Effectiveness of Home-Based Fortification of Complementary Foods with Sprinkles in an Integrated Nutrition Program to Address Rickets and Anemia

World Vision Mongolia
ULAANBAATAR, 2005

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Special thanks to the health facilitators who contributed to the understanding of the details of program implementation, to the nurses and community volunteers who smoothed data collection in the field, and the community nutrition workers and program beneficiaries whose enthusiasm made the program itself a success.

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ABBREVIATIONS & DEFINITIONS

ADP	Area Development Program
AI	Alternative Intervention
Aimag	province
Bag/kheseg	sub-district
CDC	Centers for Disease Control & Prevention
FAO	Food & Agriculture Organization
Ger	traditional felt yurt (house)
HA	Height-for-age or stunting
Hb	Hemoglobin
HH	Household
HF	Health Facilitator
HSC	Hospital for Sick Children
IEC	Information, Education, & Communication
IU	International Units
KAP	Knowledge, Attitudes, & Practices
LW	Lactating Women
M	Mean
MNTV	Mongolian National Television
MOH	Ministry of Health
n	Sample Size
NGO	Non-Governmental Organization
NO	National Office
NP	World Vision Mongolia Nutrition Program (Intervention Regions R1 & R2 below)
NPAN	National Plan of Action for Food Security, Safety and Nutrition
NRC	Nutrition Research Center
NW	Nutrition Worker
OMNI	Opportunities for Micronutrient Interventions
PHI	Public Health Institute
PLW	Pregnant & Lactating Women
PW	Pregnant Women
R1	World Vision Mongolia Nutrition Program First Intervention Region: Ulaanbaatar (Amgalan, Dari-Ekh, Bayankhoshuu, Tolgoit, & Nalaikh) & Bulgan I
R2	World Vision Mongolia Nutrition Program Second Intervention Region: Bulgan II, Erdenet & Dundgobi
SD	Standard Deviation
Soum	rural district
Tg	Tugrik
UB	Ulaanbataar
UN	United Nations
UNICEF	United Nations Children's Fund
VDD	Vitamin D Deficiency
WA	Weight-for-Age
WH	Weight-for-height
WHO	World Health Organization
WVC	World Vision Canada
WVM	World Vision Mongolia
<3s	children under age 3 (6-35 months)
<5s	children under age 5 (6-59 months)
3-5s	children 3 to 5 years of age (36-59 months)

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1.0

This report describes the first large scale implementation and evaluation of Sprinkles in the context of an integrated nutrition program.

Home-based fortification, through the use of 'Sprinkles' (an innovative multiple-micronutrient food fortificant) has been shown to be efficacious in preventing and treating anemia in children under 5 years of age (Zlotkin et al., 2005). However, there has been little experience in the scale-up of Sprinkles programming and a lack of evaluation of large-scale programs. To address this gap, World Vision Canada and World Vision Mongolia in collaboration with the Mongolian Ministry of Health, and with technical support from the Hospital for Sick Children implemented and evaluated the first large-scale implementation of Sprinkles in the context of an integrated nutrition program. This report presents the findings of this evaluation.

Rickets and anemia are the most prevalent forms of childhood malnutrition in Mongolia. The levels are unacceptably high, according to World Health Organization (WHO) standards, with anemia prevalence classifying it as a major public health problem. To address these needs, World Vision designed an integrated Nutrition Program (NP) to improve child and maternal levels of Vitamin D and iron, as a means of preventing and treating rickets (vitamin D deficiency) and anemia (iron deficiency) in WVM's area development programs (ADPs). The NP included home-based fortification (Sprinkles), supplementation, social marketing, and community nutrition education.

Sprinkles were distributed to children age 6-35 months in two regions of Mongolia from 2001-2003. Community nutrition workers (NWs) distributed Sprinkles to children 6-35 months of age, achieving 88% coverage. The Sprinkles were well accepted and the average duration of use was 13 months. Children in the 36-59 months age group who had anemia or rickets received iron syrup or vitamin D supplements, from NWs and family doctors. Pregnant and lactating women were supplemented with vitamin D and iron tablets, although coverage of these interventions was much lower than targeted.

The program effectiveness was evaluated using cross-sectional surveys which compared key indicators at baseline (2000/1) and end of program (2003). The surveys included a household questionnaire, hemoglobin measure for anemia status, clinical assessment for signs of rickets, and anthropometric measurements.

Anemia dramatically decreased in all NP areas, from 46% at baseline to 25% at final among children 6-59 months of age. This success is attributed primarily to Sprinkles intervention. Through NGO/MOH collaboration, Sprinkles were effectively distributed in this sparsely populated country and were accepted by caregivers and used with the traditional complementary foods of young children. The major limitation of the intervention was that parents did not start giving Sprinkles to their children until an average age of 13 months, even though the entire 6-35 month age group was targeted. Anemia prevalence did decline in children age 6-18 months, but remained in the range of a severe public health problem (>40%) at the end of the program. The need to ensure adequate iron intake to infants as soon as they begin complementary feeding the youngest children (6-11 months) was not effectively addressed by this intervention.

In contrast to the reduction in anemia, the prevalence of rickets did not change overall, although in one NP area it decreased significantly, from 36% to 31%. The lack of success in decreasing rickets is likely due to insufficient levels of vitamin D in the Sprinkles (400 IU/day) to prevent deficiency or to replete children who were deficient. In addition, the fact that most children did not receive Sprinkles in the first year of life may have led to the intervention being too late to prevent the onset of clinical vitamin D deficiency.

The experience of the World Vision Mongolia Nutrition Program demonstrates that home fortification through Sprinkles is an effective intervention for anemia control in young children. Expansion of this intervention within Mongolia and in other contexts where anemia prevalence is high is recommended. Increasing the dose of vitamin D in the Sprinkles formulation, re-emphasizing vitamin D treatment for all children <5 with rickets and improving supplementation coverage to pregnant and lactating women are all recommended to address the ongoing issue of rickets in Mongolian children.

2.0

Vitamin A, iodine and iron deficiencies are wide spread and can cause problems from blindness to developmental and intellectual impairments, and if severe even death.

2.1 Global Context

Over 50% of child deaths worldwide are attributable to malnutrition (Black, et. al., 2003). Children often do not consume enough food to meet their nutrient and energy needs, a situation that is compounded by illness which increases energy needs and decreases the ability to absorb nutrients. Food shortages, poor dietary quality, and imbalanced intake of macronutrients (calories, as carbohydrate, protein, and fat) also make it difficult to get enough micronutrients (vitamins and minerals). In recent decades, attention has been particularly focused on vitamin A, iodine, and iron deficiencies, which are widespread and cause problems from blindness to developmental and intellectual impairments and, if severe, death.

There has been progress in reducing the global prevalence of these key micronutrient deficiencies. Vitamin A capsules are widely distributed during immunization campaigns and iodized salt is increasingly available. However, iron deficiency has generally frustrated nutrition programmers and is of significant public health concern as iron is critical for cognitive function and psychomotor development (Oski 1983, Walter 1989, & Lozoff 1987), physical growth (Chwang 1988 & Latham 1990), and immunity (Chandra 1982 & Cook 1986). Poor iron status leads to anemia, poor scholastic performance, low birth weight and maternal mortality. Efforts to reduce iron deficiency have met with many challenges. Foods fortified with iron may not reach consumers, who perceive them as expensive, despite typically minimal price differentials. Iron supplements, though cost-effective, also have disadvantages, including poor compliance and significant logistical barriers to large-scale coverage (Yip, 1996).

In addition to the global prevalence of iron, vitamin A and iodine deficiencies, other micronutrients are of concern in particular contexts. In Mongolia, iron deficiency is widespread, but vitamin D deficiency is also a major nutrition issue. This is primarily due to the northern climate which limits exposure to sunlight, the main source of vitamin D. Vitamin D plays a major role in growth and bone strength, and is a major cause of rickets, classically manifesting as bowed legs. In many developed countries milk is fortified with vitamin D to prevent rickets, but this option is not currently available in Mongolia. Mongolians must therefore rely on other less optimal dietary sources, exposure to sunlight (a challenge where children are swaddled all winter), or supplementation.

2.2 Mongolian Nutritional Status

Over the past fifteen years, Mongolia has been undergoing the shift from a centrally planned to a market economy, while adjusting to reduced external funding, following the end of decades of Russian support. The strong trend toward urbanization and decreased focus on the traditional herding lifestyle has left urban dwellers largely unemployed, with little means to support themselves. Natural disasters, such as plagues of locusts and severe storms known as "dzud"s,[1] also greatly impact livelihood. In 2000, herders lost up to 6 million livestock in one year (about 20% of the national herd, UN and Government of Mongolia Appeal, 2001). Thus the population lacks the resources to obtain adequate nutritious food for healthy growth and development, and malnutrition is widespread. In a 1999 survey, anemia, largely caused by iron deficiency (NRC, 2003)[2,3] was reported in 42% of children under age 5 (NRC & UNICEF, 2000), making it a

[1] "White Dzud," severe snow covers grazing land; "Iron Dzud," melting snow re-freezes into ice cover, hindering grazing; and "Black Dzud," during drought; herds concentrate near water, destroying pastures.

[2] Serum ferritin tests confirmed iron deficiency as the cause in 75% of anaemic children 6-23 months old.

[3] Anemic children were 1.65 times more likely to be iron deficient than were non-anemic children (p<0.01); severe iron deficiency was more prevalent in anemic children (suggesting iron as a likely factor); and there was no difference in folic acid or B-12 deficiencies in anemic versus non-anemic children (shifting blame from these alternate explanations). Less-than-ideal exclusive breastfeeding rates and poor complementary foods (missed opportunities for iron consumption) also contribute (NRC & WVM, 2004).

serious public health problem, according to World Health Organization guidelines (WHO & UNICEF, 1995). The same survey reported a 33% prevalence of rickets in children, based on clinical signs. This level is very high and suggests an even more widespread prevalence of sub-clinical vitamin D deficiency (Tserendolgor, 1998).

Basic knowledge on nutrition issues among Mongolian women is limited. In 2001, World Vision Mongolia (WVM) and the Government of Mongolia's Nutrition Research Center (NRC) found that only 15% of women who had seen rickets knew that sun exposure was related and only 27% knew that sunshine could prevent or treat it. Forty-eight percent of women defined anemia as a lack of or low quality blood and 46% knew that eating meat was good for prevention/treatment (NRC & WVM, 2001). The Ministry of Health trains doctors but not other health practitioners to educate patients on nutrition.

2.3 Mongolian Nutrition Policy and Programs

A wide range of micronutrients, including iron, folate, vitamins A and C, and zinc, are essential to growth and development. These nutrients are scant in the diets of Mongolian children, necessitating their provision from some other source. The Mongolian National Plan of Action for Food Security, Safety, and Nutrition (NPAN - Government of Mongolia, 2001), highlights the need to prevent vitamin D deficiency in children under age 5 (<5s), iron deficiency anemia in <5s and pregnant or lactating women (PLWs), and iodine deficiency in the general population. The NPAN calls for the provision of vitamin D and iron to all of these target groups.

The Integrated Management of Childhood Illness program recommends preventive iron in the amount of 2mg/kg body weight, daily, for children 6 months to 2 years of age; the treatment dose is 3mg/kg body weight, daily, for 3 months. Low birth weight and premature infants begin iron supplementation at 2 months of age. While the recommendation is to continue iron supplementation until 2 years of age, in practice, it is provided for only 3 months due to a shortage of iron supply. After 3 months of supplementation, children are to be re-assessed to determine whether or not the anemia was caused by a deficiency of iron.

In many provinces of Mongolia, UNICEF supports the provision of vitamin A and D supplements. The vitamin D supplementation policy for prevention of rickets in children is 50,000 IU monthly from October-May until age two. For treatment the dose is 50,000 IU twice a week for seven doses, followed by the preventive regimen. However, distribution appears to be less than ideal. For example, a survey found that only 35% of children under age two had been reached with vitamin D supplements (WVM & NRC, 2001). In addition to coverage issues, supplements are often taken for an insufficient duration, perhaps in part due to unclear instructions (NRC & WVM, 2004).

While guidelines do exist for vitamin D supplementation to pregnant women (50,000 IU/month, October to May during 3rd trimester of pregnancy), a shortage of vitamin D capsules hinders implementation of this recommendation.

A wheat fortification project, funded by the Asian Development Bank, is the other major strategy for improving micronutrient intake in Mongolia. Efforts are also underway to fortify dairy products with vitamin D.

2.4 Partners in the World Vision Mongolia Nutrition Program

The Nutrition Program presented in this report was implemented by World Vision Mongolia and World Vision Canada in partnership with the Mongolian Ministry of Health. Additional technical support was provided by the Hospital for Sick Children in Toronto.

World Vision Mongolia (WVM) was established in 1991 and provides a variety of relief and development interventions in 16 provinces through its 28 Area Development Programs (ADPs). The Nutrition Program (NP) was implemented in nine ADPs by Health Facilitators, with management from WVM staff.

World Vision Canada (WVC) manages and provides technical support to many comprehensive nutrition and health programs throughout the developing world. WVC's support for nutrition programming in Mongolia began with a survey of iron and vitamin D deficiency in three regions of Mongolia in 1997. The findings of this survey prompted the development of the Nutrition Program described in this report, for which WVC secured funding and provided technical support.

Researchers at the Hospital for Sick Children (HSC), Toronto, Canada, developed a unique multiple-micronutrient home-based fortificant (Sprinkles) to prevent and treat key nutrient deficiencies in populations in need (Zlotkin et. al., 2005). More details on the product will be described in section 3.7.1. The Sprinkles Group at HSC facilitated the supply of Sprinkles to the NP, provided technical support, supervised the initial analysis for the final evaluation and helped prepare this report.

Senior officers within the MOH have been long-time supporters of WVM. Several of these officers, as well as the head of MOH's Public Health Institute (PHI) were involved in the 1997 survey. The survey was implemented by the PHI's Nutrition Research Center (NRC), an entity that is involved at some level with all of the major nutrition efforts in Mongolia. These three entities provided support during the NP, ranging from navigating bureaucracy, to helping involve WVM in processes that would further the NP's agenda, sharing relevant research, and implementing the NP's surveys and studies.

While the support from the relevant government partners enabled WVM to move forward with the innovative Sprinkles approach, the participation of the communities and willingness of community members to serve as dedicated Nutrition Workers (NWs) was also critical to the success of the program.

3.0

The nutrition program used integrated strategies with Sprinkles, supplements, social marketing, and nutrition education to improve the nutritional status of Mongolian children.

3.1 Program Goals

The goals of the Nutrition Program were:

- To improve the nutritional status of Mongolian children under five years of age (<5s[4]), decreasing anemia (from 44 to 20%) and rickets (from 30 to 20%)
- To build community and MOH capacity to improve child nutrition.

3.2 Program Objectives & Activities

The Nutrition Program goals were to be achieved through the following objectives:

1. Increasing dietary intake of and access to nutrients (iron and vitamin D) among <5s and pregnant and lactating women (PLW) through the following activities:
    - Distributing the home-based fortificant (Sprinkles) for children aged 6 to 35 months (<3s), to prevent rickets and anemia;
    - Promoting consumption of iron-rich foods, exclusive breastfeeding for six months, increased sun exposure and decreasing length of time with swaddling clothes;
    - Facilitating supply of supplements and providing training for doctors in clinical diagnosis and treatment of rickets and anemia in those aged 3 to 5 and in distributing Vitamin D and iron/folate to PLW.[5]

2. Increasing nutrition knowledge and capacity of health workers and the community by:
    - Training doctors, nurses, and pharmacists on rickets and anemia prevention and treatment;
    - Training staff (Health Facilitators and Nutrition Workers) to carry out fortificant distribution and community education;
    - Educating communities and households about nutrition, through workshops and home visits.

3. Increasing public awareness on nutrition-related issues through research, advocacy and policy:
    - Social marketing campaigns (e.g., posters, billboards, television, and radio spots),
    - Research to determine the etiology of childhood anemia in Mongolia,
    - Providing nutrition-related technical support to other programs,
    - Increasing private sector interest in nutrition, and
    - Providing input into Government nutrition policy (e.g. the National Plan of Action on Nutrition).

3.3 Program Targets

Coverage of home-based fortification (Sprinkles):

- 80% of children aged 6-35 months,[6] receiving preventive doses of vitamin D and iron, as well as other nutrients as home-based fortificant Sprinkles, mixed into the child's meal, once daily.

Coverage of supplements for treatment of anemia and rickets in children 36-59 months:

- 80% of children with signs of rickets and/or anemia, receiving 50,000 IU vitamin D (7 doses in 3.5 weeks) and/or iron syrup (3mg/kg daily for 3 months).

Coverage of supplements for prevention of anemia and rickets in children 0-6 months, via supplementation to their mothers:

- 80% of PLW receiving vitamin D & iron supplements;
- 50,000 IU of vitamin D monthly for the pregnant woman (PW) during her last trimester of pregnancy and for the lactating woman (LW) for the first six months after delivery;
- 60 mg of iron and 400 mcg folic acid for the mother daily for the last two trimesters of pregnancy and the first six months post-partum.

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[4] Throughout this report, "<5" signifies children 6-59 months, as the NP did not directly provide micronutrient fortificants/supplements to 0-6 month children. Similarly, "<3" signifies children 6-35 months.

[5] Benefiting mother and child, as children born to anaemic mothers are more likely to be anaemic

[6] This target group was chosen due to the baseline finding that anemia prevalence was greatest in children under 3 years, and given the difficulty of reversing skeletal deformations of rickets in children older than 3. Infants younger than 6 months did not receive sprinkles as the program promoted the international recommendation of exclusive breastfeeding for the first 6 months of life.

Social marketing to increase public awareness of nutrition-related topics:
- Development of 12 nutrition education videos in partnership with MOH, UNICEF & Mongolia National Television
- Development of 8 radio spots - based upon the key nutrition messages

Capacity building of community and health workers:
- 80% of families with children under 3 years of age participating in monthly nutrition workshops
- 80% of families with children under 3 years of age provided with nutrition education materials
- Quarterly training of WV health facilitators
- Quarterly training of nutrition workers
- Quarterly training for family doctors, nurses & pharmacists on prevention & treatment of vitamin D & iron deficiencies
- Design, produce & provide training materials for family doctors on supplementation

3.4 Program Timelines

Program implementation was staged, in order to effectively train staff and collaborators.

3.4.1 Region One (R1):

In July 2000, the program started in the first region (R1), in six WV Area Development Programs (ADPs) in Ulaanbataar (UB) and Bulgan[7], with program planning, hiring, materials design, and logistics. WVM and NRC collaborated to conduct the baseline survey in October. Training of NWs began in January 2001, after which NWs began to educate communities and build capacity around nutrition. Capacity building of doctors began in March. Staggered fortificant/supplement distribution began in July 2001 as supplies were procured. Full program implementation (home fortification, supplementation and other program activities) continued for 26 months until September 2003, when the final survey was carried out, again in collaboration with NRC.

3.4.2 Region Two (R2):

In 2001, the program expanded to R2, which included three additional WV ADPs in Dundgobi,[8] Erdenet,[9] and another area of Bulgan, "Bulgan II"[10]. The baseline survey was conducted in October 2001. Program implementation began in December 2001 and continued for 21 months until September 2003, when the final survey was carried out, in collaboration with NRC.

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[7] Amgalan, Bayankhoshuu, Dari-Ekh, Nalaikh, Tolgoit Districts in UB city. Bulgan, Selenge, Orkhon, Khishig-Onder, Bugat, Khyalganat, and Khangal soums.

[8] Saintsagaan, Luus, Huld, Delgerhangai, and Saikhan-ovoo soums.

[9] Bayanundur/Erdenet City and Jargalant.

[10] Mogod, Khutag-undur, Bayannuur, Teshig, Saikhan, Gurvanbulag, Dashinchilen, Rashaant, Buregkhangai, and Bayan-Agt soums.

3.5 Program Areas & Beneficiaries

The NP targeted **14,780** children aged 6-59 months, **1,250** pregnant and **4,370** lactating women, from within a population of 285,000, representing about 7% of Mongolia's total population (**Table 1**). The NP was carried out in the provinces of UB, Bulgan, Erdenet and Dundgobi, within 9 of WV Mongolia's ADPs (See map in Annex 3). In the case of UB province, 27% of its total population (of 668,800) lived in areas in which WVM worked.

Table 1. Population estimates in WVM ADPs prior to program initiation (2000).

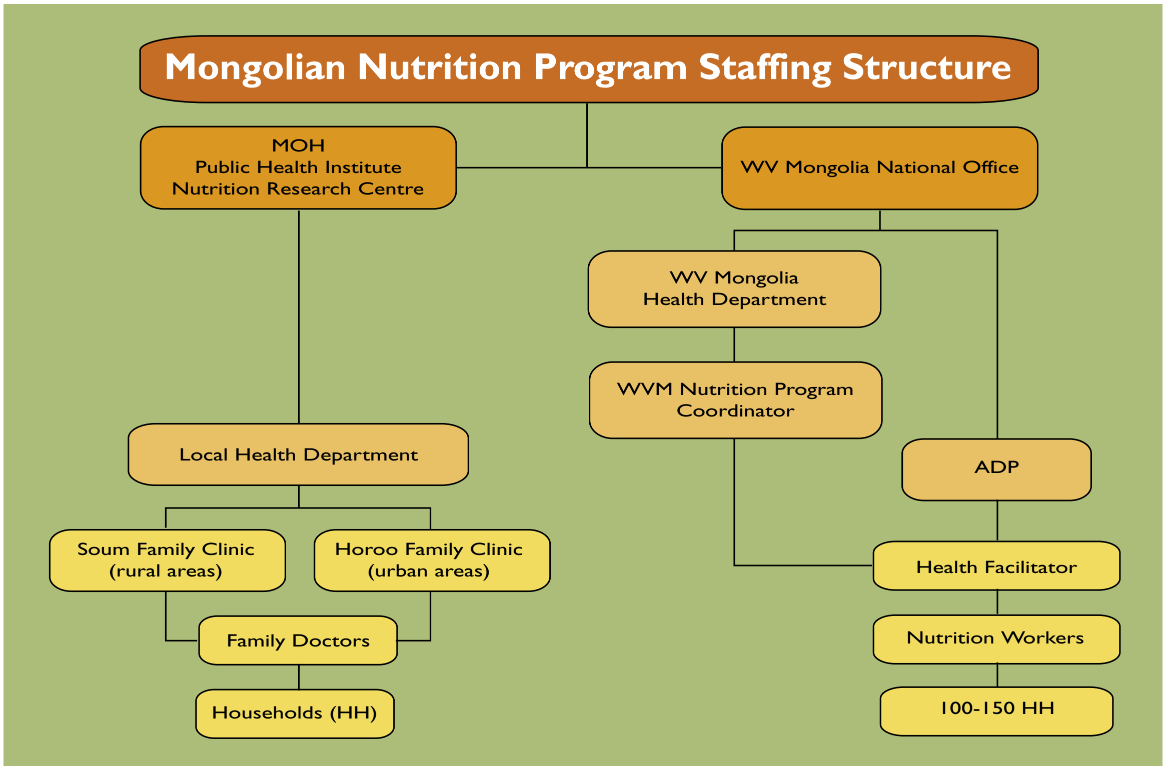
ADP	Children 0-59 mo.	Children 6-35 mo.	Children 36-59 mo.	PW	LW	Total Population
Amgalan	951	494	351	39	212	26,300
Dari-Ekh	1,591	748	693	69	672	35,600
Bayankhoshuu	3,567	1,942	1,237	402	888	48,580
Tolgoit	3,326	1,642	1,338	126	632	45,800
Nalaikh	2,026	1,038	781	180	396	21,260
WV Ulaanbaatar Areas	*11,461*	*5,864*	*4,400*	*816*	*2,800*	*177,540*
WV Bulgan I Areas	*3,209*	*1,412*	*1,530*	*177*	*267*	*29,500*
R1 Total	**14,670**	**7,276**	**5,930**	**993**	**3,067**	**207,040**
WV Bulgan II Areas	*5,455*	*2,772*	*2,093*	*137*	*1,121*	*31,783*
WV Erdenet Areas	*1,282*	*779*	*503*	*221*	*243*	*22,781*
WV Dundgobi Areas	*4,755*	*2,494*	*1,669*	*207*	*1,029*	*23,416*
R2 Total	**11,492**	**6,045**	**4,265**	**565**	**2,393**	**77,980**
NP Total	**26,162**	**13,321**	**10,195**	**1,558**	**5,460**	**285,020**

3.6 Program Organization

The WVM national office (NO) hired a Nutrition Program Manager and Nutrition Program Coordinator, stationed at the NO in UB, who were responsible for the NP in all 9 ADPs within the 4 regions, as well as for coordinating with the MOH, multi-laterals, and other NGOs. In addition, the NP NO staff managed procurement and distribution to the ADPs of all fortificants and supplements (whether procured[11] from Toronto's Hospital for Sick Children or procured from or donated by UNICEF). WVM hired one health facilitator (HF) per ADP; she trained and monitored her cadre of Nutrition Workers (NWs) and delivered fortificant from the national office to the NWs. Nutrition workers, mostly female, received a small stipend and were each responsible for providing 100-150 families of children <3 with Sprinkles and nutrition education, on a monthly basis. The HFs helped strategize on how to physically reach the families, using their cultural knowledge. The NWs arranged their own transportation and showed flexibility and resourcefulness in delivering this program to the widely dispersed target population.

Initially, iron and vitamin D supplements were provided by MOH doctors, with supply and training coordinated by the NP staff and HFs. However, after a period of implementation the staff became aware that the doctors were having limited success with supplement distribution. Since the NWs had proven themselves to be very efficient in distributing Sprinkles, they were trained to assist with supplement distribution. Doctors continued to participate, providing lists of PLWs and rachitic/anemic children, as well as treating cases they encountered. Field staff found the supply to be well coordinated.

[11] Previously funded under research initiatives; this was Sprinkles' first procurement for programmatic use.



3.7 Description of Activities

3.7.1 Home-Based Fortification (Sprinkles)

Figure 1.
Child Receiving Sprinkles.

a) Justification

In Mongolia, flour or rice porridges are the first complementary foods introduced to infants. The second National Nutrition Survey (NRC & UNICEF, 2002) found that 70% of children are weaned on:

- *bantan*, a porridge of wheat flour and meat mixed with boiling water,
- *zutan*, similar to bantan but using less flour and no meat, or
- *kasha*, rice boiled in water and milk (if available) with sugar and butter.

These complementary foods are of low nutrient density (WHO, 2002), which contribute to nutritional deficiencies such as rickets and anemia (NRC & UNICEF, 2000). Previous supplementation programs have not been effective in addressing these deficiencies. Therefore, the NP promoted home-based fortification of these complementary foods with Sprinkles, as both a short-term intervention and potentially a medium-term strategy to address iron and vitamin D deficiencies in this age group. Sprinkles were distributed free of charge to all families in program areas to enable them to fortify the local complementary foods of children 6 to 35 months of age.

This activity was carried out in parallel with activities to increase food sources of available iron, as well as advocating for the fortification of wheat flour with iron and vitamin D.

b) Sprinkles Development

Sprinkles are a microencapsulated, tasteless, colourless, multiple-micronutrient fortificant, provided in single-dose sachets, for use at home on a daily basis to improve the nutritional value of young children's foods (Zlotkin et al., 2005).

This product was developed by researchers at the Hospital for Sick Children in Toronto, Canada, upon suggestion from a consultation organized by USAID's Opportunities for Micronutrient Interventions (OMNI) Project and UNICEF (Nestel, 1996). The intention in developing Sprinkles was to provide an alternative method of supplementing young children with iron, due to the lack of global success in combating childhood anemia with traditional iron supplements.

Sprinkles have been shown to be as efficacious in preventing and treating anemia as traditional iron drops, but with fewer side effects and greater compliance (Zlotkin, et. al., 2001). The ease of adding one daily sachet of nearly tasteless, odorless, and colorless Sprinkles to a child's meal is thought to contribute to the latter. In addition, although Sprinkles were originally developed as an iron supplement, it is possible to vary the formulation and to add multiple micronutrients to the sachets, thus addressing additional nutrient needs of young children.

Sprinkles are a microencapsulated, tasteless, colourless, multiple-micronutrient fortificant, provided in single-dose sachets, for use at home on a daily basis to improve the nutritional value of young children's foods. *(Zlotkin et al., 2005)*

c) Formulation of Sprinkles

The nutrients included in a particular Sprinkles formulation are chosen either for their direct impact on anemia or for their positive interaction with the other nutrients included. The most commonly used formulation of Sprinkles consists of the following:

- Microencapsulated ferrous fumarate, (iron surrounded by a soy-based hydrogenated lipid coating, to prevent oxidation and mask the metallic taste and color of the iron—Zlotkin, 2002).
- Vitamin A, (this deficiency and anemia often coexist—Bloem et. al., 1989 and because vitamin A has a positive effect on iron status, perhaps mobilizing iron stores—Mejia, 1988).
- Vitamin C, (to increase iron absorption and prevent oxidation—Groff & Gropper, 1999).
- Folic acid, (the standard is to provide folic acid and iron together, as folate deficiency can cause megaloblastic anemia and often co-exists with iron deficiency—Fleming et. al., 1979).
- Zinc (for child growth and immune function, and as the addition of zinc increases hemoglobin more than iron alone—Smith, 1999, Fishman et. al., 2000, & Kolsteren et. al. 1999; also, folic acid is better absorbed when consumed with zinc --Groff & Gropper, 1999).

Figure 2.
Sprinkles for Mongolia, Micronutrients per sachet.

Vitamins	
Vitamin D	**400IU**
Vitamin A	**600IU**
Vitamin C	**50mg**
Folic Acid	**150mcg**
Minerals	
Iron (encapsulated ferrous fumarate)	**40mg**
Zinc (zinc gluconate)	**10mg**

Figure 2 presents the composition of Sprinkles used in the Mongolia Nutrition Program. The dose for each nutrient was selected on the basis of international recommendations (FAO/WHO, 2002) and results of efficacy trials.

In the case of iron, 12.5mg daily can prevent anemia in children age 6-24 months (Stoltzfus, 1997). If absorption of elemental iron were 10%, as often discussed,[12] 1.25mg would be absorbed from that dose. Prior to the NP, laboratory data suggested absorption of 1.7-5% for microencapsulated ferrous fumarate (Zlotkin, et. al., 2001). Thus at an average 3% absorption rate, 40mg of iron would be required for 1.2mg absorption, and thus was the dose used in the NP Sprinkles.[13]

Efficacy studies have shown that a 60 sachet course of Sprinkles over 60-120 days is sufficient to correct existing iron deficiency anemia (IDA) in toddlers and maintain these improved hemoglobin levels for 6 months (Ip et al 2005).

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[12] Five percent would be considered a very conservative estimate (FAO/WHO, 1988); the literature reflects ranges including a much higher level of absorption; but all depends on the particulars of local diet.
[13] Since that time, studies now imply absorption ranging from 2-11% depending on many factors, such as anemia status (Zlotkin, Arthur, Antwi, & Young, 2001; Tondeur, et. al., 2003). So the range of absorbed iron from the dose of microencapsulated ferrous fumarate in Mongolian Sprinkles could be 0.8-4.4 mg.

“I hope this program will continue. Not only for my children, but a lot of children in Mongolia can get good health because of Sprinkles”

(Program Beneficiary)

The vitamin A dose used is the recommended daily requirement for children up to six months. Although the children targeted with Sprinkles were older than this, there was concern about potential overdose, considering Mongolia’s efforts towards increasing high-dose vitamin A coverage. The level of vitamin C is more than the 30mg/day recommended for the target-age children, but this does not seem unreasonable, given the dearth of vitamin C in the Mongolian diet. The level of folate is more than that recommended for children under age one, but almost in line with the 160mcg recommended for children aged 1 to 3. The level of zinc is more than the 3-5 mg daily recommended (Hotz, 2004), but many studies and programs have used this dose safely.

In addition to the typical formulation for management of iron deficiency, the Sprinkles for Mongolia contained added vitamin D[14] to address the high levels of rickets. There is some difference in opinion as to the recommended dose of vitamin D for children. The FAO/WHO recommend 200 IU daily from 6 to 36 months of age (FAO/WHO, 2002). Some experts recommend 400 IU per day for breastfed infants, which is the dose provided in fortified milk and in the maintenance supplementation regimen following rickets treatment (Beers & Berkow, 2004). Others recommend up to 800 IU in the winter for those living in the north (Indian & Inuit Health Committee, 2002) such as Mongolia, at 42-50° N, or those living in polluted areas (e.g., coal-heated Ulaanbaatar), where there is reduced exposure to sunlight. The Institute of Medicine’s tolerable upper intake level is 1000 IU daily for children under age one and 2000 IU for those over age one (Higdon, 2004). The amount in the Sprinkles was set at 400 IU as recommended for the maintenance dose after treatment for rickets.

d) Acceptance of Sprinkles in Mongolia

Prior to starting the NP, WVM conducted focus groups with mothers and doctors to identify ways to optimize the acceptability of Sprinkles by the Mongolian population. It was suggested that printing the instructions and ingredients in Mongolian and stamping the expiration date on the packet would increase confidence in the product.

[14] Vitamin D and zinc deficiency can cause low height/age, found in 25% of children <5 (NRC, 1999).

A local artist designed the artwork on the package (**Figure 3**). WVM engaged in an extensive process to satisfy the Government of the product's safety, after which the MOH approved its import and enthusiastically supported its use.[15]

NWs distributed Sprinkles to beneficiaries in their homes. Initially, NWs visited families every two weeks or monthly, depending on the region (less frequently in rural Bulgan and Dundgobi, more frequently in urban UB and Erdenet). As Sprinkles became familiar, NWs shifted to visiting monthly or once every two months. Difficulties of weather, distance, and serving a nomadic population were considered in determining the frequency of visits.

During each home visit, the NW recorded the number of packets of Sprinkles remaining from the previous visit (to assess the number that appeared to have been used) as well as the number distributed during the current visit, using a form kept by the family. NWs also kept their own records of Sprinkles distribution, which they reported to their ADP HF on a monthly basis. HFs compiled the records monthly and submitted documentation to the national office.

Figure 3.
Front and back Sprinkles packaging from Mongolia.

3.7.2 Supplementation

After refresher training on symptoms, prevention, and treatment of anemia and rickets, doctors were supplied with and began distributing iron and vitamin D supplements for PLW and anemic and/or rahitic children 36-59 months old. This duty was later partially taken over by NWs, as their door-to-door distribution efforts offered the potential for greater supplement coverage.

The PLW or the child's caregiver was normally given a one-month supply of iron tablets or syrup, although in rural regions, a two-month supply was often given. The iron for PLW was given in a bottle containing printed instructions. The NP targeted iron syrup to anemic children aged 36-59 months, but distribution also reached the younger children as well.

According to national policy for the younger children, any child presenting with rickets at any time of the year was supplemented through the NP, although this was emphasized more during the winter (October-May). The NWs and doctors also distributed vitamin D supplements to PLW on a monthly basis.

NWs and family doctors recorded any supplements distributed along with the Sprinkles information on the family's form. This was to facilitate communication between health providers, to avoid potential overdose. They were also asked to keep records of the supplements they distributed and provide a copy of the records to the HF.

3.7.3 Capacity Building

To improve nutrition knowledge and practices, health professionals and NO staff trained the HFs every 3 months. Health facilitators trained an average of 11 NWs quarterly. A HF's training of her NWs was attended by a NO supervisor, for quality control purposes, and often by another HF, to encourage the cross-fertilization of ideas. HFs were provided with materials and training guidelines but were encouraged to communicate creatively and to inspire NWs.

[15] This was greatly facilitated by Dr. Sodnompil, the Secretary of the Ministry of Health, a long-time supporter of WVM, who intervened several times to keep the process moving forward.

The NWs held monthly community nutrition workshops. Approximately 20 families participated in each workshop, periodically supervised by HFs. NWs also passed on the health and nutrition messages through informal presentations when visiting families who had not attended the workshops.

The workshop sessions were focused on eight topics:

1. **Balanced diet/basic nutrition** - Variety and balance from food groups, based on a modified food pyramid, as well as guidance about moderation (e.g., limiting fat, sugar and alcohol).
2. **Key nutrients** - Carbohydrates, fats, proteins, and importance and sources of key micronutrients (vitamins D, A, and C; iron, folate, zinc, calcium, iodine). A special focus was given to:
   - **Vitamin D**: Sunlight exposure, avoiding swaddling, and eating sardines and cod liver oil; vitamin D is important for bones, growth, and immune system.
   - **Iron**: Eating liver, meat, fish, chicken, as well as plant sources; avoiding tea, coffee, or milk with iron-rich foods; eating vitamin C with iron, when possible; needing more during growth, diarrhea, or infections.
3. **Hygiene and food safety** - Selecting food, safe water, hand washing, avoiding contact between raw and cooked foods, etc.
4. **Food preparation to preserve nutrients** - Techniques to avoid nutrient loss: eat produce raw, shorten soaking/cooking/storing times, etc.
5. **Food preservation** - Drying and bottling techniques. The NP designed a food dryer (manual available from WVM) for use by community garden users.
6. **PLW nutrition** - Eating well to avoid anemia and keep baby healthy. Amounts, sources, and need for key nutrients. Items to avoid (e.g., coffee, tea, cigarettes, alcohol). Dealing with illness, taking supplements, resting, drinking liquids, and vaccinations.
7. **Infant nutrition** - Breastfeeding strategies and the importance of exclusive breastfeeding to six months. Recommendations on feeding children six months and above, such as amounts/sources of micronutrients and not filling a child with liquid, e.g., ensuring enough solids in a soup.[16]
8. **Budgeting and saving** - Why and how to budget for different expenditures and save money in case of emergency.

An "Eat Right" booklet covering the eight topics was distributed to households (HH). The booklet and workshops were intended to cover 80% of families with children under 3 years old.

[16] NWs often followed with food demonstrations.

3.7.4 Social Marketing

Social marketing campaigns aimed to increase public awareness and improve knowledge about nutritional issues, and to promote key behaviour changes.[17] Through moving billboards (on buses) and posters in buses, businesses (e.g. snack kiosks), health clinics, and pharmacies, the NP disseminated five public awareness messages:

1) Sun as a source of vitamin D;
2) Prenatal iron supplements leading to healthy mother and child;
3) Liver as an excellent source of iron/other nutrients;
4) Consuming milk products separately from meat, to reduce the chances of the calcium impeding absorption of iron[18]; and
5) A food pyramid in the form of a traditional Mongolian ger.

In collaboration with UNICEF, the MOH, and Mongolian National Television (MNTV), the NP developed 12 short nutrition education videos on most of the eight topics, broadcast nationwide on MNTV. Shorter radio spots were also developed and aired.

[17] The MOH's Surenchimeg encouraged the campaign, concerned by the lack of public nutrition messages.
[18] Calcium competes with iron for absorption, another possible reason (in addition to early weaning) for associations between children drinking cow's milk and iron deficiency (Morton, 1988 & Wharf, 1997).

4.0

"My baby was always sick and weak.... She never smiled or played like normal children, but now I am so happy to see her growing fat, walking and active. Taking sprinkles daily for just 8 months has transformed all our lives. I love to tell all mothers about the miracle of sprinkles and what it did for my little girl." *(Program Beneficiary)*

4.1 Evaluation Purpose

The purpose of this evaluation was to assess the effectiveness of WVM's 3-year NP in addressing anemia and rickets. This report focuses particularly on the effectiveness of the home-based fortificant (Sprinkles) within the larger program framework.

4.2 Evaluation Objectives

The objective of the evaluation was to assess the effectiveness of the NP's fortification, supplementation, and education initiatives, on:

1. Nutritional status of children from 6-59 months (<5s), specifically:
   - Anemia (44% at baseline, with a goal of reducing to 20%[19])
   - Rickets (30% at baseline, with a goal of reducing to 20%[20])
   - General nutritional status, i.e., underweight, wasting, and stunting
2. Nutritional status of PLW:
   - Prevalence of anemia in pregnant or lactating mothers of 6-59 month old children[21]
3. Coverage of interventions:
   - Home-based fortification (Sprinkles)
   - Supplementation (vitamin D and iron)
   - Nutrition education
4. Key practices:
   - Prevalence of exclusive breastfeeding
   - Frequency of consumption of iron-rich foods
   - Swaddling time/coverage

Overarching questions of interest were:

- Does the use of home-based fortificant Sprinkles within a broader program prevent young children from becoming rachitic or anemic?
- Does traditional supplement (vitamin D and iron) distribution treat these deficiencies in children 3 to 5 years of age?
- What are the challenges of implementing a program with several integrated interventions with different providers?

4.3 Evaluation Methodology

4.3.1 Evaluation Design

The program's effectiveness was evaluated using a pre and post-intervention design, comparing indicators from baseline (2001/2002) and final (2003) household surveys, using a cross-sectional design. The surveys included a questionnaire, adapted from WVC's Micronutrient and Health Survey; physical assessments of anthropometric measures; biochemical assessment of hemoglobin status; and clinical indicators for vitamin D deficiency. The baseline and final questionnaires included questions on demographics, a semi-quantitative food frequency questionnaire, micronutrient coverage, and knowledge, attitudes, and practices related to rickets and anemia. The final questionnaire added questions on NP use (e.g., evaluation of service delivery, the experience with Sprinkles, and whether the family had participated in the NP's nutrition education).

In addition to evaluating the NP areas pre- and post-intervention, the use of a comparison area (Tov aimag) was planned. However, the area could not be used for comparison purposes as BP-5 energy bars were distributed there by another organization during the same time as the NP (April 2002 to May 2003), in response to a natural

[19] Goal is for R1; R2 goal would have been 28%.
[20] Goal is for R1; R2 goal would have been 16%.
[21] PW: baseline of 44% in R1, 23% in R2, and 35% in AI, with a goal of reducing to 20% in R1 and 14% in R2. LW: baseline 18% in R1, 8% in R2, and 18% in AI, with a goal of reducing to 12% in R1 and 6% in R2.

disaster. These bars were targeted to all children less than two years of age, and malnourished children aged three-to-five years, as well as PLW in dzud-affected areas. If taken as directed, the BP-5 bars would provide 40 mg of zinc, 40 mg of iron, and 355 IU of vitamin D daily, for 36 days. According to the nutrition community in Mongolia, 11,100 children under age two years (the intended main target) received the bars. As a result of this intervention occuring, the intended comparison area was re-labeled the "Alternative Intervention" (AI) area. BP-5 bars were also distributed in some NP areas.

The Research Ethics Committee of the MOH gave approval for the surveys to be conducted. The MOH's Public Health Institute gave approval for its Nutrition Research Center to take a contract from WVM to conduct the field work, as had been done in the baseline surveys.

4.3.2 Anthropometry

Child weights and heights were taken in order to convert the measures into anthropometric indices to assess nutritional status. These measurements were made on children 6 to 59 months, with light clothing and no shoes, by trained staff. Weights were measured using Salter scales (Salter, Sussex, UK) to the nearest 100 g and heights were measured using locally manufactured length boards in centimetres to the nearest 0.5 cm. Children below the age of 2 years or less than 85 cm were measured in the recumbent position (length); standing height was measured in those above 85 cm. The date of birth was obtained from the child's health card/birth card, or if that was not available, from the caregiver's report of the child's age. Height for age (HA), weight for age (WA) and weight for height (WH) Z scores were calculated by using the EPI-INFO 2000 software (Centers for Disease Control and Prevention, Atlanta).

Malnutrition was defined in the following ways:

- Stunting (HA): height-for-age < -2 SD;
- Wasting (WH): weight-for-height < -2 SD;
- Underweight (WA): weight-for-age < -2 SD.

4.3.3 Anemia

Hemoglobin (Hb) levels from finger prick blood samples were used to estimate anemia in <5s and PLWs. HemoCue Photometers[22] were used to measure the amount of Hb in a blood drop placed into a disposable micro-cuvette. Hb levels less than 11.5 g/dl indicated anemia, according to the altitude-adjusted cut-off (WHO, UNU, & UNICEF, 2001).[23]

4.3.4 Rickets

Rickets was diagnosed by trained physicians, based on the presence of at least one of the following clinical signs:

- soft posterior skull
- lack of timely closure of fontanel[24]
- rows of rickets or widening of long bone
- bow legs or knock knees
- Harrison's Groove

Additional clinical signs (excessive perspiration, smell of urine, and occipital alopecia) are often used in Mongolia (Tserendolgor & Fraser, 2003), but these were excluded, due to clinical unreliability, subjectivity, or reliance upon information reported by the caretakers. Clinical rickets diagnosis uncovers only extreme cases; accuracy improves when diagnosis includes x-rays or blood tests. However, this evaluation did not have the resources to include these methods, which are difficult to carry out in the field.

4.3.5 Sampling

Sample size was calculated using the following formula estimating the difference between two proportions or prevalence:

$$n = [v \sqrt{2p_0(1-p_0)} + u \sqrt{p_1(1-p_1) + p_2(1-p_2)}]^2 \; / \; (d)^2$$

In this equation, "n" represents the sample size needed; "v" is set at 1.645, the one-tailed Z-value of a normal distribution, if significance is 95%; "u" is set at 0.842, the one-tailed Z-value of a normal distribution, if power is 80%; "p_1" signifies the estimated prevalence at baseline; "p_2" signifies the predicted prevalence at final (in an adaptation of the above, it has been adjusted for time, 26 months of intervention in R2 and 21 months in R1); "p_o" represents $(p_1 + p_2)/2$; "d" represents the difference between the prevalence. Ten percent was added for non-responders and a design effect of 2 was used.

The formula was applied to each indicator pertaining to the main target population, (children under 5), using the prevalence of anemia and rickets at baseline, and expected prevalence at the end of the program. The highest sample size (621) was needed to detect changes in rickets, and in fact an even greater number of children was actually sampled.

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[22] HemoCue Plasma/Low Hb Photometer: for determination of low serum haemoglobin levels.

[23] Mongolia's average altitude, 1580 meters above sea level, adds .5 g/dl to the 11.0 g/dl cut-off. We considered using a cut-off of 12.5 g/dl in LW, as their Hb level should be more similar to other women than to PW, but to facilitate comparison with baselines, the level was kept at 11.5g/dl.

[24] Fontanel > 2.5cm, in those over 12 months.

Tables 2 & 3 show the actual sample sizes at baseline and final in each region. The sample in NP areas during the final evaluation included a total of 1899 <5s, 55 pregnant women and 807 lactating women (see **Annex 1** for samples by district).

Table 2. Evaluation sample of children <5 (6-59 months) in NP & AI Areas.

Area	Baseline			Final Evaluation		
	Total Children	6-35 mo	36-59 mo	Total Children	6-35 mo	36-59 mo
R1	837	568	269	987	567	420
R2	1269	830	439	912	557	355
NP[25]	**2106**	**1398**	**708**	**1899**	**1124**	**775**
AI	441	273	168	166	95	71

Table 3. Evaluation sample of mothers in NP & AI Areas.[26]

Area	Baseline			Final Evaluation		
	Pregnant	Lactating	Non-PLW	Pregnant	Lactating	Non-PLW
R1	33	109	703	31	406	267
R2	62	320	926	24	401	310
NP	**95**	**429**	**1629**	**55**	**807**	**577**
AI	25	57	336	3	75	69

[25] NP signifies R1 and R2 together. When considering major NP goals, the two are reported separately.
[26] It would have been best to collect data from enough PLWs to enable discussion of significant changes in status, but this would have required impractical numbers of PLWs and could have artificially elevated the power of the survey's other indicators. The PLW information in this report is merely descriptive.

Based on the proportion of children <5 in Mongolia's population (9%[27]) and the average household (HH) size (3.71 people[28]), the total number of HHs needed for the survey was 1869. A multi-stage cluster sample design was employed. Based on the populations in each survey area, a representative number of clusters were randomly selected from each ADP and the AI. In total 75 clusters were selected, each consisting of 28 HH (each with a child <5), chosen by random number selection. Only 69 clusters were actually needed, but given past experience in nomadic Mongolia, extra clusters help avoid issues with clusters not meeting the sampling requirement. The number of clusters per region depended on the sample and the time needed to cover the area: 6 for each R1 ADP, 11 for each R2 ADP, and 6 for AI.

As the survey was only carried out in WVM NP areas and Tov aimag, it cannot be considered to be nationally representative.

4.3.6 Survey Team, Training and Data Collection

The survey team included staff from the Nutrition Research Centre (NRC) and family physicians. These individuals were trained on the questionnaire and clinical portion of the survey, including a field practice component. Following the training, the questionnaire was pretested, and minor adjustments made.

Dr. Z. Ariunbileg, Dr. N. Bolormaa, and Dr. D. Enkhmyagmar, researchers from the NRC, coordinated the survey (see **Annex 2** for a list of the survey team). Three teams of four interviewers and four medical doctors each collected data over a 32-day period from October to November of 2003, the same time of year during which the baseline surveys had been conducted.

4.3.7 Data Analysis

EpiInfo version 3.2.2 (April 2004, Centers for Disease Control and Prevention, Atlanta) was used for data analysis. Eight trained data-entry clerks double-entered the survey data into Microsoft Access. Data was cleaned and merged into Excel, then converted into SPSS version 10. Chi-squared tests were used for statistical comparisons of the prevalence of rickets and anemia between NP areas and AI (in SPSS) or between baseline and final (in Epi Info version 6's Statcalc). P-values at ≤ 0.01 were considered highly significant, at ≤ 0.05 were considered significant, and above 0.05 were considered non-significant (NS).

[27] 8.96% of population under 5, (Mongolian National Statistics Office, 1998).
[28] Estimate for 2000 (www.unhabitat.org/habrdd/conditions/eastasia/mongolia.htm, 8/04).

5.0

The decrease in anaemia prevalence observed in the nutrition program greatly exceeds the global target of reducing anemia by 1/3 by 2010.

(A World Fit for Children, 2002)

5.1 Anemia

5.1.1 Anemia in Children Under 5

The prevalence of anemia in preschool children decreased dramatically in both program areas after only 26 months of intervention (**Table 4**). This impressive result was achieved in both the children aged 6-35 months, to whom the Sprinkles were targeted, and those aged 36-59 months (**Table 5**).

However, despite a substantial decline, the prevalence of anemia in the youngest children (6-18 months) remained above 40%, the WHO cut off point defining a severe public health problem (**Table 6**). These data reflect a typical pattern of decreasing anemia prevalence with increasing age, with infancy and early childhood as the period of greatest vulnerability to iron deficiency and anemia (Osorio, 2001; Cornet, 1998; Buonomo, 1997). This may be due in part to relationships between age and other factors: diet (diet diversifies with age, providing greater access to iron); growth (more iron is required during growth, which levels out with age); and infection (decreasing iron absorption, becoming less prevalent with age).

Furthermore, the NP came close to meeting the very ambitious goal of reducing anemia prevalence to 20%. This excellent achievement is likely due to age-specific efforts to increase iron intake. In the 6-35 month group, the impact was likely achieved primarily through Sprinkles, with some contribution from iron syrup and possibly also improved maternal iron status, improved breastfeeding practices and increased consumption of iron-rich foods. In the 3-5 year age group, the improvement may be attributable to both iron syrup and iron-rich foods, but could possibly also be due to long-term protection from Sprinkles. Discussion of the anemia results in relation to coverage of these interventions is presented in the following sections.

It is expected that similar substantial achievements in anemia prevention and control can be made in other areas of Mongolia, with a similar program, as the baseline level of anemia in this study (42%) is similar to that found in a national 1999 survey (NRC & UNICEF, 2000). Iron deficiency has been identified as the main cause of anemia in Mongolian children (NRC, 2003)[29,30].

5.1.2 Anemia Control Interventions

a) Sprinkles

<u>Coverage, Compliance and Utilization</u>

The primary NP strategy for anemia prevention was Sprinkles distribution to children age 6-35 months for daily home fortification of complementary food. Sprinkles were distributed in R1 for 26 months and in R2 for 21 months. The average length of time that children used the Sprinkles was 13 months, which should have been more than adequate to both prevent and treat anemia. In fact, recent research has shown that 12.5 mg daily of micro-encapsulated ferrous fumarate, given for 60 days, is adequate to treat anemia in this age group (Christofides et al., 2006).

[29] Serum ferritin tests confirmed iron deficiency as the cause in 75% of anemic children 6-23 months old.

[30] Anemic children were 1.65 times more likely to be iron deficient than were non-anemic children ($p<0.01$); severe iron deficiency was more prevalent in anemic children (suggesting iron as a likely factor); and there was no difference in folic acid or B-12 deficiencies in anemic versus non-anemic children (shifting blame from these alternate explanations). Less-than-ideal exclusive breastfeeding rates and poor complementary foods (missed opportunities for iron consumption) also contribute (NRC & WVM, 2004).

Table 4.
Prevalence of Anemia (Hb<11.5 g/dl) in children age 6-59 months.

Area	Percent Anemic (n)	
	Baseline 2000/1	Final 2003
R1	43.0 (737)	24.2** (962)
R2	47.9 (1155)	25.6** (908)
NP	**46.0 (1892)**	**24.9** (1870)**

Table 5.
Anemia Prevalence by Age Group.

Age Group	Prevalence of Anemia (n)	
	Baseline 2000/1	Final 2003
6-35 months	55.3 (1235)	32.8** (1108)
36-59 months	28.5 (657)	13.4** (762)

Table 6.
Prevalence of anemia (Hb<11.5 g/dl) in children age 6-35 months, by age group.

Age (months)	Percent Anemic (n)	
	Baseline 2000/1	Final 2003
6-11	64.8 (270)	47.9** (144)
12-17	67.9 (274)	43.9** (239)
18-23	52.1 (259)	35.8** (215)
24-29	45.8 (227)	22.7** (260)
30-35	40.5 (205)	21.2** (250)
Total (6-35 mos.)	**55.3 (1235)**	**32.8** (1108)**

**$p\leq0.01$

Table 7.
Percent of children (6-59 mos.) who had ever used Sprinkles.

Area	Percent of Children who Ever Used Sprinkles (n)
R1	92.8 (977)
R2	85.4 (908)
Total	**89.2 (1885)**

Table 8.
Percent of children (6-35 mos.) taking Sprinkles at final survey.

Area	Percent Taking Sprinkles at Final Survey (n)
R1	44.0 (511)
R2	52.8 (460)
Total	**48.2 (971)**

Table 9.
Percent of children (6-35 mos.) taking Sprinkles at final survey who had done so for 4 or more months.

Area	Percent Taking Sprinkles at Final Survey for $\geq$4 months (n)
R1	89.4 (217)
R2	86.1 (231)
Total	**87.7 (448)**

Sprinkles were well accepted, with high coverage and compliance over an extended time period. In fact, 89% of all children under 5 had tried Sprinkles by the end of the program, before which time no caregiver or child had even seen the product (**Table 7**). This exceeded the NP goal of 80% coverage and reached up to 21,000 children[31]. As expected, given the earlier start of distribution in R1, more children used Sprinkles in this area than in R2 (93% vs. 85%, $p \leq .01$).

At the time of the final survey, 48% of children in the target group were still using Sprinkles, which also reflects a sustained interest (**Table 8**). R2 had a higher final coverage than did R1 ($p \leq .01$), which may be related to the later initiation in R2. One year into distribution, R1's coverage was 84% (Schauer, 2003), but dropped to 44% by the end of the program. Of the children taking Sprinkles at the time of the final survey, 88% had been doing so for four months or longer (**Table 9**).

In addition to the high average duration of Sprinkles intake, 88% of households reported that children used them on a daily basis. However, 10% percent of caregivers acknowledged that they had not followed the instructions in some other way. Reasons for not giving Sprinkles as directed included the belief that the fortificant had a bad taste (13%), gave the child diarrhea (12%), changed the food's appearance (11%), made the child feel 'bad' (10%); or that they did not receive it regularly (6%). Of mothers who did not give Sprinkles on a daily basis, the main reason was that they forgot (33%), despite some NWs having developed a days-of-the-week tool to help them remember (**Figure 4**). Perhaps greater use of memory aids and further education on the product could improve compliance.

Sprinkles were added to the following foods, in order of greatest frequency: bantan (57%), a portion of the family's meal (55%), water (12%), 'nothing' (i.e. no food) (7%), tea (4%), zutan (4%), kasha (3%), soup (2%), and less than 5% total added it to mashed vegetables, yogurt, and juice. Adding Sprinkles to liquids or eating Sprinkles alone is not recommended, but these practices may indicate willingness to give Sprinkles even if the HH did not have an appropriate food to fortify, and may also partially explain the "bad taste"/"feeling bad" reasons for non-compliance.

Other indicators showing that the Sprinkles were highly acceptable include perception of positive effects, and willingness to continue using the product beyond the current program. Families perceived the following positive changes in their children, which they attributed to Sprinkles: increased appetite (18%), more activity (13%), and more alert (11%). Moreover, 87% of mothers who gave their children Sprinkles said that they would like to continue doing so after the NP ended (85% in R1 and 90% in R2, $p \leq .01$). Of those, 97% said they would go to a distribution center to receive Sprinkles (95% in R1 and 98% in R2, $p \leq .01$). This is useful information, suggesting that in future programs, it may be possible for families to obtain the Sprinkles from a central location, thus reducing the burden on nutrition workers for reaching a widely dispersed population.

The major limitation of the Sprinkles intervention is that most children did not start receiving the product until 13 months of age, even though it was targeted to the entire 6-35 month age group. One of the main purposes of the Sprinkles distribution was to prevent development of anemia in young children through provision of adequate iron in complementary food. Qualitative follow-up is necessary to understand why families did not introduce Sprinkles to younger children.

[31] The target for Sprinkles was <3s, but the evaluation question asked whether the child had ever taken Sprinkles. The older children were within the Sprinkles target age when the NP began.

Figure 4.
Days-of-the-Week Tool Designed by a NW to Remind Caregivers to Give Sprinkles.

Table 10.
Prevalence of anemia in children (6-35 mos.) using sprinkles at final survey, by duration of sprinkles usage.

Duration (months)	Percent Anemic (n)
< 4	48.1 (52)
≥ 4	31.3 (387)

<u>Impact of Sprinkles on Anemia</u>
Due to the limited utilization of Sprinkles by children age 6-11 months, it is very unlikely that Sprinkles contributed significantly to the observed reduction in anemia prevalence in this age group. However, Sprinkles was likely the major contributor to the reductions in anemia in children age 12-35 months. It is also likely that the Sprinkles provided to the younger children helped to maintain iron status and prevent anemia in the 3-5 year age group. Research has shown that in children aged 6-18 months the effect of treating anemia with Sprinkles is sustained up to12 months post-intervention (Zlotkin et. al., 2003). Additionally, 14% percent of children 3-5 years old still took Sprinkles, despite no longer being part of the target age group (sharing with siblings). This indicates enthusiasm for and acceptance of Sprinkles among this age group, but also clouds the interpretation of impact of interventions directly targeting 3-5 year olds.

There was a significantly lower prevalence of anemia ($p<0.05$) among children age 6-35 months who took the Sprinkles for 4 or more months (31%) than among those who took Sprinkles for a shorter period (48%) (**Table 10**).There was no significant difference in anemia for shorter periods of use. Although efficacy studies have shown that two months is an adequate duration for Sprinkles use to increase iron stores and to reduce the risk of anemia for the next 6 months (Zlotkin, 2001), it is unknown what duration of use is required to prevent anemia in a program context, nor to prevent other deficiencies (e.g., vitamin D).

Furthermore, it was found that most (93%) of those using Sprinkles at the time of the final evaluation did so three or more times weekly. This group had a lower ($p<0.05$) prevalence of anemia (31%) than those who used the product less than three times weekly (52%) (**Table 11**). From this data, it appears that Sprinkles consumption should be recommended for a minimum of 4 months, with usage at least three times weekly.

Table 11.
Prevalence of anemia in children (6-35 mos.) taking Sprinkles at final survey, by frequency of usage.

Frequency of Use of Sprinkles (# times/week)	Percent Anemic (n)
< 3	52.2 (23)
≥ 3	30.7 (424)

b) Iron Syrup:
The NP targeted iron syrup to anemic children aged 36-59 months, but 26% of children 6-35 months, the Sprinkles target group, also received iron syrup. However, compliance with the dosing for iron syrup was poor, which makes it unlikely that this intervention made a significant contribution to the observed reductions in anemia in the younger children.

At the time of the final survey, 24% of children aged 3-5 years had received iron syrup (**Table 12**), while only 13% of the children were anemic. Assuming the syrup was primarily given to anemic children the coverage for this group was 100%. Thus, the NP target was surpassed.

Table 12.
Iron syrup coverage in children (36-59 mo.) at final survey, regardless of anemia status.

Area	Percent of Children receiving iron syrup (n)	
	Baseline 2000/1	Final 2003
R1	11.1 (252)	25.1** (411)
R2	24.0 (433)	24.6 (346)
NP	**19.3 (685)**	**24.8* (757)**

**$p\leq0.01$, *$p\leq0.05$

If given as prescribed, the amount of iron provided through the syrup (12.5 mg/ml as ferrous sulphate) would have been adequate to address anemia. Caregivers were instructed to provide 3mg/kg body weight daily for three months (i.e., 40-50 mg/day). For most children in this group, this would be three to four bottles monthly. However, 59% of those taking syrup took only one bottle, enough for about a week, far from the amount needed to cause the observed dramatic decrease in anemia.

c) Iron-rich foods:
At the time of the final survey almost all (97%) children aged 6-59 months ate meat (the main bioavailable source of iron) at least four times weekly. However, similar data is not available from the baseline, so an increase in meat consumption is not verifiable. Twenty-four percent of children eating meat at least four times weekly were anemic, while this figure doubled (48%) for those eating meat less often ($p \leq .01$). Additionally, children in HH preserving meat were less likely to be anemic than those in HH that did not ($p \leq .01$). Thus, the importance of both preservation and consumption of meat should be included in nutrition education and strongly promoted as a component of optimal complementary feeding.

Twenty-four percent of children eating meat at least four times weekly were anemic, while this figure doubled (48%) for those eating meat less often.

However, knowledge of sources of iron did not necessarily translate into changes in practices. There was no difference in prevalence of anemia among children whose caregivers could versus those who could not correctly identify causes of anemia and methods to prevent/treat anemia. The reason for households not providing meat for their children could be due to a lack of resources to obtain meat, as Mongolia is culturally a meat-eating society. Thus it is essential to support economic development and nutrition and food security strategies (e.g., decreased poverty) for increased access to meat, at the same time as providing immediate sources of iron (e.g., Sprinkles).

d) Maternal Iron Status:
In order to reduce maternal anemia, the NP promoted iron supplementation during pregnancy and lactation, as well as increased consumption of iron-rich foods. This strategy was intended to benefit both the mothers and their infants, as anemic pregnant women (PW) are more likely to produce anemic newborns (Kilbride, 1999; Colomer, 1990).

Among PW, a 38% decrease in anemia (Hb <11.5 g/dl) was found (from 33% at baseline to 22%). A similar reduction in anemia prevalence in lactating women was also observed (from 11% to 7%). These improvements may have contributed to improved iron status in their infants, leading to the observed reduction in anemia in the 6-11 month age group.

Coverage of iron supplements to PLW fell significantly below the 80% target. Of the 32% of PLW who had taken iron supplements at the time of the final survey, 89% did not take the supplements for the recommended six months. Of those who acknowledged not taking the iron according to instruction, 17% stopped because they 'felt bad' while taking the supplements and 5% each because the supplements tasted bad or they forgot.

e) Exclusive Breastfeeding:
As the average age of initiation with Sprinkles was 13 months, many of the youngest children in the target age group did not receive the fortificant. However a reduction in anemia in children 6-11 months was observed. This could be attributed to improvements in breastfeeding as well as decreases in anemia among PLWs. Exclusive breastfeeding to 6 months more than doubled during the program period, from 17% to 43%, $p \leq .01$, but there was no significant relationship found between anemia in

children 6-11 months of age and reported duration of exclusive breastfeeding. Breast milk is not rich in iron (it contains less than a milligram per liter), but babies can absorb the majority of the iron present (Williams, 1998). Thus breast milk may offer more bioavailable iron than is found in Mongolian infants' typical complementary foods, which consist mostly of liquid, flour, and little, if any, meat.

f) Nutrition and Health Education

The NP nutrition education strategy included topics related to anemia prevention and control. Those who participated in the sessions more frequently knew these causes of anemia: food/nutrition problems (48% vs. 41%, $p \leq .01$), heavy menstrual periods (17% vs. 11%, $p \leq .01$), and multiple births (20% vs. 15%, $p \leq .01$). They also more commonly knew these tools for preventing/treating anemia: meat (63% vs. 53%, $p \leq .01$), liver (60% vs. 51%, $p \leq .01$), and iron supplements (14% vs. 11%, $p \leq .05$).

The most powerful ways to address anemia in the youngest children are to ensure adequate maternal iron status throughout pregnancy and lactation, to promote exclusive breastfeeding to 6 months, and to promote nutrient-rich complementary foods.

Summary of Anemia Control Issues

Anemia prevalence decreased significantly in children under five in both NP areas. However, the NP was found to be less effective in improving anemia in children under age 1, where the highest burden appears (although it did decrease by 26%), than in children 1-5 years old, where decreases in anemia were up to 50%. The main reason for the lower achievement in the youngest children is likely to be the low coverage of Sprinkles to this group.

In this study population a large part of the anemia may be due to low exclusive breastfeeding rates and the low quantity of iron in young children's diets. In this population, over one-half of the children (about 56%) started complementary foods earlier than recommended, with the average age of initiation at 5.6 months (just shy of the recommended 6 months). In addition to missing out on their full course of iron from exclusive breastfeeding, children starting complementary feeding before 6 months were also more susceptible to certain diseases and illness (such as diarrhea and respiratory infections), which decrease iron stores. Finally, Sprinkles were not introduced until 13 months, on average, such that iron content of complementary foods was minimal.

The findings call for strengthening efforts to reach the youngest children, as they are at the greatest risk of developing severe anemia (Nestel, 1996). As mentioned, a child is usually born with enough iron stores to last for six months, as long as his/her mother was not anemic during pregnancy. The most powerful ways to address anemia in the youngest children are to ensure adequate maternal iron status throughout pregnancy and lactation, to promote exclusive breastfeeding to 6 months, and to promote nutrient-rich complementary foods (including much more meat, whether preserved or fresh, prepared so that the children will be able to eat it). As meat may not be readily available, another effective strategy to reduce anemia in among this age group would be to promote the earlier use of Sprinkles, starting at 6 months of age, with the introduction of complementary foods. Throughout the age group, Sprinkles should be continued for at least four months and given at least three times weekly.

Rickets, a painful bone deforming condition affects more than 1 in 3 Mongolian children. Further efforts are needed to address this problem as program strategies to date have had little success.

Table 13.
Prevalence of anemia by age, AI area.

Age (months)	Percent Anemic (n)	
	Baseline 2000/1	Final 2003
6-35	49.2 (199)	27.4** (95)
36-59	16.0 (156)	8.5 (71)
6-59	**34.6 (355)**	**19.3** (166)**

**p≤0.01, Chi-squared test

Table 14.
Iron syrup coverage in children (36-59 mo.), regardless of current anemia status, AI area.

Area	Percent of children receiving iron syrup (n)	
	Baseline 2000/1	Final 2003
AI	5.3 (150)	23.9** (71)

**p≤0.01

Table 15.
Percent of children (6-59 mo.) with rickets in NP areas.

Area	Percent Rickets (n)	
	Baseline 2000/1	Final 2003
R1	36.1 (737)	31.0* (869)
R2	23.8 (1269)	23.6 (450)
NP	**28.3 (2006)**	**28.4 (1319)**

* p≤0.05

5.1.3 Anemia in Children in Alternative Intervention Area

Among children 6-59 months, a similar (44%) decrease in anemia was seen in the AI (**Table 13**) as in NP. This could indicate a secular trend, but was probably the result of the distribution of BP-5 energy bars (distributed to 40% of children in AI vs. only 22% of children in NP areas[32,33]). As noted previously, the BP-5 energy bars distributed as a result of the dzud, provided 40 mg of iron daily.

There was also a significantly lower level of anemia in the AI area at baseline (35%) than in the NP areas (46%). This may reflect a higher availability of iron-rich foods, such as meat, in the AI area. More HH reported preserving meat in AI than in NP areas (96% vs. 43%, p≤.01). Lower anemia rates may also have been impacted, although to a lesser degree in this age group, through fortified flour,[34] used by significantly more HH in AI areas than in NP areas (61% vs. 48%, p≤.01).

Importantly, although the levels of anemia were higher (p≤.01) in the NP area than the AI area at baseline, there was no difference between NP and AI areas at final, suggesting that greater achievements had been made in the NP areas. This provides further evidence of the effectiveness of the NP interventions.

As in the overall <5 age group, the 6-35 month age group also saw a decrease in anemia in the AI area (**Table 13**), most likely due to the interventions discussed above. However, no decrease in anemia was seen in the 36-59 month age group (**Table 13**) despite an increase in iron syrup coverage to this group. This may be due to insufficient sample size to detect a difference, or may be that the coverage of iron syrup (**Table 14**) or quantity consumed was insufficient to reduce anemia.

5.2 Vitamin D

5.2.1 Rickets in Children

The prevalence of rickets reduced by 5% in the overall <5 age group in the R1 area (from 36 to 31%), but did not reach the 20% goal (**Table 15**). In R2 and overall, there was no change in prevalence of rickets. Unfortunately, evaluation data from three surveyors in Bulgan I (in R1) and Bulgan II and Erdenet (in R2) had to be excluded from the presentation of results, due to over-diagnosis. The identified issues were: 1) significantly higher diagnosis than other surveyors and 2) significantly higher prevalence than at baseline. This affects the interpretation of results, as the adjusted sample size was often under 621, the minimum required to detect changes in rickets.

The baseline and final levels of rickets identified in this study were similar to the findings of previous Mongolian surveys of children under 5 years. In fact, rickets has been considered a common childhood disease in Mongolia for years. In 1992, a national nutrition survey by UNICEF, in association with the Mongolian Ministry of Health and Social Welfare, reported a figure of 45% of young children having the skeletal abnormalities that are typical of rickets (UNICEF/MSHW, 1993). A 1997 survey by WVM and the Nutrition Research Center of the Public Health Institute found that 70% of children between the ages of six months and five

[32] In NP areas, children temporarily stopped using Sprinkles during their use of BP-5. Although this did not necessarily impact all NP areas, it significantly impacted the program in some, such as Dundgobi, where monthly distribution of Sprinkles decreased from 800 to 500 children during the period.
[33] Less than 1% of children received only BP-5, making it difficult to compare BP-5 to other interventions.
[34] The Asian Development Bank funded two mills' production of fortified wheat flour, "Ulaanbaatar-1" in 2002. Nutrients include thiamine, riboflavin, niacin, zinc, iron, and folic acid, but not vitamin D.

years had one or more of the clinical signs of rickets (Tserendolgor et al, 1998). A further survey by UNICEF and the Nutrition Research Center in 1999 in 15 different cities, towns and aimags (provinces) across the country found an overall prevalence of 32%, although in some area the prevalence was as high as 50-60% (NRC & UNICEF, 2000).

Breaking down the NP results by age group, a significant decrease in rickets was seen in <3s in the R1 area, but there was no change seen in R2, nor in the overall NP area (**Table 16**).

Table 16.
Prevalence of rickets in children age 6-35 months.

Area	Percent Rickets (n)	
	Baseline 2000/1	Final 2003
R1	40.5 (476)	32.9* (505)
R2	26.0 (830)	24.1 (286)
NP	**31.3 (1306)**	**29.7 (791)**

* p≤0.05

Table 17.
Prevalence of rickets in children age 36-59 months.

Area	Percent Rickets (n)	
	Baseline 2000/1	Final 2003
R1	28.0 (261)	28.3 (364)
R2	19.6 (439)	22.6 (164)
NP	**22.7 (700)**	**26.5 (528)**

No change in rickets prevalence was found in children 3-5 years old (**Table 17**). This is expected, given the difficulty in reversing skeletal abnormalities and the minimal improvements seen in the 6-35 month group. Treatment for uncomplicated rickets, provided enough calcium and phosphorous is consumed, typically includes 1600 IU vitamin D daily (similar to the preventive dose given to young Mongolian children in the winter) at the beginning of treatment and decreasing to 400 IU after a month. Vitamin D blood levels normalize after two months of this regimen. However, normal blood levels do not reverse skeletal malformations. Minor change can be seen on x-rays in about three weeks (Beers & Berkow, 2004), but clinically obvious change is not expected at this age.

Overall, the NP had a minimal impact on rickets prevalence in children. The major reason for this is believed to be that the NP was not effective in reaching children early enough with a high enough dose of vitamin D. It may also be that maternal vitamin D status during pregnancy and lactation was very low, which could have led to vitamin D deficiency in newborns and early onset of rickets, but this cannot be verified.

5.2.2 Interventions to Address Rickets

a) Sprinkles:
As noted above (section 5.1.2), 89% of children under age 5 had tried Sprinkles, with a mean duration of use of 13 months, and an average starting age of 13 months. There was no significant difference in rickets prevalence between those who did and did not receive Sprinkles, regardless of duration. However, about half of the children taking Sprinkles at the time of the final survey had also received high-dose vitamin D in the past year, implying that those in this age group needing treatment were not denied it due to their use of Sprinkles.

Only 37% of children <3 had used Sprinkles for 13 months, which, if taken as prescribed daily, would have provided them with 156,000 IU vitamin D within the entire program period (i.e., 400 IU/day from Sprinkles for 13 months). This quantity of vitamin D is less than half the annual amount recommended by the Mongolian MOH's prevention plan for children under age two (i.e., 50,000 IU monthly from October to May or 400,000 IU/yr). It is unlikely, therefore, that the amount of vitamin D provided by Sprinkles with the reported usage patterns was adequate to prevent rickets.

Moreover, recent research from Mongolia NRC, in collaboration with the University of Sydney (Tserendolgor and Fraser DR, 2003) recommend that 300,000 IU of vitamin D are needed to raise the 25 (OH) vitamin D serum levels from deficient to 'normal' in children. This would mean adding 2,000 IU of vitamin D per sachet of Sprinkles and giving it for 150 days or 5 months.

The results of this program effectiveness study and current research of efficacy of vitamin D interventions, therefore, suggest that the dose in Sprinkles was insufficient to meet the vitamin D needs of Mongolian children and to prevent development of rickets. It is recommended to increase the amount of vitamin D in the Sprinkles sachet to a level adequate to provide 300,000 to 400,000 IU vitamin D over the winter months. This would translate into 1,230 to 1,650 IU per sachet of Sprinkles, if provided for 8 months daily, during the winter. Otherwise, vitamin D supplements should be provided in addition to Sprinkles, to ensure that the recommended 50,000 IU/month (October – May) is provided as per the MOH policy. In addition, the importance of introducing Sprinkles at 6 months of age, as soon as complementary feeding begins, needs to be strongly promoted. This would increase vitamin D intake as early as possible, since many studies have found rickets in children of less than six months of age.

b) Vitamin D Supplementation:

The NP provided deficient children aged 3-5 years an average of 13,160 IU vitamin D daily for almost a month (350,000 IU in 3.5 weeks, as per the MOH mandate). High coverage of this intervention was achieved. The NP aimed to reach 80% of rachitic children 36-59 months. Only 23% of children that age had rickets, but 41% were reached (**Table 18**).

It is assumed that the children took the supplements, but compliance is not ensured. There was no significant difference in clinical signs among those who received supplements versus those who did not (28% vs. 31%), regardless of form (syrup or capsules) and duration of supplementation (from one to more than three bottles of syrup given in 50,000 IU doses or from one to eight 50,000 IU capsules/ tablets). However, as noted above, one would not expect to see clinical changes in this age group.

Table 18.
Vitamin D coverage in children 3-5 years, regardless of current rickets status.

Area	Percent of Children receiving Vitamin D capsules (n)	
	Baseline 2000/1	Final 2003
R1	62.2 (254)	47.8** (402)
R2	61.9 (430)	34.1** (346)
NP	**62.0 (684)**	**41.4** (748)**

**p≤0.01, Chi-squared test.

Although the NP initially targeted primarily older (36-59 months) children with rickets for vitamin D supplementation, 40% of younger children (6-35 months) in NP areas also received the supplement, compared to 61% at baseline. This decreased coverage with vitamin D supplements was expected; with the introduction of Sprinkles and the coordinated record-keeping (between NWs and local health personnel), those children receiving Sprinkles would not have been given traditional vitamin D supplements unless they had a clear need. If taken as prescribed by MOH, these children would have received 50,000 IU monthly from October to May, for a total of 400,000 IU/yr. However, there was no significant difference in rickets outcomes in these children, regardless of how many supplements they received. These results suggest that either insufficient vitamin D was provided through supplements and/or there are other contributing factors to rickets (e.g., such as insufficient calcium). There is also need to explore issues around compliance and acceptability of the vitamin D supplements.

c) Maternal Vitamin D Status

The lack of significant impact is also likely due, in part, to low vitamin D status of women during pregnancy and lactation. As rickets is frequently found in children less than six months and often as young as a few weeks old, vitamin D deficiency in pregnant women may contribute to the development of rickets in their children (Tserendolgor & Fraser, 2003). Infants have been found to have signs of sub-clinical vitamin D deficiency in the first months of life, even at birth, if the mother is deficient (Beers & Berkow, 2004).

One of the NP strategies was to increase the vitamin D intake of pregnant and lactating women (PLW) through supplements. However, this approach was not very effective. Vitamin D coverage (i.e., 50,000 IU monthly for the last trimester of pregnancy and the first 6 months after delivery) was very low (12%), much lower than targeted (80%), and did not improve from baseline (where the range was from 7-15%, depending on survey time and area). Reasons for the low coverage are unclear, but may have to do with vitamin D supplementation to PLWs being an intervention not backed by a government policy or program, and without the innovative appeal of Sprinkles. At any rate, it appears that these coverage levels were too low to bring change in the rates of rickets among the children under 3.

A PLW taking 50,000 IU monthly/1,650 IU daily, as directed, may improve her vitamin D status, impacting that of the fetus or breastfed infant. Research shows that a LW supplemented with 2000 IU daily will pass to the infant an amount similar to 400 IU given directly to the child (Ala-Houhala, 1986). Some question the safety of 4000 IU daily (about 2.4 times the amount given by the NP) to the PLW to meet the child's needs (Holick, 2001). Others find no evidence that even 100,000 IU daily to the PW would be harmful (Hollis, 2004).

In light of this research and the NP evaluation findings, it is recommended that a stronger emphasis be placed on improving the vitamin D status of PLW. First, the NP needs to identify the reasons for low PLW coverage with vitamin D supplements. Perhaps a product similar to Sprinkles, formulated for PLW, could be distributed simultaneously with children's Sprinkles. A Sprinkles product for PLWs is in fact currently under development and a number of projects are being conducted in different countries. Further study is warranted.

d) Social Marketing and Health Education

Promotion of sunlight exposure was a key message of the NP's social marketing strategy. At Mongolia's northern latitude, the skin cannot produce much vitamin D during winter, but from April to October, 5-10 minutes three times weekly on the head, arms, and hands should produce enough vitamin D to cover needs for the year (Holick, 2003). However, Mongolian children may not get that much sun, even in the summer. Previous Mongolian surveys (1993-4; 1996) found that 68-87% of rachitic children were born during the winter months, while only 32% were born during summer. No measurements were taken at baseline, but at final survey most (95%) infants were reportedly swaddled for a mean duration of 5 months, suggesting little improvement despite the NP's social marketing and education on increasing sunlight exposure. Of those swaddled, fewer were completely covered in R1 than in R2 (43% vs. 75%, $p \leq 0.01$). However there was no relationship between rickets prevalence and complete versus partial swaddling.

Most (95%) infants were reportedly swaddled for a mean duration of 5 months, suggesting little improvement despite the NP's social marketing and education on increasing sunlight exposure.

While it is very difficult to change such a strong cultural practice as swaddling, it is recommended that increased efforts be made to decrease the time for which a child is swaddled, especially those born in spring or summer. Formative research could be done to see what may be an acceptable target (e.g., 2-3 months).

Although knowledge related to rickets improved dramatically from baseline, this may not have translated into sufficient change in practices. Lack of sun exposure was named as the most common cause of bowed legs (rickets) more often (62%) at final survey, a dramatic improvement ($p \leq .01$) from baseline (15-17%). The incorrect response of horse riding decreased to 4% in NP areas, from 15-17% at baseline ($p \leq .05$).

Pollution is also a risk factor for rickets, but this survey found no increased risk of rickets in the capital, likely due to the fact that the heavy coal pollution occurred during winter months when the ultraviolet rays reaching ground level in Mongolia are negligible (Mongolia is situated between latitudes of approximately 42 and 50 N). Furthermore, the harsh winter daytime temperatures of –20 to –40° C greatly limit exposure of any skin to the sun.

e) Infant Feeding:

Since the complementary foods in Mongolia contain very little endogenous vitamin D, those children who were not exclusively breastfed for 6 months and/or continued with breastfeeding, likely had little dietary vitamin D intake. Although human milk is not the best source of vitamin D, vitamin D does pass through the milk (about 20-60 IU in the milk of non-deficient mothers, Greer, 1984). If the mother is deficient, vitamin D supplements are recommended, or sometimes supplementation of breastfed infants for the first six months is recommended.

As noted previously, continued emphasis needs to be placed on exclusive breastfeeding for 6 months and continued breastfeeding for up to 2 years. Moreover, it is recommended that all newborns, many of whom are sub-clinically deficient, be provided with a single dose up to 5,000 IU vitamin D at birth (Holick, 2001).

5.2.3 Rickets in Children in Alternative Intervention Area

Unlike the NP's R1 area where there was a moderate decrease in rickets among the overall <5 age group and the <3 age group in particular, the AI area experienced no significant change in rickets, in any age group (**Table 19**). Unlike in the NP area, the AI experienced no decrease in vitamin D supplementation (**Table 20**).

Table 19.
Prevalence of rickets in Alternative Intervention area, by age group.

Age (mo)	Percent Rickets (n)	
	Baseline 2000/1	Final 2003
6-35	48.7 (199)	42.1 (95)
36-59	31.4 (156)	23.9 (71)
6-59	41.1 (355)	34.3 (166)

5.3 Nutrition and Health Education

Forty-eight percent of HH of <5s reported receiving informal nutrition education in NP workshops or by NWs visiting their homes. Although the lofty target of 80% of HH was not reached, important progress was made, given the extensive geographic areas covered (up to 129,000 km^2) and the low population density— about 7 people per km^2 including cities (Law, 2005). Participation in the nutrition education workshops by those who were reached varied from 13-43% (**Table 21**). Seven percent of HH participated in all of the workshops; given their interest, they should be tapped as role models/peer educators in the future.

Households who had attended workshops correctly identified sources of nutrients more often than those who had not. For example, meat was identified as a protein source by significantly more respondents who had attended workshops (47%) compared with those who had not (40%). Similarly, vegetables and fruit were more often named as sources of vitamin A (78% vs 74%) and vitamin C (83% vs 72%) by those who had attended workshops.

The primary reported reason (58%) for HHs not attending the workshops was that they were not informed of the sessions, implying that there could be improvements in promoting the workshops. Perhaps NWs could schedule sessions far enough in advance to be able to inform families during visits in the months prior to the workshops, or could recruit doctors and others who serve the population of interest to inform the families of the sessions. Other reasons were that the location was too far away (12%) and the need to look after the children and the home (9%), problems common to most traditional nutrition education strategies.

Table 20.
Vitamin D coverage in 3-5 year olds, regardless of current rickets status, Alternative Intervention area.

Area	Percent of Children receiving Vitamin D capsules (n)	
	Baseline 2000/1	Final 2003
AI	31.1 (148)	38.0 (71)

Table 21: Participation in Nutrition Education Workshops

Topic	Percent of HH Participating
Balanced diet	33
Infant nutrition	31
Nutrition for PLW	26
Hygiene and food safety	22
Food preservation	21
Food preparation techniques for nutrient retention	20
Key nutrients	14
Budgeting and saving	13

5.4 General Nutritional Status: Anthropometry

Anthropometric indices are used as the main criteria for assessing the adequacy of diet and growth in infancy (WHO, 1995). As deficiencies of some micronutrients (e.g., zinc, iron, vitamin A) impact growth, improvements in child growth were expected, given the NP's provision of micronutrients and nutrition education.

5.4.1 NP Area

a) Stunting:

Importantly, the evaluation did find a highly significant reduction in stunting in NP areas (from 23% to 18%) over the three years of the program (**Table 22**), suggesting an impact of NP interventions on child growth. This rate of improvement is similar to the 2.4 percentage points per year found in a review of Title II programs (Swindale, et. al. 2004), but is especially remarkable given that those programs' average starting prevalence was 53%, since gains are easier to obtain from a severe level than from a level that is more moderate.

However, the levels of stunting in the surveyed population both at baseline (23%) and final (18%) were significantly higher than standard levels (e.g., 5%), indicating long-term, cumulative inadequacies of nutrition and health. The initial 23% stunting prevalence is comparable to the 25% found in a national survey carried out in 1999 (NRC & UNICEF, 2000).

Decreases in stunting may be due to a variety of factors, including increased consumption of micronutrients (zinc, iron and vitamin A) through Sprinkles, vitamin D (Sprinkles and supplements), and iodine (household iodized salt usage increased from 58% to 88%), all of which improve growth.

b) Stunting, Rickets & Anemia:

The final survey found that anemic children were more likely to be stunted (24% vs. 17%, $p \leq .01$), but found no relationship between rickets and stunting. In contrast, at baseline, children with rickets were twice as likely to be stunted as those without. Perhaps this indicates the important role of iron and/or other micronutrients (e.g., zinc) on reducing stunting. **(Figure 5)**

Table 22. Nutritional status of children under five in NP areas.

Anthropometric Indices	Percent Malnourished (n)	
	Baseline 2000/1 (2006)	Final 2003 (1767)
Stunted (height-for-age Z-score <-2)	23.1	18.1**
Underweight (weight-for-age Z-score <-2)	5.9	7.3
Wasted (weight-for-height Z-score <-2)	1.0	1.5

**$p \leq 0.01$, Chi-squared test

c) Wasting and Underweight:

Wasting did not change significantly (**Table 22**). At both baseline and final levels were well below the 2-3% expected in a healthy population, indicating that there was no recent rapid weight loss, which usually occurs as a consequence of acute starvation and/or severe disease, or a chronic dietary deficit or disease (WHO, 1995). The levels are comparable to those found in the Caucasian population of the U.S. (1.8%), and one would expect these low levels found in Mongolia to be constant. This is despite the dzud disasters throughout the program timeframe, indicating that HH may have been better able to cope or recover from the dzuds than expected, perhaps taking advantage of the relief offered by the international community.

The proportion of <5s found to be underweight (reflecting either short and/or long-term nutritional status) also did not change significantly in NP areas (**Table 22**).

d) Underweight, Rickets & Anemia:

Children who were rachitic or anemic were more likely to be underweight (underweight in rachitic vs. non-rachitic children: 10% vs. 7%, $p \leq .05$; underweight in anemic vs. non-anemic children: 13% vs. 6%, $p \leq .01$).

5.4.2 Alternate Intervention Area

Contrary to what was found in the NP area, no improvements were seen in rates of stunting in the AI area, even though stunting was initially high (**Table 23**), at similar levels to the NP areas (**Table 22**), indicating long-term inadequacies in the nutrition or health of the children. On the other hand, underweight dramatically and significantly increased from baseline to final (**Table 23**). There was no change in wasting prevalence.

Table 23. Nutritional status of children under five in AI areas.

Anthropometric Indices	Percent Malnourished (n)	
	Baseline 2000/1 (355)	Final 2003 (162)
Stunted (height-for-age Z-score <-2)	24.5	24.7
Underweight (weight-for-age Z-score <-2)	6.5	13.6**
Wasted (weight-for-height Z-score <-2)	2.5	3.1

**$p \leq 0.01$, Chi-squared test

The continued high rates of stunting and increase in underweight occurred despite reported increases in exclusive breastfeeding (24% to 52%), use of iodized salt (61% to 99%) and receipt of BP-5 bars. In fact, more children in AI (40% in AI vs. 22% in NP) received BP-5. This deterioration of the nutritional situation may have been due to the dzud (severe winter storm), which may have had a greater impact on food security in these areas than in the NP areas. Alternatively, it may be that the dzud equally affected the NP and AI areas, but that WV programs (the NP and others) mitigated the negative effects on children. Finally, it may be that those in the NP areas had coping mechanisms different from those of the AI, improving child nutrition status, despite the dzud.

Figure 5.
Twelve-year old, stunted cretin, a condition easily prevented with Iodine.

6.0

"Through the nutrition program, [my child] is now a totally changed boy, he has a much bigger appetite and is more active"

(Program Beneficiary)

6.1 Conclusions

The WV Mongolia Nutrition Program (NP) was effective in decreasing anemia and stunting, likely due to the provision of micronutrients as a home-based fortificant (Sprinkles). The Sprinkles were well accepted by beneficiary families and 89% coverage was achieved, contributing to the success of the intervention.

On the other hand, the nutrition program had very limited effectiveness in decreasing rickets, likely in large part due to inadequate vitamin D levels in the Sprinkles, not targeting children early enough, poor compliance to vitamin D supplementation, and low coverage of traditional vitamin D supplements to PLW.

6.1.1 Anemia

The NP was effective in reducing anemia in children under 5. In fact, anemia decreased much faster (by 46% of the original level in about 2 years) than usually expected (the international goal is a 30% reduction in over 10 years). The improvement in anemia in children age 12-35 months is likely due to the wide coverage and utilization of Sprinkles. Unfortunately the youngest children (6-11 months) were not effectively reached with this strategy, as parents did not give Sprinkles to their children until an average age of 13 months. This group may have benefited most from improved maternal iron status and provision of iron syrup for treatment of anemia, but anemia levels remained above 40% at the final survey.

Continued promotion of iron-rich foods, of Sprinkles (for at least four months, at least 3 times per week), and of iron syrup for anemia treatment is recommended. Also, based on recent research findings, it is recommended that the iron dose be reduced to 12.5 mg per sachet of Sprinkles.

Despite the gains made, anemia rates (33%) at the time of the final survey still need to be further reduced. Significant improvement could be achieved through better targeting the younger age group for iron fortificants/ supplements. Gains could also be made through improving the iron-density of complementary foods.

There was increased knowledge on anemia among those participating in NP education, but this did not necessarily translate into lower levels of anemia. What did seem to impact anemia was the consumption of meat, with those children eating meat more often being about half as likely to be anemic.

In the AI there was a dramatic decrease in anemia, likely due to other interventions addressing nutrition problems there as well as different practices and resources seen (e.g., greater levels of meat preservation). The AI experienced a four-fold increase in iron supplement coverage among older children and had widespread use of BP-5 energy bars.

6.1.2 Rickets

Overall, in children under age 5, rickets decreased in R1 (from 36% to 31%), but not in the combined groups, and not to the extent expected. There are a number of reasons for the limited effectiveness. The dose of vitamin D in Sprinkles was too low, such that even excellent coverage could not make a difference. Improvements in swaddling practices were limited. In addition, only 12% of PLW were reached with vitamin D supplementation, far below the target. Considering that deficiency in the pregnant woman often translates into deficiency in the child, future interventions should explore other ways to improve supplementation coverage in PLW.

Traditional vitamin D supplements appeared unable to reverse skeletal deformations in children who already show obvious signs. This was true in the rachitic children 3-5 who were actually targeted by the NP as well as in the younger children not targeted by the NP (but who were reached by a national program). Although coverage in the older children actually declined in NP areas, the NP's coverage goal was exceeded.

Knowledge about rickets increased in NP areas but the information may have been received too late or was not translated into action. As mentioned, knowledge did not correlate with occurrence of rickets.

No significant changes in prevalence of rickets occured in the AI area.

6.1.3 Nutritional Status

The NP successfully impacted one of Mongolia's most frustrating nutrition problems—children being short for their age. Stunting decreased from 23% at baseline, to 18%. Decreases in stunting were likely due to a combination of factors, including increased micronutrient intake through Sprinkles, supplements and consumption of zinc, iron and vitamin A (through Sprinkles, with 89% coverage), vitamin D (Sprinkles and supplements, 41% coverage), and iodine (household iodized salt usage increased from 58% to 88%), all of which contribute to improving growth.

Stunting rates in the AI did not change over the program lifetime, and underweight prevalence increased. Reasons for this are unclear, as the AI also benefited from micronutrient supplementation interventions (particularly BP-5 bars) and saw improved iodized salt consumption.

6.2 Summary Recommendations

6.2.1 Summary of Recommendations to Address Anemia

The dramatic improvement in anemia prevalence indicate that Sprinkles is an effective intervention for anemia prevention and control in children as part of an integrated Nutrition Program. In light of this, the following recommendations are proposed:

a) Children 0 to 35 months:

- Promote Sprinkles use at least three times per week, for no less than 4 months, starting immediately at 6 months of age.
- Decrease iron in Sprinkles to 12.5 mg/sachet.
- Establish systems for improving the reach to the children 6-12 months of age.
- Consider Sprinkles for treating anaemic children, given the fortificant's coverage and the families' compliance.
- Improve coverage of iron/folate supplementation for pregnant and lactating women (PLW).
- Investigate providing Sprinkles to PLWs, given the favourable response to Sprinkles in contrast to traditional supplements (e.g., given side effects).
- Continue to promote exclusive breastfeeding to 6 months and continued breastfeeding up to 2 years of age.
- Promote iron-rich complementary foods, preservation of meat, and more frequent use of meat in complementary foods (> 4 times/week).

To prevent anemia, Sprinkles should be provided at least 3 times/week, for no less than 4 months, starting at 6 months of age.

b) Children 36-59 months:

- Promote iron-rich foods, preservation of meat, and increased consumption of meat, through social marketing campaigns.
- Promote increased use of fortified wheat flour.
- Treatment: Encourage Family Doctors to comply with MOH iron supplementation policy. Give caregivers enough iron to treat their anemic child for the entire month, perhaps for all three months. Work with them to manage side effects and/or address the other reasons they might cease treatment.

6.2.2 Summary of Recommendations to Address Rickets

Given that improvements in rickets were minimal, the following suggestions might help similar programs to further address the disease in Mongolia and other northern settings where vitamin D deficiency is a public health concern:

a) Children 0 to 35 months:

- Keep the focus on prevention.
- Improve distribution of and perhaps increase dose (to 4000 IU daily) of vitamin D supplements to PLWs, as a way to reach the 0-6 month child.
- Determine reasons for low coverage of PLWs with vitamin D supplements.
- Doctors providing prenatal care should target PW and practitioners assisting with deliveries as well as those providing services to infants should target LW for vitamin D supplementation.
- PLWs should also be sure to spend at least a few minutes in the sun, perhaps daily, from spring through fall.
- Provide all newborns, many of which are sub-clinically deficient, with a single dose up to 5000 IU at birth (Holick, 2001).
- Promote exclusive breastfeeding for first six months and continued breastfeeding to 2 years.
- Advocate for and promote consumption of vitamin D-fortified wheat flour for pregnant and lactating women, as well as for weaning foods.
- Provide children with Sprinkles daily for the winter months (October to April).
- Increase the amount of vitamin D in Mongolian Sprinkles to between 800 IU and 1,600 IU (the former to meet recommendations for similar climates, the latter to provide the total amount of vitamin D as recommended by MOH – 400,000 IU within 8 winter months).
- Ensure Sprinkles use begins at six months, rather than the 13-month average initiation age.
- Emphasize the importance of taking infants, partially exposed, out in the sun, several times a week. Exposure of the face, hands, and arms for 5-10 minutes three times weekly is recommended. (Swaddled infants would need more frequent exposure.)
- Carry out formative research on and promote decreased length of time for swaddling.
- Treat clinical cases of rickets with vitamin D supplements, regardless of the use of Sprinkles.
- Consider implementing compliance monitoring in supplementation programs.

b) Children 36-59 months:

- Explore ways to provide all children with vitamin D throughout the winter months.
- Improve diagnosis of rickets and vitamin D distribution, perhaps including compliance monitoring for treatment doses.
- As per the National Plan of Action on Nutrition, fortify flour with vitamin D, to help reach these children.
- Advocate for the production and where available promote the consumption of Vitamin D fortified dairy products

7.0

With the successful implementation of nutrition interventions at scale, and a committment by the Ministry of Health and other partners to address micronutrient deficiencies, there is renewed hope that measurable improvements in the health and nutrition status of Mongolian children will be attained.

ADDENDUM - Progress In Improving Child Micronutrient Status In Mongolia (2004 – 2007)

World Vision

Since 2004, World Vision nutrition programs have expanded to new areas, scaling up the coverage of Sprinkles along with other nutrition and health interventions. The publication of a new 'Mother and Child Micronutrient Deficiency Prevention Strategy' by the Mongolia Government in 2006, has generated renewed commitment to address micronutrient malnutrition in Mongolia. The purpose of this addendum is to highlight recent progress in the areas of nutrition programming and policy.

7.1 Revised World Vision Mongolia Nutrition Program Strategy

Based upon the recommendations of the 2003 nutrition program evaluation, the nutrition program interventions were revised in order to address the weakness (e.g. rickets prevention & treatment), which were highlighted in the evaluation report. The current nutrition program strategy encompasses the following interventions:

Anemia prevention and treatment strategies

- Home-based fortification with Sprinkles for the prevention of anemia in children 6-36 months of age. Sprinkles are provided daily for 5 months/year. Each Sprinkles sachet contains 12.5 mg of iron.
- Provision of iron syrup (3mg/kg/day, 3 months) to children 36-59 months of age for the treatment of anemia.
- Provision of iron-folate tablets to pregnant women and lactating women (60 mg Fe, 400 mcg folic acid/day during 2nd & 3rd trimester of pregnancy and 6 months post delivery)

Rickets prevention and treatment strategies

- Provision of vitamin D capsules (50,000 IU/month from October – May), to children 2 – 6 months of age to prevent rickets. For children with clinical signs of rickets a treatment dose (350,000 IU) of vitamin D is provided.
- Provision of vitamin D capsules (50,000 IU/month during 3rd trimester of pregnancy and 6 months post-partum) to pregnant & lactating women.

Build Community and professional capacity for improved child health & nutrition

- Implementation of a Positive Deviance/Hearth model to promote community-based solutions to poor child health & nutritional status.
- Community-based nutrition & health training.
- Capacity building of medical professionals on prevention and treatment of malnutrition and micronutrient deficiency.
- Multi-media social marketing campaigns on nutrition & health issues.

Staffing – Use of Volunteer Mothers

The sustained improvement in the nutritional status of young children depends on the motivation of community members to address this issue. Thus, another modification in program strategy has been the use of 'mother volunteers' to support program activities and encourage community level participation. Volunteer mothers are chosen by their local community and are each responsible for monitoring 20 households in the program area. Volunteer mothers distribute Sprinkles, conduct home visits, and lead Positive Deviance/Hearth sessions.

7.2 Expanded WV Mongolia Nutrition Programming

With the funding support from World Vision offices in Hong Kong, Taiwan, and Canada, along with financial support from the Australian Government and corporate partnerships, WV Mongolia's nutrition program has expanded to new ADPs in 6 provinces, reaching a more than **38,000** young children and over **9,000** pregnant and lactating women (see table 24)

Table 24 World Vision Mongolia Nutrition Program Beneficiaries 2007

Province	ADP	Beneficaries	
		Children 0-59 months	Pregnant & lactating women
Ulaanbaatar	Dari-Ekh	2774	479
	Amgalan	2924	832
	Nalaikh 1	3350	332
	Chingeltei	2050	600
	Han-Uul	1610	1300
Darkhan	Erdenet	3264	1278
	Darkhan	1962	1203
Uvurkhangai	Arvaikheer	2783	
Dundgovi	Uvurkhangai	2586	1001
	Dundgovi	4621	
Hentii	Bor undur	1490	356
	Hentii	2004	582
Selenge		6926	1321
Total		38344	9284

7.3 Scaling –Up Integrated Nutrition & Health Programming

With funding support from Centerra Gold, a Canadian mining company with operations in Mongolia, the nutrition program interventions have been scaled up on a provincial level, covering all children under 5 years of age, along with pregnant and lactating women in Selenge province. The Selenge Health & Nutrition project, a 5-year intervention (2005 – 2010) is reaching approximately 7000 children under 5 years of age and 1300 pregnant & lactating women. Indirect program beneficiaries are 90,780.

The province-wide implementation of the nutrition program provides the opportunity for partnership and engagement with higher levels of government than typically involved in ADP/district level projects. A key component of government – WV engagement was the establishment of a Health Working Group, which consists of Selenge provincial officials from the Ministry of Health and the Department of Social Policy, along with World Vision representatives. This group meets on a quarterly basis to monitor project implementation and discuss program successes and challenges. The implementation of the program province-wide provides opportunities to demonstrate the feasibility of the interventions at scale, and to advocate for improved nutrition policy and programming with national level government. The profile of nutrition and health issues has been raised across the province and interest in these issues has extended beyond the Ministry of Health to other government departments.

7.4 Recent Developments in Government Nutrition Policy

The Government of Mongolia adopted a 'Mother and Child Micronutrient Deficiency Strategy' in April 2005. Prevention of deficiencies of iron, vitamin A and D in children under 5 years of age and pregnant and lactating women are the focus this strategy. The 10-year plan outlines the following key objectives:

- To improve the management and information systems for micronutrient supplement supply, distribution and monitoring.
- To establish a fixed financial system for supplying micronutrients (vitamin A, D and iron) to the target population.
- To coordinate and monitor activities for all nutrition programs and projects
- To develop social marketing materials to promote use of micronutrient rich foods and fortified food products. (Ministry of Health, 2006).

The strategy calls for increased coordination and collaboration among all partners in nutrition programming. National surveys will be conducted every 4 years to monitor progress.

It is clear that progress has been made in recent years to address micronutrient deficiencies in young children and pregnant and lactating women in Mongolia. With opportunities for expanded programming, the successful implementation of nutrition interventions at scale, and a commitment by the Ministry of Health and other partners to address micronutrient deficiencies, there is renewed hope that measurable improvements in the health and nutrition status of Mongolian children will be attained.

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Annex 1. Final Evaluation Samples of Children <5 in Each Region & District Surveyed

Region	District	Children <5 (age in months)		
		6-35 (n)	36-59 (n)	Total <5 (n)
Amgalan	10	44	11	55
	12	43	40	83
	8	19	9	28
	Sub-total	106	60	166
Dari-Ekh	2	56	28	84
	9	60	22	82
	Sub-total	116	50	166
Bayan-khoshuu	7	13	15	28
	8	16	12	28
	9	37	45	82
	10	9	19	28
	Sub-total	75	91	166
Tolgoit	1	16	12	28
	2	18	10	28
	20	21	7	28
	4	25	2	27
	5	22	31	53
	Sub-total	102	62	164
Nalaikh	1	19	9	28
	2	15	12	27
	4	24	28	52
	Gordokh, Terelj	12	14	26
	Khoukhor	11	17	28
	Sub-total	81	80	161
Bulgan I	Bugat	11	17	28
	Khishig-Onder	33	23	56
	Orkhon	27	28	55
	Selenge	16	11	27
	Sub-total	87	79	166
R1 Total		567	422	989

Region	District	Children <5 (age in months)		
		6-35 (n)	36-59 (n)	Total <5 (n)
Bulgan II	Bayan-Agt	30	25	55
	Bayannurr	11	17	28
	Dashinchilen	27	28	55
	Gurvanbulag	17	11	28
	Khutagundur	61	51	112
	Mogod	21	7	28
	Sub-total	167	139	306
Erdenet	Bayantsagaan	27	29	56
	Bulag	15	14	29
	Denj	33	22	55
	Govil	34	22	56
	Tsagannchuulut	59	25	84
	Ulaantolgoi	18	9	27
	Sub-total	186	121	307
Dundgobi	Delgerhangai	38	18	56
	Huld	21	7	28
	Luus	21	7	28
	Saikhanovoo	35	21	56
	Saintsagaan	89	43	132
	Sub-total	204	96	300
R2Total		557	356	913
Tov	Arkhust	18	10	28
	Batsumber	15	13	28
	Bayantsagan	14	14	28
	Buren	24	4	28
	Erdenesant	12	15	27
	Mongonmort	12	15	27
	A1 Total	95	71	166
Total Survey		1219	849	2068

Annex 2. Survey Team

Survey Coodinators:

Dr. Ariunbileg Z.
Dr. Enkhmyagmar D.
Dr. Bolormaa N.

Medical Interviewers:

Dr. Sugarsuren
Dr. Erdenechuluun
Dr. Avarga
Dr. Oyun
Dr. Natsagmaa
Dr. Dulamsuren
Dr. Lkhagvaa
Dr. Tsagaantogoo
Dr. Baysgalmaa
Dr. Lkhamkhuu
Dr. Tsuugaa
Dr. Gantsetseg

Survey Interviewers:

Davaajav
Badamkhand
Odshuren
Gantogs
Uranchimeg
Gankhuyg
Khandsuren
Alinchbish
Erdenetsetseg
Davaadumaa
Enkhbaatar
Amarjargal

Annex 3. Map

Courtesy of the United Nations

World Vision