteur:* P. Nestel.

While fortification seems to be an attractive medium to long–term option, its sustained implementation has in the past been bedeviled by industrial and political constraints. Even before the industrial stage appropriate food vehicles need to be sought that are affordable, accessible, widely consumed among at–risk groups, and unaffected organoleptically by the fortification process. In practice, fortification may be easier to achieve (at least initially) if the vehicle is centrally–processed, although as long as the food vehicles are accessible to the at–risk groups, decentralized small–scale fortification may be suitable. Fortification is generally of two types:

Universal i.e. consumed throughout the population with little variation in intake (e.g. sugar, margarine and potentially oil, cereals and flour, monosodium glutamate).

Targeted e.g. supplementary feeding programmes for pregnant women or welfare recipients, school feeding, complementary foods. Targeted fortification can reach target groups more readily than supplementation and indeed could replace supplementation. Fortification of food aid is an important issue.

The four evaluations described in Table A.I are from the Guatemala sugar programme, trials with monosodium glutamate in Indonesia and the Philippines, and a trial with sugar in Chile. All were effective within a year in raising serum retinol levels of target groups (both adults and children). In the Guatemala programme, and the Philippines and Indonesia trials, the effect was particularly pronounced in children classified as low or deficient in vitamin A. In Guatemala, there was a decrease in effect in the second year, attributed to an erratic application of fortification at industrial level. In addition to biochemical indicators, clinical eye signs showed improvement after 11 months among preschool children in the Indonesian trial which also succeeded in significantly raising breastmilk retinol levels among lactating mothers.

Where commercial weaning foods are widely used, or centrally processed products form the basis for home weaning food preparation, these should be fortified with vitamin A as a matter of policy, without advertising. More research is needed in this area, and no evaluations were identified for such interventions Other opportunities with future potential include local (household or community level) fortification of food using locally processed and preserved food e.g. solar dried fruits and vegetables, the use of unrefined palm oil as a fortificant, the enrichment of food by adding oil, and the possibilities for fortification of food aid, particularly for overcoming seasonal vitamin A deficiencies.

Preconditions for successful fortification interventions were found to be the following, and the presence of these should be sought in deciding on whether fortification is promising.

– vitamin A deficiency is a public health problem in sectors of the population;

– at least one (usually centrally–processed) food vehicle which is accessible, affordable, widely consumed by the at–risk group, stable over time and unaffected organoleptically by fortificant (which should retain its potency);

– a concentration of fortificant that is based on dietary consumption data from different age and socio–economic groups in different regions. The range of fortificant intake within a population should be narrow to avoid any risk of toxicity;

– a fortification process that is economically viable (costs not excessive relative to the value of the commodity), technically feasible and regularly monitored;

– population monitoring and evaluation to convince governments of benefits, as well as to indicate the need for reducing the fortificant level as the diet improves;

– political commitment, reflected in initial governmental commitment to bear the marginal costs of the fortification process before gradual phasing in consumer cost–sharing;

– policy to ensure sustained financial support;

– a good public image of the fortified food; promoting nutritionally 'bad' food should be avoided;

– prospects of raising population awareness (particularly consumers) and heightening confidence in the benefits of fortification;

– legislation or regulations that favour collaborating producers, and which protect them against unfair competition.

In general, fortification can be undertaken in conjunction with other micronutrient interventions as a long–term option (as has been done in developed countries). Successful implementation of a programme will depend on the type of collaboration between governments, producers, consumers, and donors indicated in Table 5. This includes their relative roles with respect to promoting awareness among specific population groups, raising financial resources to support fortification, as well their involvement in such areas as technological support, legislation, quality control and evaluation.

The advantages of fortification include the fact that in the long–term it may be one of the least costly interventions for a government; it has been found to be cost–effective and socially–acceptable, being one of the most natural means of supplementing intake; and a delivery system (the market chain) is already in place. Disadvantages include the initial need for foreign exchange, the recurring costs, the fact that it will reach untargeted as well as the targeted population, frequent dependence on a centrally processed food vehicle, and the need to know consumption patterns as well as food purchasing behaviour i.e. price elasticities etc.

Table 5: Required Support for Long–Term Fortification

Actors	Awareness	Finance	Technology	Legislation	Quality Control	Evaluation
Government	General public	Tax incentives. Quality control. Foreign exchange.	Quality control system	Implement and enforce the laws and/or regulations	Enforce	Implement
Producers	Workers	Capital investment	Equipment maintenance	–	Comply	–
Public (Consumer groups and	–	Cost recovery with time	–	–	Demand Outside surveillance	Collaborate

NGO's)						
Donors (International Agencies)	Govt., Producers, NGOs	Seed money	Facilitate technical assistance, methodologies for quality control, sampling, consumer education	Food aid (define which foods and at what level i.e. develop standards)	Advocate	Advocate and support

PREVENTION AND MANAGEMENT OF DISEASE

[17] *Working Group Chair.* F. Solon; *Rapporteur.* K. Bailey.

Many public health interventions have direct implications for vitamin A status. Infectious diseases exacerbate vitamin A deficiency by a variety of mechanisms, including reduced food intake (due to both anorexia and withdrawal of solid food), reduced intestinal absorption, and urinary loss of vitamin A. Infections that cause diarrhoea and giardiasis reduce absorption of the vitamin. All infections reduce appetite and most induce a catabolic response that leads to vitamin A loss. Measles has a particularly severe effect on vitamin A status through these mechanisms.

It follows that measures that will reduce the burden of infection will help to prevent or reduce vitamin A deficiency. These include immunizations, particularly against measles, pertussis, and tuberculosis; environmental sanitation, food safety and personal hygiene for reducing incidence of diarrhoea; and malaria prevention. Prevention of other nutritional deficiencies, particularly those of protein–energy and iron, will reduce the incidence and severity of many of the infectious diseases that adversely affect vitamin A status.

Preschool–age child mortality is reduced by vitamin A administration after the onset of measles; for this reason it is recommended that vitamin A supplements be given as soon as measles is diagnosed, in areas where vitamin A deficiency occurs. If a supplementation programme is under way in the area, careful records must be kept so as to avoid giving too closely spaced supplements. Vitamin A supplementation of deficient preschool–age children will reduce overall infectious disease mortality in most circumstances. Specific vitamin A–related measures are not alternatives or substitutes for the basic services that will benefit health as well as vitamin A status. Public health measures and specific vitamin A interventions will usually be complementary, and *both* are to be recommended.

Thus the question of whether a vitamin A–specific intervention is warranted if it potentially competes with resources for strengthening health services will only apply where such an intervention is somehow implemented *outside* the existing health care infrastructure e.g. single–purpose universal supplementation. It is not such an important issue if the existing infrastructure would be utilized for vitamin A (e.g. targeted supplementation) as the marginal costs of doing this would be much less than setting up a single–purpose delivery system. Also, it is not likely to be an issue if the vitamin A–specific intervention is food–based, as normally these would not be in competition for health care sector resources.

Vitamin A control programmes in the health sector should be integrated into other public health measures. This will also result in more effective utilization of limited health resources. When priorities for interventions must compete for limited resources, cost–effective choices should take into account the relative benefits of various strategies. For example, high measles vaccine coverage may be a better choice than full immunization for a much smaller proportion of the population at risk.

A common contributory cause of blindness associated with avitaminosis A is severe protein–energy deficiency. Xerophthalmia and keratomalacia may occur in children with adequate liver stores and even sufficient intake, when serum levels of retinol–binding protein are deficient. Under these circumstances improving nutritional status may be sufficient to promote mobilization of liver stores of vitamin A and alleviate the deficiency. Thus, measures to prevent severe malnutrition in young children will help to prevent vitamin A deficiency–associated blindness. These measures include growth monitoring and surveillance, nutrition education and rehabilitation, and food supplementation.

General public health–type interventions that included oral rehydration therapy, deworming, immunization and treatment of acute respiratory infections were compared with other approaches in two of the three comparative evaluations (in Nepal and the Philippines). In Nepal, the relatively limited impact on vitamin A status was ascribed to underlying food insecurity, while in the Philippines the public health component was combined with home–gardening promotion which cumulatively had a positive effect on reducing xerophthalmia.

CHAPTER IV. SOME CONSIDERATIONS IN THE CHOICE OF STRATEGY

[18] This chapter draws on the outputs of the second set of working groups at the Consultative Group Meeting. Participants were assigned to consider the mix and sequencing of vitamin A deficiency control interventions that would offer greatest potential under conditions such as level of service development and vitamin A supply as given in footnote 19.

In general, one can envisage a situation where it is known that there is a problem with vitamin A deficiency amongst preschool children, that there are possibilities for service delivery, etc. to reach the populations affected, and the decisions now need to draw upon previous experience and different characteristics of potential solutions.

One early and difficult set of considerations concerns the balance between interventions that are quick–acting, to save lives now, versus longer–run attacks on underlying causes. This is particularly difficult if, as seems to be the case, quick–acting solutions such as distribution of supplements tend to be less sustainable than the longer–run interventions, such as behavioural change. It seems undeniable that if there is a quick–acting solution available, in other words that lives could be saved sooner rather than later, then this has to form part of the attack on the problem.

SEQUENCING OF INTERVENTIONS

This leads to considerations of sequencing interventions. A likely common approach would be to introduce (or strengthen) quick–acting solutions, and at the same time bring in interventions to increase the dietary intake, in this case of mothers and weaning and older children. Long–term approaches, such as dietary modification, fortification, need to initiated concurrently with short–term approaches, not after. This is because the very existence of an ongoing intervention (despite it only being intended as a short–term measure) in practice can often detract from consideration of other longer term approaches which are necessary to sustainably attack the problem.

While the distinction between quick–acting and longer term approaches may be useful when considering sequencing, it should be noted that some of the longer term dietary modification strategies may produce results rapidly on pilot scale, while "quick–acting" supplementation may take time to advocate, train, establish systems for delivery.

Another consideration is whether there are similar types of interventions that already exist (e.g. salt iodization/social marketing) that could be utilised to accelerate the implementation of a vitamin A intervention. Vitamin A deficiency control programmes, as mentioned before, should as far as possible be integrated with other nutrition and child survival programmes.

Periodic evaluation and situation analysis will provide the basis for adjusting strategies e.g. increased targeting or phasing out certain interventions. Evidence showing the existence of a vitamin A deficiency problem is required for advocacy, and for policy formulation/programme decisions. When clinical or biological evidence from surveys is not available, an initial rapid assessment can provide information about the presence of xerophthalmia, night blindness or low dietary vitamin A intake, which may be enough for decision–making regarding early interventions. Innovative approaches, like the use of information obtained from school children and their families may be considered. When no clinical signs are present, pilot projects to assess vitamin A deficiency as measured by serum retinol levels can be undertaken. In addition, assessment of evidence of precarious health and socioeconomic conditions should be considered for deciding about the need of interventions. Research should be linked to interventions and policy, requiring strong institutional relationships and communications mechanisms.

In most situations, if xerophthalmia exists, it is almost always necessary to use supplementation in some form as a quick–acting intervention, particularly where it co–exists with any of the following conditions: high infant and under–five year mortality rates, high incidence of diarrhoea and parasitic infections, measles outbreaks, high prevalence of severe malnutrition, and severe poverty. In populations with mostly subclinical deficiency, greater reliance may be placed on slower acting interventions such as fortification or dietary change.

FACTORS TO CONSIDER IN THE CHOICE OF STRATEGY

Some important issues to consider in deciding on an appropriate mix and sequencing of vitamin A intervention are described here. In addition to the nature, extent and severity of the problem of vitamin A deficiency (described in Chapter I) the following factors would be important to consider:

i) Underlying trend in vitamin A deficiency
ii) Disease pattern, particularly measles and diarrhoea
iii) Extent of breastfeeding, maternal nutritional status and deficiency control in 0–6 month children
iv) Political support at national, regional and community levels
v) Communications
vi) Available resources
vii) Operational feasibility of the intervention
viii) Cost–effectiveness
ix) Sustainability
x) Complementarity with other interventions
xi) Urbanisation

These factors, and their type of influence over decisions on actions, are described individually below. Situations may also be characterised, based on combinations of such factors, that would indicate the type of mix of interventions with the greatest potential. The following two examples are for illustration only.

– *Situation:* Africa, rural, remote, dry, high xerophthalmia and high mortality among 9–59 month olds, high incidence of measles, inadequate health and EPI infrastructure and coverage. Breastfeeding initiation and duration generally adequate; mothers are not malnourished. Household food security adequate, but mothers not aware of benefits of mixed diet. Vegetables and fruit seasonally available.

Options: Strengthen EPI; maternal post–partum supplementation (through TBA or clinic); improve outreach and strengthen health services; incorporate inter–personal communications (between health workers and others and mothers), mass media not strong. Possible disease–targeting of supplementation through strengthened services. Fortification preconditions not all present. At the basic level: market infrastructure, public distribution.

– *Situation:* Asia, urban slum, poor community, significant xerophthalmia and mortality among under–fives, low vitamin A consumption, short duration of breastfeeding, early supplementation with liquids and foods. Working mothers with constraints on time for child care. Household food insecurity. Fruits and vegetables available year round in accessible markets. Health infrastructure and EPI coverage reasonably good.

Options: In short–term, supplementation to at least 6–59 month olds. If xerophthalmia rates sufficiently high, this should be universal single–purpose distribution through specifically trained distributors; if lower, targeting through health services (gradually phasing–out to disease–targeting). Social marketing, using mass media and interpersonal communications (focus on breastfeeding promotion and complementary feeding). In medium–term, fortification may be possible (if appropriate vehicle identified, and other preconditions met). At underlying and basic levels: crèches at work place, facilities and time for child care (through legislation); urban poverty alleviation programmes.

Moving on to consider actual country contexts and the historical development of vitamin A deficiency control strategies, Table 6 provides examples from several countries of how approaches to vitamin A deficiency control relate to the type of problem existing and the feasibility of certain actions. This corresponds to the three–tiered assessment procedure as outlined in Table 1, that is initial and epidemiological assessment of

the problem and its causes followed by an operational assessment of the feasibility of various actions. This table is based on brief presentations on all of these countries that set the context for discussions in the second set of working groups. These working groups[19] were assigned to address the approaches to the selection of interventions or a mix of interventions in different situations. These situations were broadly characterised initially by the quality of services and the level of vitamin A supply in the environment, with illustrative countries. Another group considered urban contexts. The following sections describe those factors which were seen as important considerations in the choice of strategy, and why they were considered important.

[19] There were five sets of working groups in this second session: i) Better Services and Vitamin A Supply e.g. Guatemala and Thailand (*Chair:* F. Trowbridge; *Rapporteur:* J. Rivera), ii) Better Services and Vitamin A Supply e.g. Brazil and Indonesia (*Chair:* I. Tarwotjo; *Rapporteur:* R. Stoltzfus), iii) Less−Developed Services and Poorer Vitamin A Supply e.g. Bangladesh, Ghana, Nepal (*Chair:* S. Simon; *Rapporteur:* F. Binka), iv) Less−Developed Services and Poorer Vitamin A Supply e.g. India and Tanzania (*Chair:* J. Tagwireyi; *Rapporteur:* T. Greiner), and v) Urban Contexts e.g. Mexico and the Philippines (*Chair.* R. Heyward; *Rapporteur.* T. Stone).

i) Trends in Vitamin A Deficiency

The gradual disappearance of vitamin A deficiency observed with economic development (e.g. DeMaeyer 1986) implies an underlying secular trend of improvement. This could have an important influence on decisions on vitamin A interventions; different approaches might be taken if it is likely that the problem will anyway greatly diminish in (say) 20 years, compared with persistence or indeed worsening.

Trends in vitamin A deficiency can not generally be assessed globally (ACC/SCN 1992, p2). WHO have recently updated their assessment from 1987 to 1993, in which countries are categorized by significance of vitamin A deficiency as a public health problem. Probably most changes noted from 1987 to 1993 are from reporting differences and/or improved data availability; overall the impression is not of rapid underlying change in the last six years. On the other hand, calculations from food balance sheets (given in ACC/SCN 1992, p 42, and ACC/SCN 1993, p102−105) do show substantial increases in vitamin A supply in areas previously deficient: particularly in South East Asia, but also in South Asia. Even considering the question of distribution, it would not, from this, be surprising if there was a significant improving trend in Asia. In Eastern and Southern Africa, in contrast, the vitamin A supply is low and probably not improving. West Africa is unusual because the supply is *potentially* very high, from red palm oil, although distribution from coastal areas where it is in abundance, to drier inland areas is often a significant problem. Red palm oil may however self−target to poorer people as, with increasing income, more expensive dietary fats or red palm oil in increasingly processed form (hence lower carotene content), may be used.

General economic development may raise the supply of foods rich in vitamin A and fats for absorption, improve their distribution as markets expand, and improve the purchasing power of the at−risk population. Other examples of factors that could contribute to a positive secular trend are improvements in the quality and outreach of health services, measles immunization, population (dietary) awareness, breastfeeding promotion, and indeed any other existing vitamin A control interventions.

Table 6: Some Examples of National Approaches to Controlling Vitamin A Deficiency

Country	Problem	Feasibility of Actions	Approach Adopted
Brazil	Scattered xerophthalmia, particularly in semi−arid regions in North−East, linked to protein−energy malnutrition. Problem particularly in under−twos, linked to short duration of breastfeeding. Low serum retinol clustered by region.	VA foods available but vulnerable to drought and seasonality; low consumption linked to low socio−economic status. Community organisation is growing, church plays critical role, Health services are generally available and improving. EPI campaigns have	VAC targeted by region, linked to EPI at 9 months. Programme adoption at discretion of state and local governments, which provide logistic support (thus few states have had continuous distribution, and programme is vulnerable to political changes in priorities). National breastfeeding

		80% coverage. Rural diets tend to be poorer in VA than urban diets. Breastfeeding is low and decreasing.	promotion campaigns exist. Fortification planned with milk, sugar, oil combined with iron, although lack of political commitment is currently a constraint, and food vehicle producers want guarantee of good investment in fortification. Quality control also an issue.
Indonesia	2–7% xerophthalmia in 1970, dropping to 0.3% in 1990. VAD mainly rural.	VA foods available, some seasonality. Strong political commitment, community organization and health services. Almost universal breastfeeding of long duration.	VAC is no longer universal, but increasingly targeted through the *posyandu* system of community health outposts. Social marketing and fortification being piloted. Bottom–up planning increasingly undertaken so that regions can to some extent choose appropriate mix of actions.
Guatemala	VAD a widespread, but largely sub–clinical problem.	Nature of problem and fact that preconditions do exist indicate that fortification is appropriate approach.	Sugar fortified since 1960s; interrupted in 1970s from lack of foreign exchange for fortificant. No impact data collected since 1977. Fortified sugar not labelled or promoted. Total fortification cost $2m/year; sugar price increased 2% but recovered from consumers. Cost is $0.25 per person per year. Problems with dosage levels – if these can be resolved, then perhaps no need for other interventions. At present, other interventions (food–based) are very localized.
Thailand	VAD widespread problem in underserved, poorest provinces only.	VA foods available and service infrastructure developed. VAD control efforts integrated into broader health and development strategies. Intersectoral mechanism is strong. Fortification conditions do not exist.	Major intervention is regional dietary diversification project within a wider national poverty alleviation strategy. Other nutritional benefits and social change aspects of intervention were important; intersectoral effort required; communications has to be backed by community action (e.g. in home gardening). Fortification rejected as no carrier food; recently skim milk fortified to address severe VAD in infants in urban areas.
Bangladesh	VAD is major problem, estimated 30,000	VAD associated with poor, rice–growing population	The short–term measure comprises biannual VAC

	under−six year old children go blind each year due to VAD and half of these die within weeks of blinding episode. In 1982−3, rates of nightblindness (2.8−3.6%) and Bitot's spots (0.9−1.6%) exceeded WHO threshold criteria by a multiple of three, active corneal lesions (0.1%) by a factor of ten.	groups. Breastfeeding almost universal and of long duration. VA foods vary with season and socio−economic status. Very low fat intakes reduce absorption. PEM and diarrhoeal and measles morbidity negatively interact. Lack of kitchen garden relates to VAD. Community organisation not developed, but NGO network active.	distribution to 6−72 month old children by village health workers of Ministry of Health and Family Planning, just before times of VA food shortage. In medium−term, communications−related initiatives and piloting of wheat fortification have been undertaken. In longer−term, home garden promotion is being undertaken by several NGOs. Efforts are being made to increase awareness of the need to deal with VAD at the highest policy levels through advocacy, although there is a tendency to equate the VAD problem with VAC solution. A need exists for more national support for longer term approaches. Poverty alleviation programmes will help reduce the socio−economic aspect of the problem.
Ghana	VAD occurs only in drier northern savannah. Xerophthalmia rates relatively low, but prevalence of low serum retinol up to 70% among young children.	Two main ecological regions. Equatorial forest zone in south has abundant VA supply, in contrast to drier savannah zone to north where seasonal constraints to VA availability. Increased measles immunization coverage has reduced clinical VAD signs.	Several child nutrition programmes, but no specific VAD control programme. Some paediatricians administer vitamin A in measles treatment. Some NGO primary health care programmes distribute VAC, and at least one programme provides capsules to mothers after delivery in post−natal clinics. Most VAC use remains with ophthalmic services.
Nepal	VAD is serious problem, particularly in the Terai region (where active xerophthalmia up to 3% in 1989) and certain hill regions e.g. Jumla with an active xerophthalmia rate of 13.2% in 1989.	VA foods generally available. Maternal illiteracy associated with VAD. Community organisation and health services not developed. Political commitment exists −National Planning Commission coordinates inter−sectoral health policy, and NGO capacities well integrated.	Interest developed in dealing with VAD in the 1980s. By 1986, small local vitamin A activities had been started in several districts. In 1988, an intervention study was implemented that compared three approaches (VAC distribution, PHC activities and nutrition education). Led to adoption of a national programme that focuses on supplementation in 33 priority districts and concurrent implementation of a long−term strategy to promote increased production and consumption of VA foods through

			multi–sectoral coordination, including communications component.
India	Clinical and biochemical evidence of VAD, although xerophthalmia prevalence has improved significantly in last 15 years.	Long history with attempts to control VAD. Health service infrastructure developed, although supply often a problem. Breastfeeding practices are good in rural areas, less so in urban. Community organisation not strong. Fortification may have potential regionally. IEC has great potential as VA foods generally available, and media increasing its outreach into villages.	National universal supplementation programme started in 1972, since been integrated into PHC system and nutrition programmes, such as ICDS. Coverage adversely affected in past by weak IEC component and disruptions in VAC supply. Longer term diet modification approaches now being pursued, with some local success, although difficult to secure long–term funding support for national adoption.
Tanzania	TFNC estimates 6% population 'vitamin A–deficient' (98% below 6 years of age). More severe in drought–prone areas.	Multisectoral National Vitamin A Consultative Group exists to coordinate 5–year control programmes. Supported by sentinel xerophthalmia surveillance system. VA foods availability related to drought–proneness. Health services, community organisation and political commitment all developed. Breastfeeding practices sub–optimal.	Two main approaches adopted. Firstly, disease–targeted supplementation through PHC centres, with supplements supplied through Essential Drugs Programme. Secondly, longer term approaches aimed at improving consumption of VA–rich foods through combined communications/nutrition education approach and horticultural initiatives e.g. school seedling nurseries, solar drying for preservation of VA in certain foods. Further emphasis is being placed on promoting red palm oil consumption, deworming of children and fortification of margarine (despite the latter being mainly a food for richer groups).
Mexico	No reports of xerophthalmia. Prevalence of low serum retinol in a slum in Mexico city was 22% with increased prevalences at younger ages, in low socioeconomic groups, in children with anaemia, and in those without medical coverage by the social security system. In 1980s, a decline in infant and under 5 mortality rate	Available retinol– and carotene–rich foods but prices are high, particularly for animal products. Strong community organization and sectorial commitment and developed health sector. Breastfeeding has declined sharply, particularly in urban areas, where about 20% of children are never breastfed and almost 25% are breastfed for 3 months or less. Introduction of food is early – about half of the	Successful immunization and diarrhoeal disease control programmes and several food distribution programmes, particularly in urban areas.

	has been experienced. Prevalence of stunting is 23% with important regional differences.	population consumes milk or food before 4 months of age.	
Philippines	Clinical and biochemical evidence of VAD.	National awareness is high; comercial mass media very active in promoting micronutrients. Conditions exist for linking VAC to EPI as there is massive media promotion of twice–yearly National Immunization Days. Fortification possibilities being examined with private sector after directive from President.	National VAC supplementation programme of 12–59m. children with National Immunization Campaigns twice a year at EPI outreach posts. National advocacy programme for ending hidden hunger which combines improvements in dietary intake, capsule distribution and food fortification. Programme includes incentives to food industries and the development of guidelines for food fortification, a community based nutrition programme which includes research and training for health personnel in nutritional assessment and activities for the prevention and control of VAD, and consumer education re: food fortification. Integration of nutrition and health into the elementary school curriculum.

A quick review was done for this paper, of reports over the last several decades of signs of vitamin A deficiency. While comparability is difficult, the impression is that reports of nightblindness or Bitot's spots from Bangladesh, India and Indonesia have shown an important downward trend in the last 10–30 years – see Figure 1. On the other hand, the very limited data identified from Ethiopia and Malawi (which suffered severely adverse conditions in the 1980s) give the impression of little or no improvement there.

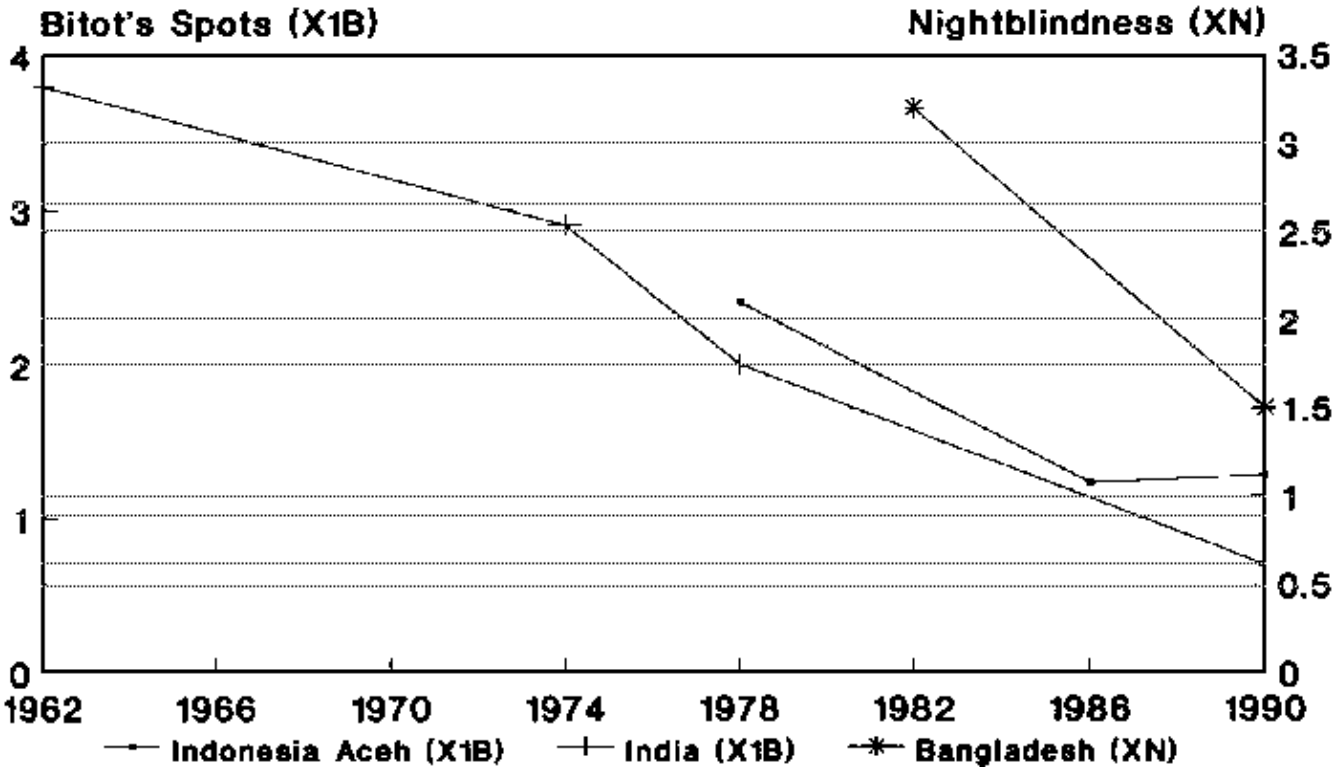

Figure 1: Trends in Xerophthalmia Children < 6 Years

The improvement in Asian countries is possibly in part due to existing vitamin A deficiency control programmes, although it is difficult to assess the proportionate degree of this effect. Some implications of a secular trend such as that shown in Figure 1 for choosing an appropriate vitamin A deficiency control strategy are as follows.

– Dietary modification may anyway be occurring. This could be built upon. Targeted supplementation however may be especially relevant in remaining pockets of deprived xerophthalmic populations. Targeting may be through existing health services and/or community–based systems of outreach. With time, supplementation may only be indicated for therapeutic or medically–targeted delivery to children who are severely malnourished/sick with or without xerophthalmia (there will probably always exist a role for supplementation for treatment of cases of xerophthalmia and measles).

– If the criteria for intervention depend on significant prevalence of sub–clinical deficiency, can it be assumed that this will be improving too, moreover at a similar rate to the clinical signs e.g. as shown in Figure 1? This question argues strongly for periodic monitoring of sub–clinical deficiency in population samples. Populations who are not improving sub–clinically may require interventions additional to those showing rapid improvement;

– When the trend is not improving, instituting measures for dietary change must be a priority –alone or with fortification and/or supplementation. One possible "hidden" cause of deficiency is the lack of dietary fat, which may be a particular problem for low socio–economic groups.

ii) Disease Pattern, Particularly Measles and Diarrhoea Incidence

It was not possible to factor out the effects of measles immunization on the mortality–reduction due to vitamin A status improvement in the meta–analysis (Beaton *et al.* 1992). Measles immunization coverage rates were generally not known, although the impression was that immunization rates were relatively low in most of the study populations (Beaton, pers. comm.). This is highly significant not only because it obviously relates to measles incidence and thus measles–related mortality, but also because there is a significant chance that death *attributed* to diarrhoea could have been partly caused by earlier measles, or may be related to measles that has yet to be manifest in a skin rash.

If measles and diarrhoea are the main causes of mortality preventable by vitamin A, what additional mortality−reduction is likely in populations where these two diseases are controlled? This could be re−phrased to ask "what additional effect of vitamin A on mortality is likely where general or specific public health measures have succeeded in reducing mortality from diseases including measles and diarrhoea?". This consideration differs between measles and diarrhoea. Whatever the implications in relation to vitamin A, measles immunization is clearly a top priority, and it seems unlikely that improving vitamin A status would be promoted in the absence of attempting to improve measles immunization coverage. Thus the question concerning mortality reduction will come to be applicable in measles−immunized populations. If health services are well developed and mortality rates relatively low, the additional effect may not be great. One possible example is the Hyderabad study which did not show a large mortality−reduction effect of supplementation. The other study that did not show a mortality−reduction effect was in the Sudan, where this lack of a mortality effect was likely to have been related to at least three factors: i) mortality rates were relatively low, ii) measles had been largely controlled and iii) in any case, virtually no effect was seen on xerophthalmia prevalence.

Furthermore, if it is true that a large part of the mortality attributed to diarrhoea is also measles−related, then would the control of measles (via immunization) prevent most of the excess mortality due to vitamin A deficiency in such populations? If this were to be the case, the policy response would be to be put much greater specific emphasis on controlling measles within public health strategy. Research addressing this question is urgently needed.

iii) Extent of Breastfeeding, Maternal Nutritional Status and Deficiency Control in 0−6 Month Children

Maternal nutrition and breastfeeding are critical concerns for infants. Early initiation of full, preferably exclusive, breastfeeding (including colostrum) maintains vitamin A status at adequate levels for about six months in well−nourished mothers and slightly less for vitamin A−deficient women unless they receive vitamin A supplementation (either a large dose soon after delivery or up to 10,000 IU daily via supplements or diet during lactation). Prolonged breastfeeding accompanied by appropriate complementary foods continues to protect against vitamin A deficiency in poor communities even beyond two years of age (Cohen *et al.* 1983).

Recent data from Nepal (West 1993) and re−analyzed data from India (Arthur, pers. comm.; Rahmathullah *et al.* 1990[10]) did not point to a significant mortality reduction among the under six month child populations studied through raising vitamin A status. Presumably both populations had a high rate of breastfeeding. The possible significance of vitamin A deficiency among non−breastfed 0−6 month populations – which are of potentially major policy relevance owing to the high absolute mortality rates of this age group – awaits future research.

If the child is *not* breastfed, there is a much higher risk of deficiency before six months – six to eight times higher xerophthalmic risk in studies in Bangladesh and Indonesia – as well as in later infancy. An added risk is present in low birth weight babies who already have relatively low vitamin A stores. Thus, in populations, for example in urban areas, where breastfeeding has declined and where dietary vitamin A intake is low, it may be especially important to carry out appropriate interventions aimed at infants of less than six months. Clearly promotion of breastfeeding itself is crucial, for this and other reasons.

However, it may also be necessary to look into possibilities of fortifying the diet that the non−breastfed infant is receiving, or increasing its vitamin A content in other ways, *providing this does not undercut breastfeeding promotion.* This proviso is critical, as some would argue that the very specification of a strategy (other then breastfeeding) for non−breastfed infants *would, in practice,* undercut breastfeeding promotion efforts.

The potential for safely building the vitamin A liver stores of under six month non−breastfed infants through direct supplementation, via immunization contacts, has been dealt with in a recent report (WHO/IVACG 1993). Important issues here include dosage level and safety, and the effect of improved vitamin A status at this age on respiratory symptoms (WHO/CDR 1993, item 6.2.2., page 11). At present, the EPI programme delivers 100,000 IU once between 6−12 months in endemic areas, usually coinciding with the 9 month measles contact (although slippage often occurs in timing).

Another important question is "can 6−12 month death rates be reduced by improving the vitamin A status of 0−6 month old infants?". In the child who is fully breastfed for six months, the protective effect is likely to continue into the second six months of life, providing the infant receives at least 50 mcg vitamin A per decilitre breastmilk. However, a large proportion of breastfed infants in developing countries, whose mothers are to

some extent vitamin A–deficient, do not receive such concentrations (Stoltzfus, pers. comm.). This again argues for attention to mothers' diets (remembering that supplementation is generally ill–advised because of teratogenic risks).

For breastfed infants of a mother who is vitamin A–deficient (e.g. with serum retinol below 20 mcg/dl), maternal supplementation with 200,000 IU VAC (vitamin A capsules) within four weeks of delivery is likely to be important, and certainly a better/safer option than dosing the infant. This has been seen to raise breastmilk retinol levels in Bangladesh (Roy *et al.* 1989[22]), while a recent study in Indonesia with a larger dose (300,000 IU) effectively raised mother's serum retinol, breastmilk retinol, and the infants serum retinol levels up to 6 months (see Stoltzfus *et al.* 1992)[20]. A question here is should all mothers be supplemented shortly after delivery in high prevalence areas? (This could be considered an option even for non–breastfeeding infants by integrating breastfeeding promotion into vitamin A deficiency control programmes from the start, in countries where breastfeeding rates are less than optimal).

> [20] In the Gambia however, a daily food supplement of 2000 IU given to lactating mothers failed to produce a sustained increase in plasma retinol levels; it was suggested that factors other than the dietary availability of vitamin A may play a role in determining levels of plasma retinol, and further studies were recommended to elucidate these (Bates *et al.* 1984).

Improving vitamin A status of women – before, during, and after pregnancy – would thus go a long way to preventing deficiency in breastfed infants, through ensuring adequate stores at birth, and good intakes during breastfeeding. Because of teratogenic risks during pregnancy, a low dose of 10,000 IU per day may be prescribed in a universal supplementation programme in an endemic area to all women of childbearing age (as it is usually difficult to identify those pregnant), although this has usually only been attempted for refugee populations. The aim would be to build up the mother's liver stores, those of the foetus, as well as subsequently her breastmilk retinol levels.

iv) Political Support at National, Regional and Community Levels

Although many governments have signed agreements committing themselves to the eradication of vitamin A deficiency, there are fewer who have specifically included elements within national planning. Key factors in order to enable this to occur include awareness of vitamin A deficiency as a problem, understanding of the ecological and sociological factors underlying vitamin A deficiency, preparedness to include vitamin A deficiency within health sector policy, conviction of the possibility of improving vitamin A status, preparedness to promote and support control programmes particularly those involving inter–sectoral activity, and sustained commitment to programmes.

In addition, those countries that have established successful vitamin A deficiency control programmes have usually done so with a strong background of activities by other groups and individuals within the country. These include research groups at universities, national and international agencies, the community and non–governmental sector, and senior health professionals in ministries with training/expertise in nutrition. Committed individual activists too have been instrumental in catalysing awareness and action for vitamin A deficiency control in several countries. Support from international agencies can also greatly facilitate local efforts.

Political support at the community level is linked to the degree the intervention empowers the community. All interventions require empowerment of the community including proposed beneficiaries, although the means through which this is engendered will depend on the type of intervention. In that active, rather than passive, community involvement is less, it is generally operationally more difficult to empower communities in supplementation and fortification strategies.

The intervention will thus depend on the type of support available. If government commitment is solid and vitamin A is prioritised then it is possible to have a well planned and coordinated programme. In Nepal, for example, the National Planning Commission was tasked with implementing the health policy; hence a multisectorial approach including all ministries, well–coordinated with NGOs resulted in the resources being well used. In Bangladesh, an NGO planned a programme with dietary diversification with no national support. In Ghana, a capsule programme was all that was possible because there was no governmental support to achieve the desired multicultural coordination.

v) Communications

Even if there are many programmes running, there will be a need to have individuals speaking out as advocates for vitamin A deficiency, demonstrations of exciting projects on television and in newspapers, inclusion of vitamin A in school children's education, commitment and activities related to vitamin A in community groups, national and international seminars held in the country with maximum media coverage, training programmes for workers, continual infiltration of vitamin A deficiency within areas of relevance such as diarrhoeal disease control, immunisation programmes and combatting childhood infectious disease programmes.

vi) Available Resources

These include economic, human and organisational resources. Economic resources will include the startup and recurrent costs of the chosen intervention (see 'cost−effectiveness'). Affordability, relative to available resources, may be a better criterion than cost *per se.* Capsules and food are both economic resources. For example, in Ghana, capsules provided by donor agencies were the primary available resource, given that the dry environment was not rich in vitamin A−food sources. In contrast, dietary modification approaches based on improving consumption of already available vitamin A−rich foods were more appropriate in wetter Bangladesh. The climate conditions thus govern the type of food resources that may be made available and will thus influence choices. Human and organizational resources include people and institutions, discussed in points (iv) and (v) above.

vii) Operational Feasibility of the Intervention

Operational feasibility can be sub−divided into its technical and managerial aspects. Technical feasibility relates to the coverage and operational capacity of services e.g. health services or specific vitamin A deficiency control programmes, in vitamin A−deficient areas. Important questions include: is the agriculture sector responsive and capable of promoting household production and consumption; is education sector more interested and capable? Additional considerations may include operational questions linked to specific interventions such as whether EPI−linked supplementation can be used to address sub−clinical problems, or what carrier foods exist that may be utilised for fortification.

Managerial feasibility is also important. In view of the inter−sectoral nature of most vitamin A deficiency projects, there is a need to achieve high quality management systems which include a range of items such as clear task definition, shared values, negotiating skills, supervision and appraisal skills, team work and ability to resolve conflicts and achieve results within a team. In managerial terms, programme success may be more important than attacking most serious problem; in this case, it would be important to get a working model of the intervention off the ground where conditions permit before extending to more severe or less well−served areas, once political support has been achieved.

viii) Cost−Effectiveness

Micronutrient malnutrition is just one of the problems facing a government, and there is usually a need to illustrate the outcomes expected for a given level of resources applied to the problem (cost−effectiveness) for successful advocacy. Cost calculations are however complex, requiring data on start−up and ongoing costs, foreign exchange rates, health worker's time, costs of the capsule (in supplementation interventions), and logistics of distribution. It should be noted that while economic value is obviously important, it is not all−inclusive when considering benefits.

Cost−effectiveness calculations require concurrent cost and effect data which are rare. There are two components: *delivery* (usually cost per targeted recipient) and *biological* (cost per case prevented, or per % xerophthalmia prevalence reduction, or per life saved). Despite the above limitations, West and Sommer (1987) estimated the annual cost per dose recipient (the delivery cost−effectiveness) of universal supplementation in 1985 US dollars as $0.44 (using early data from the Indonesia programme with 75−80% coverage, Tarwotjo *et al.* 1975[1]), and $0.44−0.66 for targeted delivery (based on the Haiti programme, Toureau *et al.* 1979[19]). Annual per caput dose recipient costs have been reported as low as $0.11 for the

national universal programme in Bangladesh (Greiner 1991[5c]), although the opportunity costs of health workers' time were not incorporated in these calculations. While the delivery cost–effectiveness is thus of a similar magnitude for universal and targeted programmes per dose recipient, when considered in terms of per at–risk target group, targeted delivery is more cost–effective, as it is more specific. This should be weighed against the possible lower sensitivity of targeted delivery, and possible irregularity of dosing.

Delivery cost–effectiveness is the same as the estimated cost per person–year of (presumed) protection. For supplementation, it refers to the cost of delivering two capsules at six–monthly intervals per target population; for dietary modification, fortification and public health interventions, it refers to the cost of coverage of the target population with the particular interventions. The empirical data available, from supplementation programmes in Indonesia, the Philippines, Haiti, Nepal and Tanzania, range from 1987 US $0.4 – 0.7 per caput per person–year protection (see Table 7). In contrast, the sugar fortification programme in Guatemala had a lower per person–year protection cost at $0.14 (in 1987 $, Arroyave *et al.* 1979[41a]). Levin *et al.* (1993) have calculated comparative per person–year protection figures for other micronutrient interventions: iodine oil injections range from $0.14 – 0.46, iron fortification of sugar or salt both cost about $0.10, while (daily) iron supplementation was found to be the most costly micronutrient intervention at $2.6 – 4.4 per person–year. It would be useful to compare these figures with annual per caput costs for other interventions; for example, the cost of fully immunizing a child is of the order of $10–15.

The *biological* cost–effectiveness will be lower (i.e. the cost per effect achieved will be higher). This may be indicated by the cost per "case" prevented, the cost per percentage prevalence decline in xerophthalmia (usually nightblindness and/or Bitot's spots), or the cost per life saved. If we take the figure of $0.44 for targeted supplementation, then delivery cost–effectiveness is $444 per 1000 target population per year. If the annual reduction in active xerophthalmia is, say, from 3.7% to 1.0% (as was the case in the Philippines targeted programme, Klemm *et al.* 1992[24]), then the number of cases prevented is 27 per 1000 population, and the biological cost–effectiveness is $16.4 per case of xerophthalmia prevented. In East Nepal, where the child mortality rate and within this the proportion of deaths attributable to diarrhoea and measles were both very high, the cost per death averted was calculated at about $11 (Daulaire *et al.* 1992). With regard to measles cases, it has been calculated that it costs about $3 to provide vitamin A to every hospitalised child with measles, but saves on average $300 per child in hospitalization costs (Hussey 1993).

Considering preventable mortality, taking the relative risk of 0.77 (from the Beaton *et al.* 1992 meta–analysis), and a 6–59 month mortality rate for 1991 in the Philippines of 23[21], then the lives saved per year per 1000 would be 5.3 giving a biological cost–effectiveness of nearly $84 per life saved for universal supplementation. If however 1991 mortality figures are taken for India, with the same assumptions regarding delivery cost–effectiveness of a targeted programme, for a 6–59 mortality rate of 70, the cost per life saved would be lower at about $56 – due to the higher absolute mortality rates and thus greater number of deaths preventable through vitamin A deficiency control.

> [21] Taking existing 1991 mortality figures for the Philippines, the under–five mortality rate was 46 per 1000 live births, and the IMR was 34. Thus the 1–4 mortality was 12 per 1000 lives births. If we assume that the 6–11 month mortality rate is 1/3 of the total IMR, this gives a 6–59 month mortality rate of 12 + 11 = 23.

Table 7 enables a *rough* comparison between different interventions with respect to the cost of attaining coverage per person per year. The table describes only delivery cost per person and does not give information on the extent to which the intervention was needed and the coverage achieved. Information is particularly needed on coverage, to indicate whether the groups most at risk have been reached, since need is not uniformly distributed. Information on effectiveness requires data not only on coverage but also on the biological outcome. For example, a diet modification programme may achieve high coverage but affect only the food habits of a relatively small percentage of the individuals reached. A broad public health programme that includes effective prevention of vitamin A deficiency may have a relatively high cost per person but also extensive additional benefits. Thus delivery cost per person is of limited value in selecting health interventions unless accompanied by good information on effectiveness.

Costing dietary modification interventions is very difficult both in measuring inputs and effects (which may include many which are not specific to vitamin A or even to micronutrients *per se.* e.g. raised income levels). The cost per presumed recipient of the Worldview International programme in Bangladesh (which included social marketing and horticultural activities) for 1990–93 was estimated at $0.11 (Greiner 1993), similar to the cost of the universal Bangladesh Nutritional Blindness Prevention Programme. Delivery cost–effectiveness was higher at $0.42 per caput target group in the North–East Thailand social marketing trial (Smitasiri *et al.* 1993[32]), while the West Sumatra project calculated biological cost–effectiveness at $0.28 per mother or child

increasing consumption of dark green leafy vegetables, per year.

Table 7: Comparing Delivery Costs of Different Vitamin A Interventions

	Country/Year	Reference	Cost per person–year participation (US $)[22]
Targeted VAC programme	Haiti 1978	Toureau *et al*. 1979[19]	0.46 – 0.68*
Universal VAC programme	Indonesia 1973–1975	Tarwotjo *et al.* 1975[1]	0.44*
Universal VAC programme	Bangladesh 1989	BRAC 1989[5a]	0.11
Universal VAC trial	Philippines 1975	Solon *et al*. 1979[12a]	0.42*
Universal VAC trial	Nepal 1988–90	Tilden *et al*. 1993[13]	0.42
Dietary modification trial	North–East Thailand 1988–91	Smitasiri *et al*. 1993[32]	0.42
Dietary modification trial	West Sumatra 1986–89	Pollard 1989[26]	0.28
Dietary modification programme	Bangladesh 1987–90	INFS 1990[30]	0.11
Sugar fortification programme	Guatemala 1975–77	Arroyave *et al*. 1979[41a]	0.14 for national population*
MSG fortification trial	Philippines 1975	Solon *et al*. 1979[12a]	0.58*
Public Health intervention (trial)	Philippines 1975	Solon *et al*. 1979[12a]	9.47 (but many other benefits)*

** note, these costs (for earlier evaluations) have been converted to 1987 US dollars (as quoted in Levin et al. 1993), for comparability*.

[22] For supplementation, this refers to the cost of delivering two capsules at six–monthly intervals to the population covered. For dietary modification and fortification, it refers to the annual per caput cost of covering the target population.

Fortification of sugar in Guatemala had an annual cost per caput for whole population in 1976 of US $0.07 (or $ 0.14 in 1987 $). If just the target population of 1–5 year olds in the low and medium–income strata is considered, the annual cost per person protected was $20 for children with initially "deficient" levels (<10 mcg/dl), and $3.7 for low levels (<20 mcg/dl) of serum retinol. In the Indonesia trial (Muhilal *et al.* 1988), fortification was subsidized to retain price parity. The government targeted fortification to small packets of MSG (bought by poorer families) and the subsidy was progressively reduced over time. The marginal cost of fortified MSG was 13% non–fortified MSG. While only 35–50% MSG was fortified (through targeting), the cost increase was spread over all MSG produced – therefore the cost increase to be borne by consumer over several years was < 7% the cost of non–fortified MSG.

As well as cost–effectiveness, time frame, scale and available resources need to be taken into account in deciding on the most efficient allocation of resources to deal with the problem. For example, Tilden *et al.* (1993)[13] found in Nepal that, if over $0.5 per year per targeted individual was spent, then nutrition education plus maternal literacy was most cost–effective (and more sustainable) when compared with other interventions including supplementation (which cost $0.42 per caput); this took into account extra benefits on child growth and health care utilization.

A cost–benefit analysis in the Philippines (Popkin *et al.* 1980[12a]) showed supplementation to have lower "social costs" than fortification or education, with long (above 15 years) and short (below 5 years) time scenarios. Fortification had highest social benefits, but supplementation had highest benefit–cost ratio; public health interventions were not as effective as fortification and more expensive. Such analyses however are fraught with difficulties relating to the quantification of benefits, both direct and indirect.

In sum, cost–effectiveness differences between different interventions for controlling vitamin A are usually not very great. Given this, and given the fact that accurate data are usually difficult to collect, cost–effectiveness may thus not in practice be the most useful discriminating variable for use in choosing an appropriate single or mix of interventions. Context–specific considerations of preconditions, feasibility and appropriateness are likely to be more relevant in facilitating such decisions.

ix) Sustainability

Sustainability has financial, political, managerial, technical and socio–cultural aspects, and is linked to factors such as intervention cost–effectiveness, community involvement, political will and economic resources. Owing to the difficulties in combining and operationalizing these different aspects and thus quantifying the concept of Sustainability, it is considered more in relative terms when comparing strategies.

For example, dietary modification through a combination of social marketing/communications and vitamin A food production and marketing is usually considered to be the most sustainable long–term strategy for improving population vitamin A status. To the extent that new positive behaviours become habits, such changes are (by definition) sustainable. However, the potential long–term Sustainability of a strategy is just one aspect which may need to be traded off with its ability to control the problem in the shorter–term. The latter will depend on the extent and severity of vitamin A deficiency at that time – hence the need in most cases to combine short or quick–acting and longer–term strategies. Some would argue that a combined strategy of breastfeeding promotion, fortification and medically–targeted capsules is sustainable, as well as being more cost–effective in the medium term. Universal supplementation, being so dependent on foreign exchange (for the supplements) and on a separate distribution system, is relatively unsustainable compared to other strategies; it may also not be very cost–effective, depending on coverage and other factors. As health services strengthen, the coverage of a health–service targeted strategy would thereby increase, further reducing the need any single–purpose universal distribution, providing regular monitoring and supervision of health personnel is achieved.

Fortification, also requiring foreign exchange (for the fortificant and technologies), has been seen in Central America to be dependent on economic resources and political will, having been curtailed during periods of economic crisis. It has been suggested that information that fuels positive advocacy may be crucial in generating and maintaining such political will (World Bank 1993). The government and public will need to learn more of the effects of fortification to sustain support for this strategy – particularly as the consumer may increasingly be meeting its costs. Providing the costs of fortification are relatively small compared to the product, and these are progressively passed on to the consumer, fortification can be self–sustaining.

Community awareness of the benefits of micronutrient deficiency control, and their pressure as consumers on governments to allocate resources to these problems, are crucial factors of Sustainability. Others include institution–building and human resource development – committed and skilled health care workers, fully sensitized to micronutrient problems are essential parts of this.

The share of intervention cost borne by the consumer may be one positive indication of the degree of long–term financial sustainability. Using data from Grosse and Tilden (1988) who compared different interventions in Indonesia, for dietary modification, the consumer met 80% costs, for fortification, 75% and for supplementation, just 5% total costs.

x) Complementarity with Other Interventions

There is considerable potential for complementarity between interventions (despite this not having been widely tested in the efficacy trials which tend to look at single interventions). The multi–purpose potential of social marketing has been used to increase the acceptance and use of supplements, and to foster home gardening and behavioural change favourable to vitamin A intakes. Because behaviour is critical to the full

implementation of all micronutrient activities, social marketing is likely to become a common element. Similar considerations apply to complementarities between vitamin A interventions, other nutrition interventions, and indeed in the areas of health, agriculture, etc. In nutritional terms, issues can concern multiple fortification, as well as the beneficial effects of anaemia reduction on vitamin A status, increased fat intake on vitamin A absorption, etc. Similarly, the use of communication to promote, for example, consumption of green leafy vegetables, may have beneficial effects on not only vitamin A nutrition, but possible iron and other micronutrients. The potential for complementarity between interventions is another important consideration in the choice of overall strategy, as it may result in an increased *overall* cost–effectiveness of combined approaches aimed at reducing several nutritional problems.

xi) Urbanisation

Finally, urban areas merit separate consideration because they often differ from rural areas in the prevalence of vitamin A deficiency, the relative importance of its determining factors (food availability, food production and commercialization, dietary patterns, sources of vitamin A, fat intake, breastfeeding, prevalence of infections, etc), and in the characteristics of the potential delivery systems and facilitating/inhibiting factors for interventions: community participation, health care services, communication channels and education opportunities, availability of centrally processed and marketed foods, opportunities for food production, etc. These factors should be assessed when considering intervention choices.

In assessing the situation, urban areas should not be assumed to be homogeneous; rather, they should be disaggregated to cover slums and periurban areas. The particular opportunities or constraints with different types of interventions in an urban context are outlined here.

i) There is a special need for the promotion of behavioural change improvements at a number of different levels, in urban areas. The training of health care providers is important, since it cannot be assumed that all have an adequate knowledge base regarding vitamin A, its sources, and the health consequences of deficiency.

ii) Provision of water and sanitation services and promotion of personal hygiene are particularly important in urban areas for improving vitamin A status through the prevention of disease. Increased access to public health services in many urban areas provides more opportunities for the management of infectious diseases. Vitamin A should be given to children with measles as soon as possible after the onset of the disease. Children with other infectious diseases should receive vitamin A if they have not received it in the previous three months.

iii) Supplementation should be considered when clinical signs are present, particularly where they co–exist with high child mortality rates, high incidence of diarroheal disease and parasitic infection, measles outbreaks, a high prevalence of protein–energy malnutrition, and severe poverty.

iv) Since health and nutrition information and education, and the encouragement of behavioural change are essential to most interventions, the possibilities in urban areas, fortunately somewhat greater than in rural areas, should be fully used.

v) More centrally processed marketed foods are often available in urban than in rural areas, which may offer promising conditions for food fortification programmes. These fortification programmes are to be encouraged if conditions for their sustainable operation can be fulfilled.

vi) Breastfeeding practices are deteriorating in many urban areas. Breastfeeding promotion activities for the prevention of vitamin A deficiency as well as for other reasons are strongly recommended.

vii) With respect to the availability and consumption of vitamin A–rich foods, food production in urban areas is usually less frequent than in rural areas, although urban production may be promoted (e.g. the cultivation of vacant areas or urban garden lots). Food production and consumption require nutrition education in order to achieve changes in behaviour. In designing education programmes, constraints for adoption of behaviours should be carefully considered. An example of a possible role of nutrition education for improving the

consumption of vitamin A–rich foods is in elevating the status of low prestige foods that can be good sources of the vitamin.

The first step in programme development is to find out views and perceptions of target populations about aspects of vitamin A status and potential interventions. Dialogue should be maintained with community associations in the development and implementation of these activities so that the target groups are fully involved. Included in 'target populations' are private sector, professional, auxiliary, and traditional health providers and other groups in contact with the population e.g. school teachers, religious leaders. Use should be made of literacy training, the schools and parent–teachers associations.

PROCESS LEADING TO SELECTION OF INTERVENTIONS

While the above section examined how certain factors may condition the choice of a strategy, the following sets out step by step the likely stages through which a government may decide to deal with a problem of vitamin A deficiency:

i) Recognition/identification that a problem does/is likely to exist. Available information may be screened for risk factors;

ii) A lead agency (focal point) may be identified to initiate actions;

iii) A national seminar may be convened among participants likely to be involved in solving the problem. This will involve bringing together all the available information, analyzing the problem, identifying available resources, determining what interventions are appropriate, what additional needs exist for information/resources, and what other existing programmes may contribute to the solution. It may also consider means of strengthening existing operational programmes that contribute to the solution e.g. breast–feeding approaches, maternal nutrition programmes, dietary improvement, immunization services;

iv) Missing information may be gathered to fill in gaps necessary for selection of intervention mixes appropriate to national or regional typologies found in areas of country;

v) Interventions may then be initiated with a long–term, sustainable dietary approach receiving attention concurrent with quick response intervention when latter is needed;

vi) A national plan may be developed that is based on a profile analysis of the problem nationally and a commitment to intervene. Following development of a national plan, an appropriate dialogue can be established with donors.

The following are two national examples of how vitamin A deficiency was recognised and the approaches that evolved to deal with it:

Tanzania: In the mid–1980s, Tanzania questioned whether they had a significant vitamin A deficiency problem that warranted a national programme. Following the assess/analysis/action paradigm involving multisectoral national and community participants, a national programme was initiated to reduce the prevalence of xerophthalmia estimated as affecting 6% of the population, 1.3% under 6 years of age. The focal point for coordination was the Tanzania Food and Nutrition Centre (TFNC), a relatively autonomous body attached to the government that could facilitate interdepartmental activities. The programme from the start was a mix of interventions including disease–targeted supplementation, nutrition education/public awareness, dietary modification and research applied with different emphases as appropriate to the typologies of specific areas within the country (e.g. greater focus on preservation in dry areas plagued by seasonality in vitamin A–rich foods). An evaluation which was carried out after the first five years when the problem was better defined, mapped and causes known, suggested a reduction in the prevalence of the problem based on sentinel clinic information. Continuation with adjustments in the national programme, however, was needed (e.g. greater emphasis placed on production/consumption of vitamin A–rich foods). The decision to adjust emphasis was based on concern for sustainability and for meeting other nutritional needs.

India: In the 1960s, India recognized that there was a vitamin A deficiency problem and received endorsement from the Prime Minister early on. A national assessment was carried out to determine the magnitude of the problem and several research projects were conducted to evaluate the safety of high dose

supplementation of 300,000 and 200,000 IU. A programme was initiated based on the universal distribution of 200,000 IU to 1–5 year old children in the 1970s in two states from which it gradually expanded over a five year period to all states. The programme began as a vertical program and was not well targeted. An evaluation in 1980 revealed widely varying coverage due to implementation problems. A resurvey in 1990 showed reduction in xerophthalmia but wide variations from state–to–state. Economic considerations, supply limitations and need for more targeting to the highest risk groups led to decisions to adjust the delivery system of the supplementation programme, and increasing concern for sustainability led to decisions to place more emphasis on food–based approaches. India is now developing a national plan of action for control based on their commitment to achieving global goals to which they have subscribed.

CHAPTER V. CONCLUDING STATEMENT THE CONTROL OF VITAMIN A DEFICIENCY

The following statement was agreed upon by participants of the ACC/SCN Consultative Group Meeting on Strategies for the Control of Vitamin A Deficiency, supported by CIDA and the Micronutrient Initiative and held at the Micronutrient Initiative, Ottawa, 28–30 July 1993.

The elimination of vitamin A deficiency as a public health problem has been identified as a high priority in international nutrition and health by the International Conference on Nutrition, the World Summit for Children and the World Health Assembly. Control of vitamin A deficiency in many areas of the world will lead to substantial and lasting improvement in childhood survival as well as preventing the scandal of irreversible blindness due to malnutrition.

The cause of vitamin A deficiency is a lack of pre–formed vitamin A, carotene and sometimes fat and oil in the diet. Promoting the year–round availability and adequate consumption of vitamin A/carotene–rich foods and dietary fat is fundamental to eradicating the deficiency. Because prevention of vitamin A deficiency is an integral part of the overall strategy to improve nutritional well–being and child health, and to conserve limited resources, vitamin A programmes should be integrated with other programmes concerned with health and development. Efforts to identify, advocate, plan, implement, evaluate, and monitor the control of vitamin A deficiency should as far as possible be combined with the control of other co–existing nutritional deficiencies. The following specific points concerning vitamin A deficiency control were agreed:

1. A combination of interventions is usually needed to prevent vitamin A deficiency; these include dietary modification (including the production, processing, marketing and consumption of vitamin A/carotene– rich foods), breastfeeding promotion, food fortification, and supplementation. The appropriate combination of interventions may change over time, depending on trends in the level of deficiency, programme outreach to vulnerable population groups, availability of technical inputs, and administrative and political priorities.

2. Periodic situation analyses and the evaluation of programme cost–effectiveness provide a basis for adjusting strategies, especially in relation to population responses to intervention activities, and provide the opportunity for phasing out programme components, as appropriate.

3. In all circumstances, the promotion and protection of breastfeeding is a fundamental aspect of preventing deficiency of vitamin A. Promotion should include attention to initiation, optimal breastfeeding practices, and duration, as required by local situations. Enhancing the nutritional status of the mother is a valuable component of such breastfeeding promotion activities.

4. Nutrition education is an essential component of programmes aimed at preventing vitamin A deficiency. Dietary modification can also be supported by other means, such as social marketing and promotion of home production.

5. If dietary sources of vitamin A are not readily available to those at risk of deficiency, intervention activities should include improving their availability. Efforts may be needed to improve the production, processing, preservation, pricing and marketing of such foods. Bioavailability of the vitamin A should be increased by ensuring that diets contain sufficient fat and that intestinal parasites are controlled.

6. Dietary modifications that increase vitamin A intake will often improve the status of other micronutrients, particularly iron and vitamin C. For example, many foods that promote iron absorption (especially green leafy vegetables, animal products and some fruits) are also good sources of vitamin A. Furthermore, improving vitamin A status can also improve iron status through an interaction between these two nutrients. Therefore, a combined food–based approach to deficiencies of vitamin A and of iron should be pursued.

7. Where feasible, food fortification is a highly recommended intervention for the prevention of vitamin A deficiency. Consumption of processed foods by the target population, food technology expertise, and multisectoral commitment are requisites for successful food fortification programmes. Social marketing may also have an important role in increasing awareness of the problem and creating demand for action. Early participation of the food industry in this process, and an effective food control system, are essential.

8. In situations where vitamin A deficiency is endemic in the population, certain opportunities may be taken to provide high–dose preparations of vitamin A. The first of these is with immunization contacts from 6 months of age, especially the 9 months measles contact.[23] Secondly, if the mother is in contact with health services (e.g. attended delivery or postnatal visit), provision of a single large dose of vitamin A within the first 4 weeks after birth can improve the vitamin A content of breast milk and hence offer protection of the breastfed infant. Thirdly, for children between 1–5 years, other contacts with health services may also be appropriate for providing supplements; in this case adequate record–keeping is necessary to reduce the dangers of excess supplementation and to ensure that potency of preparations is maintained by regular turnover of stocks.

[23] Opportunities for administration of vitamin A supplements to children under 6 months of age have been discussed in a recent WHO publication "Using Immunization Contacts to Combat Vitamin A Deficiency" but are not as yet reflected in WHO policy.

9. Case management of measles and of severe protein–energy malnutrition requires the therapeutic use of high–dose preparations of vitamin A where there is a risk of sub–clinical deficiency; this use should not be limited to children with clinical vitamin A deficiency. The goal here is an immediate effect on the course of morbidity and on reduction of case fatality rates. Such case management is complementary and additional to approaches for controlling vitamin A deficiency at a population level.

10. Political support and sustained allocation of government resources are needed for the development, implementation and maintenance of vitamin A programmes. Support from international organizations (multilateral, bilateral, and non–governmental) is important in fostering political commitment, and often in providing financial support in line with local priorities.

11. Linking research and human resource development with intervention activities continues to be important in initiating, maintaining and building on vitamin A interventions.

12. Effective management is essential to the success of any type of vitamin A programme. Experience has shown that the success of vitamin A programmes is limited more by management problems than by lack of appropriate intervention technologies. Development of an effective management system will usually require as much attention as the choice of intervention. Similarly, evaluation of vitamin A programmes should involve management aspects as well as impact.

14 September 1993

ANNEXES

Annex I: Study Objectives

a) Establish criteria/provide guidelines to be applied in deciding whether a vitamin A intervention is warranted as a means to reduce mortality;

b) Provide age–specific estimates of the magnitude of benefits, specifically young child mortality and blindness, to be expected, given certain baseline levels, when vitamin A status is improved from a demonstrably deficient state;

c) Identify and critique alternative strategies for improving vitamin A status by age group. These strategies will include, at a minimum:

– supplementation:

  – universal
  – targeted (e.g. through health services, EPI)
  – disease–targeted (e.g. to severe PEM, xerophthalmia)
  – targeted to lactating women post–partum;

– dietary modification:

  – increased production of known and used foods in inadequate supply
  – introduction and promotion of new or "exotic" foods
  – increased availability of high quality vegetable seed
  – food policies affecting availability and price of vitamin A–rich foods;

– fortification;

  – public health measures, such as diarrhoeal disease control, immunization, control of respiratory infections, malaria control, water and sanitation;

  – breastfeeding promotion.

d) For each strategy, establish:

  – efficiency and effectiveness, compliance and coverage, expected effect on vitamin A status;

  – acceptability, community involvement and sustainability;

  – costs including infrastructure costs;

  – time line for effects to be seen;

  – potential for detrimental effects associated with excessive intakes in absolute terms and relative to age and physiological status;

  – settings in which the strategy is most likely to be effective;

  – complementarity and linkages with other strategies;

e) Recommend which approaches are to be favoured over other competing alternatives, and in what circumstances; describe considerations to be taken into account in phasing one approach into another. Recommendations will address project design issues, programme funding issues and needs for further research.

Annex II: Age–Specific Benefits of Vitamin A Deficiency Control

In absolute terms, the age–specific mortality rate is the major predictor of the mortality–reduction effect of vitamin A. Mortality rates differ with age, the under–two rates being considerably higher than those for 2–5 year olds. Beaton *et al.* (1992) provide estimates of the likely absolute mortality reduction impact of vitamin A

expressed as lives saved per 1000 covered for different age groups. Table II. 1 below uses median age−specific mortality rates for the studies that formed part of the meta−analysis. However, as mentioned, these control group mortality rates may be considerably lower than true population−based rates. It should also be noted that the similarity in mean rates for the 6−11 month and 12−23 month age groups may be consistent with a mortality peak of 12 months − at around the age at which the protective effect of breastfeeding becomes insufficient to maintain adequacy in the child's vitamin A status.

Table II. 1: Impact of Age and Mortality Rate on Vitamin A Effect Expressed as Lives Saved per 1000 Covered

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

** median rate for projects reporting ages.*

Source: Beaton et al. (1992)

Such absolute benefits are probably more useful for advocacy and planning purposes. The average percentage mortality reduction in the eight meta−analysis trials for 6−59 month olds was 23%. This obviously should be considered as an 'order of magnitude' gross average figure, which will vary with respect to local conditions. Given this average, and using recent demographic data for Category I countries (where vitamin A deficiency is a significant public health problem in part or whole of country), rough estimates of the *maximal* potential absolute numbers of lives saved for two different age groups − 6−11 months and 12−59 months − can be determined (although as discussed below, such maximal effects are very unlikely to be achievable in real, non−trial, situations).

As of October 1988, there were 23 countries, defined by WHO as harbouring the greatest risk of vitamin A deficiency in the world. Four of these (India, Indonesia, Bangladesh and the Philippines) had endemic vitamin A deficiency, as indicated by "sound, population−based xerophthalmia prevalence data" (Humphrey *et al.* 1992). The following analyses focus only on these Category I countries, while recognizing that the lack of population−based data preclude the accurate assessment of national−level prevalences for other countries where vitamin A deficiency may be a serious problem, at least in certain areas.

Table II.2 uses 1989 demographic data to estimate the region− and country−specific absolute mortality impact for two age groups − 6−11 months and 12−59 months. A paper by Humphrey *et al.* (1992) used these same data, but with different assumptions regarding the likely mortality reductions due to vitamin A interventions. In addition, 1991 data are provided for the four high−risk countries. Essentially, the findings are that in 1989, a maximum of about 700,000 lives of 1−5 year olds, and 420,000 lives of 6−11 month infants, could potentially have been saved in these 23 Category I countries − a total of 1.12 million preschool lives. Of this total, 678,000 (or 60%) come from the four high−risk (and high population) Asian countries.

It is interesting to compare 1989 with 1991 figures. In 1991, 559,000 lives would have been saved − 18% fewer than in 1989 − due to improvements in baseline mortality and birth rates during these two years. In addition to the improving secular trend in xerophthalmia occurring in many countries, the changing demographic profile thus will also affect the potential absolute number of lives saved by vitamin A interventions.

There are however some very important caveats to the type of calculations shown in Table 9. The estimation of maximal potential lives saved in these countries/regions assumes:

i) that the vitamin A deficiency−related mortality relationship applies to the whole under−five population;

ii) that a vitamin A intervention operates over the whole country;

iii) that its coverage and compliance rates are as high on average as those in the mortality trials reviewed by Bcaton *et al.* (1992), and

iv) that it is effective in reducing vitamin A deficiency to a similar degree to these trials.

If these conditions did obtain, then the annual mortality reduction among 6–59 month olds would be of the order of 23%. In practice, however these conditions are highly unlikely to be met. Firstly, vitamin A deficiency tends to cluster geographically (Cohen *et al.* 1985, Darnton–Hill 1988, Mele *et al.* 1991), so the population groups where the mortality relationship holds may be much smaller than the national under–five population (and a national programme may not thus be warranted). Secondly, coverage and compliance rates of universal supplementation programmes in particular have been found to be very low in many national programmes (e.g. Bangladesh and India) – far lower than what was achieved in the controlled mortality trials. Programme fatigue is another problem (see West and Sommer 1987) whereby coverage rates, even if initially above say 65%, may drop significantly in subsequent years. Furthermore, those communities, households or individuals that are not covered or "drop out" of the programme have been seen to be more likely to be at higher risk of deficiency than those covered.

Illustration: A District in India

The probabilities of certain degrees of effect actually occurring can be illustrated in an example, using conditions typical of a district of India, which approximates to a real situation. The Beaton *et al.* (1992) meta–analysis findings concluded that there was a 89% chance that the real effect in a future large–scale programme would be a mortality reduction of at least 10%, a 62% chance of a 20% reduction, and a 23% chance of a 30% reduction (assuming moderate to high baseline mortality rates).

We will take as an example, a vitamin A programme targeted to all 6–59 month old children in a typical (but fictional) district of India in 1989. Such a scenario for estimating effects is more realistic for the future; if the signs of improving secular trends in xerophthalmia are real and sustained, then increasingly for many countries, interventions will be targeted to smaller sub–national localities and socio–economic groups where the problem persists.

Population:	10 million
Under–five mortality rate:	145 per 1000 live births
Total active xerophthalmia prevalence (6–59 months):	4%
Targeted 6–59 month population: (approx. 14% population)	1.4 million

Assuming 23% mortality reduction and scaling down the absolute effects shown in Table 9 proportionate to the new target population, approximately 3600 lives of 12–59 month olds and 2370 lives of 6–11 month olds would be saved that year (i.e. a total of nearly 6000 children). This assumes that the coverage and compliance rates of this programme are as high as those obtained in the mortality trials throughout the year. As mentioned, this is unlikely to be the case in reality. We could thus posit a more likely scenario, whereby the coverage rate is 50% of the target group with this 50% only containing 25% of the high–risk children (as approximately the case in the Bangladesh programme; Greiner, pers. comm.). Thus, about 1500 (not 6000) lives could be saved per year. There would almost be a 1 in 4 chance that up to 1950 children's lives could be saved, but conversely, a chance of about 1 in 10 that the number of lives saved would be as low as 650. The chance of there being no effect at all is only 2%.

The numbers of lives saved may be even higher than predicted above, due to an unknown non–specific beneficial effect of the intervention on factors affecting child mortality (or "Hawthorne effect"). Also, the original mortality trials differed again from real–life conditions in that xerophthalmia cases (where the mortality–reduction effect would likely be most pronounced) were treated and selected out of the trial at the beginning. Both these factors may increase effect seen in real–life conditions.

Countervailing this, there are several factors which might reduce the effect actually seen. Where measles immunization coverage is high and/or health service or nutrition programme coverage is high, then the *extra*

or incremental mortality effect of a specific vitamin A programme would likely be less. Coverage and compliance rates of a real vitamin A programme, as mentioned, would be lower than those achieved in the trials, reducing the programme's mortality impact. Moreover, it is incorrect to assume that, by applying expected coverage and compliance rates found in large–scale operational programmes, the impact of a real–life programme can be calculated. The (incorrect) assumption is that those children covered by the programme have mortality risks equal to those who are missed. (If this was the case, then a simple scaling down of the likely absolute effect by the ratio of real coverage/compliance rates to the ideal (mortality trial) rates, could be done.) Experience, however, particularly in India, Indonesia and Bangladesh, has shown that those children missed by programmes are almost always at greater risk than those covered, and such a scaling down is thus unrealistic. In addition to coverage rates, the proportion of at–risk population actually covered needs to be known (as shown in the example above).

The question of the degree of mortality–reducing effect that vitamin A status improvement has in populations with biochemical (sub–clinical) deficiency, but no manifest clinical signs, may become increasingly important as xerophthalmia prevalences for many Category I countries continue to drop.

Table II.2: Estimated Potential Lives Saved by Country/Region and Age Group for 1989 (1991 data in parentheses for four countries)

	No of 0–59 month children[a] (x1000)	***Under 5 mortality rate***	***Deaths among 12–59m. children[b] (X1000)***	***No. of lives saved[c] (X1000)***	**Deaths *among 6–11m. infants[b] (x1000)***	***No. of lives saved[c]***	***TOTAL LIVES SAVED (X1000)***
Four Asian countries	164,000 (168,500)		1784 (1468)	410 (337)	1165 (965)	268 (222)	678
India	113,400 (115,900)	145 (126)	1277 (1092)	293 (251)	834 (713)	192 (164)	485
Indonesia	22,700 (23,500)	100 (86)	134 (118)	31 (27)	122 (107)	28 (24.6)	59
Philippines	9100 (9400)	72 (46)	56 (35.7)	13 (8.2)	29 (18.5)	7 (4.3)	20
Bangladesh	18,800 (19,700)	184 (133)	317 (222)	73 (51)	180 (126)	41 (29)	114
Sub–Saharan Africa[d]	50,800		1024	235.5	499	115	350.5
Latin America Caribbean[e]	19,800		109	25	92	21	46
Asia[f]	4900		52	12	33	8	20
TOTAL	243,900		3042	700	1827	420	1120

[a] United Nations Population Division figures (extracted from UNICEF State of the World's Children)

[b] Using infant and under–five mortality rates and annual birth rates, the annual number of 0–11 month and 12–59 month deaths per year can be calculated. The assumption is then made that the 6–11 month year death rate is a third of the total infant (0–11 month) mortality rate (as per Humphrey *et al.* 1992[24]) in order to determine the annual number of deaths in the 6–11 month group.

[c] Lives saved per 1000 = (1–Relative Risk) x Baseline mortality rate. The Relative Risk is 0.77, which gives a mortality rate multiplier of 0.23 to give lives saved.

[d] Benin, Burkina Faso, Chad, Ethiopia, Ghana, Malawi, Mali, Mauritania, Mozambique, Niger, Nigeria, Sudan, Tanzania, Zambia,

[e] Brazil, Haiti

[f] Nepal, Sri Lanka

[24] *Humphrey, J. West, K.P. and Sommer, A.* (*1992*) *Vitamin A Deficiency and Attributable Mortality among Under–Five Year Olds, Bulletin of the World Health Organization, 70* (*2*), *225–232.*

Annex III: Evaluation Inventory

The main criterion for selection of evaluations into this inventory was the inclusion of measurements of at least one of the following indices: clinical eye signs, biochemical indices (*e.g. serum retinol*)*, dietary vitamin A consumption, associated with large–scale control programmes or community trials. The evaluations are numbered for easy reference in the text and in Annex V* (*for some evaluations, more than one citation exists*).

SUPPLEMENTATION

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Indonesia

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India

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The Philippines

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Annex V: Summary Information on Evaluations Reviewed, by Strategy Type

[1] Further details are available for these studies, in the form of one–page summary sheets. Photocopies of these can be obtained, upon request, from the ACC/SCN Secretariat.

Country/Year	***Reference***	***Input/Target***	***Study Design/Measurements***	***Conclusions***
SUPPLEMENTATION				
1. Indonesia Java 1973–75 Rural & urban	*Tarwotjo, I. et al 1975*	*Trial.* *VAC 200,000 IU to 1–5 year olds.*	*Before/after, with/without, double–blind* (*VAC, placebo*). *2812 children from 7 urban sites & 5 rural villages. Xerophthalmic children treated & excluded.* *Eye signs* (*Bitot's spots*) *measured at 0, 6& 12 months.*	*10%* toss to *follow–up. VAC 91% effective. Bitot's spots decreased from 4.7% to 0.3%* (*control: 4.7% to 2.9%*) *in one year. VAC distribution was acceptable, appropriate & effective providing high coverage maintained* (*latter depends on VAC supply pipeline & admin, support*). *Cost data exist.*
2. Indonesia Aceh Province Northern Sumatra 1982–84 Rural	*Djunaedi, E. et al 1988* *Tarwotjo I. et al 1989* *Tielsch J.M. et al 1990*	*Trial.* *VAC 200,000 IU to 1–5 year olds.*	*Large–scale randomized, with/without. 1032 children from 229 villages.* (*981 children in 221 control villages*). *Eye signs* (*nightblindness & Bitot's spots*) *at 0 & 12 months.*	*82% drop in xerop: 1.08% to 0.21%* (*XN*) *and 1.11% to 0.10%* (*X1B*). *Control also dropped by 49%. Relative risk* (*control vs programme*)*: 3.3* (*XN*) *and 5.0* (*X1B*) *at 1 year. Nightblindness ceases to be useful indicator when prevalences are low, & comparison of Bitot's spots should be confined to new cases. Cost data*

				exist.
3. Indonesia Aceh Province Northern Sumatra 1982–84 Rural	*Sommer, A. et al.* (*1986*)	*Mortality trial.* *VAC 200,000 IU biannually to 12–71 month olds.*	*25,939 children in 450 randomly selected villages* (*experimental: 229, control: 221*). *Eye signs measured at 0 and 12 months.*	*Active xerophthalmia declined from 1.9% to 0.3% in 1 year in experimental villages, and from 2.3% to 1.2% in control villages. Significant* (*p<0.05*) *increase in risk of xerop. occurring in control relative to experimental villages after 1 year* (*4 times more likely*).
4. Bangladesh 1982–83 Rural & urban	*Cohen, N. et al 1987*	*Universal programme.* *VAC 200,000 IU to 3–71 month olds.*	*Rural stratified two–stage sampling of:* *i*) *rural census enumeration areas* (*CSAs*)*;ii*) *cluster of 150 households* (*= 1 site*). *Purposive sampling of poor urban slums. Sample: 18,660 children in rural, and 3675 in urban areas.* *All eye signs measured at 0 & 12 months.*	*Only XN rates fell after 1 year* (*to 2.5% VAC, 4.6% control*) *where coverage > 75%. If coverage 0–24%, little change. Relative risk: 1.9* (*XN*), *2.7* (*X2/3*), *1.3* (*X1B*). *Recommends massive VAC dosing at ideally < 6–monthly intervals to be combined with other nutrition & health interventions.*
5. Bangladesh 1989 Rural & urban	*BRAC*(*1989*) *Brandt, J.* (*1990*) *Greiner, T.* (*1991*)	*Universal programme.* *VAC 200,000 IU to 6–71 month olds.*	*5000 randomly selected children in 40 upazilas in 31 districts.* *VAC coverage, reported nightblindness and mother's knowledge measured.*	*Only 35% VAC coverage in 27th round* (*39% in EPI upazilas, 34% in non–EPI*). *25% of all under 6 month old children also received VAC, as did some >71 month olds. If all VAC had reached target group, coverage would be 45%* (*same as 1982–3 survey*). *>50% VAC administered by mothers.* (*Brandt 1990 found 2.2 million tablets in store, leftover undistributed from 30th round i.e. about 37% semi–annual requirements*). *Nightblindness by recall: 1.8%*(*> 50% cases untreated, VAC received by only 15% nightblind*

				children). *46% mothers reported no programme–related discussions with health workers, only 3.4% discussed vitamin A. 90% mothers did not know about VAC target age, frequency or causes or remedies for nightblindness. Programme considered a very low priority. Other problems: staff shortages, lack of motivation and awareness, lack of supervision, lack of transport.*
6. India 1971–73 West Bengal Rural village	*Sinha, D.P. and Bang, F.B.* (*1976*)	*Trial.* *VAC 200,000 IU to 12–71 month olds, every 4 months.*	*First year: no VAC, but seasonality measured. Second year: Before/after, with/without* (*double–blind*) *of 310* (*153/153*) *children in one village.* *Eye signs measured monthly for 2 years.*	*Marked seasonal variations in eye signs. Nightblindness eliminated and new Bitot's spots prevented in statistically significant number of supplemented children. Old Bitot's spots non–responsive. VAC is a suitable short–term measure, but permanent control requires socio–economic development.*
7. India Eight States Rural & urban	*Vijayaraghavan, K. and Pralhad Rao, N.* (*1982*)	*Universal programme.* *VAC 200,000 IU to 12–71 month olds.*	*Multi–stage random sampling of 69,300 1–10 year old children* (*75–80% expected child population*) *in 58 sub–centres distributed in 29 PHCs in 8 states.* *Eye signs* (*Bitot's spots*). *As baseline data not available, regression of prevalence on age used to detect biological effectiveness* (*latter associating with absence of age trends*).	*Of 21 PHCs with initially high prevalence* (*>3% in 5–10 year olds*), *absence of age trends was noted in 13* (*considered as "effective"*). *Coverage was poor* (*<20%*) *in remaining 8 PHCs, mainly due to poor capsule supply, health workers not adhering to guidelines* (*e.g. often clinic–based distribution, not house–to–house*), *and very limited community awareness/demand.*

8. India Hyderabad 5 year study Urban	*Vijayaraghavan, K. et al 1984*	*Universal programme.* *VAC 200,000 IU to 1–5 year olds.*	*Longitudinal, with/without. 231 slums in 1st phase, 144 two years later, 75 randomly selected slums as control. Sample: 50,000 children from 450 urban slums. Hospital admission = cases* *Keratomalacia measured.*	*Mean programme coverage 87% (10% not at home, 3% refusal). 63% received all doses. Keratomalacia (X3B) dropped by 80% in VAC areas, 20% in non–VAC areas. 12.5% odds ratio (keratomalacia and receipt of dose). VAC 92% effective.*
9. India Hyderabad 1987–88 Rural	*Vijayaraghavan, K. et al. 1990*	*Mortality trial.* *VAC 200,000 IU biannually to 12–71 month olds.*	*Before/after, with/without. 7691 children in experimental group, 8084 in control, from 5 PHCs which serve 84 villages.* *Eye signs measured at 0, 6 and 12 months.*	*Active xerophthalmia decreased from 6% to 1.3% (experimental), 2.9% (control). In experimental group, coverage was 58% (2 doses), 34% (1 dose); in control, 57% (2 doses placebo), 32% (1 dose).*
10. India Tamil Nadu	*Rahmathullah, L. et al. 1990*	*Mortality trial.* *VAC 8333 IU weekly to 6–60 month olds.*	*Before/after, with/without randomized, placebo–controlled, masked clinical trial. 15,419 children from 3 drought–prone panchayats. Eye signs measured.*	*11% baseline xerophthalmia. Approximately 50% reduction in treated vs. controls (count of cases detected and treated).*
11. India Gujarat and Maharasthra 1984–90 Rural & urban	*Gujral, S. and Gopaldas, T. 1991*	*Programme (ICDS).* *VAC 200,000 IU biannually to 12–72 month olds.*	*Before/after. 3–7 randomly selected anganwadis in each of 19 blocks selected from two districts in two States.* *Data included coverage and eye signs in 1984–85 and 1989–90.*	*Coverage of national programme improved when anganwadi worker distributed VAC through ICDS services. In 1989–90 coverage was 47% for one state, 75% for the other (up from 21% and 13% respectively). Coverage still needs improvement. Active xerophthalmia decreased from 4 to 1% and from 12 to 1% in two States in 6 year period. Partly attributable to VAC – 64% xerophthalmic children in 1989–90 had not received VAC in previous year (cf. 20%, 1 dose, 16% 2 doses).*

12. Philippines Cebu Island 1973–75 Rural & urban	*Solon, F. et al 1979 Popkin, B. et al. 1980*	*Trial.* *3 interventions: VAC 200,000 to 1–5 year olds, MSG* fortific, *& public health/horticulture.*	*Before/after (1973–75). Sample: 1715/1407 (18.5% loss to follow–up).* *Eye signs and serum retinol measured at 0 & 24 months.*	*VAC coverage: 90% 1st round, 83% in 2nd. Total active xerop. dropped from 3.1–0.6% (VAC), from 4.2–1.0% (MSG) & from 4.9–3.4% (pub. hlth). Combined interventions led to drop from 4.1–1.7%, incl. drop of X1B (1.4–0.9%) and XN (2.2–0.6%). Only MSG intervention resulted in significant biochemical as well as clinical improvements. Public health intervention was expensive & not very effective, though had other benefits. Cost data exist.*
13. Nepal Terai 1988–90 Rural	*Tilden, R. et al. 1993*	*Trial. 3* *interventions: VAC 200,000 IU, public health, & nutrition education, for 6–120 month olds.*	*Before/after, with/without. 16,000 children per intervention cohort from 25 sites randomly selected from 7 districts (13,500 were measured throughout). Total of 100 sites altogether comprising 395 wards/villages.* *Eye signs and serum retinol measured at 0, 12 & 24 months.*	*Coverage of 70% (after 1st year), 80% (2nd year) for VAC and public health. VAC most effective with Bitot's spots; nutrition education and public health more effective with serum retinol. New cases clustered in certain sites. Over fives more responsive. Nutrition education/maternal literacy highly effective in reducing risk of corneal xerophthalmia, wasting and mortality in those who participate within 1 year. PHC effect limited by caloric availability which reflects underlying food insecurity which needs to be addressed to sustainably reduce site risk. Costs ranged from VAC $ 0.10–0.15 per year per beneficiary, to nutrition education ($1.2)*

14. Vietnam 1986–88	*Tu Giay et al. (1989)*	*Trial.* *VAC 200,000 IU to 12–71 month olds.*	*Before/after, with/without. 1074 children in experimental group (933 in control) in nine "high–risk" communes.* *Eye signs measured at 0, 6, 12, 18 and 24 months.*	*After 24 months, no case of xerophthalmia detected in experimental group and nutritional status improved (particularly moderately or severely underweight). Following this, in 1988, pilot programmes undertaken in 7 districts, with expansion planned. In 1992, delivery effectiveness assessment revealed problems with health worker distribution and community awareness.*
15. El Salvador 1971–1974 Rural & urban	*Sommer, A. 1975 Sommer, A. 1976*	*Universal programme.* *VAC 200,000 IU to 1–4 year olds.*	*Retrospective hospital record review of keratomalacia cases among 1–9 year olds.*	*50% cases ineligible lor VAC due to age. VAC had no effect on no. of children admitted with presumed vit. A related* corneal *destruction, asi) VAC might not have reached children at greatest risk, ii)* possible *inadequate prophylaxis of dose. The raising of serum retinol levels & reduction of milder clinical signs is not necessarily associated with a reduction in* cornea/*destruction. The latter is associated with severe PEM with affects absorption & utilization of vit. A, & recent measles.*
16. Sudan 1988–90 Rural	*Herrera et al. (1992)*	*Mortality trial.* *VAC 200,000 IU to 9–72 month olds.*	*Before/after, with/without. 28,753 children.* *Eye signs measured at 0, 6, 12 and 18 months.*	*2.9% xerophthalmia at baseline. Little change in de novo incidence of xerop after 18 months: 0.013% in treated, 0.015% in controls (possible need for increased VAC frequency). De novo*

				appearance of nightblindness reduced by 50% (*cf. control*).
17. Brazil 1983–84 Rural and urban	*Araujo, R.L. et al 1987*	*Trial.* *VAC 200,000 IU to 1–14 year olds.*	*Before/after in 2 sites.* *Eye signs and serum retinol measured, though xerop. prevalence too small at baseline to permit comparison.*	*VAC effective. Prevalence of serum retinol < 20 mcg/dl dropped from 16.3% to 4.3%* (*preschool*), *and 20.3% to 2.9%* (*school age*). *Recommendation to target high–risk areas. Form of VAC* (*gelatinous*) *crucial in high acceptability & ultimately effectiveness of programmes. Cost data exist.*
18. Malawi 1989–91	*Barrows, J.M.* (*1993*)	*Targeted programme.* *VAC 200,000 IU to 12–71 month olds, and VAC to mothers, post–partum.*	*Retrospective assessment of delivery effectiveness only, including VAC coverage* (*within previous 6 month period*) *and mother's knowledge.*	*91% 12–23 month olds* (*50% at 36 months, 12% at 60–71 months*) *attended Under–Five clinic in last 6 months. However, VAC coverage was very low at 14% – highest among 12–23 month olds* (*18%*), *lowest among 60–71 month olds* (*only 6%*). *73–82% eligible attendees were thus not provided VAC. Mothers' knowledge also poor* (*22% knew purpose of VAC*). *Even among knowledgeable mothers, VAC not perceived as a beneficial intervention.*
19. Haiti 1976–1980 Rural & urban	*Toureau, S. et al 1989*	*Targeted programme. VAC 200,000 IU to ill or malnourished 1–7 year olds & lactating mothers, supported by nutrition education.*	*Before/after. Ocular surveys conducted three years after programme started. Stratified random sampling* (*urban/rural, locality, household, child*) *of 5000 children in 12 urban and rural localities.* *Eye signs measured in 1974–75 and 1979.*	*Only 9.4% coverage nationally, with large regional differences. Tenfold decrease* (*0.81% to 0.09%*) *in* corneal *destruction since 1974–75 survey, at least partially attributed to VAC. Xerop. though is still a major problem. Recommends*

				improved supervision & monitoring of reporting system, mass media education, & integration into health care system. Cost data exist.
20. Indonesia Lombok island From May 1991 Rural	*Sutanto, A. et al 1993*	*Targeted programme. VAC through EPI to lactating mothers, and under–fives.*	*Only coverage measured.*	*Coverage of 77% women, 85% infants at 10 weeks, 47% at 36 weeks, & 84% 1–5 year olds. Integration of VAC delivery to mothers & newborns into routine EPI is feasible & successful.*
21. Indonesia 1990 Rural	*Stoltzfus, RJ. et at 1993*	*Targeted trial.* *VAC 300,000 IU as retinyl palmitate to post–partum mothers.*	*Randomized, placebo–controlled, double–masked. 153 mothers at 1–3 weeks post–partum in 12 villages. Mothers' serum retinol, breastmilk retinol & infants' serum retinol, RDR measured at 0, 3 & 6 months.*	*Significant improvements in maternal and infant vitamin A status. High dose VAC supplementation of lactating mothers is an efficacious way to improve the vitamin A status of both mother & breastfed infant.*
22. Bangladesh Urban	*Roy et al. 1989*	*Targeted trial.* *VAC 200,000 IU to 50 women 16–35 years, 24 hours after delivery.*	*Random allocation to treatment (n=26) or control (n=24) cohorts. Treatment group divided into BMI<18 and BMI>18 sub–groups.* *Serum retinol and breastmilk retinol levels measured.*	*Serum retinol levels higher (p<0.02) in BMI<18 treatment group up to 3 months; only up to 1 month in BMI>18 group. Breastmilk retinol levels sig. higher to 6 months. No difference between groups with respect to serum retinol binding protein levels at 1, 3, 6 and 9 months. Thus, limited benefit of supplementation to poor lactating women, but – as 0–20 month Bangladeshi children receive 70% vit A requirements from breastmilk – overall effect could be considerable.*
23. Philippines Luzon island	*American Foundation tor*	*Targeted programme. VAC*	*2nd or 3rd degree (Gomez) underweight*	*No difference in new xerop. cases after 12*

1975–76 Rural & urban	*Overseas Blind, Inc. 1976*	*200,000 IU through supplemental food distribution programme, to 6–60 month children.*	*children with no eye signs randomly allocated to treatment and control groups. Double–blind VAC/placebo administration to 450 randomized 2nd or 3rd degree children.* *Eye signs measured at 0 & 12 months.*	*months between groups, possibly due to i) increased vit A intake due to supplemental foods (which could have supplied 50% RDA) and/or ii) a 4 month interval being more appropriate than 6 months. VAC was 82% effective in clinically improving early xerop. within 6 months. Only 3rd degree cases responded positively to VAC. Recommends increasing content of vitamin A in supplemental foods and targeting 3rd degree children who are most at risk.*
24. Philippines Antique province Western Visayas 1987–89 Rural	*Klemm, R.D.W. et al. 1992*	*Disease–targeted programme. VAC 200,000 IU (therapeutic regime) to 12–83 month old children with xerop. or specific diseases. Mass media and interpersonal communications to mothers of 6–72 month children.*	*Cross–sectional before/after surveys in 5000 children 12–83 months and 3000 mothers. Multi–stage stratified cluster random sampling design in 49 villages. No* less *than 80% children surveyed in each village. Lack of control precludes attribution of any positive changes to interventions alone.* *Eye signs, vitamin A consumption and KAP measured at 0 & 24 months.*	*Coverage of high–risk children rose from 3% to 30% after 18 months, though VAC not well integrated into case management lor diseases such as ARI and diarrhoea. Xerop. prevalence dropped from 3.7% to 1.0% (p<0.001) (all active signs except* corneal *ulcers, and for all age groups). Knowledge and awareness of vitamin A–related concepts increased significantly. Dietary intake of vitamin A–rich foods increased 65% (children) and 29% (households). Integration of VAC into routine health services delivery is possible, but training and supply factors are crucial. Vertical programmes (e.g. CDD, ARI) need strengthening for disease–targeting to*

				work. Nutrition education findings: formative research needed, emphasis on doable actions in limited number of unambiguous messages that offer rewards; mixed reinforcing media, repetition. VAC and education should be seen as complementary short and long–term approaches.
25. Brazil Northeast 1985–87 Urban	*Caruaru Vitamin A Program. Reported in IVACG (1992).*	*Targeted programme. VAC 200,000 IU to 1–6 year olds, integrated into polio immunization. Nutrition education of local authorities.*	*Before/after evaluation of universal VAC distribution. No control group.* *Eye signs, serum retinol and RDR at 1.5, 6.5, 11.5 and 18.5 months.*	*Coverage greater than 90%. 100% participating children had improved serum retinol, RDR and clinical signs at 1.5, 6.5, 11.5 and 18.5 months after first VAC round. Improvements with first three rounds before stabilization. Effective low–cost acceptable and sustainable approach. Community and health authorities both saw benefits and wanted to see the programme continue. Cost data exist.*
DIET MODIFICATION				
26. Indonesia West Sumatra 1986–89 Rural	*Pollard, R. 1989*	*Trial. Mass media and interpersonal communications (health kader counselling) for improved vit. A consumption and to promote existing universal VAC programme.*	*Before/after, with/without (villages). Pregnant and nursing mothers and 5–60 month children were target groups.* *KAP surveys and 24 hour dietary recalls of mothers carried out in October 1987 and August 1989.*	*Kader drop–out rate was 70% due to poor motivation for counselling; market medicine sellers vitamin A promotion was not sustained, and only one–third radio spots aired. Routine VAC coverage in the area increased from 35% to 58% (partially attributable to demand creation via social marketing). Amongst those who heard radio spots (42% of mothers),*

				considerable positive attitudinal change did occur. Increases of 10–33% in dark green leafy vegetable (DGLV) consumption seen in target groups after two years. Recommendations: an intensified communications campaign, with a further evaluation. Cost per mother/child increasing consumption of DGLV to sufficient levels was $0.28.
27. Philippines Western Visayas 1988–89 Rural and urban	*David, F.P. 1990*	*Programme. Mass media and interpersonal communication via health workers (vitamin A training modules integrated into normal duties).*	*Before/after, with/without (by region). Stratified random sampling (province, municipality/city, barangay, mother). Sample of 1000 mothers of 13–83m children (experimental) and 500 (control).* *Mothers' KAP and 24 hour dietary recalls measured at 0 & 12 months.*	*Sig. improvements in exposure, knowledge, but not attitudes, (although belief in need to add oil to childrens' diet increased). Practices improved in both control and experimental (significant over time, but not between groups). A significant positive correlation was found between exposure level and practice, controlling for attitudes and knowledge. Dietary changes not significant. Recommends improvement in interpersonal aspects to effect significant behavioural change.*
28. Philippines	*See number 24.*			
29. Nepal	*See number 13.*			
30. Bangladesh Rangpur 1987–89 Dinajpur 1988–90 Rural	*INFS (1990)*	*Programme. Follows on from 3–year WIF pilot in Rangpur. Mass media and interpersonal communications. Schools and folk singers, radio, TV, posters. Women particularly targeted.*	*Before/after evaluation of 2000 randomly selected households in 3–4 upazilas of each district.*	*Media campaign deemed successful. Reduction in nightblindness (to 1% in Rangpur, 1.7% in Dinajpur) thought to be due to programme, though longer–term trend assessment with larger sample necessary. Increases*

				of 40–60% in production and consumption (*by young children*) *of green leafy vegetables particularly* (*GLV*) *as well as yellow fruits. Awareness of nightblindness, its cause and remedy, at 88–95% after 3 years. Radio efficient at reinforcing other media messages. Posters less effective due to illiteracy. Emphasis now needed on training community leaders and school teachers and incorporating TV.*
31. Bangladesh Comilla District 1990–91 Rural	*Mir Mahboob Ali et al. 1993*	*Trial.* *Mass media and interpersonal communications, aimed at counteracting cultural resistance to feeding GLVs to young children.*	*Before/after, with/without* (*neighbouring control area*)*. Stratified multi–stage random sampling in both areas. Within village, equal number of households randomly selected for each of 4 categories: preg. women, nursing women* (*with 0–5 m child*)*, mothers of 6–12 month child and mothers of 13–72 month children. Baseline sample of 800 respondents from 8 villages, and control of 400 from 4 villages* (*evaluation sample of 1000 & 600 from same villages*)*. Mothers' knowledge and awareness, child food frequencies, and child nightblindness measured, by maternal recall.*	*Mass media effective in changing awareness and knowledge, but further interpersonal efforts needed to change practices. Credibility of dietary recall data dubious due to perceived need to respond according to practices "prescribed" in counselling. Nightblindness rates very small before and after* (*possibly due to random factors*)*. Report concluded that programme was able to develop an effective media mix campaign, but that interpersonal communications were difficult to develop on a low budget, leading to a "reduced effect". More attention in future needed on economic constraints.*
32. Thailand Northeast 1988–91	*Suttilak Smitasiri et al. 1993*	*Trial.* *Multi–media communications*	*Before/after, with/without* (*regions*)*. Preschool and school–aged children and pregnant and lactating*	*Sig. KAP improvements. Large increases in ivy gourd consumption.*

		(*interpersonal as well as mass*) *for education, communication and promotion with the emphasis on one most locally feasible source.* *Project to act as a catalyst lor inter–sectoral involvement.*	*mothers were targeted* (*total of about 100,000 reached*). *24 hour dietary recall, anthropometric, eye signs, serum retinol & maternal KAP measured at 0 and 36 months.*	*Significant differences between project and control areas in cooking* (*with oil*) *techniques. Most effect with mothers of 24–72 month children. Also improvement in non–target group of over–fives. By third year* (*not before*), *significant dietary vit A and fat increases for pregnant and lactating women. Also preschool children* (*but not significant with respect to control*). *Serum retinol levels did not show improvement* (*attributed to delay in transport of samples to laboratory and high prevalence of hookworm*). *Bitot's spots prevalence too low initially to be of evaluative use, though statistically significant decrease of nightblindness from 4.8% in 1989 to 1.4% in 1991 in project area* (*p=0.04*), *compared to increase in control area* (*from 0% to 3.4%* (*p=0.01*). *Anthropological evaluation revealed successful behavioural change among mothers and school children. Pregnant women though still influenced largely by traditional beliefs. Catalytic effect on governmental awareness and inter–sectoral colaboration on vit A activities. Cost: US $0.42 per caput target group per year.*

33. Brazil Northeast, Recife 1988 Rural	*Mariath, J.G.R. et al. 1989*	*Trial.* *Treatment of xerophthalmia using buriti fruit.*	*Before/after. 12 xerophthalmic under 12 year old children, 32 controls. Mothers instructed to feed 12g buriti sweet/day for 20 days.* *Eye signs and RDR measured.*	*Of the 12 xerop. children, 6 presented complete regression, and 4 others improved. RDR was negative in all 10 after 20 days, indicating provitamin A carotenoids satisfactorily replenishing hepatic reserves. Concordance between clinical and biochemical (RDR) findings was 82%. Recommends incorporation of buriti into existing supplementary feeding programmes in the Northeast.*
34. Philippines	*See number 12.*			
35. Bangladesh 1992 Rural	*HKI/AVRDC (1993)*	*Trial.* *Home gardening and nutrition education.*	*Before/after, with/Without. 1000 target, 200 control and 100 "interaction' households from 81 villages.* *Production and consumption practices, nightblindness and child growth measured at 0 and 24 months.*	*After 24 months in target hhs: Decrease of 3.3 kg/week in purchased vegetables (10% normal expenditure), increase from 4% to 53% in households selling vegetables (comprising 10% total cash income); increase in caloric intake of 15%, decline in nightblindness though still of public health significance.*
36. India Andhra Pradesh 1989–90? Rural	*NIN (1991–2)*	*Trial.* *Horticultural project and nutrition education.*	*Initially about 30 households from each of 25 randomly selected villages. 609 received inputs in first year, 1982 in second year.* *Coverage and diet quality measured at 3 seasonal points.*	*Diet quality survey showed that 43% children remained in same at–risk group throughout year, 20% improved, 12.5% worsened. Nutrition education (via "burrakatha" folk media) showed a significant improvement in community awareness of vitamin A–rich foods. Incorporation of anganwadi workers envisaged for third year, after which final*

				evaluation will be conducted.
37. Senegal 1969–88 Rural	*Brun, T. et al. 1989*	*Programme.* *Horticultural project targeted to women.*	*Before/after* (*households*) *Dietary surveys in 1970–71 and 1980–81.*	*Home gardening had a marked positive impact on female income levels* (*through sale of vegetables*)*, but not on vitamin A* (*or other nutrient*) *consumption. Also positive impact on female social status and awareness of urban and social habits.*
38. Philippines Bukidnon province Mindanao island 1984–5 Rural	*Bouts, H. 1991*	*Economic change* (*price and production*) *and seasonality effects on vit A consumption.*	*4 survey rounds on same 448 households were undertaken at four–month intervals during 1984 and 1985. 24 hour dietary recall assessed 520 food items and derived household–level nutrient adequacy ratios. Disaggregated by household expenditure quintile and season.*	*Vit A demand behaviour is different from calories because i*) *intake is concentrated in few foods, primarily vegetables, and ii*) *vegetables have low income elasticities being cheap sources of dietary variety, and Hi*) *staples have virtually no vitamin A. Because of this concentration and because consumers are unaware of their intakes, intakes fluctuate widely with prices, even though daily requirements can be met relatively inexpensively. The poorest quintile consumed the recommended allowance of vit. A, although there was a wide variation with 34% households below 80% RDA. Vit. A intakes varied seasonally by a factor of three due to GLV price increases. Recommends social marketing and GLV extension programmes* (*the latter providing households with a ready supply of micronutrients* (*unless they sell*

				produce) *as well as price–lowering effect of increased production.*
FORTIFICATION				
39. Indonesia West Java 1985 Rural	*Muhilal et al. 1986 & 1988*	*Trial.* *810 mcg RE/g MSG 84% potency after 4m, 57% after 11m.*	*Before/after, with/without* (*villages*) *5 programme and 5 control villages. Sample of 5,500* under–live *year old children, and all breastfeeding mothers with < 6m old children.* *Eye signs, serum and maternal breastmilk retinol and MSG consumption measured, for children and mothers, at OS 11 months.*	*In preschool children after 11 months, Bitot spots dropped from 1.2 % to 0.2% – associated with a daily vitamin A intake from MSG of about 194 mcg* (*initially with potency * 100%*), *dropping to about 110 mcg after 11 months* (*potency = 57%*). *In lactating mothers after 11 months, serum retinol increased from 19.1 to 26.3 mcg/dl – associated with a daily vitamin A intake from MSG of about 323 mcg* (*initially*) *and 184 mcg after 11 months. Breast milk levels also rose significantly. Cost data exist.*
40. Philippines	*See number 12.*			
41. Guatemala 1975–77 Rural	*Arroyave, G. et al. 1979 & 1981*	*Programme.* *Vitamin A fortified sugar.*	*5 cross–sectional surveys between October 1975 and November 1977, at 6 monthly intervals from initiation of fortification in April 1976, in 12 villages. 611 children randomly sampled several times, thus available for longitudinal paired comparisons.* *Dietary recall data collected from 359 households, and child serum retinol levels measured at 0, 12 & 24 months.*	*Highly significant increase in serum retinol after 1 year, and an increase barely short of significance after 2 years. If initially low serum retinol cases* (*< 20 mcg/dl*) *considered alone, effect was more significant. Regression to the mean effect said to be negligible, as amplitude of these changes is much greater than in control groups of similar intervention programme* (So/on et *al. 1979*)*; also, those near the mean initially also increased highly*

				significantly. The decrease in effect in the 2nd year attributed to erratic industrial application of fortification leading to irregular delivery. Effective approach, especially for high–risk cases.
42. Chile 1975 Rural	*Toro. O. et al. 1976*	*Trial.* *Vitamin A fortified sugar.*	*Before/after/before. 4 high–risk remote Indian villages with 1600 inhabitants. Fort, sugar sold blind by 4 stores, with concentration determined by adult RDA. Eye signs and serum retinol measured at 0 (before), 3 (after) and 6 months (i.e. 3 months after trial stopped.)*	*Prevalence of serum retinol below 20 mcg/dl was 76%, 29% and 51% at 0,3 and 6 months for schoolage children; 59%, 0% and 50% for adults – indicating raised serum retinol due to fortification. Clinical signs were not responsive in the short time period, and thus effect on xerophthalmia unknown.*
PUBLIC HEALTH				
43. Philippines	*See number 12.*			
44. Nepal	*See number 13.*			
BREASTFEEDING				
45. Bangladesh 1983–85 Urban	*Mahlanabis, D. 1991*	*Breastfeeding*	*Case–control based on stratified analysis (Mantel–Haenszel) and multivariate analysis (logistic regression) of data from a treatment centre based surveillance system. 2687 children 6–36 months representing a 4% systematic sample of all children in this age group treated yearly at the centre over 3 consecutive years. 66 had xerophthalmia; 2621 served as a control group.*	*The odds ratio relating breastfeeding to vitamin A deficiency after adjustment for a large number of confounding variables (0.26 (95% conf. int. 0.14 to 0.49; p< 0.001) reflected a 74% reduction in the risk of vitamin A deficiency among breastfed children. The estimated reduction of risk did not decline with age, and some 49% children 24–35 months were still being breastfed. The odds ratio in the 3rd year reflected a 65% reduced risk.*

46. Malawi Rural	*West, K.P. et al. 1986*	*Breastfeeding and weaning practices*	*Case–control retrospective comparison. 152 children 24–71 months with xerophthalmia compared with 151 clinically normal children, matched for age, sex and village.*	*Children with xerop. had begun weaning with porridge sooner (p=0.05), had stopped breastfeeding earlier (p<0.01 for 24–47m olds), had a shorter weaning interval (p<0.005) and had been fully weaned longer (p<0.025) than controls, implying a strong protective role of breastfeeding against xerop. in early childhood.*

Annex VI: Consultative Group Meeting Participants

ACC/SCN Consultative Group Meeting on Strategies for the Control of Vitamin A Deficiency[25] 28–30 July 1993, Micronutrients Inititiave, IDRC, Ottawa, Canada

[25] A meeting organized by the ACC/SCN, hosted by the Micronutrients Initiative, supported by CIDA and the Micronutrients Initiative.

Chairman: Dr A. Horwitz, Chairman ACC/SCN

Dr S Acharya, Planning Commission, Nepal
Dr D Alnwick, UNICEF, New York
Dr K Bailey, AGN/WHO, Geneva
Prof. G Beaton, AGN/University of Toronto
Dr F Binka, VAST, Ghana
Dr H Bouis, IFPRI
Dr J Cervinskas, Micronutrient Initiative
Dr I Chowdhury, WIF, Bangladesh
Mr W D Clay, FAO, Rome
Dr N Cohen, WHO, Geneva
Dr O Dary, INCAP, Guatemala
Dr J C Dillon, France
Dr J E Dutra de Oliveira, IUNS, Brazil
Dr M Garcia, ACC/SCN [part]
Dr S R Gillespie, ACC/SCN, Geneva
Dr T Greiner, SIDA, Sweden
Ms M Griffiths, AGN/Manoff International
Mr R Heyward, AGN/UNICEF
Prof. R Martorell, AGN
Dr J B Mason, ACC/SCN, Geneva
Dr J McGuire, World Bank
Dr G Ndossi, TFNC, Tanzania
Dr P Nestel, VITAL
Dr G Pelto, WHO, Geneva
Dr S Rabeneck, CIDA, Canada
Dr V Reddy, NIN, India
Dr J Rivera, Mexico
Dr J Sclafani, HKI, New York
Dr N Scrimshaw, UNU
Dr R Seifman, US AID
Dr S Simon, Micronutrient Initiative
Dr S Smitasiri, Thailand
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Dr A Sommer, Johns Hopkins
Dr R Stoltzfus, Johns Hopkins
Dr T Stone, Canada

Dr J Johnston, IDRC

Dr R Korte, GTZ, Germany

Dr H Kuhnlein, McGill University

Dr M Lotfi, Micronutrient Initiative

Dr M Mackey, CIDA, Canada

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Dr F Trowbridge, CDC

Dr B Underwood, WHO

Dr C West, Wageningen