

Integrated Anemia Control Strategy has significantly reduced anemia in women and children in Nicaragua

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Integrated Anemia Control Strategy (IACS) has significantly reduced anemia in women and children in Nicaragua. Jose O. Mora, MD

Executive Summary

Anemia was identified as a problem of public health significance in Nicaragua since 1993, when its prevalence amounted to 28.5% in children 1-4 years and 33.6% in non pregnant women of childbearing age. The average intake and absorption of iron by both children and the general population was very low, and intake of other nutrients (vitamin A, thiamine, riboflavin, niacin and folate) was also deficient. Because of the grossly deficient iron intake, most anemias were attributed to iron deficiency; other possible causal factors were intestinal parasites (especially hookworms) and systemic infections. Vitamin A deficiency (VAD) was also significant in children. As part of a National Micronutrient Plan (NMP), an Integrated Anemia Control Strategy (IACS) was developed by the Ministry of Health (MOH) and implemented since 2004. The IACS included iron and iron/folic acid supplementation for pregnant women and children <5 years; periodic delivery of anthelmintic medications to children 2-10 years; fortification of wheat flour with iron and B-vitamins; interventions to control vitamin A deficiency (supplementation and fortification of table sugar); behavioral change communications (BCC); comprehensive training of health service personnel, community health volunteers (CHVs) and non governmental organizations (NGOs); strengthening of other public health interventions; and a program monitoring and evaluation (M&E) system. Steps for implementing IACS comprised: clear policies; updated technical guidelines; incorporation of iron and iron/folic acid supplements in the official list of essential medicines; addressing supply issues by establishing effective systems for procurement and logistical management of supply, as well as demand and compliance issues; and conducting operational research to address key constraints to implementation. The effectiveness of involving community health volunteers (“brigadistas”) in supplement delivery, follow up and counseling, was tested with positive results. Better knowledge and skills of health care providers and CHVs on anemia, supplementation and counseling improved supplement demand and compliance with supplementation. The community-based “brigadista” model for iron supplementation was gradually extended throughout most of the country.

Mandatory wheat flour fortification with iron, thiamin, riboflavin, niacin and folate was established in 1997; a mass media campaign was carried out to inform the population about the benefits of fortified foods (e.g. fortified wheat flour). Regulatory monitoring by the MOH/FCD was established, which comprises periodic inspections at production plants and collection of samples of wheat flour from plants and retail stores for assessment of iron content; monitoring has consistently shown adequate iron content. Household monitoring was established in 2002; samples of bread have shown to comply with expected minimum levels of iron (55 mg/kg). Ferrous fumarate substituted for reduced iron in wheat flour fortification since 2003.

The VAD control component of the NMP/IACS consisted of distribution of vitamin A for children <5 years and post-partum women, and mandatory sugar fortification. National Health Rallies (NHRs) twice a year (only once since 2003) are used for delivery of vitamin A, iron, iron/folic acid and anthelmintic medications to the target groups. NHRs are planned jointly by the central MOH and the districts; communities are massively mobilized by engaging media, municipal authorities, the church, community groups and NGOs. Sugar is produced by five privately-own plants, it is consumed regularly by nearly all families, and supply per-person amounts to about 87 grams per day. Fortification of sugar started with the 1999/2000 sugarcane harvest. Regulatory and household monitoring have proceeded smoothly: nearly all sugar for domestic consumption is regularly fortified.

A behavioral communications (BCC) strategy and plan was developed after extensive formative research, to increase the demand for and compliance with supplements; prevent and manage side effects; increase consumption of micronutrient rich foods; discourage simultaneous intake of iron absorption inhibitors; encourage consumption of absorption enhancers; and strengthen knowledge and skills of health care providers and CHVs to provide guidance, counseling and follow-up to supplementation. Messages and materials tailored to specific audiences were field tested. The strategy contemplated a mass media and a person-to-person communication component. A baseline assessment in 1998 showed that coffee drinking by pregnant women and children was significant. Intensive training of health care staff in person-to-person education and use of communication materials by MOH and NGO health service personnel was carried out and a positive assessment of the BCC strategy related to iron supplementation was conducted in 2001.

Micronutrient topics were incorporated into the undergraduate curriculum of health professionals and of graduate public health trainees, and in the field orientation of newly graduated physicians and nurses. The majority of the health care providers and NGO field staff were trained through two-day workshops at central and district levels, to enable them to carry out promotional activities and comply with the technical guidelines on prevention and control of micronutrient deficiencies. The training plan improved knowledge and commitment to address micronutrient deficiencies. Other public health interventions have been given especial attention: integrated management of childhood illnesses (IMCI); improvements in sanitary conditions and hygienic practices; expanded program of immunizations; malaria prevention and control in endemic areas; breastfeeding promotion and protection; and improved feeding practices of children <2 years through growth monitoring and targeted education and counseling to mothers.

In 2000, a second national micronutrient survey revealed a dramatic reduction of VAD in children <5 years from 31.3% in 1993 to 8.8%. VAD was not found to be a problem of public health significance in women. There was a significant drop in the prevalence of anemia in non pregnant women from 33.6% to 23.7%. Iron deficiency indicators were not assessed. No improvement in anemia rates was observed among children 12-59 months. By 2000 coverage was nearly 70% in pregnant women and only 37% in children. Fortified wheat flour was found to reach mostly urban consumers and child's intake of wheat flour products was presumed to be low; however, dietary intake was not assessed. Since 2000 the MOH assigned the highest priority to strengthen the IACS, particularly the supplementation program, by addressing supply and demand constraints and establishing a nutrition program monitoring and evaluation (M&E) system.

In 2002 the MOH put in operation the Integrated System for Surveillance of Nutritional Interventions (SIVIN), an information system to inform decision-making in nutrition programs. The system periodically collects information on nutrition program implementation process and performance, as well as on biological indicators of nutritional status to assess impact. SIVIN uses service statistics routinely gathered by local health services, data from existing internal program monitoring systems, and an especially designed national household survey (HHS). A trained MOH field team is highly committed to conducting the HS operation. From 2003 to 2005, the HHS annually covered a total national random sample of 1,500 households with children 6-59 months. From 2000 to 2003-2005 the prevalence of anemia in women continued dropping from 23.7% to 11.2%, and in children 6-59 months from 33.5% to 16.2%, with most significant reductions in infants 6-11 months and children 12-35 months. Anemia reduction in the latter group amounted to about 50%, whereas in older children reached 31-39%. Serum ferritin as an indicator of iron deficiency was assessed in 2004 and 2005, when the estimated prevalence of iron deficiency amounted to 31% in women and 39% in children 6-59 months; despite the relatively large decline in anemia rates, iron deficiency may remained a significant problem.

To ascertain whether the observed trends in anemia rates in Nicaraguan women and children may plausibly be attributed to IACS programs, program performance may be examined vis-à-vis changes in anemia rates, with potential effects from other programs and potential confounding factors taken into account. Population coverage of iron/folic acid supplementation in pregnant women has generally been >80, with an average duration of >4 months. Coverage of children 6-increased to 63% by 2003-2005. CHVs regularly provide follow-up and counseling to supplemented pregnant women and children in most of the country, although their actions and coverage have not been quantified. Side-effects of iron supplementation in pregnant women and in children have not been disturbing enough to affect compliance. Twice-a-year distribution of anthelmintic medications for children 2-10 years through NHRs has continued regularly. Population coverage of children 2-4 years from 1994 to 1998 has remained very high (66-98%); however, no specific evaluation has been made of program impact on parasite rates. High coverage and quality of wheat flour fortification has been maintained over time. MOH periodic monitoring at production plants and retail outlets has been sustained. Since 2003, ferrous fumarate substituted for ferrous sulfate in wheat flour fortification. Regulatory monitoring at the three production plants and retail outlets has shown adequate levels of iron, with mean content >60 mg/kg. and the average iron content of bread has remained about 62 mg/kg. However, wheat flour products are consumed by a lower proportion of households in rural areas and, due to low daily intake, the estimated contribution of fortified wheat flour to daily iron intake is modest.

Sustained high coverage of vitamin A supplementation in children has resulted in sharp reductions in VAD prevalence, initially to levels of non public health significance and later on, after sugar fortification was introduced, to levels compatible with virtual control of VAD. Vitamin A supplementation coverage of children 6-59 months has reached 80-90%, although additional coverage through routine health services remains low (under 4%), as it does coverage of post-partum women (12%) despite 58% of the deliveries attended at institutional maternity services. Sugar fortification has continued with high coverage and quality, and consumption is nearly universal; the content of vitamin A in sugar has remained within expected useful margins. Fortified sugar is estimated to provide close to the average daily need per person. BCC has been an important component of the IACS; its purpose has been to create awareness, provide information, educate and induce desired behavioral changes. BCC was introduced in 1999 and its implementation monitored in 2001 with positive findings. The objective is to increase iron intake

from natural sources and fortified foods by promoting changes in feedings practices resulting in dietary diversification. However, there is no information on trends in feeding patterns and dietary intake after 1993, let alone about dietary iron intake.

The changes in the prevalence of anemia in Nicaraguan women and children have shown a temporal relationship with improvements in IACS implementation, e.g. increasing coverage of program interventions such as iron and iron/folic acid supplementation and de-worming, and sustained wheat flour fortification. The lack of changes of anemia in children from 1994 to 2000 coincided with a period of relatively low coverage of iron supplementation and moderate coverage of anthelmintic medications, whereas the significant decline after 2000 followed substantial improvements in coverage of both interventions. The plausibility that changes in anemia are most likely related to the IACS becomes stronger when considering the temporary relationship between program implementation and the dramatic changes in anemia prevalence in women, as well as the absence of changes in children 12-59 months in 1993-2000 when coverage of iron supplementation was low, followed by a large reduction when coverage increased markedly. Changes in other known determinants of anemia (e.g. malaria rates) could not explain the observed decline in anemia. There was an inverse association between intensity of the intervention and changes in anemia rates of children and women in 1993-2000 and in 2000-2005, after increased coverage of supplementation and introduction of wheat flour fortification and BCC.

Other public health programs may have contributed to anemia reduction, e.g. those aimed at improving women's reproductive health (improved coverage and quality of antenatal care, improved access to quality delivery care, increased use of modern contraceptive methods) which may have a long-term impact through lower fertility, widely spaced pregnancies, better women's health and nutrition, and hemoglobin levels. Oral contraceptives, especially those supplying iron containing inert tablets instead of sugar placebos, are known to improve iron nutrition and decrease the risk of iron deficiency anemia. The proportion of women utilizing modern contraceptive methods dramatically increased, with a concomitant reduction in fertility rates. A significant increase has occurred in population coverage of antenatal care, as well as significant improvements in the prevalence and duration of exclusive breastfeeding in infants. Malaria is endemic in the northern under-populated Atlantic region, and its prevalence has shown a declining trend over the past decades.

Some significant improvements from 1993 to 2001 in access to piped water and to proper sanitary facilities and in the prevalence of diarrhea among children <5 years, and a dramatic increase in the use of oral rehydration therapy has been reported. The potential impact of food distribution programs, some of them including fortified foods, to improving nutritional status and reducing anemia is hard to estimate. Other small to large-scale nutrition programs, some of them including growth monitoring of young children and nutrition education of their mothers, have been implemented by the MOH and NGOs and may have contributed to reduce child malnutrition rates; from 1998 to 2005, the prevalence of stunting dropped from 27.0 to 12.9%, and low weight-for-age from 13.5% to 6.2%.

Accounting for the consistent decline in the prevalence of anemia in non-pregnant women of childbearing age is perplexing and poses an especial challenge as they are covered by the supplementation program only during pregnancy. Due to its limited time coverage (about 5 months) and the facts that pregnant women represent a relatively low proportion (<10%) of the total population of women of reproductive age, and that non-pregnant women are not targeted by the program, even the relatively high coverage >80% and duration achieved during pregnancy may

not fully account for the large reduction in anemia rates in all women. A potential effect of fortified wheat flour on total iron ingested and absorbed and on anemia rates would be more likely in women than in children who are known to consume much lower amounts of wheat flour products, particularly in rural areas. In addition to high coverage and duration of iron/folic acid supplementation during pregnancy, other factors likely to have contributed to anemia reduction in women include improved coverage and quality of antenatal care, increased contraceptive use (particularly of iron containing oral contraceptives), reduced fertility with longer birth spacing and, to a lesser extent, consumption of fortified wheat flour products. Positive developments in other public health areas and a modest improvement in social and economic conditions may have also contributed to reduce anemia in both women and children. Although it is not possible with the information available to assess the individual contribution of program and non program inputs to the observed reduction in anemia in women, adequacy and plausibility assessments support the contention that the consistent reduction in anemia rates in Nicaraguan women and children may to a large extent be related to IACS implementation.

Potentially confounding factors for the attribution of changes in anemia prevalence to program interventions would include eventual changes in the incidence or prevalence of infection associated with other programs, and improvements in social and economic indicators. Some reductions have been reported in the prevalence of acute respiratory infections and acute diarrhea in children <5 years. Immunization coverage has reached useful levels despite some recent decline. Changes in infection rates could be reasonably ruled out as a factor likely to account for the positive trends in VAD and anemia. A modest progress in a number of social and economic indicators from 1993 to 2001 has been reported: the proportion of households in poverty and in extreme poverty somewhat declined, to a larger extent in urban areas; positive changes occurred in primary and secondary school enrollment, completion of primary school, life expectancy at birth, GNP growth, and annual inflation rate. Government expenditures in health and education rose and those in defense declined. Despite the modest magnitude of social and economic improvement, some contribution to improved health and nutrition indicators beyond the impact of specific programs may not be totally ruled out.

The magnitude of the countrywide reduction achieved from 1993 to 2000 in the prevalence of anemia in women of childbearing age double the 30% goal set up by the NMP; this was not the case with children <5 years who experienced no change at all. Overall, an impressive reduction of anemia rates of women between 1993 and 2005, and in children after 2000 has been documented. Country wide reductions of anemia rates in pregnant women and children have been reported from only a few countries. Unfortunately, anemia rates in pregnant women have not been assessed in Nicaragua. The magnitude of anemia reduction among young children has been greater than the one reported from other countries.

The approach used by the Nicaraguan MOH in 1994 for designing the IACS included a series of concrete steps: high-level advocacy; a situation analysis on the magnitude, distribution of anemia and its most important causes in the country; an assessment of the existing policies and programs related to these causes; a review of the economic and policy context and the resources available for implementing anemia control programs; creation of a task-force in charge of coordinating the development and implementation of the IACS. Critical actions towards implementation were: developing of updated protocols and guidelines; formulation of a BCC plan; design and testing of communications materials; training and supervision of personnel on the different program components; establishment of adequate supply and delivery systems for program services; fostering demand and compliance with the services delivered; and development of a program monitoring and evaluation system.

Adequacy and plausibility assessments support the contention that the remarkable decline in anemia rates in Nicaraguan women and children are most likely the results of the implementation of an effective IACS by the MOH in collaboration with the food industry and a large network of NGOs and CHVs, and with assistance of international cooperating agencies. The key program interventions included iron and iron/folic acid supplementation for children and women; periodic delivery of anthelmintic medications for children; mandatory universal fortification of wheat flour; social communications; intensive training of service delivery staff and person-to-person education and counseling targeted to mothers. Program interventions have been implemented countrywide with increasing coverage and quality over the past twelve years. Full advantage has been taken of the opportunities offered by NHRs and the increased coverage and quality of antenatal and integrated child care for delivery of services to pregnant women and children, which have benefited from especial efforts to enhance community participation and to promote active involvement of CHVs in counseling and follow-up. The introduction of a more bioavailable iron compound in 2003 presumably increased the effectiveness of the wheat flour fortification program.

Despite significant progress in program implementation over time, some practical problems remain that require further attention: the monitoring system for iron supplementation needs to be strengthened; there is a need for formal definition of the official policy on iron/folic acid supplementation for pregnant women; a critical analysis of the implications of the reduction of NHR to once per year on control of micronutrient deficiencies and anemia is of great importance to guide pertinent decisions; there is a need for updated information on individual dietary intake to assess trends for iron and other nutrients as intermediate program outcomes leading to reduced anemia; other effective options to improve iron intake by infants and young children should be considered; finally, systematic M&E of the BCC strategy and an assessment of the cost-effectiveness and sustainability of the IACS anemia control are recommended.

The following general lessons have been learned from Nicaragua:

- Success in addressing anemia appears to be most likely when a multi-pronged integrated approach is adopted to address the main causes of anemia by multiple reinforcing interventions than through an isolated program.
- Pilot/demonstration projects to address operational constraints are extremely useful.
- Existence of a strong health infrastructure, effective health delivery services and community support is a plus.
- Program ownership by health districts and local units is a sound basis for institutional sustainability.
- A functional management logistic system is critical to maintain continue availability of supplements at delivery posts thus removing supply constraints affecting program success.
- Food industry commitment is critical for maintenance of high quality and coverage of food fortification.
- Monitoring and evaluation (M&E) systems provide important information for decision making.
- Effective international cooperation and coordination facilitates rational use of external resources.

Glossary of Terms

AIN-C	Atención Integral a la Niñez en la Comunidad
BASICS	USAID Project
BCC	Behavioral Change Communications
CDC	Centers for Disease Prevention and Control
CHV	Community Health Volunteers
CIPS	Centro de Insumos para la Salud
DNIM	Dirección de Normación de Insumos Médicos
EAR	Estimated Average Requirements
EPI	Expanded Program of Immunizations
FAO	Food and Agriculture Organizations of the United Nations
FCD	Food Control Department
HHS	Household Survey
ICNND	International Committee for National Defense, USA
IEC	Información, Educación y Comunicaciones
INACG	International Vitamin A Consultative Group
INCAP	Instituto de Nutrición de Centroamérica y Panamá
IMCI	Integrated Management of Childhood Illnesses
M&E	Monitoring and Evaluation
MI	The Micronutrient Initiative of Canada
MOH	Ministry of Health
MOST	USAID Micronutrient Operational Strategies & Technologies Project
NGO	Non-Governmental Organizations
NHR	National Health Rallies
NICASALUD	Federación Nicaragüense de ONGs para la Salud
NMC	National Micronutrient Commission
NMP	National Micronutrient Plan
NMS-93	Nicaragua National Micronutrient Survey, 1993
NMS-00	Nicaragua National Micronutrient Survey, 2000

PAHO	Pan-American Health Organization
OMNI	USAID Operational Micronutrient Intervention Project
ONG	Organizaciones no gubernamentales
PAHO	PanAmerican Health Organization
PROCOSAN	Programa Comunitario de Salud y Nutrición (Health and Nutrition Community Program)
PROSALUD	Programa de Salud de USAID
PVO	Private Voluntary Organizations
QA/QC	Quality Assurance/Quality Control
SILAIS	Sistemas Locales Integrados Salud
SIVIN	Sistema Integrado de Vigilancia de Intervenciones Nutricionales
SOYNICA	Asociación de la Soya de Nicaragua
UNICEF	United Nations Children's Fund
UNU	United Nations University
USAID	US Agency for International Development
VAD	Vitamin A Deficiency
WHO	World Health Organization

1. Introduction

Anemia, defined as a lower than normal level of hemoglobin in the blood, is one of most widespread public health and nutrition problems worldwide. It is estimated that above two billion people or one third of the world's population are affected, including above one third of the women and children in developing countries (WHO/UNICEF/UNU, 2003). In Latin America alone, the proportion of the population suffering from anemia by the end of the past decade was estimated to reach >100 million (nearly 20% of the total): 22 million children < 5 years, 26 million children 5-14 years, 26 million non pregnant women of childbearing age, 4 million pregnant women, 11 million males 15-45 years, and 12 million people older than 45 years (Mora & Mora, 1998). Children under two years of age, pregnant women and female adolescents are the groups at the highest risk.

Anemia has been recognized as a major threat to health, survival and wellbeing of developing country populations. The functional consequences of an insufficient level of hemoglobin are serious. A number of negative implications for health have been documented, including increased maternal and perinatal mortality, and poor pregnancy outcomes such as low birth weight and premature birth (Allen, 2000; Brabin et al, 2001), retarded cognitive development and reduced learning capacity and school performance in children (Nokes et al, 1998; Grantham-McGregor, 2001; Pollitt, 2001) and decreased productivity in adults (Hass & Brownlie, 2001). Anemia not only threatens survival and deteriorates the quality of life and the physical and mental development of populations but also reduces productivity and leads to significant economic losses in the affected countries (Ross and Horton, 2000).

Despite the seriousness of the problem, little progress has been made worldwide in controlling anemia as a public health problem, which continues to get relatively low priority in national public health policies compared to more publicized life-threatening health and nutrition problems. This is probably because the health and survival implications on the individual are less visible and its consequences for national economic growth and social development harder to quantify. An additional constraint appears to be the scarcity of solid information on best practices to reduce anemia and the disappointing results from most large scale intervention efforts (Yip, 1996; UNICEF/UNU/WHO/MI, 1999; Allen and Gillespie, 2001).

Among the multiple causes of anemia as a public health problem, iron deficiency appears to be by far the single most frequent, accounting for at least 50% of the cases in developing countries, followed by a number of other factors leading to insufficient or abnormal hemoglobin and red cell production, and/or excessive red cell destruction and iron losses (WHO/UNICEF/UNU, 2003). Low dietary intake of bioavailable iron is an important cause of iron deficiency anemia, usually coupled with factors responsible for low absorption of dietary iron and excessive losses, e.g. parasitic diseases and systemic infections (Yip and Dallman, 1988). Iron deficiency alone is associated with poor cognitive, motor, social and neurophysiological development (Lozoff and Georgieff, 2006) and is likely to have long-term consequences in low income groups (Lozoff et al, 2006). Deficient iron intake and absorption can be addressed by targeted interventions providing

iron supplements to vulnerable groups (women and children), complemented by food-based approaches such as fortification of one or more food staples and dietary diversification (i.e. changes in dietary practices) to improve intake and absorption of iron rich foods. High losses of iron may be compensated by iron supplements and prevented through other public health interventions such as periodic de-worming.

The relative contribution of different etiologic factors to anemia in a population is often difficult to single out. Besides iron deficiency, they include other nutritional deficiencies (vitamins A, C, folate, riboflavin and B12), as well as parasitic infections, particularly hookworm and schistosomiasis, malaria in endemic areas, and systemic infections (Yip & Dallman, 1988; Dreyfuss et al, 2000; Van den Broek NR and Letsky EA, 2000). It is generally accepted that most anemia in developing country populations is of nutritional origin, that is, it may be the result of iron and other nutrient deficiencies. While iron interventions are seen as the core of anemia control programs, the multi-causal etiology of anemia calls for an integrated multi-sectoral approach comprehensively addressing major nutritional (iron and other nutrients) and non-nutritional causal factors (parasites, systemic infections), particularly in settings where preventable causes other than iron deficiency are likely to play an important role (Stoltzfus, 2001a). It has been shown that in populations with a low to moderate prevalence of anemia iron deficiency is likely to be the most important causal factor whereas other etiologic factors, including other nutrient deficiencies and infections, tend to become more important as the prevalence of anemia increases (Yip, Stoltzfus and Simmons, 1996).

The potential for iron interventions to reduce anemia may vary in different settings contingent upon the relative contribution of iron deficiency (Stoltzfus, 2001b). Unfortunately, anemia control efforts in population groups have suffered from reliance on single interventions (e.g. iron supplementation), limited programmatic experience and the influence of negative experience often associated with poor program performance because of failure to address supply, demand and compliance constraints to iron supplementation programs (Sloan et al, 1992; Beaton & McCabe, 1999; Yip, 1994; Yip, 1996). This has generated general skepticism compounded by lack of awareness on the seriousness of the problem and of its health, development and economic implications. More recently, better understanding of the multi-causal nature of anemia, the identification of critical issues related to effective program design and implementation, and increased experience from large scale programs, have provided a firmer basis for designing effectively integrated anemia control strategies (Stoltzfus, 2001b; USAID/UNICEF/PAHO/WHO/FAO, 2003; INACG, 2003; MOST/USAID, 2004; Lynch et al, 2007).

There is an urgent need for carefully examining lessons learned from successful large scale anemia control programs to understand the critical factors for success that could be replicated in other settings, draw practical lessons from both successful and ineffective programs, and share such experience with policy and program professionals seriously committed to address anemia as a public health problem. The purpose of this paper is to describe the integrated anemia control strategy (IACS) adopted by the government of Nicaragua since 1994, the experience gained during 12 years of implementation, the

positive results in reducing anemia rates in both women of childbearing age and children countrywide, and the lessons learned that may be applicable to other developing countries.

2. Anemia as a public health problem in Nicaragua

Nicaragua, a small Central American country with a population around 5.5 million (42% rural), is the second poorest of the region after Haiti. The existence of anemia as a problem of public health significance in Nicaragua was reported since the mid-1960s (INCAP/ICNND, 1972). However, it wasn't until 1993 that the Ministry of Health (MOH) conducted a National Micronutrient Survey (NMS-93) in a representative sample of 1,791 households with children <5 years of age, including an epidemiological assessment of anemia in women and children by age group and region (Nicaragua, Ministerio de Salud, 1994). Hemoglobin was measured with Hemocue hemoglobinometers using a drop of venous blood collected with Sardstead syringes and the results adjusted for altitude. The NMS-93 reported an anemia prevalence (hemoglobin <11 g/dL) of 28.6% in children 12-59 months (55.1% at 12-23 months, 31.8% at 24-35 months, 14.6% at 36-47 months, 12.7% at 48-59 months) and of 33.6% in non pregnant women of childbearing age (hemoglobin <12 g/dL), with little differences by geographical region; pregnant women were not examined. Neither the impoverished rural Atlantic Region (5% of the population) nor children <12 months were included in the study, thus actual national prevalence rates may have been somewhat higher.

In NMS-93 the average intake of iron by the general population, estimated by the 24-hour recall method, was 10.5 mg per person/day, 75% of it from vegetable sources; assuming 15% absorption of iron from animal sources and 5% from vegetable sources, the overall dietary iron absorption was estimated at 7.5%, and mean absorbed iron at 0.8 mg per person/day or 27% of the FAO/WHO Recommended Nutrient Intake (RNI) of 2.94 mg per-capita (FAO/WHO, 2004). Children 1-4 years consumed an average of 6.4 mg of iron per capita/day, 68% of it from vegetable sources; with an estimated overall absorption of 8.2%, total iron absorbed was 0.52 mg/day or 85% of the FAO/WHO RNI of 0.61mg. A study in neighboring rural Honduras in 1999 reported grossly deficient dietary iron intake among women and children 3-24 months, with bioavailability about 4.5% and 5.5%, respectively (Ohri-Vachaspati & Swindale, 1999). A study in 1996 in a national sample of 600 Nicaraguan infants <1 year reported 71.3% prevalence of anemia (hemoglobin <11 g/dl), with 77.8% in infants 6-11 months (Nicaragua, Ministerio de Salud, 1996). Sub-national studies confirmed the relatively high prevalence of anemia in Nicaraguan children and women: the University of Nicaragua reported a 40.6% prevalence among 1,939 women of childbearing age from Managua (Wallace and Miranda, 1997); a study by SOYNICA (local NGO) in 1999 (cited by Perez, 2001) reported a 30% prevalence in 1,600 children 2-4 years from four departments; and a study in 2000 by project HOPE in 360 children <2 years from the department of Chontales reported a 49.4% prevalence (Proyecto HOPE, 2000).

Because of the grossly deficient iron intake, it was then assumed that most anemias could be attributed to iron deficiency, although this was not confirmed using biochemical

indicators of iron deficiency until 2004-2005 (about 12 years after the 1993 baseline) when, based on serum ferritine assessments, iron deficiency was found in 38% of children 6-59 months and 31% of non pregnant women 15-49 years; iron deficiency anemia represented 62% of total anemia in women and 34% in children (SIVIN, 2003-2005). Potentially significant factors not quantified in 1993 included nutrient deficiencies other than iron which were suggested by the dietary survey but not confirmed by biochemical methods, as well as, eventually, hookworm parasites and malaria in endemic areas. In addition to iron, deficient intake of other nutrients in the general population (e.g. thiamine, riboflavin, niacin and folate, and vitamin A in children) were also revealed by the dietary survey component of MNS-93.

A high prevalence of intestinal parasites in children, including hookworm was documented in small-scale studies conducted in the early 1990s. A case-control study involving 330 children 24-59 months (110 anemic, 220 non anemic) in a Managua health center (cited in Perez, 2001) reported 52% of the anemic children infected with parasites compared to 31% of the non anemic; significant factors accounting for anemia included malnutrition, ascariasis, giardiasis, trichuriasis and overall parasites burden (few children had hookworms). Malaria was endemic in the under-populated northern rural region, but national incidence rates have dropped consistently to 10.1 per 10,000 inhabitants in 2005 (Nicaragua, Ministerio de Salud, 2007) thus its contribution to national anemia rates is not estimated to be significant.

3. Development of the Integrated Anemia Control Strategy (IACS)

After the results of NMS-93, the MOH Department of Nutrition implemented a three-year micronutrient advocacy and action plan (1993-1996). The plan included an aggressive sensitization campaign to generate awareness among the general population about the existing micronutrient deficiency problems, their implications, and the need to address them as a MOH high priority. It was then thought that no sustained commitment to address micronutrient deficiencies could be elicited without aggressive awareness and sensitization efforts. The campaign targeted MOH technical personnel, politicians, academic institutions, health professionals, the food industry, non governmental organizations (NGOs), community groups, media networks and the general population. The purpose was to promote strong country's political commitment to address anemia, as well as vitamin A and iodine deficiencies. Political commitment was generated at the highest levels of the government and the private sector (food industry and non governmental organizations – NGOs).

The survey results were widely disseminated. Presentations were made to MOH technical staff at central and district (SILAIS) levels, the food industry and academicians; press releases were periodically issued; brief technical documents on key micronutrient deficiencies (vitamin A, iodine and iron deficiency anemia) were prepared and distributed to health professionals; and frequent meetings were held with high level officials from the MOH and other Ministries. Three major local food industries were targeted: the salt industry, which was willing to collaborate with the public sector but was not well organized; the sugar industry, which was recuperating from a difficult period of

confiscatory threats and actions by the previous government; and the wheat flour industry that was only sporadically complying with an old poorly enforced legislation on mandatory fortification. A country situation analysis was conducted in 1994, comprising an examination of the most probable causes of micronutrient problems, a comprehensive assessment of the policy and program environment, and an inventory of the technical, institutional, human and material resources available that could be tapped to address the problem.

The high priority assigned by the central government to preventing and controlling micronutrient deficiencies materialized in the creation of a National Micronutrient Commission (NMC), presided over by the MOH Vice-minister. The NMC was assigned the responsibility for developing and coordinating the implementation of a five-year national micronutrient plan. The NMC, which has operated regularly since 1994, is composed of representatives from over 20 institutions from the public and private sectors, including the Ministries of Health, Education, Social Action and Industry and Commerce, as well as the food industry, NGOs, the consumer's league, and international cooperation agencies (USAID, UNICEF, INCAP/PAHO). A Task Force was designed to prepare a 5-year National Micronutrient Plan (NMP); the NMP was completed in 1995 with assistance from international agencies and in consultation with academic groups, the food industry, MOH technical personnel and high level decision-makers (Nicaragua, Ministerio de Salud, 1995). Involvement of several organizations and individuals in periodic meetings and discussions throughout the planning process was very productive and allowed for additional advocacy and reinforcement of political commitment. The NMP was formally adopted in 1995 by the central government and began to be implemented in 1996.

The NMP became a blueprint for a course of action to put in operation a series of specific micronutrient interventions. The NMP adopted an integrated national strategy to primarily address vitamin A and iodine deficiencies, as well as nutritional anemia, with vitamin A and anemia control program interventions closely integrated (Figure 1). Two major goals were set up for the year 2000:

1. Virtual control of vitamin A and iodine deficiencies in the population.
2. Reduction by 30% of the baseline 1993 rates of anemia in women of childbearing age (33.6%) and in children (about 60%).

These goals were expected to be achieved through: high coverage (>80%) and quality of the following program and support interventions, for which specific policies, technical regulations and implementation manuals were prepared:

1. Vitamin A supplementation twice per year for children from 6 months to 10 years of age and once for post-partum women.
2. Iron/folic acid supplementation to pregnant women and iron supplementation to children 6-59 months of age during 6 and 4 months per pregnancy and year .

3. Single-dose anthelmintic medications to children 2-10 years twice per year.
4. Mandatory universal fortification of sugar with vitamin A and of wheat flour with iron and B-vitamins, in addition to ongoing salt iodination.
5. A behavioral change communications (BCC) strategy to promote demand of and compliance with micronutrient supplements, dietary diversification and positive changes in infant and child feeding practices to increase consumption of micronutrient rich food sources and iron absorption enhancers, and to reduce intake of iron absorption inhibitors.
6. Training and periodic retraining of health care providers, health professional faculty and students, and community health volunteers (CHV) in implementation of the different micronutrient interventions and in communication skills for systematic delivery of BCC messages to the target population.
7. Program monitoring and evaluation (M&E) systems to inform program decisions along implementation.
8. Strengthening of other public health interventions likely to improve the micronutrient status of the target population.
9. Operational research aimed at improving program effectiveness.

The anemia control strategy was a component of the comprehensive NMP which, in turn, was framed within the overall national social and economic developing plan. The strategy adopted a comprehensive approach aimed at addressing the most important known causes of anemia, including iron, vitamin A and other nutrient deficiencies (Figure 1). Intervention programs were aimed at increasing intake and utilization of iron, vitamin A and B-complex vitamins, including folate, while reducing parasitic worm load and iron losses. Malaria control was under way since the 1980s but did not become an explicit component of anemia control. The *integrated anemia control strategy (IACS)* included the following interventions and supporting actions, which were planned for sequential implementation contingent upon their political and/or operational feasibility and complexity:

- Iron/folic acid supplementation for children <5 years, launched in 1994.
- Periodic delivery of anthelmintic medications to children 2-10 years, also launched in 1994.
- Fortification of wheat flour with iron and B-vitamins, which began in 1997.
- Interventions to control vitamin A deficiency (VAD), including supplementation since 1994 and fortification of table sugar since 2000.
- Behavioral change communications (BCC) on micronutrients since 1999.
- Comprehensive training of health services personnel from 1999 to 2002.
- Strengthening of other public health interventions.
- Program monitoring and evaluation (M&E).

3.1. Iron supplementation of children <5 years and iron/folic acid supplementation of pregnant women. MOH iron supplementation policies and programs had existed for at least two decades but needed updating, and several supply and demand constraints hindered them from being effective. The IACS assigned high priority to strengthening iron and iron/folic acid supplementation, with particular emphasis on: a) establishing clear policies, updating the technical guidelines and incorporating iron/folic acid supplements in the official list of essential medicines; b) improving supply by establishing an effective system for regular procurement and for logistical management of supply to secure continue availability of supplements at distribution points; c) making especial efforts to promote demand of and compliance with supplements; and d) carrying out operational research to address key constraints to effective implementation.

Supplementation policies and guidelines. Preventive and therapeutic supplementation policies for pregnant women and for children 6-59 months were developed. The policy called for systematic assessment of hemoglobin or otherwise detection of pale skin and/or mucosal membranes as part of antenatal and child health care at local health services for treating anemia. An initial hemoglobin assessment was recommended to be carried out routinely at the first prenatal visit and, if possible, at the first contact with a child <5 years. Technical guidelines on iron, folate and vitamin A supplementation were developed in 1994, and revised/updated in 1998 (Nicaragua, Ministerio de Salud, 1998a). Based on international recommendations (Stoltzfus and Dreyfuss, 1998), the following guidelines were then established:

Pregnant women. *Preventive* (all non anemic or untested pregnant women): 120 mg of elemental iron and 500 µg folic acid weekly (two tablets, each containing 60 mg elemental iron as 300 mg ferrous sulfate and 250 g folic acid) for at least six months throughout pregnancy and lactation; *therapeutic* (pregnant women with hemoglobin <12 g/dl or skin/mucosal parlor): 60 mg elemental iron as 300 mg ferrous sulfate and 250 g folic acid (one tablet) daily during 4 months, followed by a weekly preventive schedule up to the end of pregnancy.

Children <59 months. Systematic detection of pale skin and/or mucosal membranes during either the first routine or any morbidity child care visit beginning at two months, and administration of preventive or therapeutic doses of iron, as follows: *preventive* 1-2 mg elemental iron per kg/day during four months each year as iron sulfate drops containing 1.25 mg elemental per drop (15 drops or 18.75 mg) for children 6 to 23 months, and 2-3 mg elemental iron per kg/day during four months each year as iron sulfate drops containing 1.25 mg elemental iron per kg/day (30 drops or 37.5 mg) for children 24-59 months; *therapeutic* 4 mg elemental iron per kg/day (10 drops for infants 2-3 months, 20 drops for infants 4-11 months, 40 drops for children 12-35 months, and 50 drops for children 36-59 months) as iron sulfate syrup during four months.

In concert with the supplementation policy, iron and iron/folic acid supplements were officially included in the official MOH list of essential medicines since 1995: iron tablets containing 60 mg elemental iron as 300 mg ferrous sulfate and 250 µg folic acid; and iron drops (syrup) in flasks of 30 ml (600 drops) containing 1.25 elemental iron per drop or 25

mg elemental iron per ml (20 drops per ml). The policy was disseminated among health care providers during training and included in supplementation guidelines, protocols and communication materials. Supplementation guidelines and materials were prepared for training of and consultation by health care providers as either stand alone documents or additional sections to be included as part of the following materials:

- Community guidelines on antenatal and postnatal care, 1997.
- Manual on Micronutrients – iron and vitamin A- for health care providers, 1998.
- Manual for the community health volunteer (“brigadista”), 1998.
- Manual of procedures for Integrated Management of Childhood Illnesses (IMCI), 1998.
- Manual for health care promoters, 1999.
- Clinical Protocol for Integrated Child Health Care, 2000.
- Clinical training course on Integrated Child Care, 2000

Since 1994, delivery of iron and iron/folic acid supplements was included as part of the package of services provided through twice-a-year National Health Rallies (NHR). Although the continuous nature of iron supplementation doesn’t lend itself to campaign approaches, NHRs provided important opportunity contacts to deliver monthly supplies of iron supplements for children and pregnant women twice per year (once per year since 2003), coupled with systematic distribution through local health services.

Addressing supply and demand issues. Supply and demand constraints have plagued iron supplementation programs worldwide (Galloway & McGuire, 1994). A system for procurement and logistical management of micronutrient supplements (including donations) was established in the first year of NMP implementation. Supplement needs are estimated by local health units, compiled at the district level and consolidated at the central MOH offices for procurement through twice twice-a-year purchasing bids and/or donations. However, final estimates by health districts (SILAIS) for procurement of non donated supplements, particularly iron/folic acid tablets, are ultimately contingent upon budgetary resources available to the districts. Allocations for medical supplies and supplements represent nearly one third of the total district budget, and the higher priority usually given to curative medicines often results in insufficient allocations left for supplements. Some medicines (antibiotics, analgesics, oral re-hydration solutions and others) and micronutrient supplements are provided free to the target individuals.

Based on district estimates and pledges for supplement donations, decisions on national needs and amounts of supplements to be procured are made jointly by the Departments of Nutrition and of Women, Child and Adolescent Health Care, and other central MOH units in charge of procurement and logistics of pharmaceutical products (Dirección de Normación de Insumos Médicos –DNIM-, Centro de Insumos para la Salud –CIPS-, and the Office of External Cooperation). Supplements are stored at CIPS central storehouses and distributed to the 17 districts (SILAIS), which are responsible for periodic distribution (every 1-2 months) to local health units. The procurement, logistics and distribution system appeared to work properly following specific guidelines; however, an assessment by the MOH in 1998 (Nicaragua, Ministerio de Salud, 1998b) revealed plenty or even excess

supply of iron drops in most local units, coupled with insufficient supply of iron/folic acid tablets during periods ranging from one to three months. A subsequent cross-sectional assessment in 2000 found 54% of the units lacking iron/folic acid supplies (cited in Perez, 2000).

A national health facility survey in 2000 (Nicaragua, Ministerio de Salud, 2000a) reported that nearly 98% of the 1,011 MOH local health units and about 93% of the 203 private health services had sufficient stocks of iron and iron/folic acid supplements. However, an assessment of the iron/folic acid supplement logistics and supply system conducted in 2001 in local health units of randomly selected areas (Nicaragua, Ministerio de Salud, 2001a) revealed the need for special efforts to strengthen the management logistics system to secure availability of supplements at distribution points on a continue basis. The MOH made additional efforts to improve supplement supply, but the need for a well-established management logistics system persisted for some years.

In 2005, USAID/MOST assisted the MOH in conducting a more in-depth assessment of the existing micronutrient supplement management logistics system, including iron and iron/folic acid supplements, which revealed a largely effective system, except for the need for standard procedures for estimating supplement needs and a more systematic use of the information for timely decisions regarding inventory replenishment at distribution points. After establishment of standard procedures (Nicaragua, Ministerio de Salud, 2005) and training of pharmacy staff, supply issues have been properly addressed and continue availability of supplements in sufficient amounts at the local units has been achieved, despite district budgetary restrictions, except for hard to access communities in the Atlantic region. Demand and compliance with iron supplements have not been systematically evaluated in Nicaragua; the longitudinal study by Wallace and Miranda in 1997 found relatively high levels of compliance with iron/folic acid supplements by women of childbearing age and a moderate frequency of side effects (mostly gastrointestinal) which, however, led to suspension of supplement consumption in only 3% of the cases.

Operations research. In 2001, concern about the poor performance of iron supplementation in children motivated the MOH, assisted by USAID/MOST, to design and implement a *community-based iron supplementation pilot demonstration project* in rural communities of El Cuá, Department of Jinotega (Nicaragua, Ministerio de Salud, 2001b). The purpose was to explore the feasibility of increasing iron supplement demand and compliance through systematic involvement of community health volunteers - CHVs (“brigadistas”) in encouraging demand, carrying supplement distribution, and providing counseling and follow-up through family visits. The study by Wallace and Miranda in 1997 had demonstrated a significant impact of regular individual counseling and follow-up by trained CHVs on two large groups of anemic women who were provided either daily or weekly iron/folic acid supplementation supported (Wallace and Miranda, 1997).

The MOH pilot project aimed at demonstrating the feasibility of increasing access to and compliance with iron supplements delivered to children 6-23 months through trained community health volunteers working with mothers and families in their homes. This was expected to be facilitated by Nicaragua’s long tradition of participation of CHVs in

provision of preventive health services. Specific objectives of the project were: to upgrade the knowledge, attitudes and skills of local health care personnel and CHVs on iron supplementation and counseling practices; to improve CHVs knowledge, attitudes and practices regarding iron supplementation and anemia; to enable CHVs to support the program and provide follow-up and counseling at home; to improve the knowledge, attitudes and practices of the beneficiary population; and ultimately, to improve compliance with iron supplements and reduce the prevalence of anemia in children 6-23 months.

At the same time, the MOH was in the process of incorporating iron supplementation into community-based initiatives. The MOH, with technical assistance from USAID-sponsored projects PROSALUD and BASICS, had begun implementation of a community based integrated child health care strategy (AIN-C) in several areas of the country. The iron supplementation pilot project was carried out in four rural communities participating in AIN-C. In El Cuá, iron supplements were distributed by trained CHVs to 117 children aged 6-23 months over a four-month period, in daily dosages of 12.5 mg elemental iron for infants 6-11 months and 25 mg for children 12-23 months. MOH health personnel and CHVs recruited for AIN-C were trained on administration of iron supplements to children and counseling to their mothers, including supplements dosage and administration, facilitating factors for iron absorption (lemonade, orange juice) to be encouraged and inhibitors (coffee) to be discouraged, as well as how to provide counseling and to prevent and control potential side effects. CHVs were given pre- and post-training tests. The pilot project was successful in improving iron supplementation knowledge and skills of health professionals and CHVs, with substantially higher after training scores.

As part of AIN-C, CHVs in El Cuá held monthly meetings with the mothers and the participating children. At the meetings, children under two years of age were weighed, mothers were asked about the health status of their child and were informed about the supplementation program; flasks of iron syrup supplements (drops) were distributed to be given daily to the child at home in dosages according to his/her age. USAID/MOST supported logistics and transportation for health workers in various communities, and assisted the training of medical professionals at two local schools and social service physicians in support of supplementation. Supplements were acquired through the regular MOH procurement system. After distribution, CHVs made two or more home visits as needed between monthly meetings to monitor compliance with the prescribed dosage and to inquire about and address eventual side effects. At inception and four months later, capillary blood samples were taken by finger prick from participant children to assess hemoglobin levels using the Hemocue hemoglobinometer.

The work of the CHVs increased supplement demand and acceptance by mothers and improved compliance of children. A 52% reduction was documented in the prevalence rate of anemia in the participant children from 54% at baseline to 26% after four months of supplementation. It was clearly confirmed that CHVs, in the Nicaraguan context, could be an important ingredient in the realization of effective iron supplementation programs. The impact of the pilot project was profound. As a result of the project, the MOH expanded the community-based “brigadista” model for iron supplementation to fifty AIN-C

communities, and subsequently to a larger number of communities through a coordinated effort with PROSALUD, NICASALUD (a large NGO/PVO network) and other NGOs and PVOs. USAID/MOST provided additional training and limited supervision through the expansion phase. A new AIN-C approach with emphasis on health, nutrition and infant feeding education, the Community Health and Nutrition Program (PROCOSAN), financed since 2002 by the World Bank-supported Nutrition Project, adopted the CHV model, which was then extended throughout most of the country.

3.2. Periodic delivery of anthelmintic medications to children 2-10 years. The NMP contemplated periodic (twice-a-year) distribution of anthelmintic medications (Albendazole or Mebendazole in single doses of 400 and 500 mg, respectively) for de-worming of children 2-10 years as an additional intervention expected to contribute to reduce VAD and anemia. Distribution of anthelmintic medications to children became an integral component of NHRs since 1994, and was included in the Clinical Training Course on Integrated Child Care and formally incorporated into IMCI. The coverage of anthelmintic medications in children 2-4 years was modest in the first two years but increased after 1996; from 1999 to 2005 it consistently reached 95% or more in both rounds, with only one annual round since 2003. Unfortunately, no follow-up assessments of intestinal parasites have been made thus the impact of periodic de-worming of children is not known although is presumed to have been significant. In 1998, a small study of 160 children <10 years attending the MOH health unit in Com Island, a poor rural community in the hard to access Atlantic region (cited in Perez, 2001), found a moderate prevalence of parasites: ascaris 23%, amebas 19%, giardias 18%, hookworm 15%, and other parasites (13%). Delivery of anthelmintic medications for pregnant women has not been established as a standard practice in antenatal care.

3.3. Wheat flour fortification with iron and B-vitamins. Data from 1993 indicated that 49% of the families and 47% of the children regularly consumed wheat flour products, with an average intake of 27 g per person/day or 9.7 kg per year (NMS-93). In 1998 about 97% of the children and 95% of the pregnant women consumed such products (Nicaragua, Ministerio de Salud, 1998c), although mean intake per person/day remained stable. Most wheat flour is produced in the country by three large millers from imported wheat grain and consumed as different types of bread and pasta. Negotiations with the wheat flour producers for establishing mandatory fortification proceeded smoothly in 1997 under the coordination of the NMC, and were completed in less than six months, together with updating of the old technical regulations. Legislation and regulations on mandatory wheat flour fortification existed since the 1970s but were never enforced thus producers reportedly complied with the regulations sporadically. The new regulations for mandatory fortification were established in collaboration with the wheat flour industry and began to be enforced in 1998.

Revised wheat flour fortification standards for levels of micronutrients added and total, including those naturally available in refined wheat flour of 72% extraction, were established for Central America and adopted by Nicaragua since 2003 (Table 1). These levels are also valid and enforced with imported wheat flour. Packaging, labeling and

nutrition declarations were also regulated. Complying with MOH regulations, wheat flour millers periodically purchase a fortification premix from international suppliers.

Table 1. Central American standard for wheat flour fortification, 2003.

Nutrient	Addition (mg/kg)	Total (mg/kg)	% RDI from wheat flour (60 g/day)
Iron (ferrous fumarate)	45	55	16.5
Thiamin	5.4	6.2	31.0
Riboflavin	3.6	4.2	19.4
Niacin	45	55	20.6
Folic acid	1.8	1.8	27.0

A formal industry commitment was facilitated by miller's familiarity with routine addition of several ingredients throughout the milling process, and by the existence of previous legislation and regulations. Commitment and compliance by the industry was achieved through a carefully conducted negotiation process in which the social role of the industry in collaborating with the government and in providing effective solutions to public health problems without harming their legitimate business interests was emphasized, and efforts were consistently made to reconcile the industry and public health interests. Unilateral imposition of fortification legislation was avoided by all means. Producers began regularly fortifying wheat flour late in 1997. Concurrently with program launching, a mass media campaign informing the population about the benefits of fortified foods (e.g. fortified wheat flour) was carried out for about four months using TV spots, radio spots, posters at public sites and retail outlets, leaflets and others communication materials.

At inception, both industry and MOH staff (Food Control Department - FCD) were trained by the Institute of Nutrition of Central America and Panama (INCAP) in quality assurance and control and assurance (QC/QA) methods and in specimens collection, handling, and laboratory methods for monitoring of fortified foods, including wheat flour, sugar, and salt. Regulatory monitoring by the MOH/FCD was established, comprising periodic inspections at production plants and collection of samples of wheat flour from plants and retail stores for assessment of iron content; such monitoring has consistently shown adequate iron levels. Household monitoring was established since 2002. A large proportion of the samples of bread collected from households have been found to contain more than the expected minimum level of iron (55 mg/kg). Following international recommendations (PAHO/WHO, 2002), ferrous fumarate added at 45 mg/kg substituted for reduced iron in wheat flour fortification since October 2003. Otherwise, the program has continued without modifications, with high coverage and quality.

3.4. Interventions for control of vitamin A deficiency (VAD). VAD was found a significant public health problem in children <5 years in 1993. The VAD control component of the NMP, to be implemented as part of IACS, contemplated a sequence of interventions including supplementation of children and post-partum women and deworming of children, as short-term temporary measures to be later complemented by

more sustainable food-based interventions, e.g. food fortification and a communication strategy for dietary diversification. Vitamin A supplementation had been documented to contribute to reduce anemia in Indonesia (Suharno et al, 1993). An early decision was made in 1994 to take advantage of the twice a year National Health Rallies (NHRs) delivering a variety of preventive services to the community (immunizations, oral rehydration salts and others) to also deliver vitamin A, anthelmintic medications and iron supplements to the target groups. Local health units are ultimately responsible for distribution of supplements but coordination of NHR implementation is a responsibility of the districts. MOH central units set the stage for, coordinate and support NHR implementation by securing sufficient supplement supplies and providing training as needed to the districts, and these, in turn, to the local health services. Most vitamin A supplements have been donated by Wisconsin Lions Club and UNICEF.

During the NHRs, communities are massively mobilized by engaging media, municipal authorities, the church and other community groups, with active participation of primary school teachers, secondary school and university health science students, community volunteers, traditional birth attendants, the military and NGOs. A NHR may take one week in urban areas and as many as four weeks in rural isolated areas where this is practically the only opportunity for people's contact with the public health system. Each campaign is planned jointly by the central MOH and the districts, and largely funded by international donors in addition to regular MOH budgetary allocations. To increase the coverage achieved through the NHRs, the districts are encouraged to tap other opportunities for contacts with mothers and children to deliver vitamin A and iron supplements through routine health services. Delivery of vitamin A, anthelmintic medications and iron supplements is registered on each child's health and immunization card (Expanded Program of Immunizations- EPI). Delivery of vitamin A and anthelmintic (but not iron/folate) is also registered in the regular service forms from which health service statistics are estimated at the MOH Department of Statistics by district and for the whole country.

The NMP contemplated mandatory fortification of sugar as a major program intervention for vitamin A control since 1995. Sugar is a suitable vehicle because it is produced by a small number of privately-own plants (seven by program inception), it is consumed regularly by about 99% of the families, and the supply per-person amounts to about 37 kg per year or 87 grams per day, including sugar contained in soft drinks, candies and other products (consumption as table sugar reaches 65 g per person/day). Technology developed by INCAP for fortifying sugar with vitamin A was readily available since the mid-70s (Dary, 1998). The small number of production plants (currently five) and the absence of imported sugar made government control of fortification less complex. Policy dialogue and negotiations with the industry about establishing mandatory fortification of sugar took longer than those with the wheat flour millers. In 1999 a formal agreement was signed up by which a government/industry partnership was formally established with the purpose of initiating sugar fortification in the 1999/2000 sugar cane harvest. Sugar monitoring was added in 2000 to MOH/FCD regulatory monitoring system for fortified foods through periodic inspections of production plants and retail outlets. Household

monitoring for estimating actual population coverage began in 2002. By 2007 sugar fortification is a well-established program, with population coverage nearly 100%.

3.5. Behavioral Change Communications (BCC). The NMP contemplated a number of supporting components cutting across specific micronutrient intervention programs, including a behavioral change communications (BCC) strategy coupled with a comprehensive training plan in micronutrients. The purposes of the dual BCC/training strategy were: sensitization and promotion of community participation in actions to control micronutrient deficiencies (vitamin A, iron/anemia and iodine) as a national priority; person-to-person education and social communications aimed at increased intake of micronutrient rich foods (fortified or natural foods through dietary diversification); and improved quality and better utilization of health care services targeting micronutrient deficiencies (e.g. supplementation, de-worming).

A strategic planning process was followed to develop a formal BCC plan as a component of the integrated micronutrient strategy. Formative research studies were conducted in 1997 and 1998 to get a better understanding of existing knowledge, attitudes and practices related to micronutrients, anemia and supplements in the target population (Nicaragua, Ministerio de Salud, 1997, 1998b,c), using in depth interviews, focus groups discussions and trials of improved practices (TIPS). Relevant areas of information from formative research include knowledge, attitudes and practices regarding anemia and its implications; iron/folic acid supplements and potential adverse effects in pregnant women; iron supplements and side effects in children; and consumption of iron absorption enhancers and inhibitors. About 5% infants <6 months, 15% infants 6-8 months, 22% infants 9-11 months and 42% children 12-23 months, as well as 54% pregnant women, were regular coffee drinkers; coffee is known to reduce iron absorption from foods (Morck et al, 1983).

On the basis of the results of formative research, a BCC strategy and plan with a mass media and a person-to-person component was developed in 1999 as one of the main courses of action to address micronutrient deficiencies (Nicaragua, Ministerio de Salud, 1999a). Major emphasis regarding iron/anemia was given to the benefits of iron and iron/folic acid supplements; effective means for prevention and management of side effects; increased access to supplements by the target population utilizing non-traditional channels (e.g. NGOS, CHVs, health promoters, community pharmacies); improved consumption of iron rich foods; discouraging simultaneous intake of iron absorption inhibitors (e.g. coffee) while encouraging consumption of absorption enhancers (e.g. citric fruit juices); strengthen knowledge and ability of health care providers and CHVs to provide guidance, counseling and follow-up to supplementation; and encouraging cultivation of iron rich vegetable products.

An important step was the development and field testing of education and communication messages and materials designed after the findings of formative research and tailored to specific audiences (e.g. health authorities, health professional and other providers, CHVs, women of childbearing age and mothers of young children, school children, and the general population). In addition to the supplementation guidelines, materials prepared and delivered during BCC training included: a manual for CHVs (“Manual del Brigadista”); a

brochure for health care providers with technical information on micronutrients; a flipchart entitled “Health and energy with iron and vitamin A” for educational purposes; a technical brochure on micronutrients for medical professionals; an information folder on micronutrients for mass media staff; a planning/negotiation card with feasible behaviors for pregnant women and children; a monthly calendar to keep a record of iron/folic acid tablet consumption; stickers on vitamin A and iron; and a series of mass communications materials for radio and TV. A baseline BCC assessment covering 1,193 women of childbearing age and 609 pregnant women was completed in 1998 (Nicaragua, Ministerio de Salud, 1998b).

By mid-2000, the BCC strategy was revised with the purpose of enhancing its effectiveness in promoting changes in specific behaviors leading to improved micronutrient intake (Nicaragua, Ministerio de Salud, 2000b). The new strategy provided a more integrated framework and approach to behavioral change; it identified specific behaviors that could be changed and considered environmental and other factors affecting such behaviors; educational messages were revised together with effective means to deliver them, with special attention to behavioral results. The revised strategy included specific objectives for sensitization and advocacy; supply, quality, delivery and utilization of services; and knowledge, attitudes and practices of the target population. Finally, it called for different activities to be implemented in coordination, including training, supply, service delivery, community involvement, mass media support, individual counseling, and monitoring and evaluation. In 2001 an assessment of the implementation of the BCC strategy related to iron supplementation was carried out (Nicaragua, Ministerio de Salud, 2001b).

3.6. Comprehensive training of health service personnel. In addition to integration of specific micronutrient knowledge into the undergraduate curriculum of health professionals (medical, nursing and nutrition schools) and of graduate public health trainees (Nicaragua, Ministerio de Salud, 1998d), and in the field orientation of newly graduated physicians and nurses, a training plan for health care providers was prepared together with the person-to-person component of the BCC strategy. The objective was to enable them to carry out promotional activities and comply with the technical guidelines on prevention and control of micronutrient deficiencies. A training curriculum and manual was prepared, and technical guidelines developed for training in supplementation and counseling (e.g. in the use of educational materials).

From 1999 to 2002, and sporadically thereafter, public health staff (physicians, nutritionists, nurses, auxiliary nurses), as well as university faculty and students, were comprehensively trained in micronutrients through two-day training workshops carried out at the central and district levels. A high proportion of the country’s local health care providers (above 1,500 or nearly two thirds of the total) were trained in 1999-2002 in all aspects of micronutrient deficiency prevention and control (vitamin A, iron/anemia, iodine), with emphasis in supplementation, food fortification and BCC, and particular attention to counseling, communication messages and the use of educational materials (Nicaragua, Ministerio de Salud, 1999b). Field staff from NGOs and CHVs, including those involved in the expansion of the community-based “brigadista model” for iron

supplementation through AIN-C and PROCOSAN, were also trained to participate in implementation of micronutrient interventions, with especial emphasis on iron and iron/folic acid supplementation.

Training topics on iron/anemia included: micronutrient deficiencies in the country; MOH strategies and intervention programs for prevention and control; iron deficiency and anemia, detection, causes and health/development implications; role of breastfeeding; iron rich foods; iron/folate and iron supplementation for pregnant women and children <60 months; preventive and therapeutic dosage and duration; potential side effects, prevention and management; and use of educational messages and materials. Training methods included slide presentations, practical exercises, group dynamic sessions, social dramas, and plenary discussions. Sets of educational materials were given to the trainees at the end of each training cycle. Training sessions were systematically evaluated through pre and post-tests; the results showed significant improvements in knowledge and attitudes regarding iron deficiency and anemia, and their prevention and control. Since 1999, refreshment training has been regularly provided once per year to newly graduate physicians enrolled in the one-year program of compulsory social service in rural areas. The training plan generated awareness and improved knowledge and commitment regarding micronutrient deficiencies, including iron deficiency and anemia, among health care professionals and other health service providers.

3.7. Other public health interventions. Although not an explicit component of the NMP thus not fully integrated with it, strengthening other public health interventions likely to enhance the impact of specific programs on micronutrient deficiencies by promoting improved health care, proper hygienic practices and environmental improvements to reduce infectious diseases, has been given especial attention by the MOH. Such interventions include: integrated management of childhood illnesses (IMCI), with emphasis on early oral rehydration and proper nutritional management of diarrhea and acute respiratory infections (ARI); improvement in the sanitary conditions and hygienic practices of the population; expanded program of immunizations (EPI) whose coverage rates had some decline in the late 1990s but still remain >80%; malaria prevention and control in endemic areas; breastfeeding promotion and protection; and improved feeding practices of children <2 years through child growth monitoring and targeted education and counseling to mothers (PROCOSAN). These interventions are successfully implemented by the MOH in collaboration with a large number of NGOs and NGO networks (e.g. NicaSalud) and assistance from external cooperation agencies. In addition, a very active reproductive health program has provided education and promoted modern contraceptive methods that may contribute to reduce fertility rates and the risk of iron deficiency in women of childbearing age.

4. Program monitoring and evaluation (M&E)

The need for a functional program monitoring and evaluation (M&E) system was identified at inception of the NMP. Efforts were then made to establish internal program monitoring and supervisory systems collecting information on the program implementation process for management purposes and for evaluation of program performance. Examples

of these efforts are the system for regulatory monitoring of fortified foods operated by the MOH/FCD; the system for routine supervision of local health services; and the internal information system of the Expanded Program of Immunizations (EPI), vitamin A supplementation and anthelmintic medications, which produces periodic information on program coverage by district. In 2000, the MOH carried out a second national micronutrient survey (NMS-00).

4.1. 2000 National Micronutrient Survey (NMS-00). The 2000 National Micronutrient

Survey (NMS-00) covered a national representative sample of 2,370 households with children <5 years (Nicaragua, Ministry of Health, 2002). NMS-00 evaluated changes in the micronutrient status of the population compared to the NMS-93 and to the 1998 Demographic and Health Survey (DHS). The survey estimated the prevalence of VAD and anemia in children 6-59 months and their mothers/caregivers; the coverage of iron/folic acid supplementation in children and women; the consumption pattern of fortified foods and of some foods with potential for fortification (vegetable oil, corn flour); the levels of nutrients in samples of fortified foods from households; and the nutritional status regarding iodine and fluoride in children 6-9 years.

One of the 2000 survey's most outstanding findings was the dramatic reduction in the levels of VAD in children under five years of age to 8.8% compared to 31.3% in 1993, which was attributed to the high population coverage of vitamin A supplementation (>70%) twice per year in children 6-59 months. VAD was assessed in mothers/caregivers and found not to be a problem of public health significance (<11% prevalence). There was also a significant drop in the prevalence of anemia in women from 33.6% to 23.7% (29% of the 1993 rate). No improvement in anemia rates was observed among children; even in the age group 12-23 months that had the highest prevalence in 1993 (55.1%), anemia prevalence remain unchanged at 54.2%. This was attributed to poor coverage and compliance with iron supplementation in children, with little increase, if any, in consumption of dietary iron; coverage of iron supplementation reached only 37% in children. Fortified wheat flour was found to reach mostly urban consumers and child's intake of wheat flour products was presumed to be low; however, neither dietary intake of wheat flour or iron nor biochemical indicators of iron deficiency were measured.

4.2. Integrated System for Surveillance of Nutrition Interventions (SIVIN). By 2001 nutrition policies and programs had been carried out with strong political commitment and significant private sector participation, but little systematic monitoring and evaluation (M&E). Weak program monitoring hindered the MOH ability to use program results for informed decision-making; hence the need was recognized for a nutrition program M&E information system. In 2002 the MOH began to put in operation the Integrated System for Surveillance of Nutritional Interventions (SIVIN) that became fully established in 2003, with technical and financial assistance from USAID/MOST, the US Center for Disease Control and Prevention (CDC), MI, UNICEF, and INCAP/PAHO. SIVIN is a centralized, modular, integrated management information system for periodic M&E of nutrition programs (Nicaragua, Ministry of Health, 2004, 2005). The system collects, processes, analyzes and uses information on service provision, utilization and coverage to assess

nutrition program process and performance, as well as on biological indicators of nutritional status to assess impact. Information is collected from several sources on vitamin A, iron and iron/folic acid supplementation, food fortification, breastfeeding protection and promotion, and community growth monitoring/promotion of children under two years of age, as well as on the status of energy-protein and selected micronutrient deficiencies.

SIVIN uses three sources of information: service statistics, that is, data routinely gathered by local health services (e.g. on coverage of vitamin A and anthelmintic medications); data from existing individual program monitoring systems (e.g. regulatory monitoring of fortified foods); and an especially designed national household survey (HHS) collecting information not available from other sources (e.g. on iron and iron/folic acid supplementation). An MOH field implementation team was trained and has been highly committed to operation of the HHS. Each year from 2003 to 2005, the HHS covered a nationally representative sub-sample of 500 households from a national random sample of 1,500 that was completed in a three-year cycle and the results broken-down by three geographic strata. The modular system allows for addition or deletion of specific information modules annually. Data processing and analysis is centralized at the MOH, within the Department of Statistics of the Planning Office. In the three-year period, the HHS produced information similar to that obtained by the NMS-00. Impact monitoring is carried out through nutritional surveillance, and evaluated by relating changes in nutrition status to program performance indicators. In a second 4-year implementation cycle 2006-2009, an expanded national sample of 2,160 households is being covered and the information will be broken down by seven strata.

5. Trends in outcome indicators

Information of trends in anemia as a key program outcome indicator is available from hemoglobin assessments conducted in 1993 (NMS-93 baseline), 2000 (NMS-00) and 2003-2005 (SIVIN). All assessments used the standard Hemocue equipment and method with a drop of venous blood taken by syringe. There was a dramatic improvement in the mean and distribution of adjusted hemoglobin levels among non-pregnant women 15-49 years from 1993 and 2005. Distribution curves revealed a consistent shift towards the right, with a progressively less disperse curve over time. Figure 2 shows the trend in the prevalence of anemia in women, which fell down from 33.6% in 1993 to 23.7% in 2000 and to 11.2% in 2003-2005 (Nicaragua, Ministry of Health, 2004). By 2003-2005 (12 years after the 1993 baseline) anemia rates in women had dropped down by about two thirds of the 1993 rate, one third by 2000 and an additional third by 2003-2005.

The distribution of hemoglobin levels in children from 12-59 months remained unchanged between 1993 and 2000, and subsequently moved to the right and became less disperse by 2003-2005. The mean prevalence of anemia in children 12-59 months persisted in 2000 around 29% and rates didn't change significantly across age groups (infants 6-11 months and the rural Atlantic region were excluded in 1993). Anemia rates in children 12-59 months dropped significantly after 2000 (Figure 3) from 29.0% to 18.1% in 2003-2005 (62% of the 2000 rate or a 38% drop), and in the whole group 6-59 months from 33.5% to 20.1% (60% of the 2000 rate or a decline of 40%). There was a significant reduction in infants 6-11 months (from 61.8% to 38.0 in 2003-2005 (39% of the 2000 rate), in children

12-23 months from 54.6% to 29.4% (46% of the 2000 rate), and in the group 24-36 months from 29.9% to 16.4% (45% of the 2000 rate); declines in older groups were less marked. The change in infants 6-11 months would be even more dramatic (65%) if estimated on the basis of the national prevalence reported in 1996 (77.8%).

6. Accounting for changes in outcome indicators

In order to establish whether the observed trends in anemia rates in Nicaraguan women and children may plausibly be attributed to program interventions implemented within the IACS, program performance indicators (provision, utilization, coverage) should be examined vis-à-vis the observed effects on the expected outcomes (e.g. prevalence of anemia in the population), with other possible contributing factors and potential confounding variables taken into account. An evaluation providing evidence of effectiveness may be made with the information available, utilizing a combination of adequacy and plausibility assessments as described by Habicht, Victora and Vaughan (1999). Adequacy performance evaluations assess how well the program activities have met the expected objectives, while adequacy impact evaluations assess whether outcome indicators have improved among program recipients or among the target population as a whole. Plausibility assessments intent to control for the influence of confounding factors which might have caused the observed effects, either by using a historical control group, e.g. comparing change from before to after program implementation with an attempt to ruled out external factors, or an internal control group, e.g. looking at a dose-response relation between intensity of the intervention and the observed outcome. For a number of reasons, probability evaluations with randomization to treatment and control groups are often not feasible for assessing public health program effectiveness (Black, 1996)

The effectiveness of micronutrient deficiency control programs may be estimated on the basis of pre-post differences or trends in outcome indicators, e.g. prevalence of biological indicators of deficiency, and program performance indicators, provided that other plausible explanations for such trends are weighed or ruled out. Effectiveness has been defined as “the extent to which a specific intervention, procedure, regimen or service, when deployed in the field, does what it is intended to do for a defined population” (Last, 1988). Program effectiveness/impact of universal anemia control interventions would ultimately be expected on hemoglobin levels (adjusted for altitude) and on the prevalence of anemia in the population as long-term outcomes, provided that programs have performed as planned (e.g. with the expected coverage and quality during a long enough period), and that an effect of other contributory or facilitating factors and potentially confounding influences on anemia rates can be accounted for or discarded.

Given that most anemia control interventions aim at improving iron intake, absorption and utilization, iron status indicators would be appropriate intermediate indicators of short to medium-term intermediate outcomes that may lead to long-term effectiveness in reducing anemia; however, for a number of reasons, including cost and complexity, these indicators are not often included in M&E of anemia control programs. In Nicaragua, information on trends in intermediate outcome indicators (e.g. iron status) that would be expected to be modified as a result of iron interventions is not available. Indicators of iron deficiency,

such as serum ferritin, would be more sensitive and specific than hemoglobin in demonstrating impact of iron interventions (Stoltzfus and Pillai, 2002).

As levels of serum ferritin tend to increase in the presence of inflammation/infection, WHO has suggested the use of low serum ferritin (<12 µg/dL in children and <15 µg/dL in women) in individuals with normal α -1 acid glyco-protein (AGP =<1.0 g/L)), an acute phase reactant often used as a marker of infection, as a means to identify iron deficiency (e.g. depleted stores). Normal levels of AGP are supposed to occur only in those without concomitant infection processes (WHO, 2001). This would allow for estimating the prevalence of both iron deficiency and iron deficiency anemia in population groups. Thus serum ferritin was assessed in Nicaraguan women and children in 2004 and 2005 by SIVIN, using a standard enzyme immunoassay method (Ramco). The prevalence of iron deficiency amounted to 30.9% in women 15-49 years with at least one child <5 years of age; the prevalence of anemia reached 11.2% and that of iron deficiency anemia was 6.9%, that is, 62% of the cases were attributable to iron deficiency, with other causes accounting for 38% (Figure 4). Of 713 children 6-59 months examined, 37.9 % were iron deficient, 20.1% were anemic and 6.9% had iron deficiency anemia; indicating that iron deficiency contributed to 34% of the cases of anemia in children (Figure 5). About 24% of the women and 31% of the children had iron deficiency but not yet anemia. It would appear that, despite the relatively large decline in anemia rates en Nicaraguan women and children, iron deficiency still remain a significant problem; however, there are no data available to ascertain long-term trends in iron deficiency.

6.1. Program performance assessment. Information on population coverage of iron/folic acid supplementation in pregnant women and children was not available before the 2000 micronutrient survey (NMS-00). Coverage of pregnant women reached 70% in 2000 and increased to 85% in 2003-2005 when 58% of the women consumed iron/folic acid tablets for at least 6 months and 76% for four or more months (Nicaragua. Ministerio de Salud, 2007). Coverage of children 6-59 months rose from 37% in 2000 to 63% in 2003-2005 (Figure 6), although only 34% were supplemented for at least three months. CHVs now regularly provide follow-up and counseling to supplemented pregnant women and children in most of the country, although their actions and coverage have not been evaluated. Reportedly, side-effects of iron supplementation in pregnant women (nausea, dark feces, heartburn) and in children (tooth staining, dark feces) have not been disturbing enough to affect compliance.

Reasons for dropouts from iron supplementation programs are more likely to be related to poor supply and availability of the supplement than to side effects. By 1997, there was little international evidence that non compliance due to gastrointestinal side effects was an important reason for pregnant women not taking the recommended dose of iron/folic acid tablets (MotherCare, 1997). A MotherCare review of the experience in eight developing countries found that about one third of pregnant women reported that they experience negative side-effects; only about on tenth of the women stopped taking the tablets due to side effects, and the major barrier to effective supplementation programs was inadequate supply (Galloway et al, 2002). Additional barriers included inadequate counseling and distribution of tablets, difficult access and poor utilization of prenatal health care services,

and some belief against consuming medications during pregnancy. No specific reports are found in the literature on persisting side effects affecting compliance in children; in Nicaragua teeth staining and dark feces, usually not severe enough to affect compliance, have been reported sporadically.

Iron and iron/folic acid supplementation proved to be the IACS most difficult component to implement and monitor. Compliance with MOH policies on routine assessment of anemia and therapeutic supplementation has been poor mainly because of insufficient resources for routine laboratory diagnosis; systematic assessment of skin and mucosal parlor to identify anemia may have suffered from the well known low sensitivity of clinical signs to identify non severe cases of anemia (PATH, 1997; Dusch et al, 1999). On the other hand, the lack of consensus on daily or intermittent iron/folic acid supplementation policies for pregnant women among Nicaraguan health professionals has resulted in the use of non standard protocols. In addition, monitoring coverage and duration (e.g. through pregnancy and per child/year) of supplementation was practically non existent during the 1990s and later on has relied on mother's recall due to absence of a routine recording and tallying system at distribution points. Coverage rates at the national, district and even local level are regularly available for vitamin A but no for iron supplementation, a persistent constraint not yet resolved¹.

Establishing an effective monitoring system for supplement supply, distribution and local inventories has been a difficult task. For several years iron and iron/folic acid supplement supplies and availability at local units were irregular, with missing opportunities for both pregnant women and children, and diminished population coverage. Most iron/folic acid tablets for pregnant women have been procured locally by the MOH (at a cost of \$0.0024 per tablet or \$0.43 per person cycle of 180 days in 2004) and the total amount procured per year has been affected by budgetary constraints. Most iron drops are donated by the Japanese Government, as part of its assistance to IMCI. In 2004, supplies of iron syrup would allow for 70% coverage during about 2.4 months; if purchased locally, their cost in 2004 would have been \$0.24 per flask of 30 ml or an average of about \$0.96 per 4-month cycle per child/year (one flask per month).

Twice-a-year distribution of anthelmintic medications for children 2-4 years and for school-aged children 5-10 years through NHRs has continued regularly. Annual population coverage from 1994 to 1998 in children 2-4 years ranged between 66% and 98% in first rounds and between 35% and 98% in second rounds, but from 1999 to 2005 coverage figures remained around 98% in both rounds (Figure 7); however, no specific evaluation has been made of program impact on parasite rates. If deworming is effective, the resulting lower parasite rates would not only improve the iron status of the target children but also reduce parasite load and transmission to the general population, including women of childbearing age, thus improving their iron and hemoglobin status. A school-based deworming program in Zanzibar showed that thrice-yearly or twice-yearly anthelmintic medications had significant effects on parasite load, iron status and the risk of moderate to severe anemia in children (Stoltzfus et al, 1998).

¹ Health care service forms do not include a space for registering information on iron or iron/folic acid supplements.

High coverage and quality of wheat flour fortification have been maintained over time. MOH periodic monitoring at production plants and retail outlets has been sustained, with ferrous fumarate substituting for reduced iron since 2003. Regulatory monitoring at the three production plants and at retail outlets has shown adequate levels of iron, with a mean content >60 mg/kg; the average iron content of bread has remained around 62 mg/kg. However, wheat flour products are consumed by a lower proportion of households in rural areas (76% vs. 94% in urban areas) and, due to low overall daily intake (27 g in 1993 and 2000), their contribution to iron intake would probably be modest. Dary has recently estimated that with the amounts of iron usually added to wheat flour, even when flour intake reaches 100 g/day the contribution of fortified product would barely meet 8-15% of women's RNI using refined flours or 3-7% using unrefined flours (Dary, 2007). This has been confirmed by a recent analysis of the potential impact of wheat flour fortification in Guatemala, with a median daily intake of 50 g per person/day (about twice that of Nicaragua). The lack of updated information on consumption of wheat flour products precludes estimation of their actual contribution to iron intake of the Nicaraguan population, including women and children.

Population coverage of vitamin A supplementation in children has been consistently $>80\%$, more recently $>90\%$, most of it through twice a year NHRs which, however, have been reduced to once per year since 2003 (Figure 8); additional supplementation coverage through routine health services is barely 4%. Coverage of post-partum women has remained low (about 12%) despite 58% of the deliveries attended at institutional maternity services and relatively high post-partum care coverage ($>60\%$). Sugar fortification has continued with high coverage and quality; fortified sugar is consumed by the vast majority of the population, importation of unfortified sugar is not permitted, and the retinol level at production plants, retail stores and households has remained within expected useful margins; with an average content of retinol 7.8 $\mu\text{g/g}$ and a mean intake of about 87 g per person/day, fortified sugar is estimated to provide about 679 $\mu\text{g/day}$, close to the average need per person; table sugar alone, with 65 g consumed per person/day would contribute 507 $\mu\text{g/day}$ or about two thirds of the individual needs.

Figure 9 shows the trend of VAD in children 6-59 months of age from 1993 to 2005; VAD prevalence (plasma retinol <20 $\mu\text{g/dL}$) declined significantly from 31.3% in 1993 (with 7.9% <10 $\mu\text{g/dL}$) to 8.8% in 2000 (with 0.2% <10 $\mu\text{g/dL}$) and to 1.8% in 2003-2005. This was a dramatic reduction of the initially high prevalence to levels of non public health significance and then, after sugar fortification was introduced, to levels compatible with virtual control of VAD. Virtual control of VAD may have contributed to reduce anemia rates in children and, eventually, in women through sugar fortification, whereas fortified wheat flour would be expected to have only a modest impact on the iron status of women and, given presumed consumption patterns, would be unlikely to benefit the neediest (Imhoff-Kursch et al, 2007). Vitamin A may improve iron status by reducing the effect of phytates and polyphenols as inhibitors of iron absorption (Layrisse et al, 2000). In NSM-00, about half of the children 6-59 months with VAD and less than one third of those without VAD had anemia, and there were also significant differences in anemia rates between children who were supplemented with vitamin A in the previous 12 months (28.8%) and those who were not (40.3%).

The important role of communications in comprehensive anemia control has been recently highlighted (Hyde, Agble and Nestel, 2003). Social communications have been an important component of the Nicaragua IACS; it was designed to create awareness, provide information, educate and induce desired behavioral changes. A revised BCC plan has been in operation since 2000. BCC implementation was monitored in 2001, after one year of implementation, with positive findings (Nicaragua, Ministerio de Salud, 2001c): >90% of the women knew about the importance, causes and consequences of anemia and the need for taking iron supplements with enhancers of iron absorption and avoiding inhibitors; they recognized adverse effects but also significant beneficial effects, and did not perceive difficulties in accessing iron supplements either at health posts or local pharmacies; about 77% reported having been taught by health care personnel about the importance of iron during pregnancy and childhood; 96% got clear instructions on how to take iron/folic acid tablets; 52% were advised to take the tablets with orange juice or lemonade, and 27% about not taking them with coffee; and 96% reported no significant side effects on them or their children. No impact evaluation of the BCC program has been conducted.

The BCC strategy also aimed at increasing iron intake from natural sources and fortified foods by promoting changes in feedings practices resulting in dietary diversification. However, evidence for effectiveness or even efficacy of dietary diversification interventions in anemia control is scanty (Allen and Gillespie, 2001). There is no information on trends in feeding patterns and dietary intake of the Nicaraguan population after 1993. The evidence of improved iron intake as a result of behavioral changes in feeding practices in developing countries is not conclusive (Allen and Ahluwalia, 1997; Ruel and Levin, 2000).

6.2. Program impact assessment. Conceivably, the prevalence of anemia in the population should come down as a direct outcome of anemia control programs, especially those increasing intake and reducing losses of iron whenever this is a major causal factor for anemia, and also indirectly as a result of other public health intervention programs; overall social and economic improvements may also contribute to anemia reduction and act as confounding factors to the relationship between anemia control programs and outcomes. Changes in the prevalence of anemia in Nicaraguan women and children have shown a temporal relationship with IACS implementation, particularly with significant improvements in the coverage of program interventions such as iron and iron/folic acid supplementation and deworming, sustained wheat flour fortification, reductions in VAD and positive changes in knowledge, attitudes and practices related to anemia. The lack of changes of anemia in children from 1993 to 2000 coincided with a period of relatively low coverage of iron supplementation and moderate coverage of anthelmintic medications, whereas the significant decline after 2000 followed substantial improvements in the coverage and quality of both interventions.

Plausible mechanisms by which the IACS may have resulted in positive long-term outcomes in women and children (e.g. hemoglobin, anemia) include: increased iron intake and/or absorption; reduced iron losses; and improved intake of other nutrients. A drop in parasite loads in children and in the overall environment, which may have reduced iron losses, has not been documented in Nicaragua. Efficacy of iron

supplementation and periodic deworming in reducing anemia rates has been reported in populations at risk, particularly when iron is a major etiologic factor (Sloan et al, 1992; Beaton and MsCabe, 1999; Stoltzfus et al, 1998); the evidence is inconsistent regarding behavioral change interventions (Allen and Gillespie, 2001), and established for wheat flour fortification in a few countries (Layrisse et al, 1996; Hurrell, 1997). In 1993, folate and vitamin B12 deficiencies didn't appear to be significant public health problem in Nicaragua; however, their significance may turn to be higher with the new cut-off levels for serum folate and B12 soon to be recommended by WHO. .

The plausibility that the observed changes in anemia are most likely related to the IACS becomes stronger when considering: a) the temporary relationship between program implementation and the dramatic change in anemia prevalence in women between 1993 and 2003-2005 (67%) when coverage of iron/folate supplementation raised >80%, as well as the absence of change in children 6-59 months in 1993-2000 when iron supplementation coverage was low, followed by a 40% reduction by 2003-2005 when such coverage increased markedly (congruence of expected trend); b) changes in other known determinants of anemia (e.g. malaria rates) could not explain the observed decline in anemia (lack of measurable confounding); and c) an inverse association between intensity of the intervention and changes in anemia rates was observed in both children and women, when comparing the periods 1993-2000 and 2000-2005, after higher coverage of supplementation and introduction of wheat flour and sugar fortification and BCC (congruence of dose-response). For impact evaluation purposes, the way iron supplementation performed in children resembles a two-step staggered design with different intensity of the interventions, e.g. an initial period of low coverage and quality.

In order to further assessing the plausibility of the program-outcome relationship, health and/or nutrition interventions other than the specific anemia control interventions should be examined to look at the extent to which they may have also contributed to final outcomes; potential confounding factors that might also account for certain outcomes should also be considered. Other public health programs that may have contributed to anemia reduction include those aimed at improving women's reproductive health and survival during pregnancy, which have been given considerable support in the last decades in Nicaragua. Table 2 shows changes in the coverage of basic public health services and household sanitation in the period 1993-2001 alone. In addition to improved quality of curative health care for women and children, there have been specific interventions to enhance reproductive health care, e.g. provision of early and periodic antenatal care, improved access to quality delivery care, and increased use of modern contraceptive methods, resulting in larger interval between pregnancies and lower fertility rates. Besides the long-term impact of lower fertility and widely spaced pregnancies on women's health and nutrition, these methods have shown to improve hemoglobin and iron indicators and lower the risk of anemia (Rivera et al, 1983; Frassinelli-Gunderson, 1985) by inducing amenorrhea and reducing menstrual bleeding.

Oral contraceptives, especially those supplying seven iron containing inert tablets with 75 mg ferrous fumarate (25 mg elemental iron) in 28-day packages, instead of sugar placebos, would be expected to have some impact on women's iron indicators. Oral contraceptives

are known to improve iron nutrition and decrease the risk of iron deficiency anemia by reducing menstrual bleeding by one third to one half, more regular menstrual cycles, and less dysmenorrhea (Population Reports, 2000); those providing iron are likely to have additional nutrition benefits. A study of Mexican women with anemia found that both hemoglobin and serum iron levels increased significantly after one year of oral contraceptive cycles consisting of active contraceptive pills for 21 days followed by iron containing pills for 7 days (cited in Population Reports, 2000). The proportion of women utilizing modern contraceptive methods increased in Nicaragua from 49% in 1993 to 66% in 2001, with a concomitant reduction in fertility rates from 5.1 to 3.2 (Table 1), and an increase in birth space to 30.4 months in 1998 (Perez, 2001). Regular use of oral contraceptives reached 9% of the women of childbearing age by 2001 and that of injected contraceptives (Depo-Provera) around 5% (cited in Perez, 2001); most oral contraceptives used in Nicaragua (e.g. Neogynon) contain iron.

In addition to their benefits for the general health and survival of pregnant women, improvements in the access and quality of antenatal care are usually a pre-requisite for achieving high coverage of iron/folic acid supplementation during pregnancy. In practice, regular health services constitute the major, if not the only, channel of distribution of iron/folic acid supplements to pregnant women; therefore, the maximum feasible level of population coverage becomes basically contingent upon that of antenatal care. In Nicaragua, the MOH population coverage of antenatal care has remained high (around 72%); an undetermined portion of the remaining gap may be covered by the private health sector. The coverage of supplementation in 2003-2005 reached 85%, exceeding the maximum allowed by that of MOH antenatal care.

One of the country's most successful initiatives has been the breast feeding promotion and protection strategy, which accounts for significant improvements in the prevalence (30% by 4 months) and duration of exclusive breastfeeding in infants; mean duration increased from 0.6 months in 1993 to 2.5 in 2001. Malaria is endemic in the northern underpopulated Atlantic region, and its prevalence has declined consistently over the past decades. This is most likely the result of adequate implementation of a targeted malaria control program encompassing vector control mainly by insecticide spray, follow-up to malaria cases and individual prophylaxis, under the responsibility of MOH inspectors, community health promoters and "brigadistas". Malaria rates have continued dropping even from the previously low levels, from 19.6 x 10,000 inhabitants in 2001 to 10.1 in 2005; at these levels, the contribution of reduced malaria rates to reduce anemia would probably be negligible.

The MOH has for many years carried out an Environmental Sanitation Program with assistance from external cooperation agencies (UNICEF, USAID, and PAHO/WHO). The program aims at improving the quality of water supply, removing sources of contamination and disease transmission by vectors, improving excreta disposal (sewage systems in urban areas and latrines in rural settings), proper removal of liquid and solid wastage, and hygienic education (hand washing with locally produced low cost soap products). In addition to a Diarrheal Disease Control Program encouraging prevention and proper management of acute diarrhea in children, there has been an especial National Plan for

Prevention and Control of Cholera which was designed in response to a series of cholera epidemics. Some significant improvements from 1993 to 2001 in the sanitary conditions of households have been reported: households with access to piped water rose from 54% to 77% and those with access to proper sanitary facilities from 27% to 85% (Table 2). The MOH diarrheal disease control program may be credited to account for the drop in the prevalence of diarrhea among children <5 years from 17.6% to 13.1% and the dramatic increase in the use of oral rehydration therapy from 40% to 82% reported by Demographic and Health Surveys (Table 2). Improvement in the sanitary conditions may have contributed to declining diarrhea prevalence, and this, together with a possible reduction in parasite rates, might have somewhat contributed to reduce anemia rates, particularly in children, a presumption that can not be confirmed with the information available.

USAID and the World Food Program have supported food distribution programs aimed at improving dietary intake of vulnerable groups in impoverished areas, both regularly and in response to natural disasters (e.g., earthquakes, floodings, hurricane Mitch). Food distribution, carried out mostly by NGOs, usually consists of daily or weekly food rations of donated foods targeted to women and children, together with nutrition education. A surprising 64% of SIVIN's national sample of households with children < 5 years reported having been recipients of food donations in the last 12 months (Nicaragua, Ministry of Health, 2005). The potential impact of food donations, some of them including fortified foods, to improving nutritional status and reducing anemia in women and children is hard to estimate, but may be restricted by the relatively short duration of food handouts, and the well known sharing of such foods with other family members. A number of other small to large-scale nutrition programs, some of them including growth monitoring of young children and nutrition education of their mothers, have been implemented by NGOs. Although the impact of those programs has not been evaluated, they may have contributed to the significant drop in overall child malnutrition rates documented by the 1998 and 2001 Family Health Surveys and SIVIN in 2003-2005 using anthropometric indicators: stunting dropped from 27.0 to 12.9%, and low weight-for-age from 13.5% to 6.2% (Nicaragua, Ministerio de Salud, 2007).

The consistent dramatic decline in the prevalence of anemia over the past 10 years in non-pregnant women of childbearing age is perplexing and accounting for it poses an especial challenge. Non pregnant women are not covered by the iron/folate supplementation program; despite evidence on the positive impact of intermittent preventive iron supplementation in non-pregnant women of childbearing age, the feasibility of implementing a routine supplementation policy for them in Nicaragua has been hindered by their limited opportunity of contacts with the public health system for delivery of the supplements. Due to the limited time coverage (5.5 months during pregnancy) and the facts that pregnant women represent a relatively low proportion (<10%) of the total population of women of reproductive age, the 6-month recommended duration of supplementation during pregnancy occurs in nearly 60% of the pregnant women, and non-pregnant women are not targeted by the program, even the relatively high coverage >80% and duration of supplementation during pregnancy would not fully account for such a large (two-third) reduction in anemia rates. The benefit of iron supplementation in terms of accumulating iron stores is temporary, especially for women (Lynch, 2000); however, the NMS-00

reported that, among women who had delivered within the previous year, those who consumed iron supplements during pregnancy had a significantly lower prevalence of anemia (24.5%) than those who did not (41.1%). On the other hand, periodic deworming of children may have reduced environmental worm load and potential exposure to transmission of intestinal parasites by the general population, including women.

As mentioned earlier, the contribution of fortified wheat flour to absorbed iron per capita represents only about 6% of the EAR and one tenth of the intake gap reported in 1993. Furthermore, the percentage of households consuming wheat flour products is relatively high but lower in rural than urban areas, and the amount of daily intake per person is low (27 g) compared to other countries and likely to greatly differ by urban/rural area. Other factors that might have contributed to reduce anemia rates in women would be the child spacing and iron balance potential effect of the use of modern contraceptives methods, particularly iron containing oral contraceptives, and the significant drop in fertility in the period 1993-2001. In theory, an additional contributing factor may be a possible consumption of iron supplements procured by non pregnant women through channels other than the MOH programs, including purchase from local retailers. Finally, an eventual effect of additional intake of iron and other nutrients from large scale food distribution programs targeted to women, although not quantifiable, may be considered. It is not possible with the information available to assess the individual contribution of program and non program inputs to reducing anemia; however, adequacy and plausibility assessments support the contention that the consistent reductions of anemia in Nicaraguan women and children may to a large extent be related to IACS implementation.

6.3. Potentially confounding factors. Potentially confounding factors for the attribution of changes in anemia prevalence to program interventions include eventual positive changes in the incidence of infection and in iron balance associated with other programs, and eventual improvements in social and economic indicators during the reference period. Periodic Demographic and Health Surveys (DHS) carried out in 1992 and 2001 reported modest reductions in the prevalence of acute respiratory infections and diarrhea in children <5 years. As an unknown proportion of infections may progress unnoticed, biochemical markers of infection, such as AGP, are used to assess their frequency and trends in populations groups. AGP levels in children were measured by the NMS-00 and subsequently in 2003-2005 by SIVIN to identify the presence of infection; the prevalence of high AGP (>1.0 g/L) rose in 2004, yet anemia rates in children continued dropping. The overall coverage of immunizations had already reached high levels (>85%) by 1993 and showed some decline afterwards although still within useful levels (>70%). Changes in infection rates in children may be reasonably ruled out as a factor likely to contribute to the positive trends in anemia over time.

A modest progress in a number of social and economic indicators from 1993 to 2001 has been reported from Nicaragua (Table 3). In this period, the overall proportion of households in poverty and in extreme poverty somewhat declined from 50.3% to 45.8% and from 19.4% to 15.1%, respectively. Positive changes have been documented in primary and secondary school enrollment, completion of primary school, and life expectancy at birth. GNP growth in the previous ten years changed from -4.4% in 1993 to

-0.1% in 2001, and the annual inflation rate dropped from 584% to 45%. Government expenditures in health rose from 11 to 13% of the national budget, and in education from 9% to 15%, whereas those in defense declined from 50% to 6%. Despite the modest magnitude of social and economic improvement, some contribution to improved health and nutrition indicators beyond the impact of specific programs may not be totally ruled out.

7. Discussion

There is wide acceptance of the need for a multi-factorial and multi-sectoral approach to anemia control in developing countries. An effective anemia control strategy should be evidence-based, tailored to the local conditions and taking into account the specific etiology and prevalence of anemia in a given setting and population group (Stoltzfus, 2001b). In the health sector, multiple integrated strategies have been recommended to be built into the primary health care system and existing programs and services including IMCI, adolescent health, maternal and child health, antenatal care, safe motherhood, malaria, periodic de-worming and control of infections (WHO/UNICEF, 2004).

The magnitude of the countrywide reduction achieved from 1993 to 2000 in the prevalence of anemia in women of childbearing age (29%) nearly met the 30% goal set up by the NMP; this was not the case with children <5 years who experienced no change at all. A total impressive two-third total reduction of anemia rates in women and 40% in children was documented from 1993 to 2005. Although some progress in implementation of national anemia programs targeting women and/or children has been achieved in a number of countries, countrywide reductions of anemia rates in pregnant women but not in all women of childbearing age have been reported from only a few countries, including Thailand and Indonesia (Harvey, 2004); the prevalence dropped in Thailand from about 40% in 1986 to 18% in 1997 (55% of the initial rate), and in Indonesia from 74% in 1985 to 51% in 1995 (31% of the previous rate). Unfortunately, anemia rates in pregnant women have not been assessed in representative samples of the Nicaraguan population. The magnitude of anemia reduction among young children has been greater than that reported from other countries, from 41% in 1986 to 25% in 1997 in Thailand and from 56% in 1992 to 41% in 1995 in Indonesia (Winichagoon, 2002; USAID/UNICEF/PAHO/WHO/FAO, 2003). From 1996 to 2004, there was a dramatic reduction in the level of anemia in children 6- 59 months in Ghana (75% to 31%), Malawi (86% to 60%), Senegal (85% to 69%) and Tanzania (88% to 75%), which was attributed to effective iron supplementation with community involvement (Main, 2006).

The most salient feature of effective country programs has been the use of a multiple comprehensive approach addressing major preventable causes of anemia in the context of expanded coverage and quality of antenatal and child care services, and active participation of CHVs. Successful countries have combined iron and iron/folic acid supplementation of young children and pregnant women with intestinal parasite and malaria control, and, eventually, food staple fortification. Known barriers to implementation of supplementation programs have been properly addressed through comprehensive training of both health service personnel and CHV, and BCC focused on improving awareness, knowledge, attitudes and practices of the target groups, and especial attention to removing existing supply and demand constraints affecting supplementation coverage, demand and

compliance. This includes effective logistics management systems to secure a continue supply of supplements; establishing effective delivery systems eventually utilizing non conventional distribution networks (e.g. NGO, CHV); transmitting clear messages on dose, frequency and duration, ensuring adequate supervision; and training on counseling and prevention and management of adverse effects (Harvey, 2004).

A combination of adequacy and plausibility assessments supports the contention that the remarkable decline in anemia rates in Nicaraguan women and children are plausibly the results of the implementation of an effective IACS by the MOH, with assistance of international cooperating agencies and in collaboration with the food industry and a large network of NGOs and CHVs (“brigadistas”). The key program interventions included iron and iron/folic acid supplementation for children and pregnant women, periodic delivery of anthelmintic medications for children, mandatory universal fortification of wheat flour, social communications, intensive training of delivery staff and person-to-person education and counseling targeted to mothers through local health services. Program interventions have been implemented countrywide with increasing coverage and quality over the past twelve years. Full advantage has been taken of the opportunities offered by NHRs and the increased coverage and quality of antenatal and integrated child care for delivery of services to pregnant women and children, which have benefited from especial efforts to enhance community participation and to promote active involvement of CHVs in counseling and follow-up. The introduction of a more bioavailable iron compound in 2003 presumably increased the effectiveness of the wheat flour fortification program, although (given the relatively low consumption of wheat flour products) its contribution to increased iron intake and absorption would be at best modest, particularly in rural impoverished communities.

Consistent reductions in anemia rates have occurred concomitantly with implementation of the IACS and in parallel with improvements in program performance. Just as the lack of change in anemia rates in children between 1993 and 2000 can be attributed to poor program performance, the significant drop after 2000 is most likely related to increased children’s coverage and compliance with supplementation and anthelmintic medications twice-per year, with some minor contribution from intake of fortified wheat flour products. A potential effect of fortified wheat flour on total iron ingested and absorbed and on anemia rates would be more likely in women than in children who are known to consume much lower amounts of wheat flour products, particularly in rural areas. In addition to high coverage and duration of iron/folic acid supplementation during pregnancy, other factors likely to have contributed to anemia reduction in women include improved coverage and quality of antenatal care, increased contraceptive use (particularly of iron containing oral contraceptives), reduced fertility with longer birth spacing and, probably to a lesser extent, consumption of fortified wheat flour products. Positive developments in other public health areas and a modest improvement in social and economic conditions may have also contributed to reduce anemia.

The successful Nicaraguan experience provides convincing evidence that a properly designed and implemented multi-pronged integrated strategy addressing the most important causes of anemia in women and children is effective in reducing the prevalence

of anemia in the population. Such strategy starts with an appropriate situation analysis, general and high-level sensitization and advocacy, creation of a functional anemia task force, examination of the options available to address the main known causes of anemia in the population, a carefully crafted anemia control program aimed at increasing intake of iron and other relevant nutrients and reducing parasitic worms and, eventually, at controlling other major causes of anemia such as malaria and systemic infections. Iron/folic acid supplementation, delivery of anthelmintic medications and fortification of food staples appear to have a synergistic impact in increasing intake of iron and other nutrients and reducing anemia; the role of modern contraceptive methods deserves further evaluation. A pre-requisite for effective program performance is a functional health system securing high enough coverage and quality of health care, particularly of antenatal and child care services. Important program features are: proper selection of target groups and interventions, updated protocols and guidelines for program implementation, intensive and refreshing training of health care personnel, a properly designed BCC strategy, provisions to address supply, delivery and demand/compliance constraints affecting delivery of services, and a functional program M&E system.

8. Remaining challenges to anemia control in Nicaragua.

Despite significant progress in program implementation over time, some practical problems remain with IACS implementation that require further attention. First, both coverage and duration of iron supplementation and its monitoring system need to be strengthened, particularly with children; delivery of iron supplements to pregnant women and children is registered in the prenatal clinical record and the child's card, but the information is not systematically transferred to tally sheets thus reliable coverage rates other than those based on mother's recall are not regularly available. Second, there is a need for a formal definition of the official policy on iron/folic acid supplementation for pregnant women, as intermittent dosing was established in 1998 but a shift to daily iron dosage following international recommendations (WHO/UNICEF, 2004) may be considered in a forthcoming revision of the technical guidelines; a large number of health districts and local units have already shifted to daily dosage in anticipation to the revised guidelines. Third, a critical analysis of the implications of the reduction of NHR to once per year on maintaining control of micronutrient deficiencies, particularly on VAD and anemia, is of great importance to make pertinent decisions accordingly². Fourth, there is a need for updated information on individual dietary intake to assess trends for iron and other nutrients as intermediate program outcomes leading to reduced anemia; this is critical for a more precise estimation of the actual contribution of fortified wheat flour to iron dietary intake. Fifth, additional options for improving iron status of infants may be considered, including delayed cord clamping as part of routine delivery care technical norms and its enforcement, fortified complementary foods and/or home fortification (e.g. sprinkles) targeted to young children at risk of iron deficiency. Finally, systematic M&E of the BCC strategy and an assessment of the cost-effectiveness and sustainability of the IACS may be recommended.

² There is some evidence that twice a year distribution of anthelmintic medications to school children is less effective than thrice-yearly in reducing parasite rates and improving iron status, let alone only once per year (Stoltzfus et al, 1998).

9. Lessons Learned

Implementation of the Nicaraguan anemia control strategy has evolved through a mix of successes and failures, constraints and solutions, positive and disappointing developments, and finally encouraging results, some of which are not yet fully understood and would deserve closer documentation and examination (e.g. fully accounting for the dramatic reduction in anemia rates in women; assessment of the potential contribution of wheat flour fortification to reduce anemia rates). The integrated multi-pronged strategy adopted by Nicaragua to control anemia appears to have been very effective. Given the scarcity of positive reports on successful efforts to addressing anemia as a problem of public health significance in developing countries, sharing the Nicaraguan experience and lessons on potentially effective IACS planning and implementation would be worthwhile, even though the experience has not yet been systematically evaluated nor its cost effectiveness and sustainability documented, and despite incomplete information to account for some of the results. The following general lessons have been learned from Nicaragua.

- *Success in addressing anemia appears to be most likely when a multi-pronged integrated approach is adopted to address the main causes of anemia with multiple reinforcing interventions than through an isolated program.* A sequence of different program interventions was gradually introduced with remarkable performance and effectiveness in Nicaragua. As simultaneous launching of multiple interventions may not always be possible, gradual introduction of reinforcing actions would be a more realistic way to proceed in most countries. In addition to specific programs aimed at anemia control, concomitant progress in other public health domains such as health service coverage (e.g. reproductive health and antenatal care, integrated child care services) and improvements in environmental, social and economic conditions may help to enhance program impact.
- *Pilot/demonstration projects to address operational constraints are extremely useful.* Key accomplishments in implementation of El Cuá pilot/demonstration project provided health workers with strong motivation and badly needed evidence that apparently resilient operational problems (e.g. poor demand of and compliance with supplements) may be successfully resolved. The pilot project provided evidence that properly trained CHVs can be successfully involved in iron supplement distribution, counseling and follow up thus enhancing coverage and compliance as pre-requisites for program effectiveness. The positive experience was rapidly transferred by the MOH to other areas and scaled up to the whole country with active NGO involvement. Systematic participation of CHVs in program implementation appears to be critical for improving program performance and effectiveness.
- *Existence of a strong health infrastructure, effective health delivery services and community support is a plus.* Not many countries would be in a position to build on such a long history and experience of community mobilization in support of health programs and to take advantage of the availability of an extended local health

service infrastructure. With a large network of well established local health centers and posts in all municipalities, a longstanding tradition of community support and participation in health programs, successful public health interventions (e.g. high coverage and quality of antenatal and delivery care by trained and motivated personnel, consistently high rates of immunizations, improved rates of exclusive breast-feeding), and a roster of more than 12,000 trained and/or trainable and motivated CHVs (“brigadistas”), Nicaragua offers an ideal context for effective public health programs and primary health care interventions (IMCI, ORT, micronutrient supplementation, BCC, growth monitoring and promotion, community health and nutrition education).

- *Program ownership by health districts and local units is a sound basis for institutional sustainability.* Participation of health district staff in information dissemination and program planning workshops, and the ensuing sharing of information by district staff with local units, enhances MOH ownership of the overall program and of specific activities. Under the Nicaragua decentralized health system, program ownership is fostered by regular participation of districts in developing and evaluating annual plans. Evaluation meetings with SILAIS are scheduled after each NHR to review program performance and yearly to discuss annual reports of fortified foods monitoring. District program ownership stimulates a healthy competition among districts regarding program performance (e.g. supplementation and deworming coverage), motivates pertinent districts to take full responsibility for monitoring of fortified foods, and stimulates district authorities to make provisions to improve program performance.
- *A functional management logistic system is critical to maintain continue availability of supplements at delivery posts thus removing supply constraints affecting program success.* Even the best technical plans for health service delivery are unlikely to succeed if supplies are not available on a continue basis at distribution points. Irregular supply of supplements is a common barrier to supplementation programs in developing countries. Although this is often a generic problem affecting all pharmaceutical products delivered through public health systems, supplementation programs tend to suffer disproportionately because of their reliance on routine supplement distribution for daily consumption. Addressing supply constraints in the whole pharmaceutical system may not be feasible thus in some cases, strengthening the management logistics system for micronutrient supplements would be a more realistic approach; this has also been the case with reproductive health programs that require a constant supply of contraceptives.
- *Food industry commitment is critical for maintenance of high quality and coverage of food fortification.* The contribution of wheat flour fortification to increase intake of iron, folate and other nutrients, although possibly modest due to existing consumption patterns, can not be ignored, particularly when considered on top of supplementation rather than in isolation. The excellent performance of the wheat flour fortification program is clearly the result of strong industry commitment, coupled with adequate training and effective government monitoring.

- *Monitoring and evaluation (M&E) systems provide important information for decision-making.* Although not always systematic, M&E efforts were made since program inception, and existing limitations in program M&E systems were for the most part resolved with assistance from external donors. Regulatory monitoring was readily accepted and valued by the food industry as a means for leveling the playing field. Household monitoring of fortified foods was integrated into SIVIN since 2003. Current efforts aim at enhancing sustainability of the SIVIN system for M&E of nutrition programs; however, securing systematic use of M&E information for decision-making would require additional efforts.
- *Effective international cooperation and coordination facilitates rational use of external resources.* USAID and other cooperating agencies have propelled the health and nutrition agenda in Nicaragua. USAID, UNICEF, INCAP/PAHO, CDC and MI have been strongly committed to providing technical and financial support for NMP implementation, including anemia control. Excellent inter-agency coordination has been established with emphasis on collaboration over competition. In addition, a number of international and local NGOs, notably the NicaSalud network, have been active in child survival and nutrition and have collaborated with the MOH in implementation of micronutrient programs at the community level, particularly in vitamin A, iron and iron/folic acid supplementation and BCC.

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Figure 1. Integrated Approach to Vitamin A Deficiency and Anemia Control in Nicaragua

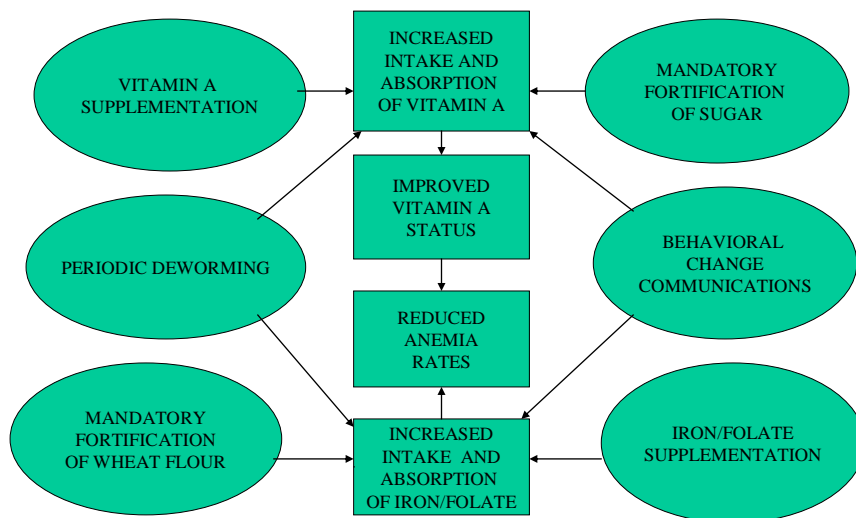


Figure 2. Prevalence of anemia in non pregnant women 15-49 years. Nicaragua, 1993,- 2005.

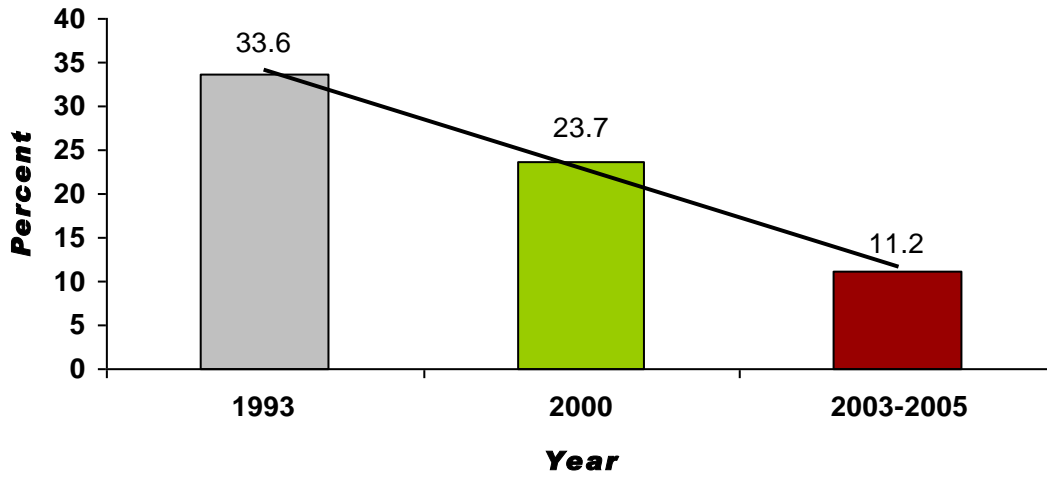
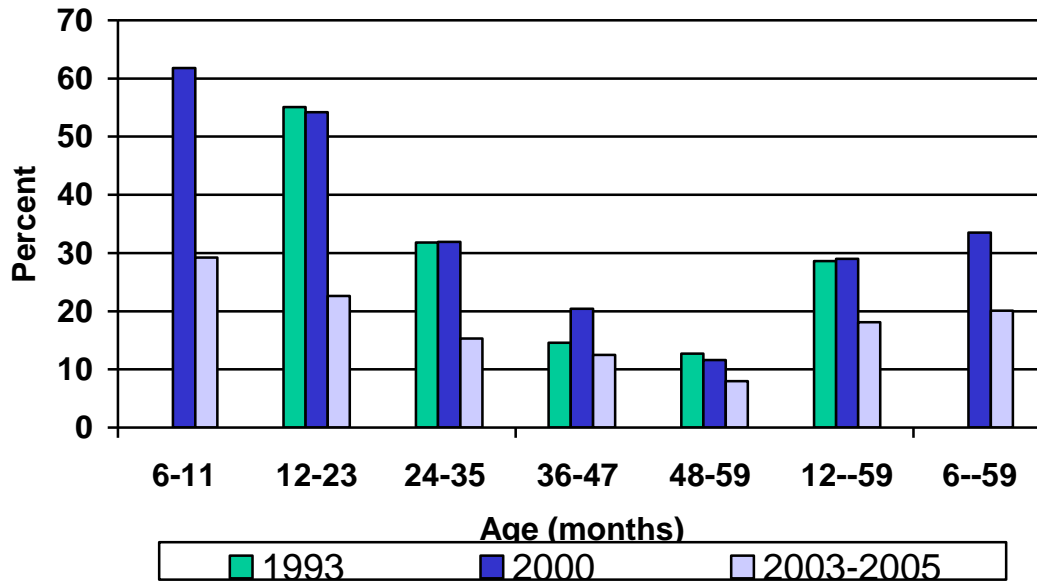


Figure 3. Prevalence of anemia in children 6-59 months*, by age group. Nicaragua, 1993-2005



* Children 6-11 months were not covered in 1993

Figure 4. Prevalence of anemia, iron deficiency (ID) and iron deficiency anemia (IDA) in non pregnant women 15-49 years, by region and geographic area. Nicaragua, 2004-2005.

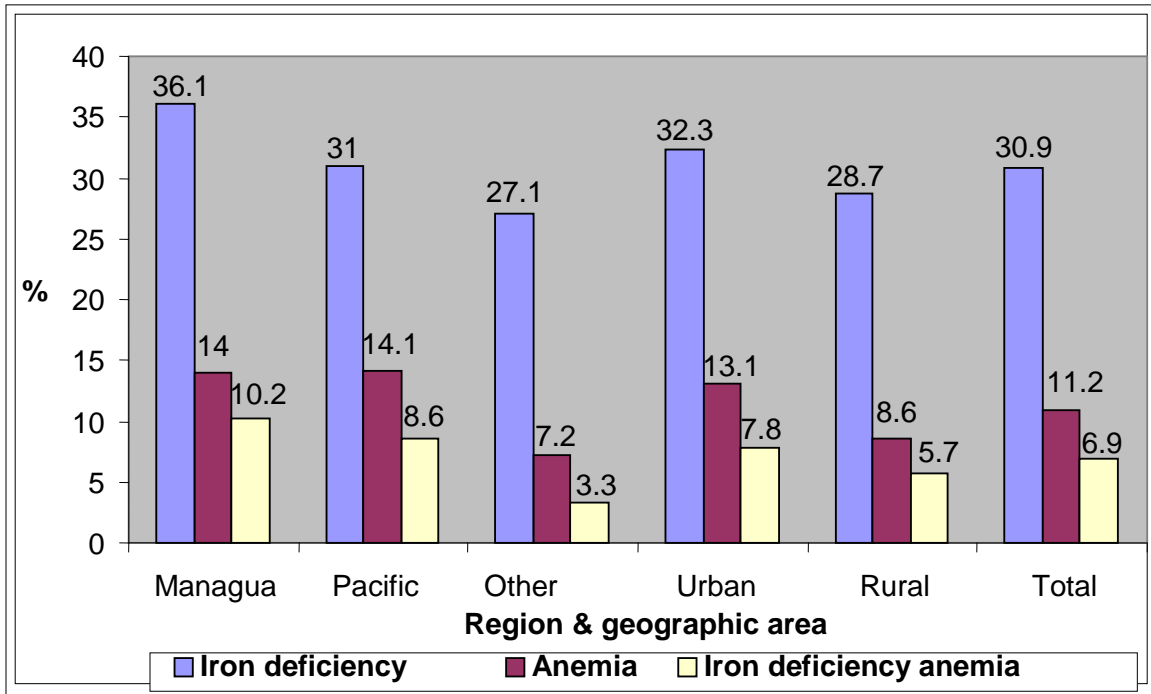


Figure 5. Prevalence of anemia, iron deficiency (ID) and iron deficiency anemia (IDA) in children 6-59 months, by age group. Nicaragua, 2004-2005.

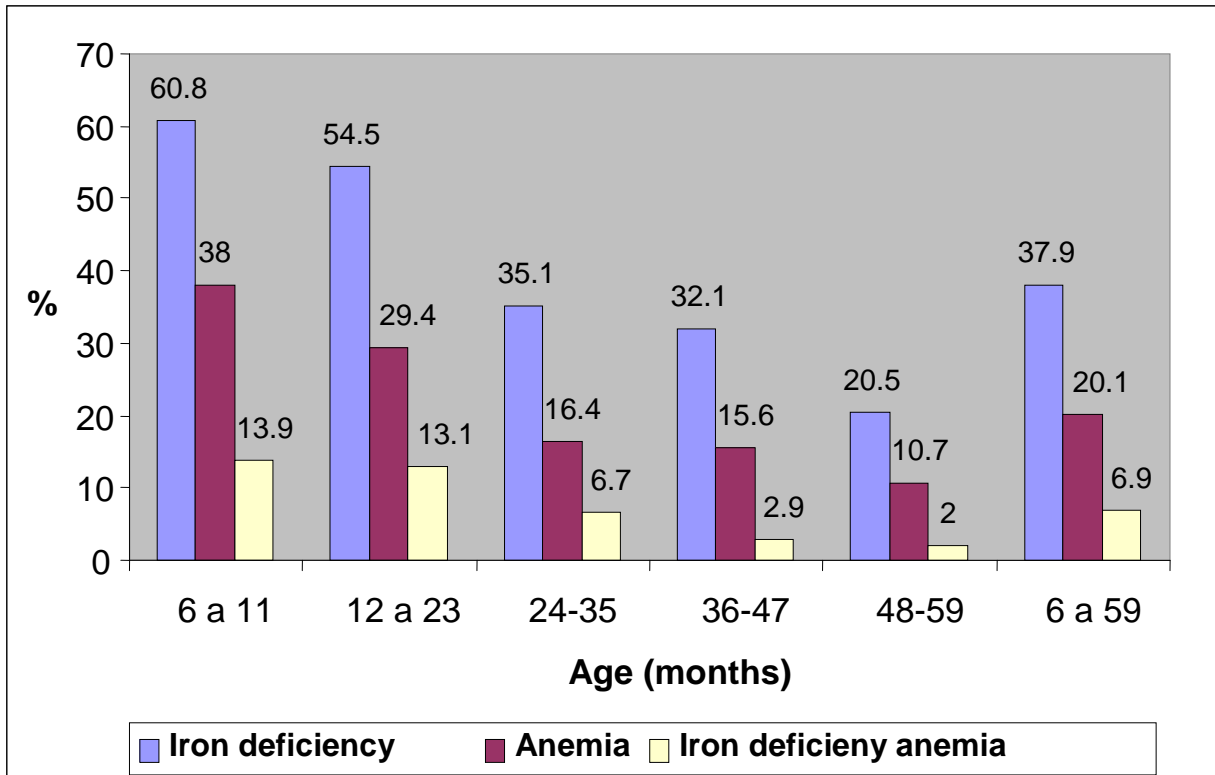


Figure 6. Coverage of supplementation with iron /folate in pregnant women and with iron in children 6-59 months. Nicaragua, 2003-2005

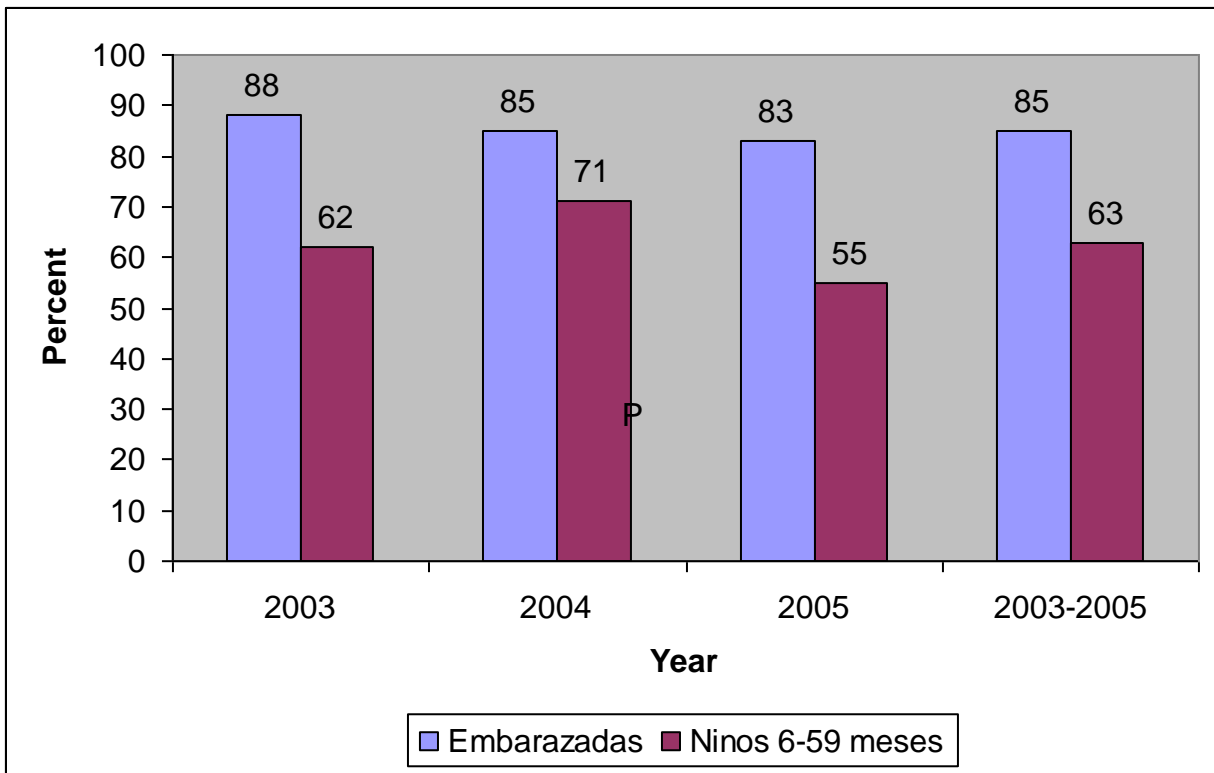


Figure 7. Coverage (%) of anthelminth medications distributed to children 2-4 years. Nicaragua, 2002-2005.

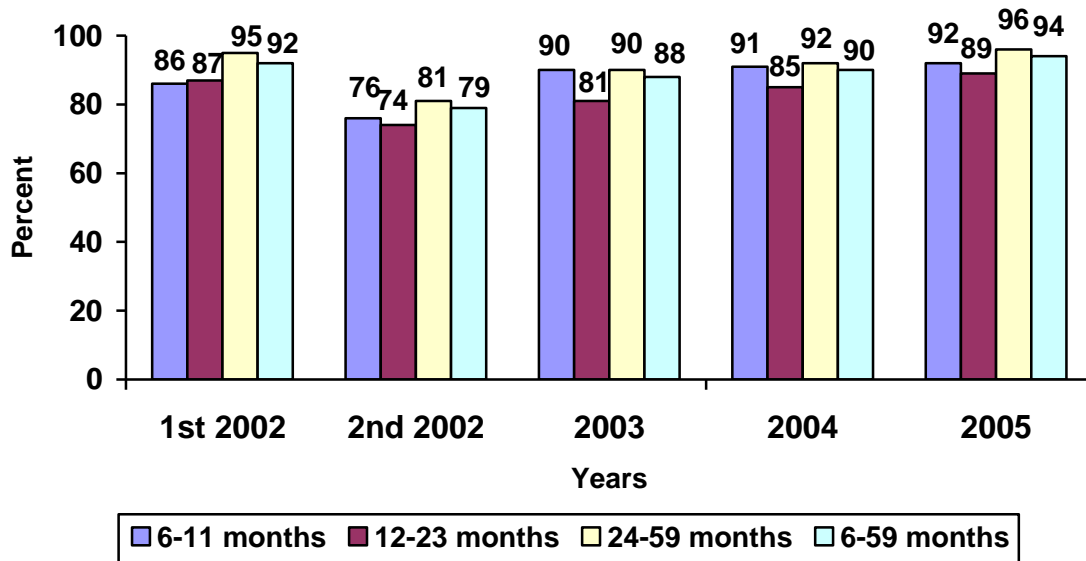


Figure 8. Coverage (%) of vitamin A supplementation to children 6-59 months, by age group. Nicaragua, 2002-2005.

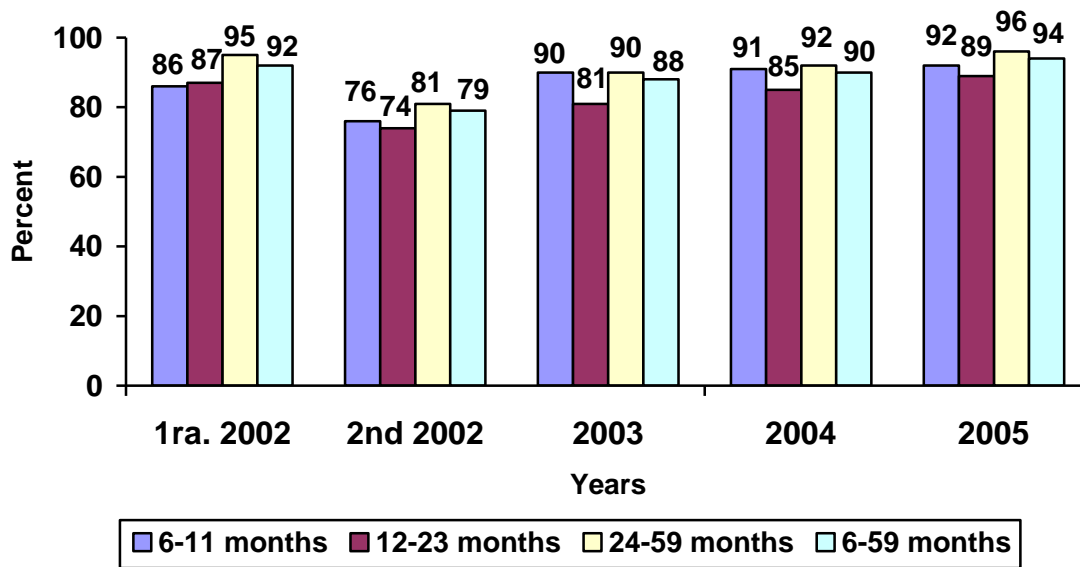
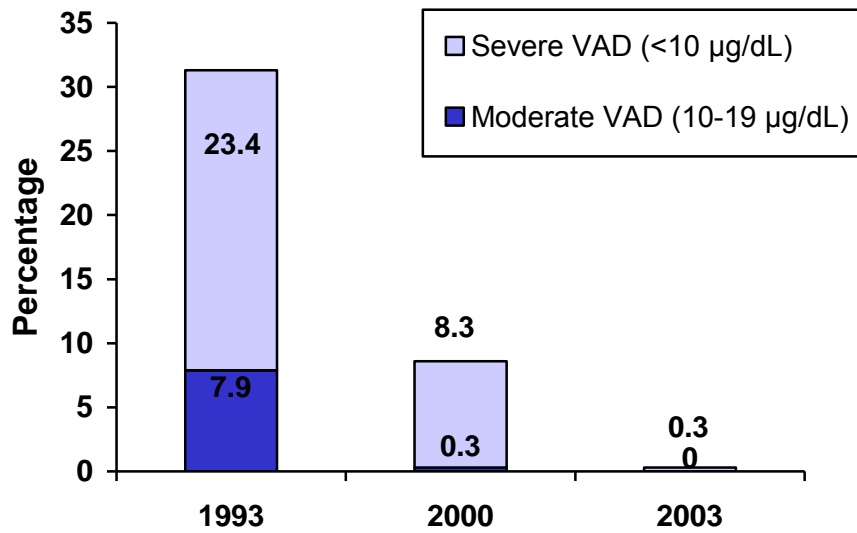


Figure 9. Prevalence of vitamin A deficiency (plasma retinol <20 µg/dL) in children 6-59 months*. Nicaragua, 1993-2005



* Children 6-11 months were not covered in 1993.

Table 2. Changes in coverage of basic public health services and household environmental sanitation. Nicaragua, 1993 - 2001*

Indicators	1993	2001
% households with:		
access to piped water (urban/rural)	54 (76/21)	77 (91/59)
access to sanitary facility (urban/rural)	27 (30/16)	85 (95/72)
electricity	66	73
access to gas for cooking	24	37
radio receptor	77	81
television set	52	59
telephone service	6	12
refrigerator	23	26
% ORT use for treatment of diarrhea in children	40	82
% use of modern contraceptives by women of childbearing age	49	60 (1998)
Global fertility rate (per woman)	5.1	3.2
Crude birth rate per 1000 population	41	33
Mean duration of exclusive breastfeeding (months)	0.6	2.5
% coverage of prenatal care (at least one visit)	72	86
% deliveries assisted by trained personnel	73	90
% children with complete immunizations:		
BCG	90	77
DPT	81	71
Polio	83	73
Measles	85	71
All vaccines	75	64

* Sources: Encuesta de Salud Familiar (ESF), 1992/93
 UNICEF State of the World's Children, 1996
 Ecuesta Nicaraguense de Demografia y Salud (ENDESA), 2001