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A CONCISE OVERVIEW OF MICRONUTRIENT DEFICIENCIES IN AFRICA AND FUTURE DIRECTIONS

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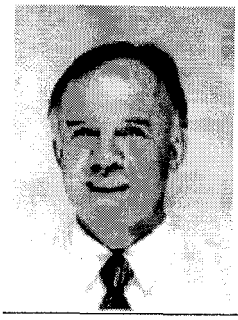

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ABSTRACT

Despite some encouraging progress, micronutrient malnutrition remains a public health problem affecting all countries in Africa. Estimates show that over 85 million people living on the African continent are iodine deficient. A further 180 million are at risk of iodine deficiency disorders. With iodized salt reaching about 70% of African households, these figures are presumably lower. Anemia is a major public health problem in Africa, affecting over 80% of women, infants and young children. Vitamin A deficiency is a public health problem in 64 countries. With a focus on the prevention and control of micronutrient deficiencies, supplementation with vitamin A capsules has been successfully integrated into the National Immunization Days in 43 of 64 vitamin A-deficient countries. Iron/folate supplementation of pregnant women is government policy in virtually all countries but has had very limited success. Multimicronutrient supplementation is another approach that is being explored. Food-based approaches such as dietary diversification are both sustainable and culturally well-accepted in the African context. Many countries in Africa are progressing with food fortification efforts including wheat flour fortification with iron in Zimbabwe and vitamin A fortification of sugar in Zambia. Ongoing complementary public health measures include breastfeeding, immunization, control of infectious diseases and poverty alleviation policies. Many existing challenges devalue the potential impact of nutrition programs on development and national progress. There exists however, a wealth of innovative promising experiences in Africa such as national micronutrient days and hammermill fortification. The major initiatives currently addressing malaria, tuberculosis, HIV/AIDS and infectious diseases will also contribute.

Key words: micronutrient malnutrition, vitamin A, iron, iron deficiency anemia, Africa

UNE VUE GLOBALE CONCISE DES INSUFFISANCES EN MICRONUTRIMENTS EN AFRIQUE ET ORIENTATIONS FUTURES

RÉSUMÉ

Malgré quelques progrès encourageants, la malnutrition en matière de micro-nutriments demeure un problème de santé publique qui affecte tous les pays en Afrique. Les estimations montrent que plus de 85 millions de personnes vivant sur le continent africain ont des insuffisances d'iode et que 180 millions d'autres sont menacés d'avoir des perturbations causées par l'insuffisance d'iode. Etant donné que le sel iodé atteint près de 70% de ménagers Africains, ces chiffres sont sans doute inférieurs à la réalité. L'anémie est un problème majeur de santé publique en Afrique ; elle affecte plus de 80% de femmes, de nourrissons et de petits enfants. L'insuffisance en Vitamine A est un problème de santé publique dans 64 pays. L'accent étant mis sur la prévention et la réduction des insuffisances en micro-nutriments, le supplément par des capsules de vitamine A a été efficacement intégré dans les Journées Nationales d'Immunisation dans 43 sur 64 pays accusant une insuffisance en vitamine A. Un supplément de fer/folate chez les femmes enceintes est une politique gouvernementale dans pratiquement tous les pays, mais il a eu un succès très limité. Le supplément de multimicronutriments est une autre approche qui est explorée actuellement. Des approches basées sur les aliments, telles que la diversification du régime alimentaire, sont viables et culturellement bien acceptées dans le contexte africain. Plusieurs pays d'Afrique progressent avec

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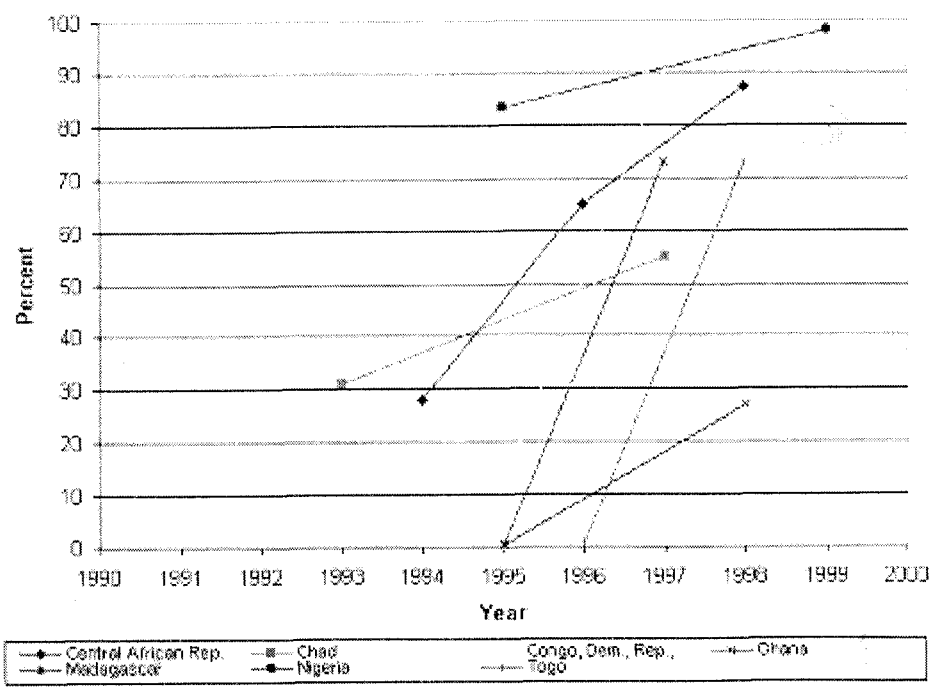
des efforts de fortification alimentaire, comme la fortification de la farine de blé avec du fer au Zimbabwe et la fortification de la vitamine A avec du sucre en Zambie. Les mesures en cours qui sont complémentaires de la santé publique sont notamment l'allaitement, l'immunisation, la lutte contre les maladies infectieuses et les politiques d'allègement de la pauvreté. Beaucoup de défis actuels dévaluent l'impact éventuel des programmes de nutrition sur le développement et le progrès national. Il existe, cependant, une richesse d'expériences novatrices prometteuses en Afrique, telles que les journées nationales des micro-nutriments et la fortification de hammermill. Les initiatives majeures de lutte contre la malaria, la tuberculose, les maladies infectieuses connexes du VIH/SIDA apporteront également des contributions.

Mots clés: malnutrition par manque de micro-nutriments, vitamine A, le fer, l'anémie causée par l'insuffisance du fer, Afrique.

INTRODUCTION

African nations, as part of the FAO/WHO International Conference on Nutrition in Rome in 1992, agreed to work towards the elimination of iodine and vitamin A deficiencies as public health problems, and to substantially reduce iron deficiency anemia by a third of 1990 levels [1]. Despite some encouraging progress, micronutrient malnutrition remains a public health problem affecting all countries in Africa. The State of the World's Children 2002 Report quotes 'The African Common Position' as saying that ***"...Africa's children in many ways are the most disadvantaged in the world....They are vulnerable to malnutrition and disease"*** [2]. The exact magnitude of the problems continues to be identified at the same time as interventions are being initiated. Concurrently, devastating diseases such as HIV/AIDS and malaria are necessarily competing for the usually very limited health resources, aggravated by the ravages of poverty and armed conflicts. At the same time, and contrary to the trends observed in the rest of the world, protein-energy malnutrition rates remain elevated in Africa. It remains that in sub-Saharan Africa, about one third of the population lacks sufficient food [3]. Many Africans subsist on a diet based on cereal staples and little else. This lack of diversity in the diet is one of the main causes of micronutrient deficiencies. The term for micronutrient deficiencies, ***"hidden hunger"***, seems particularly opposite in much of Africa. Iron and

Figure 1: *Trends in Percent of Households Consuming Iodized Salt*



vitamin A deficiencies disproportionately affect children and women of reproductive age, and as such they hinder both the development of individual human potential and national social and economic development. Nonetheless, considerable progress has been made with vitamin A and iodine deficiency control programs, with little progress made on iron deficiency anemia control, even as zinc and folic acid deficiencies become recognized as significant public health problems.

MAGNITUDE OF THE PROBLEM

Existing published data give some estimation of the magnitude of the micronutrient deficiency problem, but in the African context particularly, the data is rarely national or representative of a whole population, and is often out-of-date. The 2002 State of the World's Children Report actually emphasizes that in the field of nutrition, where the primary goal was to cut malnutrition rates of children under five by half between 1990 and 2000, the absolute number of malnourished children in sub-Saharan Africa has actually increased [2].

Iodine

Iodine deficiency is the main cause of preventable mental retardation. Iodine deficiency disorders (IDD) include goiter and cretinism, but more importantly on a population basis, lower intelligence quotients, increased peri-natal mortality and reduced economic well-being at both household and national levels. While IDD prevalence rates and clinical manifestations in Africa are generally less florid than on some other continents, the assumption must be made that IDDs continue to cause a significant loss of potential cognitive development to many infants born to mothers living in endemic areas in Africa. Currently available estimates are predominantly based on total goiter rate (TGR), and are usually not representative national figures, and hence much underestimate the very high prevalence in localized areas (over 60% prevalence in parts of the Congo, Mali, Niger, Rwanda, Tanzania and Uganda). The estimated number of total affected population in Africa is 124 million [4]. With the impressive levels of salt iodization in the last decade in Africa, and the accompanying trends in increased consumption of iodized salt at the household level (see Figure 1), it is estimated that globally, the number of children with mental deficiencies due to lack of iodine had decreased from 40 million to 28 million [5].

Iron

Anemia is a major public health problem in Africa, affecting over 80% of women in many countries and with similarly higher prevalence rates in infants and young children. The contribution of iron deficiency or other nutritional causes such as folate, vitamin A and riboflavin deficiency to this widespread prevalence of anemia depends on geographic location, the prevalence of malaria, and more recently HIV infection prevalence, along with conventional determinants of age, sex, and parasitic load. It affects mostly children and women of reproductive age [6]. An overall estimate from the mid-90s was that 206 million Africans were anemic, with, on average, a 52% prevalence in pregnancy [7]. In areas of high malarial prevalence, a moderately high proportion of men are also anemic, in which cases iron deficiency is less likely to be the main cause. Such high national prevalence rates are certain to have a negative impact on maternal mortality rates and the severe anemia in pregnant women may cause fetal growth retardation or low birth weight. In young children it may impair physical growth, cognitive development, and immunity; in school-aged children it may affect school performance; and in adulthood it can cause fatigue and reduced work capacity and hence reduced economic and social development [6].

Vitamin A

Populations with vitamin A deficiency are at risk of preventable blindness in children, and significantly increased mortality in children and possibly also in pregnant women. The problem of vitamin A deficiency is global and affects over 100 million children in the world [2]. An estimated 250 000 to 500 000 vitamin A-deficient children become blind every year, half of them dying within 12 months of losing their sight. Children with vitamin A deficiencies face a 25% greater risk of dying from childhood illnesses than those with an adequate vitamin A status. Vitamin A deficiency disorders are now recognized to be a larger problem in Africa than originally anticipated. UNICEF reports 64 countries where vitamin A deficiency is a public health problem [2]. It seems likely from early results from research in Zimbabwe that women of reproductive age also have a significant problem that may impact on the high levels of maternal mortality. A recent analysis for the 15 countries of the Economic Community of West African States estimates that 38.1% of children are at risk of vitamin A deficiency, and that over 228,000 under-five deaths per year in the region are attributable to vitamin A deficiency [8].

Other Micronutrients

Folate and zinc are other micronutrients that are found to be deficient at levels of public health significance in the African context. Depending on the circumstances, riboflavin, niacin, and vitamin C can also be problematic. As indicated, anemia is a major problem for the continent, and while often a consequence of iron deficiency, it more usually is of multiple etiology. Women with anemia, especially pregnant women, suffer

a variety of nutritional inadequacies, including often a limited energy intake leading to insufficient weight gain during pregnancy. Zinc deficiency, while rarely occurring in isolation can lead to growth failure, depressed immune function, anorexia, and increased mortality due to diarrhea and probably respiratory disease [9].

PREVENTION AND CONTROL

The most effective interventions are those using an integrated approach to address micronutrient malnutrition and its multiple etiologies throughout the life cycle. The main strategies for the prevention and control of micronutrient deficiencies are supplementation and food-based strategies of fortification and dietary diversification, combined with nutrition education. All of the approaches are necessary, but insufficient on their own. The key to solving the problem of micronutrient malnutrition is ciirdubated effort among the stakeholders.

Supplementation

Supplementation consists of providing a high dose of a micronutrient(s) in a pill, capsule, suspension, or tablet form. Much of the challenge is in the delivery mechanism through existing, or innovative systems. Compliance can be a constraint depending on the supplement dosage schedule. By the mid-1990s, little progress had been made towards ending vitamin A deficiency. To expedite progress, various concerned organizations, donors and leading technical experts met in an informal technical consultation in December 1997 [10]. The group stressed the importance of vitamin A supplementation as a reliable and effective way to combat vitamin A deficiency and highlighted the potential effectiveness of food fortification. The informal consultation also advised all countries with under-five mortality over 70 deaths per 1,000 live births to begin the distribution of vitamin A supplements immediately, regardless of whether or not the nation's vitamin A problem had been assessed, thus removing a constraint to progress. Since then rapid progress has been made. The number of developing countries providing at least one high dose vitamin A supplement to 70% or more of under-fives has risen from only 11 nations in 1996, to 27 in 1998 and 43 in 1999 (see Table 1).

Of the 43, 10 countries conducted two rounds of high dose vitamin A supplementation with high coverage, thereby achieving the goal of virtual elimination of vitamin A deficiency [11]. UNICEF estimates that between 1998 and 2000, as many as a million child deaths may have been prevented as a result of vitamin A supplementation [12]. More than half of these countries are in sub-Saharan Africa. One of the significant factors contributing to this increase in vitamin A supplementation coverage has been the successful integration of vitamin A capsules into the National Immunization Days in a large number of countries in Africa. However, with the goal of Polio eradication within reach, many countries in Africa are phasing out the National Immunization Days Campaigns for Polio. Alternative methods for the delivery of vitamin A capsules on such a large scale are urgently needed. Such alternative activities are being organized in Africa, and have been implemented in West Africa where National and Regional Micronutrient Days, or Child Health Weeks, or special vitamin A campaigns have been successfully organized in Burkina Faso, Ghana, Guinea, Mali, Niger and Senegal. In Burkina Faso, Mali and Niger, these successful campaigns were focused on the provision of vitamin A capsules to children 6-59 months and post-partum women, and iron/folate tablets to pregnant women. The success of the initial campaign in Niger and the dissemination of the results to neighboring countries contributed to making the adoption of this strategy at the national level a success. Alternative strategies relying on child health weeks and community-based distribution are also being explored. Iron/folate provision programs to distribute tablets to pregnant women is government policy in virtually all countries but has had very limited success at a population level. Many factors help to explain this limited success. The dosage for iron supplementation requires a daily intake of an iron supplement for a prolonged period of time (approximately 6 months). This tends to limit compliance and presents a challenge to keep the women motivated to take their supplement. Further, the delivery mechanism stays a challenge where often the supplements are prescribed at the health center and the women then have to go to the pharmaceutical depot to purchase them, often with limited funds, making it impossible to obtain at once all the supplements needed for the time period in question. Finally, another limiting factor dealing with compliance is the potential side-effects of iron supplements that require a minimum of counseling for the health worker in order for the woman to know what to expect and how to minimize the side effects. There are, however, successful interventions focusing on community-distribution of iron/folate supplements to pregnant women. One such project in Niger improved coverage rates from 22 to 90% of pregnant women through routine distribution in communities [13]. The success of this approach has led to the planning of an expansion of the project.

Another strategy currently implemented at a pilot level in several countries in Africa is that of integrated supplementation programs. Burkina Faso is one such country where a school health pilot program is implementing effectively the integrated distribution of vitamin A and in iron supplements. These combined approaches can help control the multiple micronutrient deficiencies found in school children, once the programs have been successfully replicated at the national level.

Multimicronutrients consist of a supplement in any variety of forms, containing several micronutrients in different concentrations. Trials are ongoing to assess the effectiveness and efficacy of multimicronutrients. Despite initial optimism, studies do not seem to indicate that controlling vitamin A deficiency will significantly reduce the number of HIV infected children born to infected mothers, although may have an impact on pre-term births, and associated disease in HIV+ infants.

Food-based strategies

Food-based strategies are an essential component of a long-term global strategy for the control of micronutrient malnutrition. They include a variety of interventions that all aim to improve micronutrient status through increasing the production and intake of micronutrient rich foods, and increasing the bioavailability of the micronutrients. The approaches used include promotion of the production and consumption of micronutrient-rich foods, and fortification activities. Food-based strategies are appealing because they can address multiple nutrients simultaneously, including energy, proteins, and various micronutrients. Food-based strategies also have the uncontested advantage of allowing for the natural interaction of micronutrients within the same food or meal. Some of the constraints with these strategies are, for example in the case of vitamin A, that the usually assumed bioavailability of carotenoids was recently questioned as being much lower than previously estimated. A proposition was made to use a hierarchy of carotenoid availability based on a relative ranking of foods rather than on specific conversion factors [14]. There still remains, however, quite some uncertainty on the bioavailability of carotenoids. In the case of iron, the factors that affect the amount of iron absorbed from a meal include the individual's iron status and requirements, the sources and content of iron in the meal, and the other constituents of the meal. The positive impact of the inclusion in a meal of heme iron from red meat, and vitamin C-rich foods, on overall iron absorption in a meal is well known. Similarly, it is widely accepted that improving vitamin A status will improve iron status [15]. Diets high in phytates, common in Africa, are known to inhibit the absorption of iron and zinc. Zinc deficiency in man has been linked with vitamin A underutilization. Iron deficiency results in an increased susceptibility to lead poisoning - a concern in increasingly polluted and growing urban environments.

Dietary diversification has an important role to play in the African context, as both a sustainable and culturally well-accepted strategy. Successful dietary diversification programs rely on sound nutrition education and behavior change activities. They also depend on availability and access to micronutrient-rich foods, community involvement and commitment. Homestead gardening activities and animal husbandry to increase the access to micronutrient-rich foods are often complementary or integral parts of dietary diversification and play a crucial role in the availability and accessibility components of the approach. Many such programs have been successfully implemented in Africa and their sustainability lies in the cultural acceptability of the gardening activities in the continent. The success of home gardening programs is closely related to their combination with nutrition education or promotion activities [16]. In Kenya, such a successful program focused on beta-carotene rich sweet potatoes [17], in Ethiopia the gardening and nutrition education activities were built into an existing dairy goat project [18] and in Tanzania interventions focused on solar drying [19] and horticultural activities with nutrition education [20]. Consistently, projects are indicating that the integration of production and education activities are much more successful in improving knowledge, attitude and practice when compared to the home gardening interventions carried out in the 1980s and which for the most part did not include education activities. In many countries in Africa though, climate remains a significant challenge to all gardening activities. Research is being conducted on the best varieties of micronutrient-rich foods to be grown under these climatic conditions. Such is the case, for example, in Niger and Mozambique where different varieties of orange-fleshed sweet potatoes are grown locally to determine the best respective strains of sweet potatoes for the 2 countries. Some of the other interventions aiming at improving the micronutrient status of populations rely on processing and conservation techniques of foods including preparation, cooking and preserving. Such projects as the Ethiopia project on cooking with iron pots have confirmed previous studies' result on the potential benefit of this cooking method on the control of iron-deficiency [21]. The focus on home-preparation and processing techniques has led to the promotion of techniques to reduce inhibitors of non-heme iron absorption such as fermentation, germination and food-to-food fortification. This latter technique relies on either including food that promotes the absorption of non-heme iron in a meal or on excluding foods that inhibit non-heme iron absorption.

Food fortification, the adding of micronutrients to a food, ideally consumed by most of the target population, has been successfully implemented in many countries in Asia and Latin-America. Fortification is usually considered an ideal approach in countries with the infrastructure to implement it, as it requires less behavior change than the other dietary approaches, and has proven to be successful when complemented with an advocacy or awareness raising campaign. Many countries in Africa are currently assessing suitable foods for fortification [22,23]. Several countries in West Africa have completed the necessary steps of identifying an appropriate food vehicle for fortification and have conducted industry assessments to determine the

feasibility of fortification. Countries such as Egypt Morocco, and Zimbabwe have started fortifying wheat flour with iron and other micronutrients. Fortification of sugar with vitamin A in Zambia is one of the often-cited success stories of fortification in Africa. The most common and successful fortification story remains salt that of iodization. As a result, according to the International Council for the Control of Iodine Deficiency Disorders (ICCIDD), iodized salt coverage now reaches about 70% of all African households. An innovation that is currently being tested is the multiple-fortification of salt. Adding other nutrients, such as vitamin A and iron, to salt would allow iodine deficiency, vitamin A deficiency and iron deficiency to be addressed through a single, universal mechanism. The Micronutrient Initiative is supporting research that has made significant advances in the development of double-fortified salt (salt with iron and iodine added) and triple-fortified salt (salt with iron, iodine and vitamin A added). The technology for double fortification of salt is now developed and ready for scale-up; it is undergoing field trials in four countries and is expected to be commercially produced in the near future. Researchers are conducting stability tests for triple-fortified salt before commercial field trials can begin [5].

Although traditionally food-based strategies relied on dietary diversification and food fortification efforts, increasingly innovative alternative approaches are being used. These consist of making staple foods more nutritious, and the nutrients they contain more bio-available through horticultural development and genetic modification. This strategy has the advantages of being low cost (apart from one-off initial start-up development costs), being sustainable and generally not requiring a change of dietary habits. Beta-carotene rich (pro-vitamin A) varieties of sweet potato have been developed at the Kenya Agricultural Research Institute. These orange-fleshed varieties have been found to be acceptable and were introduced through women farmers. There are also varieties awaiting further development of high B-carotene cassava, maize, and wheat, and the recently biogenetically engineered 'golden rice'. Improved rice and wheat varieties with high zinc and iron content have also been identified. Plant breeding strategies for increased micronutrient content and bioavailability are still in theearly stages, and limited information is available on their ultimate value to human nutrition [24].

As with any program, monitoring and evaluation activities are essential for the success of food-based programs. With the appropriate monitoring and evaluation components integrated into food-based programs, the result will be an improved implementation, as well as a direct demonstration of the comparative effectiveness of these strategies [25].

Other public health measures including breastfeeding

The protection, promotion, and support of optimal breastfeeding practices and complementary foods are key to preventing micronutrient malnutrition in infants and young children. Ensuring full immunization, control of infectious diseases and policy support of poverty alleviation are all essential to the prevention and control of micronutrient malnutrition.

CHALLENGES

One of the main challenges in the African context is the complexity of the etiology of micronutrient malnutrition. Overall protein-energy malnutrition is complicated in many cases by specific micronutrient deficiencies, HIV/AIDS, malaria and widespread infectious disease. Consequently, programs are addressing this through an Integrated Management of Childhood Illness (IMCI) approach, increasingly in both the community and in health centers, within a life-cycle framework. This addresses antenatal care to promote increased birth weights, and includes other vulnerable stages of life such as adolescence and the school years.

A related problem is the need for more prevalence data, including the more effective consolidation (and hence access to), what data are already around but not necessarily readily available. A further difficulty is measuring the extent of the problem in the field (although the HemocueTM photometer has been used extensively to assess anemia). Misclassification of micronutrient status can occur because of the confounding effects of concurrent infections in countries where infections are prevalent, such as in much of Africa.

Cities in Africa offer a wide range of street foods that are accessible to all [26]. The consumption of these foods contributes to decreasing the risks of micronutrient deficiencies because of the diversity they bring into the diet of urban dwellers, many such foods whom live in underprivileged urban environments. The requirements of consumers as to the hygienic quality of street foods are, however, weak, and the ensuing health problems are often mentioned [23]. The organization of this sector and the improvement of the hygienic quality of foods sold in public places remain a major challenge.

Particularly in Africa, a further problem that applies not just only to micronutrient malnutrition, consists of institutional challenges whereby administrative/ government systems in charge of nutrition policies, programs and priorities are under-financed, under-staffed and the potential impact of nutrition programs to development and national progress under-valued. Other challenges are related less directly to nutrition but include continuing internal wars, refugees, epidemics

and increasing urbanization, along with increasing environmental pressures.

However, the situation is by no means all negative. Some of the most innovative operational research is currently taking place in Africa and should lead to new solutions to micronutrient malnutrition. There is continuing refinement of the actual extent of the problem and determination of who is most at-risk. The astonishing success of adding vitamin A to the polio national immunization days presents the challenge of how this high level of coverage will be maintained as many countries are discontinuing the National Polio Immunization Days. There is considerable progress and experience with new distribution systems of vitamin A with national micronutrient days, and other innovations for micronutrient delivery. Fortification will play an ever greater role in micronutrient deficiency prevention and control besides iodine. The major initiatives currently addressing malaria, tuberculosis, HIV/AIDS and infectious diseases in general will all contribute.

CONCLUSION

Experience has shown that any one approach will not be enough to sustain a significant improvement in the micronutrient status of populations. The key is to use a combination of approaches, delivered in an integrated and participatory manner. In the end, it is this complementarity that will contribute to reaching the revised micronutrient goals set at the UN's Special Session on Children.

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Table 1

Developing countries providing at least one high-dose of vitamin A

UNICEF region	Number of countries in the region	Number of countries where Vitamin A supplementation is advised[a]	Number of countries providing one high dose of supplements to over 70% of under-fives		
			1996	1998	1999
Sub-Saharan Africa	46	44	1	16	29
Eastern/Southern Africa	(22)	(20)	(0)	(9)	(11)
Western/Central Africa	(24)	(24)	(1)	(7)	(18)
Middle East/North Africa	20	16	1	2	2
South Asia (excl. India)	8	8	1	3	5
East Asia/Pacific (excl. China)	28	14	7	6	6
Latin America/Caribbean	33	18	1	0	1
CEE/CIS and Baltic States	27	-	0	0	0
Total	162	100	11	27	43

Source: UNICEF global database

[a]Countries where under-five mortality is greater than 70 deaths per 1,000 live births, and/or where vitamin A deficiency is known to be a public health problem