MICRONUTRIENT DEFICIENCIES AND INTERVENTIONS IN CAMBODIA

Information for Improved Programming

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A2Z - The USAID Micronutrient and Child Blindness Project

Phnom Penh, Cambodia

Contents

This report is dedicated to Dr. Ou Kevanna and the staff of the National Nutrition Program (NNP) of the Cambodian Ministry of Health. Despite the numerous constraints including limited financial and human resources, the NNP by their perseverance and hard work have made progress in addressing maternal and child under nutrition.

The National Nutrition Program is to be commended for its achievements. Dr Ou Kevanna, as the head of the National Nutrition Program is especially recognized for his untiring efforts to increase awareness among policy makers about the relationship between the population's health and the achievement of Cambodia's socio-economic development goals.

With increased commitment and support from the Cambodian government and development partners the National Nutrition Program will be able to effectively deliver nutrition interventions to improve the health of all women and children. Without improvements in the nutrition of women and children, Cambodia's plan for sustainable development and continued economic growth will be unachievable.

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IRIS - International Research on Infant Supplementation
IVACG - International Vitamin A Consultative Group
IZiNCG - The International Zinc Nutrition Consultative Group
KFP - Key Family Practices
LBW - Low birth weight
LQAS - Lot Quality Assurance Sampling
MICS - Multiple Indicator Cluster Surveys
MoH - Ministry of Health
NCHS - National Center for Health Statistics
NGOs - Non-Governmental Organizations
NIS - National Institute of Statistics
NNP - National Nutrition Program (of the Cambodian Ministry of Health)
ORS - Oral rehydration salts
PSI - Population Services International
RACHA - Reproductive and Child Health Alliance
TASK - Tratrung ning Akphiwat Sokhaphiep neak Kre Kraw (Supporting the Development & Health of the Poor)
UCLA - University of California – Los Angeles
UNICEF - The United Nations Children's Fund
USAID - United States Agency for International Development
VAD - Vitamin A Deficiency
VIF - Variance Inflation Factor
WHO - World Health Organization
WIF - Weekly Iron Folate

Executive Summary

Introduction

Anemia and micronutrient deficiencies are invisible, insidious forms of malnutrition that affect individuals, families and countries. Micronutrient malnutrition decreases the chances of leading a healthy life by reducing immune function, work capacity and education ability. At key points in the life cycle these micronutrient deficiencies can lead to severe growth retardation and death.

A2Z - The USAID Micronutrient and Child Blindness Project is working towards identifying and implementing effective and affordable interventions to address anemia and micronutrient deficiencies. In Cambodia, A2Z works to mainstream micronutrients into the health system and advance food fortification through critical analysis, ongoing coordination with government and nutrition partners and provision of technical support and innovation.

Cambodia's economy has grown dramatically in the past years and the floods and droughts common to the past have fortunately been absent. Living conditions on the whole are improving for the general population. Despite these improvements, Cambodia has a higher maternal mortality rate and an equal rate of child under-five mortality compared to Bangladesh. Cambodian conditions of anemia and micronutrient malnutrition are among the worst in south-east Asia. There is an urgent need to address malnutrition in Cambodia.

Cambodia is fortunate to have many sources of data on maternal and child health and nutrition, such as two Demographic and Health Surveys, a Health Information System and several smaller studies. This report documents what the available data sources reveal about the conditions of anemia and micronutrient deficiencies, their prevention and treatment. The conditions of child malnutrition used in this analysis are based on the heights and weights from the Demographic and Health Surveys calculated with the new International Growth Standards released from WHO in 2006. The indicators of malnutrition are presented in the annex.

The new child growth standards show that stunting or chronic malnutrition in Cambodian children (43%) is higher than what was reported in the CDHS 2005 (37%), which used the old NCHS/WHO/UNICEF growth standards. The prevalence of wasting or acute malnutrition increased slightly (8%) when the new growth standards are compared to the old (7%). The findings concerning micronutrient deficiencies continue below.

Inequity in utilization of services

The most consistent finding throughout this analysis was that the Cambodian women and children who are most in need of micronutrient and deworming interventions are the least likely to receive them. The great inequities in the delivery of child survival interventions were first documented in the CDHS 2000 and continue to be evident today. The micronutrient interventions in this report are promoted for all women and children, but anemia and micronutrient deficiencies will not decrease unless the population in need receives the appropriate interventions. Cambodia is following international recommendations to iodize salt and provide universal micronutrient supplementation and deworming as needed but a dramatic intensification of efforts is required. Elimination of this inequity will allow delivery of the micronutrient and deworming interventions to the correct populations and result in rapid measurable improvements in health.

No improvement in rates of maternal night blindness.

Vitamin A deficiency is a serious public health problem among women and children in Cambodia. Twenty-two percent of rural children 6-59m of age had severe vitamin A deficiency (low serum retinol) in 2000 (CNMS 2000). In Kampong Thom and Stung Treng/Preah Vihear, almost 5% of women reported night blindness during their last pregnancy in 2005 (CDHS 2005). Comparison of the adjusted levels of reported maternal night blindness from the CDHS 2000 and CDHS 2005 shows no improvement. For children, data is available only from 2000 and the trend of vitamin A deficiency cannot be assessed.

What is the coverage of vitamin A supplementation in children?

The CDHS 2005 reported a rate of vitamin A supplementation in children of 34%. The vitamin A supplementation questions changed between 2000 to 2005 allowing mothers to respond "don't know" when child received vitamin A. Analysis showed that poor mother's recall and mothers reporting "don't know" when child received vitamin A (30%) significantly biased the estimate. Adjustments for recall bias and use of imputation for cases where mothers reported "don't know" when child received vitamin A produced a coverage estimate of 50%. Supplementation rates in children appear to have improved (from 29% to an estimated 50%) but the trend of vitamin A coverage in children is not precise due to the high percentage of "don't know" when responses in 2005.

The rate of utilization of vitamin A supplements in children (ever received vitamin A) was not biased by the conditions detailed above. Counts of children who never received vitamin A were calculated and graphed on a map. In Kampong Cham province over 45,000 children aged 6-59 months never received vitamin A. This analysis showed that provincial utilization (and coverage) rates alone do not clearly identify where the largest populations of children are not receiving interventions. Actual numbers of children need to be taken into account in the intensification of delivery of micronutrient interventions.

Post-partum vitamin A supplementation improved but still very low coverage.

The CDHS 2005 reported that 27% of post-partum women received supplementation with vitamin A in the eight weeks after delivery. The post-partum indicator was not affected by biases identified with the child supplementation indicator. The post-partum supplementation rate almost tripled from 2000 to 2005 (from 11% to 27%) but is still low. The HIS data shows improvements in vitamin A supplementation rates in both post-partum women and children over time.

Anemia in women and children remains a serious problem.

In Cambodia, anemia has been documented repeatedly as a serious public health issue in children under five and women of reproductive age. Anemia increases the risk of maternal and perinatal mortality and negatively affects child development and educational and economic potential.

The most recent measures in the CDHS 2005 showed that 47% of women aged 15-49 years were anemic and 11% had moderate or severe anemia. Sixty-two percent of children aged 6-59 months were anemic and 33% had moderate or severe anemia. From 2000 to 2005 the prevalence of anemia in children was stagnant. In women of reproductive age in the same time period, the prevalence of anemia in women decreased by 11 percentage points.

The exact causes of anemia in affected populations have not been accurately quantified but the most important causes are considered to be:

- Dietary iron deficiency
- Other micronutrient deficiencies
- Infection with hookworm and/or schistosomiasis
- Hemoglobinopathies and
- Malaria

Iron deficiency

No data on iron deficiency in women of reproductive age was identified. The iron needs during pregnancy are known to be the highest throughout the entire life cycle. Iron deficiency is assumed to be a significant cause of anemia in pregnant women in Cambodia. Two studies on iron and multi-micronutrient supplementation were done in pre-school children in Kampot and Kampong Chnnang provinces. The children in the control groups who did not receive iron but received vitamin A and deworming (depending on age) had a prevalence of iron deficiency (low serum ferritin adjusted for inflammation) of about 50%.

Low coverage of deworming in under-five children and pregnant women.

No national level data on prevalence of intestinal parasites was identified but hookworms that cause anemia are considered common in school children and adult populations. Less than one-third of children 12-59 months received deworming treatment in 2005. Children are more likely to receive deworming after 2 years of age and possibly when they start to show symptoms of parasitic infection. About 10% of pregnant women received deworming overall. In some provinces, such as Mondolkiri and Rattanakiri, deworming was virtually non-existent for pregnant women. The highest coverage rates for pregnant women in any province were about 20%.

No data was collected on post-partum deworming. No data was collected on deworming in the CDHS 2000 precluding trend analysis.

Malaria infection rates are low.

After the rapid deforestation that occurred over the past 15 years, malaria appears to have largely disappeared as a serious cause of under-five mortality. Using the prevalence estimates of slide positive malaria from the Cambodian National Malaria Baseline Survey 2004 and WHO estimates of populations living in malaria risks zones, a national level prevalence of 0.4% was calculated. Malaria is regularly diagnosed in marginal forested zones with low population density. On the national level, it is not considered to contribute significantly as a cause of anemia or under-five mortality.

Hemoglobinopathies

The genetic causes of anemia common in Cambodia have been documented in at least five recent studies. There is no national level data, but hemoglobin E and alpha thalassemia are the most common hemoglobinopathies while beta thalassemia was less common. In a review of all studies, it was concluded that the majority of hemoglobinopathies were clinically benign. There is still the need to determine the effect of hemoglobinopathies on hemoglobin concentration. If hemoglobinopathies are responsible for 30% of anemia for example, then interventions will never decrease the anemia prevalence below that 30% platform. The information on the effect of hemoglobinopathies will help determine the criteria of success for programs addressing preventable anemia.

More robust data and action is needed on low birth weight.

Children born with low birth weight often develop iron deficiency anemia before reaching six months of age. Supplemental oral iron is recommended for low birth weight infants starting from 6 to 8 weeks of age. This is not practiced in Cambodia. The CDHS 2005 reported a low birth weight rate of 8%, but only 40% of children were measured and the source of 80% of birth weights was maternal recall. Using accepted methods of estimation of low birth weight accounting for size at birth and adjusting for heaping at the 2.5 kg cut-off produced a low birth weight rate of 15%. More robust data is needed to help focus attention on this issue. Public health interventions are needed to prevent low birth weight and treat its consequences in Cambodia.

Utilization of Iron Supplementation increased but poor compliance continues.

Iron supplementation of 90 days is recommended for all pregnant women in Cambodia. In 2005, only 18% of women took the recommended number (90+ tablets) of iron supplements during their last pregnancy. Only two-thirds of women reported that they received any iron supplementation during their last pregnancy. Nine percent of women who received iron reported "don't know" the number of days that they took iron/folic acid (IFA) tablets. To avoid this introducing bias, utilization rates (ever received IFA tablets) were used in provincial and trend analyses.

Utilization of IFA tablets increased from 21% in 2000 to 63% in 2005. Counts of the number of women who never received IFA tablets during pregnancy were calculated and inserted into a map graph. Due to small populations, the provinces with the lowest rates of utilization (Preah Vihear/Stung Treng and Mondolkiri/Rattanakiri) have small numbers of women who have never received any IFA tablets compared to other provinces. The higher population density provinces had larger numbers of women not utilizing IFA tablets. The two provinces with the worst conditions were Kampong Cham and Kandal provinces with 400,000 and 260,000 women, respectively who never took any IFA tablets during pregnancy

Provincial utilization (and coverage) rates do not clearly identify where the largest populations do not receive interventions. Actual numbers of the target population need to be taken into account in the intensification of delivery of micronutrient interventions.

Low coverage of post-partum iron supplementation

Women's iron stores are often exhausted after delivery. Only 11% of women reported receipt of any IFA tablets post-partum in 2005. There was no data collected in 2000 so a trend cannot be assessed.

Increase in household use of iodized salt but problems remain in border areas.

Iodine deficiency is one of the leading causes of preventable cognitive impairment. The most current data on iodine deficiency in Cambodia from the 1996/7 National Goiter Survey found 17% of school-aged children with iodine deficiency. UNICEF is currently preparing for a new national iodine deficiency study in school children in 2008. The prevalence of iodine deficiency has likely decreased rapidly after producers and distributors began to comply with the universal salt iodization law of 2003.

The percent of households with no salt or non-iodized salt decreased from 86% in 2000 to 29% in 2005. No information was collected on fish sauce, which may contain iodine and is used commonly in Cambodian households. The only provinces where use of iodized salt decreased (Svay Rieng, Mondol Kiri/ Rattanakiri) are along the border with Vietnam. This is considered due to the importation of non-iodized salt. More efforts are needed to ensure that iodine deficiency is not a problem in remote areas like Mondul Kiri and Rattanakiri.

Almost 650,000 children under-five years of age are zinc deficient.

Adequate zinc nutrition is necessary for normal pregnancy outcomes, optimal child health and physical growth. National measures of zinc deficiency based on biomarkers do not exist and estimates are based on proxy measures such as prevalence of stunting. From 2005 data, Cambodia is considered to have among the highest rates of zinc deficiency in children in SE Asia (stunting-43%). An estimated 647,000 children under five years of age are zinc deficient.

Children in every province in Cambodia are at a high risk for zinc deficiency (>20% stunting). The provinces with the highest rates of risk are Pursat, Siem Reap and Mondolkiri/Rattanakiri while the provinces with the highest number of children at risk are Kampong Cham, Battambang/ Krong Pailin, and Siem Reap.

Current recommendations for use of zinc in children are for diarrhea treatment. Oral rehydration salts used along with 10 days of zinc supplementation was found to reduce the length of illness and prevent reoccurrence. In 2005, the prevalence of diarrhea in children in a two-week period was 20%, representing almost 300,000 children under 5 years of age. The prevalence of diarrhea was highest among children 6 to 23 months of age. This coincides with the child's growth spurt and greatest need for zinc.

In 2006, an innovative social marketing program of diarrhea treatment kits (ORS bundled with 10 days of 20mg zinc supplements) was piloted in two provinces. The program was evaluated (rapid assessment) and found successful. This pilot project ended and progress on the national level implementation of the ORS plus zinc treatment has been stalled.

Conclusions

For progress to be made with nutrition, strong collaboration is needed between health workers, national programs and organizations working in child survival, rural development, water and sanitation, food safety, education and several other sectors.

Micronutrient nutrition, macronutrient nutrition and illness all play a large role in explaining the health conditions of Cambodia. Despite recent improvements in maternal and child health and nutrition, this analysis shows that several long term and complex challenges remain, such as:

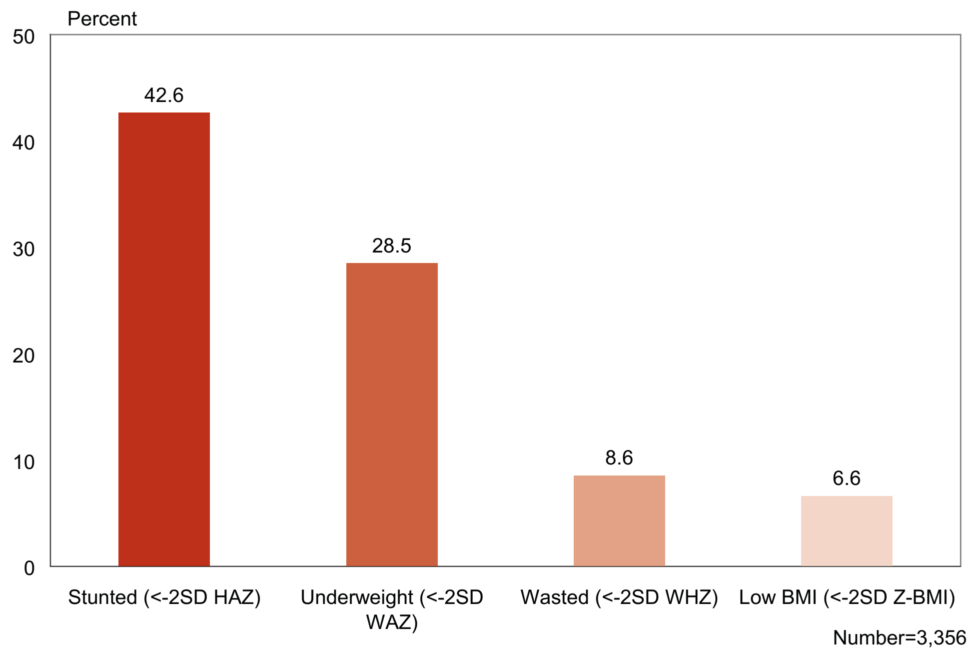
- increasing and maintaining micronutrient supplementation coverage rates
- reaching remote and poor inaccessible populations
- improving the quality and use of health information

Recommendations related to all of these challenges are presented in the conclusions of this document, which also includes the issues and recommendations related to individual micronutrients.

Introduction

Malnutrition and micronutrient deficiencies are the result of the complex interactions of poor diet, feeding behaviors, hygiene and illness. Micronutrient malnutrition affects physical and mental growth and development. Physical growth is much easier to measure and commonly assessed by height, weight and age. In this report, the international WHO Child Growth Standards (WHO 2007) were used to calculate new estimates of stunting, wasting and underweight in children under five years of age. According to these new indicators, 43% of children are stunted, 29% are underweight and 9% are wasted. Further tables and charts presenting the new malnutrition estimates are included in the annexes.

Figure 1: Prevalence of stunting, underweight, wasting, and low body mass index in children under five years of age, CDHS 2005 with new international growth standards.



Micronutrient malnutrition can be addressed in several ways including supplementation, fortification, dietary counseling and behavior change and prevention of illness through hygiene and food safety. Organizations working in Cambodia have implemented or are starting many innovative projects to address micronutrient deficiencies. These projects include:

- Homestead Food Production – Helen Keller International, Cambodia
- Social Marketing of Diarrhea Treatment Kits (Oral Rehydration Salts bundled with 10 tablets of zinc) - Population Services International, Cambodia
- PlumpyNut for management of severe acute malnutrition - National Pediatric Hospital, Magna, TASK and Clinton Foundation
- Sprinkles for school children in selected program areas - World Food Program
- Fortified MI DARA Noodles - International Relief and Development, Cambodia
- Fortified Fish Sauce - RACHA
- Iron and Vitamin A rich fish research - RVA University, Denmark and Inland Fisheries Research and Development Institute, Cambodia
- In-home micronutrient fortification and complementary feeding counseling - Good Food for Children Project (National Nutrition Program (HSSP), A2Z, HKI, WHO and UNICEF)

Despite these projects, there is serious need for basic system support to make government programs more effective. This analysis attempts to show what is known about the current situation of malnutrition, anemia and micronutrient deficiencies, and the national programs that address these problems. The report intends to provide relevant stakeholders with information to enable better prioritization of resources and targeting of nutrition interventions. Detailed information is given on the sub-groups most affected by micronutrient deficiencies, the geographical areas with high prevalence rates or population counts with micronutrient deficiencies, and the possible reasons for increased vulnerability to micronutrient deficiencies.

Cambodia is fortunate to have many sources of data on maternal and child health and nutrition. These data include two Demographic and Health Surveys (CDHS 2000 and CDHS 2005), a Health Information System (HIS), the Twelve Key Family Practices for Health report and other studies conducted in Cambodia and the region. Further details on the analysis methods are given in the annexes at the end of the report.

The report is concerned with anemia, deficiencies of iron, vitamin A, zinc and iodine and deworming which are dealt with in sections. Each section addresses the following points:

How many persons have the problem?
Where are they located?
What are their defining characteristics?
What is the trend with the problem?
How many receive the intervention?
Where are they located?
What are their defining characteristics?
What is the trend with the intervention?

This report is long but far from comprehensive. There is a great deal more information that can be uncovered from the existing data sources. We hope that the information included in this report will be used to improve program implementation.

Vitamin A

Children are born with low stores of vitamin A. The first "vaccination" that they receive is the vitamin A rich colostrum in the first few days after birth. Exclusive breastfeeding in the first six months of life has a protective effect against vitamin A deficiency, but mothers who are vitamin A deficient produce breastmilk that is deficient in vitamin A (Miller et al, 2002). After six months of life, breastfeeding no longer provides adequate nutrition for the rapidly growing infant. Children older than six months of age and women of reproductive age are considered to be at special risk of vitamin A deficiency.

Vitamin A deficiency is a result of low intake of foods from animal sources (such as meat, liver, fish, and eggs), vitamin A rich fruits and vegetables and illness (Miller et al, 2002). For nutrition and health staff promoting vitamin A rich foods, it needs to be clear that fruits and vegetables are important sources of vitamin A, but the bio-availability of vitamin A is much higher from foods from animal sources compared to fruits and vegetables (West et al, 2002). Good vitamin A stores boosts immunity and significantly reduces the harmful effects of diarrhea and measles. Deficiency of vitamin A leads first to increased morbidity. More severe deficiencies of vitamin A cause night blindness and xerophthalmia, and increased risk of death.

Conditions of Vitamin A Deficiency

Vitamin A Deficiency Summary Points

Prevalence: 22% of rural children 6-59m of age had severe vitamin A deficiency as measured by serum retinol in 2000 (CNMS 2000) and 2% of women had night blindness during their last pregnancy in 2005 (CDHS 2005).

Geographic Distribution: Kampong Thom and Stung Treng/Preah Vihear have the highest reported prevalence of maternal night blindness. The rates in these three provinces are close to 5% (CDHS 2005), which indicates a problem of public health significance. In 2000 the provinces of Kampong Thom, Preah Vihear, Koh Kong, Oddar Meanchey and Rattanakiri reported rates of child night blindness over 1% indicating a significant public health problem (CNMS, 2000)

At-Risk Populations: Rural, uneducated women of the lowest wealth quintile have the highest prevalence of night blindness. For children, no background details were reported with the vitamin A deficiency or night blindness indicators, but the children of the women most at risk are likely to be vitamin A deficient also.

Trends: Comparison of the adjusted levels of reported maternal night blindness from the CDHS 2000 and CDHS 2005 shows no change. For children, data is available only from 2000 and the trend cannot be assessed.

The prevalence of severe vitamin A deficiency in the region is given in table 1 below. All countries included used the same measure and standard cut-off for severe vitamin A deficiency. The reported prevalence of severe deficiency among rural children 6-59 months of age from the Cambodia National Micronutrient Survey (CNMS) 2000 is 22%. The prevalence of severe vitamin A deficiency in Cambodia is lower than Laos and Nepal, but is nearly twice the prevalence of neighboring Vietnam and is well above the 10% cutoff value used to signify a public health problem (WHO, 1996)

Table 1. Prevalence of Severe Vitamin A Deficiency in Children in S & SE AsianCountries

Country	Sample Size & Population Group	Date & Source	Prevalence
Cambodia	Children 6-59 months (N=359)	2000, CNMS	22.3
Lao PDR	Children 0-59 months (N=419)	2000, National Survey	44.7
Vietnam	Children 6-59 months (N=1,975)	2000, National Survey	12.4
Nepal	Children 6-59 months (N=843)	1997-98, National Survey	32.3

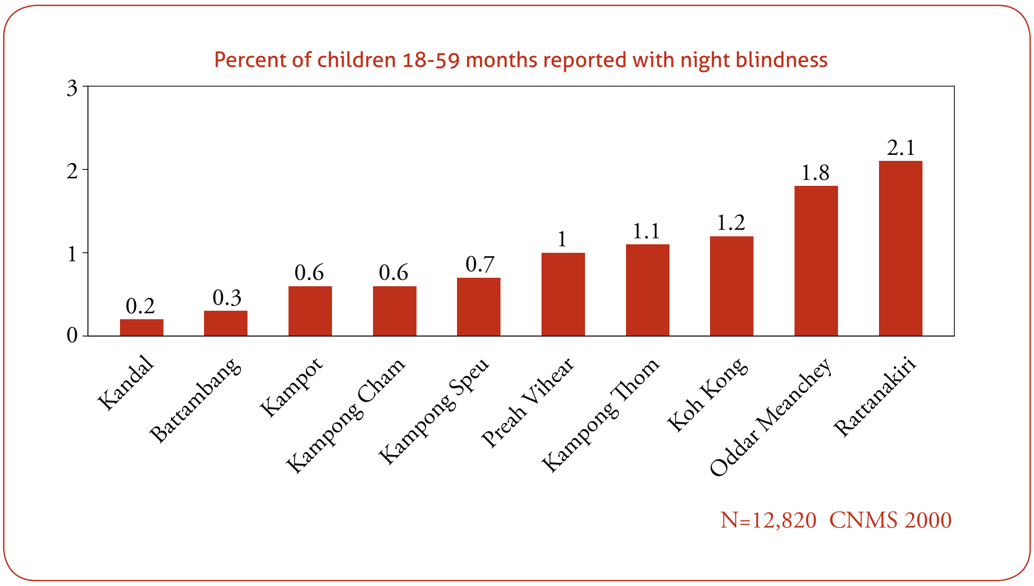
Note: Severe vitamin A deficiency is defined as serum retinol < 0.7 mmol/Liter.

Sources: Hix et al, 2006 (Cambodia).
Ministry of Health [Lao People's Democratic Republic]. Report on national health survey: health status of the People of LAO PDR. Vientiane, Ministry of Health, 2001.
National Institute of Nutrition. Report on Vietnam National anemia Survey, 2000. Hanoi, 2001.
Nepal Micronutrient Status Survey December 1997- May 1998.

During the data collection of CNMS 2000, blood samples were collected from over 2,000 preschool children. Vitamin A results have not been reported for all children. In the laboratory, 385 tubes were randomly selected from the total sample. Serum retinols were measured in 359 children for whom adequate serum volume was still available (Hix et al, 2006). No background information was presented to show that these 359 children were similar in characteristics to the original sample of 15,550 children. This survey was only conducted in rural areas of ten provinces and cannot be considered nationally representative. The prevalence reported from the CMNS 2000 should be considered an approximation of the prevalence of vitamin A deficiency in rural Cambodian children.

In the CNMS 2000, mothers were asked if their children currently had night blindness. Two well-understood terms that both mean night blindness were used in the Khmer translation of the question. The World Health Organization and IVACG established that a prevalence of night blindness greater than or equal to 1% among young children (18-59 or 24-59 months) constitutes a "problem of public health significance" and suggests that a much larger proportion of the population suffers from sub-clinical vitamin A deficiency, which increases the risk of morbidity and mortality (WHO, 1982).

Figure 2. Night Blindness in Children 18-59 months of age, CNMS 2000



In the CNMS 2000, the provinces of Preah Vihear, Kampong Thom, Koh Kong, Oddar Meanchey and Rattanakiri reported rates of child night blindness over one percent, indicating a significant public health problem (figure 2). With the exception of Kampong Thom, all of these provinces are remote and have small populations. It is important to note that compared to the provinces with high prevalence, the prevalence of 0.6% of night blindness in Kampong Cham could represent close to three times as many children with night blindness due to the large population in that province.

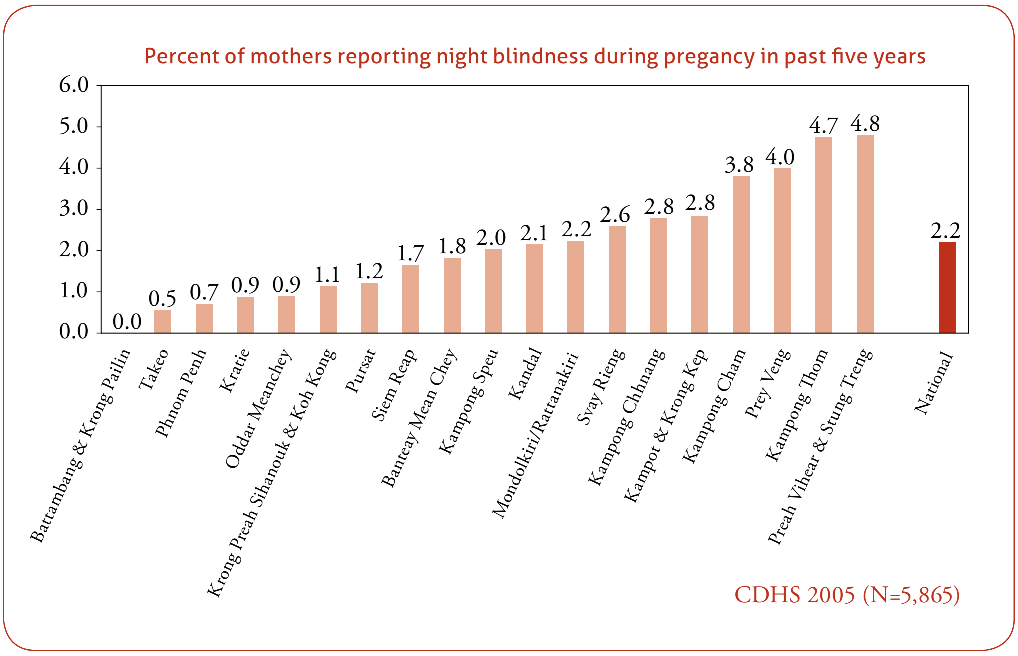
The indicator of child night blindness has never been collected in DHS surveys due to questions about its accuracy. Maternal night blindness has been validated as an indicator of vitamin A deficiency (Christian, 2002), but the only study identified to validate child night blindness as an accurate method to determine vitamin A deficiency in a population found that in an area with no defined term for night blindness, reported night blindness did not identify vitamin A deficiency in a population (Wedner et al, 2004). A more accurate measure that is less common, but represents more advanced vitamin A deficiency in children, would be visual identification of xerophthalmia, bitot's spots and corneal scarring by trained experts.

The CDHS 2000 and 2005 reported data on night blindness during pregnancy in women who gave birth in the last five years. In 2000 and 2005, the woman was asked if she had night blindness with the local term and if she had vision problems during the day. The indicator for night blindness was based on women who reported having night blindness and adjusted by subtracting the women who reported having vision problems during the day.

An adjusted maternal night blindness prevalence of 5% or more is recommended as a cut-off at which vitamin A deficiency may be considered to be a problem of public health significance within the community (IVACG, 2002). The adjusted national prevalence of night blindness among women during their last pregnancy in 2005 is 2% (shown in the national column on the right hand side of figure 3).

There is significant variation of the prevalence of maternal night blindness by province in 2005. In the Battambang/Pailin domain, there was no reported maternal night blindness, while in Kampong Thom and the Preah Vihear/Stung Treng domain, the prevalence was almost 5%.

Figure 3. Adjusted prevalence of maternal night blindness by province, CDHS 2005



According to the CDHS 2005, rural women, those with no schooling, and those of the lowest wealth quintile had the highest prevalence of night blindness. These women have the highest risk of vitamin A deficiency (Table 2).

Table 2. Prevalence of maternal night blindness by background characteristics, CDHS 2005

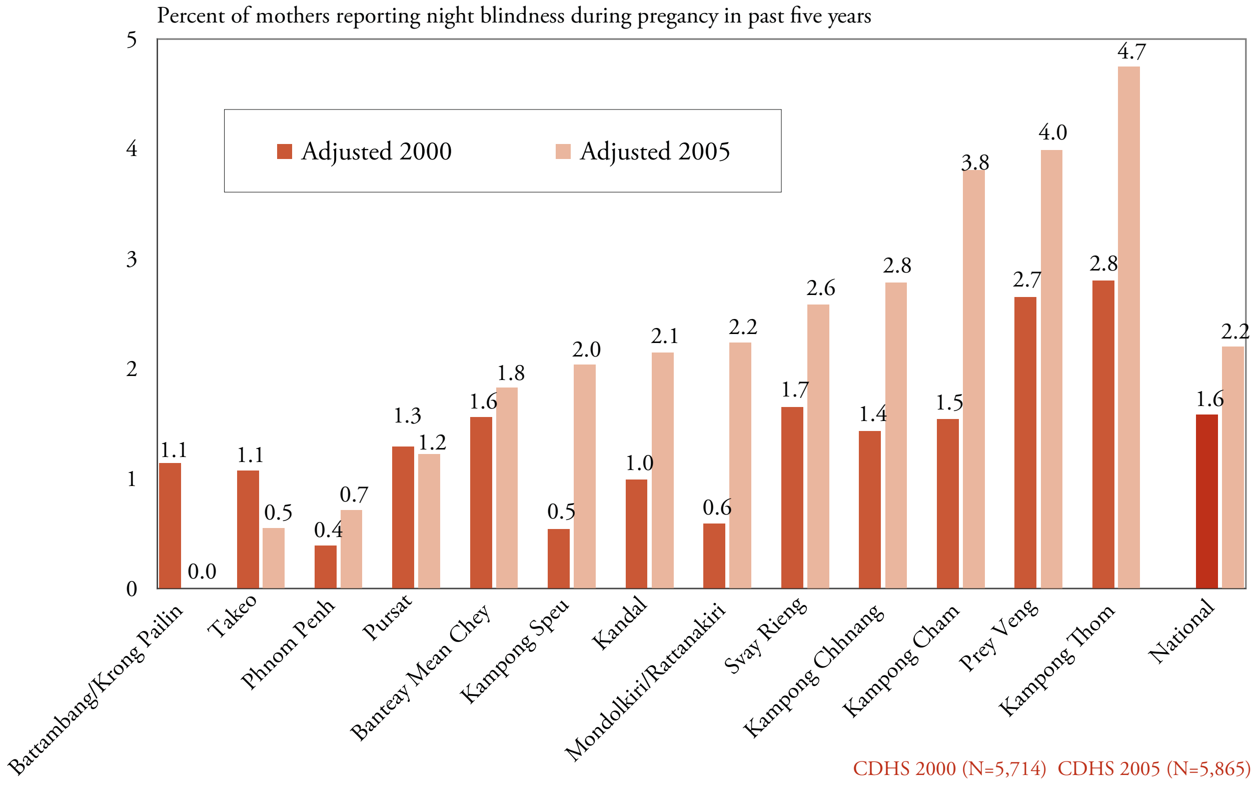
	Percent	Number
Education		
No Schooling	3.3	1,356
Primary	2.3	3,482
Secondary +	0.7	1,028
Wealth Quintile		
Lowest	3.9	1,477
Second	2.8	1,320
Middle	1.8	1,077
Fourth	1.2	1,003
Highest	0.8	988
Place of Residence		
Rural	2.4	827
Urban	1.3	5,039
Overal	2.2	5,865

The CDHS 2000 collected data from 15 domains while the CDHS 2005 collected data from 19 domains. The thirteen domains that are directly comparable are shown in figure 4. The data is sorted by the adjusted percent of reported maternal night blindness from low to high.

The adjusted national prevalence of night blindness among women during their last pregnancy appears to have increased from 1.6% in 2000 to 2.2% in 2005 (shown in the national column on the right hand side of figure 4). The rate of maternal night blindness appears to have gone down in only two domains (Battambang/Pailin and Takeo) remained the same in Pursat, and to have increased in the remaining ten domains. The biggest increases were found in Kampong Speu, Mondolkiri/Rattanakiri, Kampong Cham, Prey Veng and Kampong Thom.

The large variation between the adjusted rates of maternal night blindness between 2000 and 2005 could suggest that despite the existence of a local term in the Khmer language for night blindness, this indicator is not very robust to identify vitamin A deficiency in women during the last pregnancy by province. The variation also could be due to differences in understanding the question and recording the answer by interviewer teams. The recommended indicator is for women who have been pregnant in the last three years, but the difference between three year and five year recall is not considered to affect the estimates greatly.

Figure 4. Adjusted rates of maternal night blindness by province, CDHS 2000 and CDHS



Preventive Vitamin A Supplementation

Vitamin A Supplementation Summary Points

Coverage: The vitamin A supplementation rate for children from the CDHS 2005 was widely considered to be an under-estimate. Analysis adjusting for recall bias and using imputation for cases where mothers reported "don't know" when child received vitamin A produces a coverage estimate of 50%.

The CDHS 2005 reported that 27% of post-partum women received supplementation with vitamin A in the eight weeks after delivery.

Preventive vitamin A supplementation began in Cambodia in the mid 1990s as part of National Immunization Days. Since then, vitamin A supplementation for children 6-59 months and post-partum women has been integrated into routine outreach activities.

Vitamin A is provided at health centers, hospitals, and through routine monthly immunization outreach. Children are supposed to receive vitamin A twice a year during Vitamin A supplementation activities, which are implemented through routine outreach. Before 2008 supplementation activities were scheduled every March and November (8 months and 4 months apart) rather than the recommended six months apart. To correct this, from 2008 on, the supplementation activities are scheduled in May and November.

In the past, Ministry of Health policy mandated that Community Health Volunteers were not allowed to distribute vitamin A in order to protect a woman or children from receiving an overdose. In the last revision to the Vitamin A Policy in 2007, Community Health Volunteers were given a defined role to help with vitamin A supplementation and mop-up activities.

Current IMCI guidelines in Cambodia recommend vitamin A to be given as a curative supplement for persistent diarrhea, measles, anemia, severe malnutrition (underweight), and night blindness (MOH/WHO/UNICEF, 2006). Curative supplementation of vitamin A is not discussed here as there is no data on this issue in the CDHS.

Issues with the Indicators from the CDHS and HIS

Vitamin A Supplementation in Children

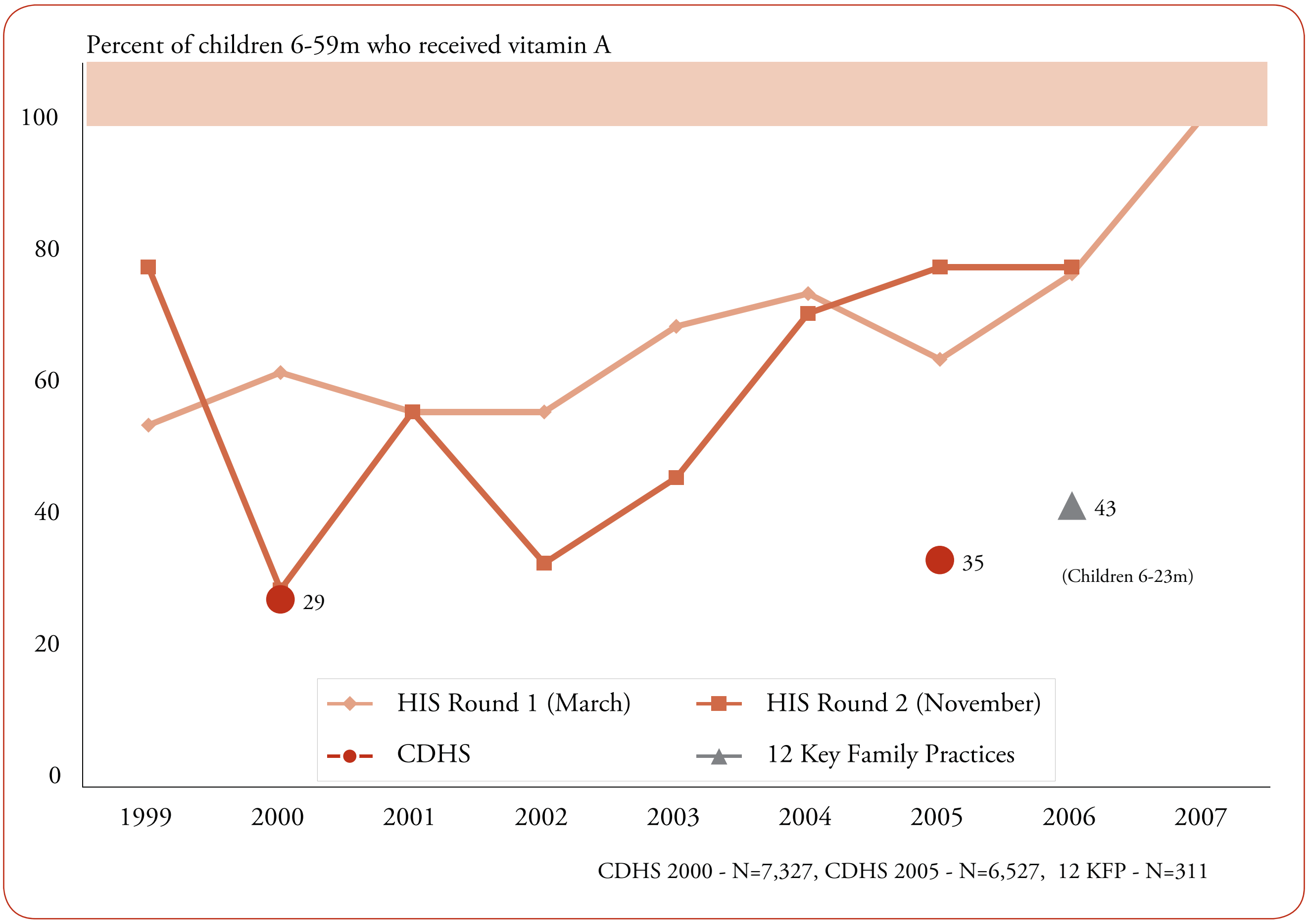
The CDHS 2005 results for vitamin A supplementation in children under-five showed that only close to one-third received vitamin A. Closer analysis on the vitamin A indicator suggests this number is an under-estimate.

Figure 5 presents vitamin A coverage from the HIS by round and year and the CDHS and 12 KFP surveys by year. In 2000, the CDHS matches exactly the November round of the HIS. The CDHS 2000 collected data from February to June of 2000, and should be compared to the supplementation given in November 1999 and March 2000. The HIS data showed coverage of 80 and 63%, respectively. In 2005, the CDHS 2005 collected data mostly from children supplemented in November 2005. The CDHS coverage rate (35%) was less than half of the HIS rate (79%). It is common for DHS surveys to report that vitamin A coverage is about half that normally reported from Health Information Systems in developing countries (Robin Houston, personal communication).

The coverage rate from the 12 Key Family Practices survey of 2006 was slightly higher (43%) than the CDHS 2005 but only included children aged 6-23 months. These younger children are more likely to receive vitamin A compared to older children as shown by the CDHS 2005 (Figure 6). The HIS has shown continual improvements in vitamin A coverage of children since 2002. March of 2007 was the first time the HIS showed that the national coverage reached over 100% (the pink area on the graph).

Due to procurement issues, two blue colors of vitamin A capsules were used during the data collection period of the CDHS 2005. Some suggested that the change in color of vitamin A capsules was the cause of the low coverage. While only one of these colors matched the sample vitamin A capsules displayed by the interviewers during the interviews, it is likely that other issues are more likely to affect the vitamin A supplementation rate.

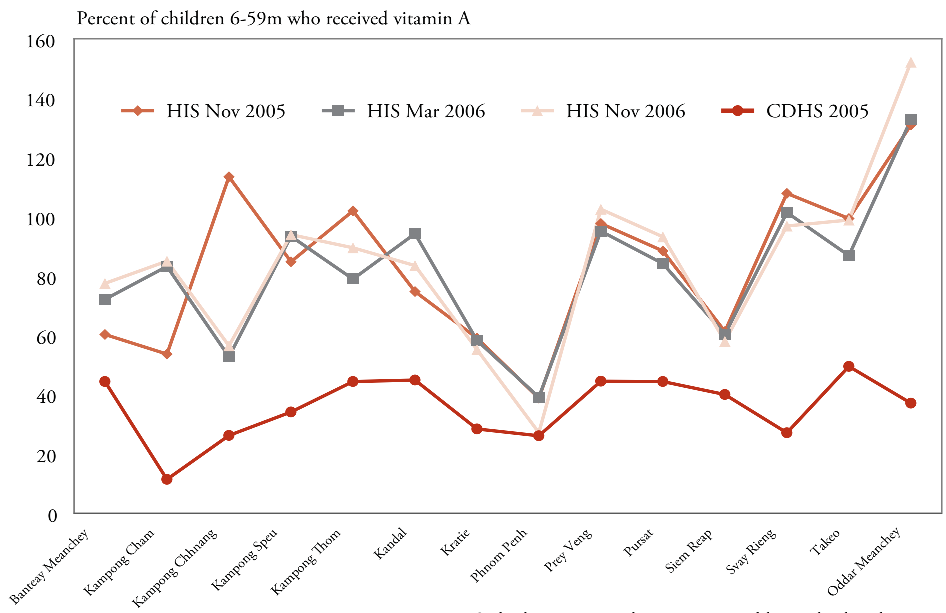
Figure 5. National vitamin A supplementation coverage in children by round, year and source of data, HIS, CDHS 2000 & 2005 and 12 KFP 2006



Analysis of the CDHS 2005 and HIS data by province (figure 6) more clearly shows the trend of the DHS vitamin A supplementation indicator to follow about half of the HIS estimates. According to the HIS, several provinces exceeded 100% coverage in 2005 and 2006 (the pink area on the graph). The HIS data from March and November 2006 matches very closely. The HIS data from November 2005 shows a similar trend on the right hand side of the graph. On the left side of the graph, more variation is evident, as if the program and/or denominators changed in these provinces. Only 14 of the 25 provinces are shown on the graph due to comparability issues.

The province where the DHS and HIS most closely match is Phnom Penh. It is not known if data quality of the HIS is better in Phnom Penh compared to other provinces. Further investigation is needed to demonstrate if this is the case. It is often difficult to achieve high coverage of interventions like vitamin A in urban centers. Caregivers are often too busy working or have other tasks that they consider more important than vitamin A supplementation.

Figure 6. National vitamin A supplementation coverage in children by province, round, year and source of data, HIS and CDHS 2005



Note: Only the provinces that are comparable are displayed.

One simple explanation for the low vitamin A coverage rate from the CDHS 2005 is that very few records are made on the yellow card. There is space on the yellow card for reporting, but outreach staff do not commonly record the supplementation. Of the 35% reported vitamin A supplementation in children, only 4% was recorded on the yellow card (not shown). The data presented in the CDHS on vitamin A supplementation comes from maternal recall. These mothers have to remember an event that occurred up to 6 months in the past.

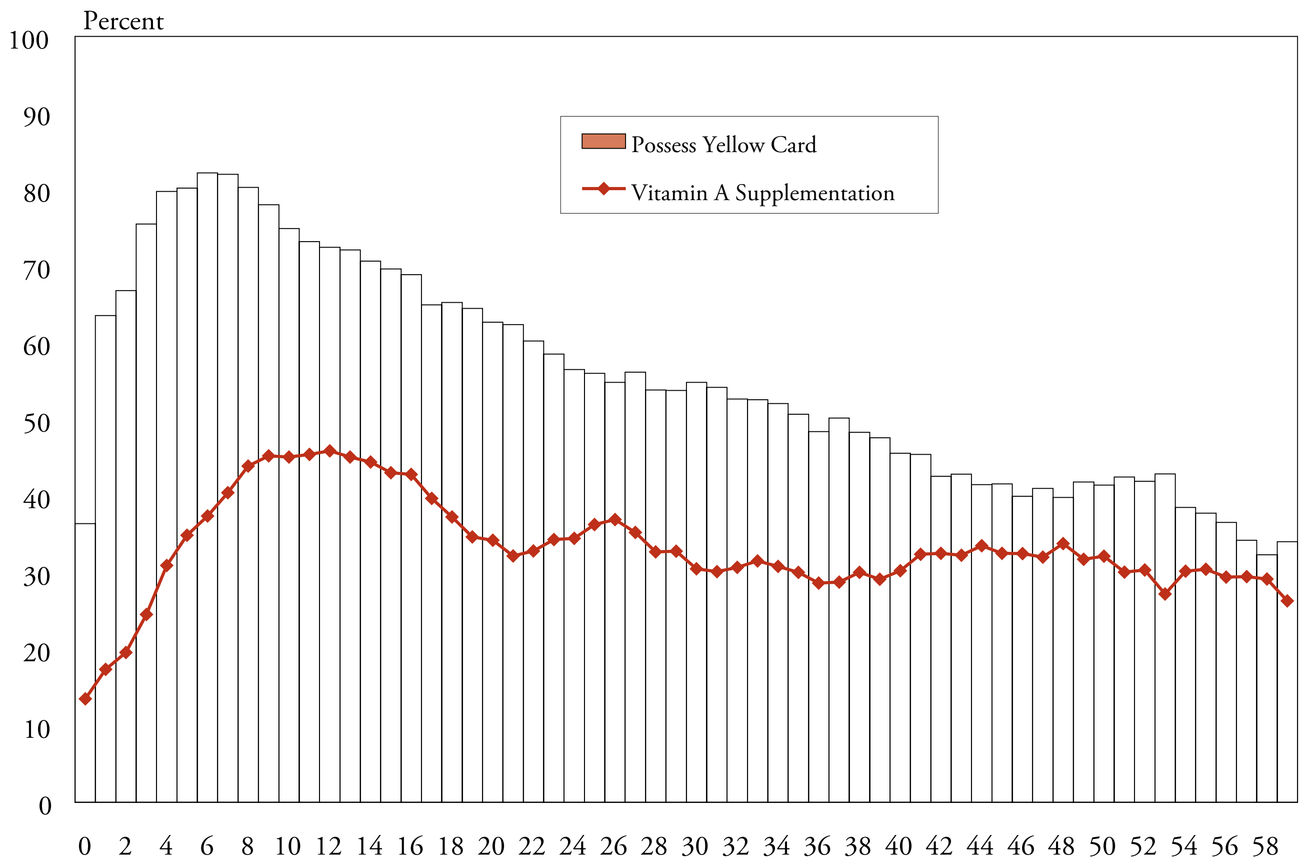
Mothers have difficulties distinguishing vitamin A from other orally administered interventions such as polio and most do not know that their child should receive vitamin A twice a year. Qualitative research in 3 provinces in Cambodia showed that mothers of children under five do not clearly know what vitamin A looks like or when vitamin A is available in the vitamin A round for their child (Johnston & Ly, 2007).

Maternal recall is not considered a very robust source of information. A recent validation study of recording and reporting vitamin A by A2Z in India found that mothers recalled only 42% of vitamin A supplementation that was recorded on their child's vaccination record (A2Z, 2007a). Conditions are likely to be very similar in Cambodia.

A complication to recording vitamin A supplementation on the yellow card is that caregivers commonly lose the card after the vaccination schedule is complete. Figure 7 below shows that by 4 months of age of the child, about 80% have yellow cards. After 8 months, caregivers begin to lose the yellow card. By the age of 35 months, only 50% of caregivers retain the child's yellow card.

Vitamin A supplementation in children by age follows a similar pattern. The highest supplementation rates (45%) are found in children between 8 to 14 months of age. The rates fall to close to 35% by 18 months of age and decline as the child grows older. Supplementation rates are not related to yellow card retention in Cambodia, but the graph demonstrates the trend of declining interest in and involvement with public health interventions after the child reaches one year of age. Also it is important to note that loss of the yellow card prevents improvements in recording vitamin A supplementation.

Figure 7. Possession of yellow card and vitamin A supplementation by age in months, CDHS 2005



Note: values are smoothed with a five month moving average

A recent Global Vitamin A Alliance technical advisory group meeting on vitamin A supplementation reported "Large scale household surveys are considered the gold standard for monitoring purposes, currently these surveys do not provide reliable estimates of supplementation coverage" (GAVA, 2007). This group suggested that further research on methods is needed to address these issues.

Further analysis of the two CDHS surveys shows other issues affect the vitamin A supplementation indicator in Cambodia. The standard indicator for vitamin A coverage in children 6-59 months of age considers a child protected from vitamin A deficiency if he or she has been supplemented in the last six months. Analysis of the data on vitamin A supplementation shows that the indicator is affected by multiple biases. These biases are reviewed below.

Figure 8. Possession of yellow card and vitamin A supplementation by age in months, CDHS 2005

454	Did (NAME) receive a Vitamin A dose like this during the last 6 months? SHOW CAPSULE..	YES .... 1 NO .... 2 DON'T KNOW 8	YES .... 1 NO .... 2 DON'T KNOW 8

It is important to note that the vitamin A supplementation questions changed between 2000 and 2005. In the CDHS 2000, only one question is used (figure 8), while in the CDHS 2005 two questions are used (figure 9).

Figure 9. Child vitamin A supplementation questions, CDHS 2005 questionnaire

504	Has (NAME) ever received a vitamin A dose like this? SHOW CAPSULE.	YES .... 1 NO .... 2 (SKIP TO 506) ← DON'T KNOW 8	YES .... 1 NO .... 2 (SKIP TO 506) ← DON'T KNOW 8	YES .... 1 NO .... 2 (SKIP TO 506) ← DON'T KNOW 8
505	How many months ago did (NAME) take the last dose?	MONTHS AGO . . ☐☐ DON'T KNOW 98	MONTHS AGO . . ☐☐ DON'T KNOW 98	MONTHS AGO . . ☐☐ DON'T KNOW 98

In the CDHS 2005, the first question asks if the child has ever received vitamin A supplementation. The first question and the percent distribution of responses are given below:

Table 3. Percent distribution of child (6-59m) ever received vitamin A (First Question), CDHS 2005

Ever received vitamin A	Percent	Number
Yes, received	73.3%	4780
No, never received	24.9%	1629
Don't know	1.8%	117
Total	**100.0%**	**6527**

If the mother responded "No" or "Don't Know", that child is considered not supplemented. If the answer is "Yes," the mother is then asked "how many months ago did (child) take the last dose." These answers are given below (table 4).

Table 4. Percent distribution of when child received vitamin A out of children who had ever received vitamin A (Second Question), CDHS 2005

Timing	Percent	Number
< = 6 months ago	46.6%	2226
> 6 months ago	23.6%	1127
Don't know	29.8%	1424
Missing	0.1%	3
Total	**100.0%**	**4780**

The children with answers of ">6 months ago" or "Don't Know" are considered not protected. Only the children who received a dose "<=6 months ago" are considered protected and used as the numerator for supplementation coverage.

It is a common DHS practice to count "Don't Know" as "No" in calculation of indicators. When the number of "Don't Know" responses is low, this does not bias the results. Assigning the 30% of cases who replied "Don't Know" into the "No" category may have caused a significant underestimation of supplementation coverage.

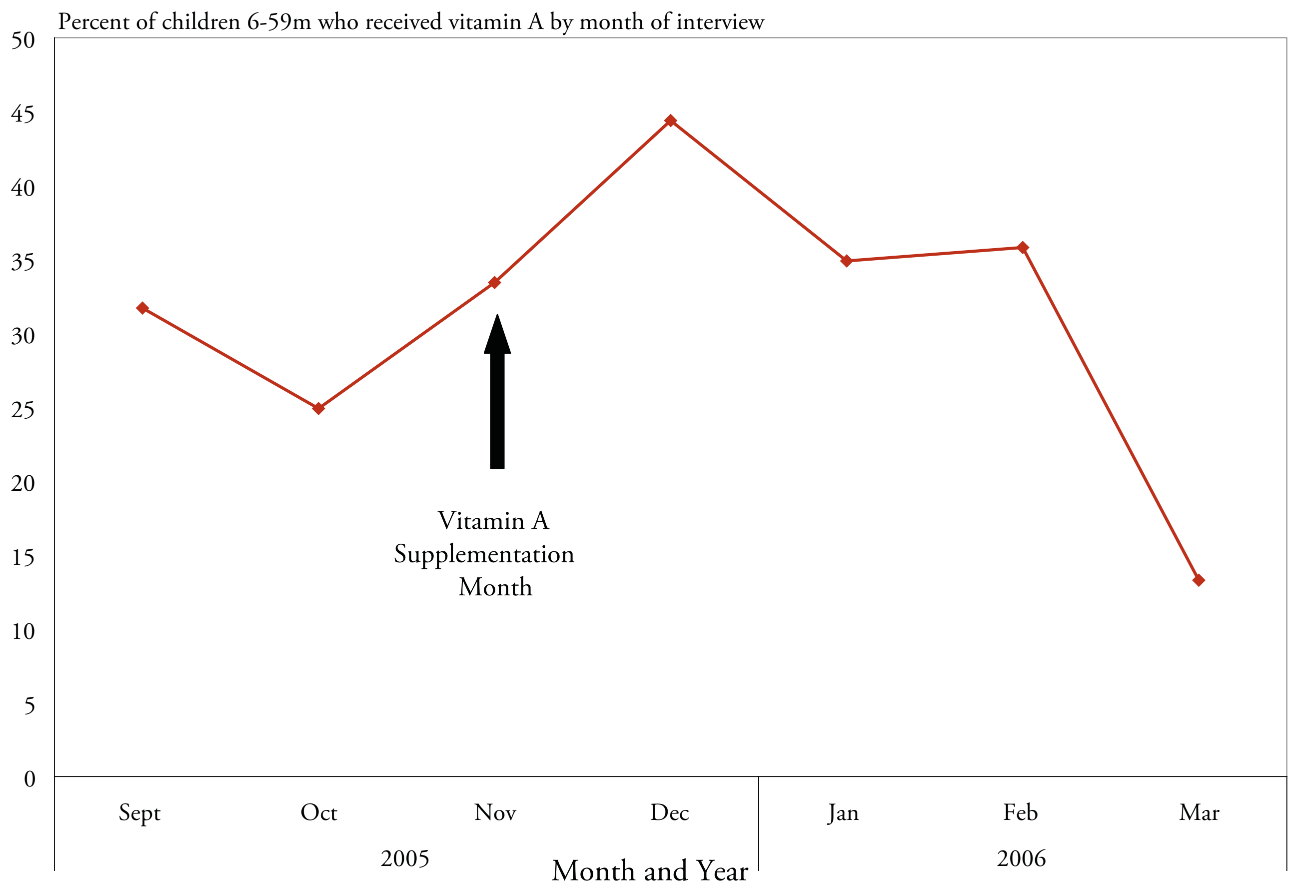
Other issues that could affect the question on timing of vitamin A supplementation are recall bias and date heaping. Further analysis was done to determine if these problems may have also affected vitamin A coverage in children.

Preventive vitamin A supplementation occurs twice a year. Data collection for the CDHS 2005 took seven months. During that time there was one vitamin A supplementation month. Vitamin A is not commonly given as a curative treatment, so there should be little to no variation by month of data collection.

Analysis of vitamin A supplementation coverage by month (figure 10) shows that recall bias affected reported supplementation rates. There is substantial variation by month (from 15 to 45%). This indicates that recall bias is likely also to cause the indicator to be an underestimate.

The month after supplementation should have the lowest recall bias as the respondents do not have to remember an action in the distant past. The highest reported coverage is found in December, the month after vitamin A supplementation.

Figure 10. Percent vitamin A supplementation in children by month of data collection, CDHS 2005

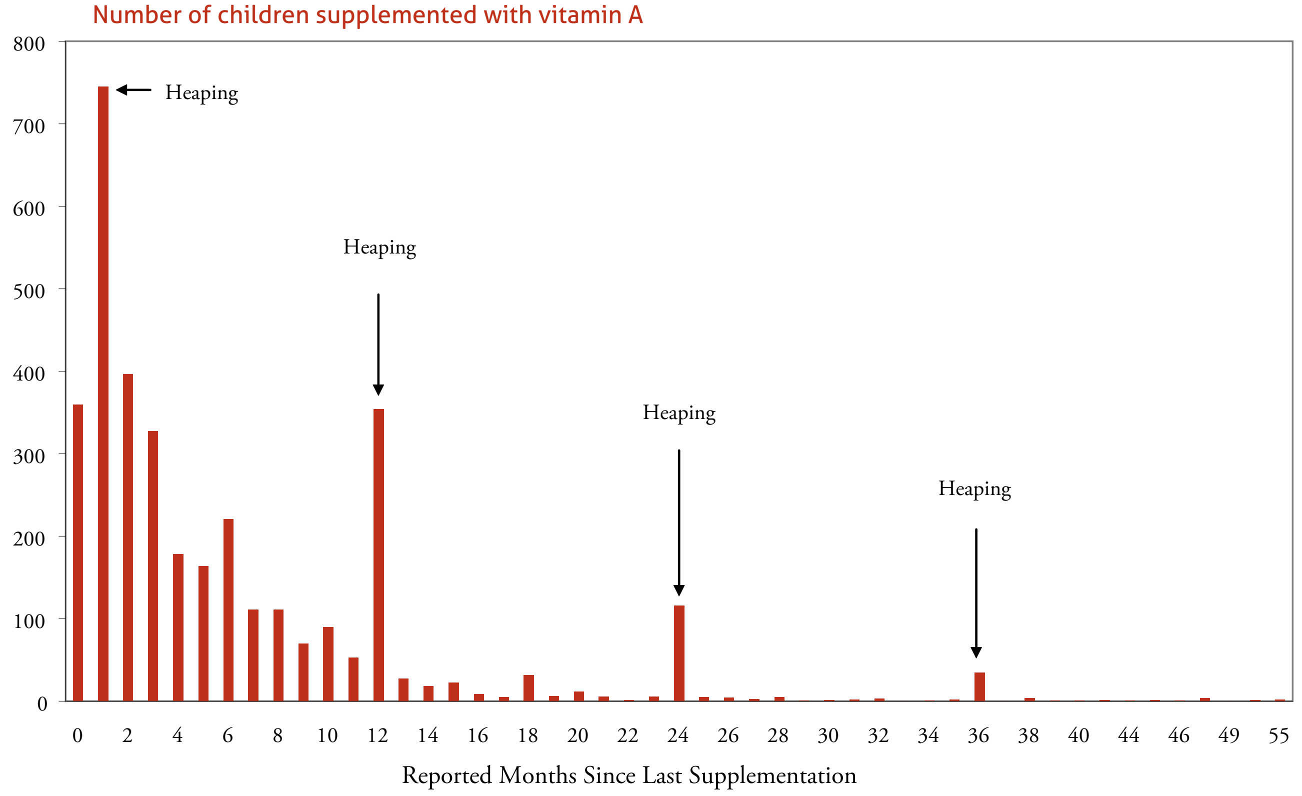


Date heaping or a preference for reporting certain times (such as one month or one year) can bias results. To determine if date heaping occurred in the response to the question when the child received supplementation, a histogram of the reported number of months prior to the interview when the child received vitamin A is presented (figure 11). As the data collection took seven months, there should be no date heaping evident.

The graph shows that there was significant heaping in the response. Mothers were more likely to answer with a simple number such as one month, one year, two years or three years instead of reporting the accurate number of months. This heaping is not considered to have affected the estimate of vitamin A supplementation. If the extra numbers of children found in the one month response were distributed evenly through the 0 to 3 month categories, these children would still be considered protected.

The effects of recall bias and date heaping cannot be completely eliminated, but they can be minimized by reducing the time between the interview and supplementation activity.

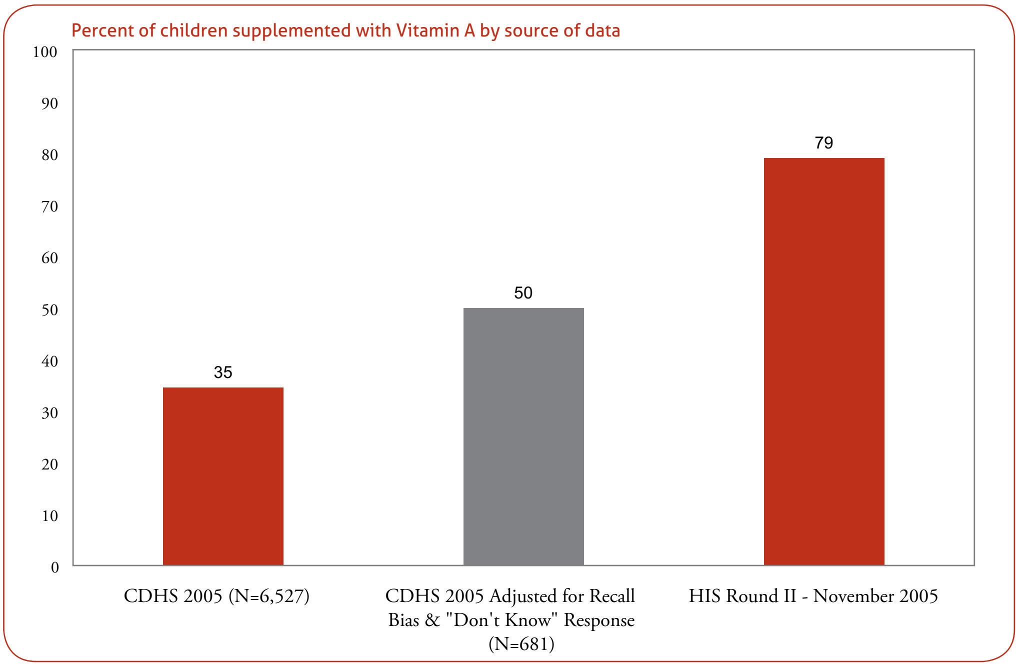
Figure 11. Number of children supplemented with vitamin A by reported number of months since last supplementation, CDHS 2005



It is not possible to quantify the exact effect of recall bias, and "Don't Know" responses on the vitamin A coverage indicator, but a more accurate estimate can be calculated. Using data from the month after supplementation will minimize the effect of recall bias and date heaping. The "Don't Know" responses can be accounted for by imputing (predicting) values for this population. These methods were used to make the new estimates for vitamin A supplementation coverage in children given below. The exact methods and their potential limitations are presented in the annex of the report in the Methodology section.

The adjusted vitamin A supplementation rate for children based on data from December 2005, with values imputed for "yes" supplemented but "don't know" when is 50%. This adjusted indicator is 15 percentage points higher than the CDHS reported coverage and 29 percentage points lower than the HIS 2005 Round II (November) estimate (figure 12).

Figure 12. Reported and adjusted vitamin A supplementation rates in children 6-59m, CDHS 2005 and HIS (November 2005)



The Health Information System is the only source of timely monitoring data for preventive interventions like vitamin A supplementation in the country. The HIS is representative on the national, provincial, health operational district and health center level. An effective HIS is needed for monitoring and evaluation of public health interventions.

The HIS overestimates vitamin A supplementation in children as demonstrated by recent estimates reaching over 100% (figures 5 & 6). The HIS currently uses official population figures from the National Institute of Statistics (NIS) to calculate the denominators for the HIS. The issue of inaccurate estimates of target populations from the NIS is well-known and is considered to be one major cause for the disparity between the CDHS and HIS estimates. A national census is planned for 2008, which should help to improve the denominators but results may not be available until 2010.

Two other issues are likely to affect the HIS coverage estimates:

- Supplementation outside the target group
- Double counting

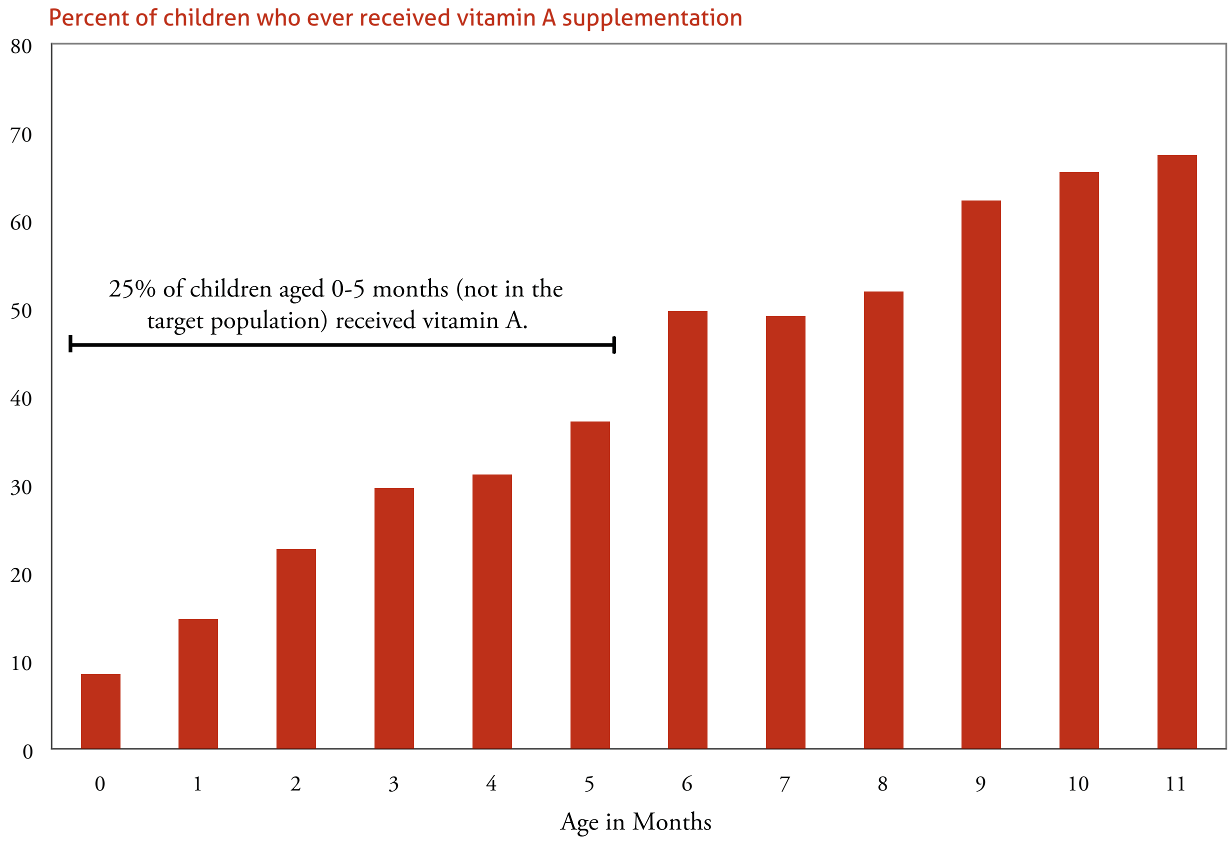
Coverage estimates in the HIS are calculated by including all reported supplementation over a six month period (January to June and July to December). A problem with this method is that during the outreach workers are not likely to check whether or not the child has been supplemented within the last six months. Most often there is no record of supplementation if the worker wanted to check. The new IMCI guidelines recommend giving a vitamin A supplement to children who have not received one in the last four months, not six. It is possible, but not likely that a child receives supplementation twice during a six month period and is double counted in the HIS coverage estimate.

The second issue is supplementation of children outside the target age group. No adverse health consequences have been found with supplementing an infant under six months of age. Studies are currently being implemented to test the benefit of vitamin A supplementation in children in this age group. Despite the fact that outreach workers are trained to give vitamin A to children starting from six months of age, 25% of mothers of children less than six months of age report that their child received vitamin A (figure 12).

If one quarter of children under the age 6 months are supplemented and included in the numerator but not the denominator for the HIS coverage indicator, the potential for overestimation is considerable. The CDHS does not collect data on vitamin A supplementation of children older than 59 months of age making it impossible to estimate the overall effect on coverage of supplementing children outside the target population. Qualitative research has shown that supplementation of children both younger and older than the target population and the elderly occurs in Cambodia (Johnston and Ly, 2007).

Supplementation of children outside the target age group affects coverage estimates, but is not considered to have any adverse health consequences. This is not the case for vitamin A supplementation of women. Post-partum mothers are recommended to receive a high-dose vitamin A supplement only in the six weeks after delivery (MoH, 2007). High doses should never be given to women outside this time period, as vitamin A can cause birth defects in pregnant women (WHO, 1998). It is not possible to determine the exact timing of post-partum supplementation from the CDHS 2005, but the lack of attention to age with child supplementation raises concern that pregnant women may receive high doses of vitamin A at improper times as well.

Figure 13. Percent of children who ever received vitamin A supplementation by age in months, CDHS 2005



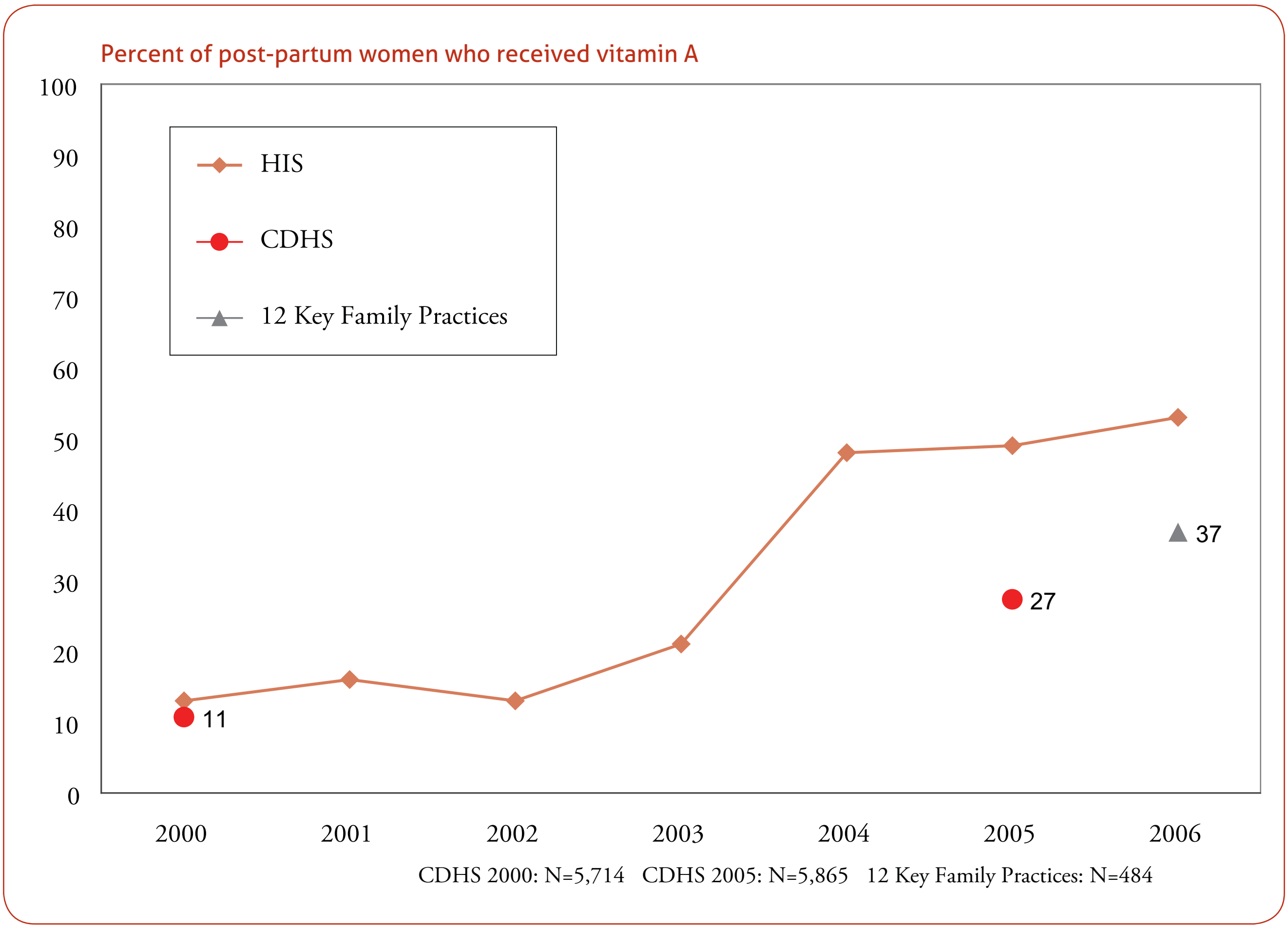
Vitamin A Supplementation in Women

Post-partum vitamin A supplementation is a public health intervention that normally occurs during outreach activities every month. In 2000, the CDHS and HIS reportd that only about 11% of women received vitamin A post-partum. According to the HIS, the coverage rate increased to about 45% in 2004. The CDHS 2005 reported 27% and the 12 KFP 2006 reported 37% (figure 14).

It is important to note that the CDHS reported the indicator in women who gave birth in the past 5 years, while the 12 KFP 2006 reported on women who gave birth only in the past 2 years. If the HIS documents a real change in post-partum vitamin A supplementation, it is easy to see how shortening of the time period for the 12 KFP indicator explains the 10 percentage point increase in one year.

There have been questions on the benefit of post-partum vitamin A supplementation. These questions have been attributed to the lack of universally recognized definitions of successful outcomes among policy makers and program managers. A review of supplementation studies found that post-partum supplementation provides measureable increases in serum retinol concentrations and reductions of morbidity for women and their children (Rice, 2007).

Figure 14. Post-partum vitamin A supplementation by year and source of data, HIS, CDHS 2000 & 2005 and 12 KFP 2006



There is only one question on post-partum vitamin A supplementation in the CDHS questionnaires and "don't know" is not given as an option. This eliminates the "don't know" response as a source of bias seen above with child supplementation.

The monthly or bi-monthly supplementation can help to reduce the effect of recall bias, but the longer women have to remember into the past, the more this bias returns and the data quality deteriorates. As no date or number of months is asked for, there is no heaping or number preference in the answer.

Trends and Conditions in Vitamin A Supplementation

Vitamin A Supplementation Summary Points

Geographic Distribution: There is significant variation of vitamin A supplementation by province. The provinces with the lowest coverage for children also have the lowest coverage for women (Preah Vihear, Stung Treng, Mondolkiri/Rattanakiri and Phnom Penh).

Excluded Populations: Children from households of the poorest wealth quintile and those of an uneducated mother were the least likely to ever receive any vitamin A supplementation. Women of the poorest wealth quintile and those who were not educated were the least likely to ever receive post-partum vitamin A supplementation.

Trends: Supplementation rates of post-partum women almost tripled from 2000 to 2005 (from 11% to 27%). Supplementation rates in children appear to have improved (from 29% to an estimated 50%) but the trend of vitamin A coverage in children is not precise due to the high percentage of "don't know when" responses (30%). The HIS data shows improvements in vitamin A supplementation in both post-partum women and children over time.

The vitamin A supplementation indicator in children from the CDHS 2005 does not accurately provide a national estimate due to recall bias and "don't know when" responses as discussed above. Provincial estimates are also affected by a large degree of variation of "don't know when" answers (from 4 to 44% by province).

To address this problem when analyzing provincial conditions, coverage of vitamin A supplementation is replaced with utilization. This variable is defined as the child ever receiving vitamin A. Utilization is not affected by the "don't know when" answers (table 3). Nationally, 73% of children 6-59 months of age have ever received vitamin A supplementation. Utilization does not provide information on whether the child is protected from vitamin A deficiency, but describes if the intervention has been delivered to the target population in the defined area.

For post-partum women, the standard coverage indicator of receiving vitamin A supplementation within eight weeks after delivery does not have problems like those described above and is used in the analyses. In each section, the post-partum supplementation details are presented first followed by those of children.

Where do populations have the lowest supplementation rates?

Provincial variation of vitamin A supplementation is high for both mothers and children. It ranges from 6 to 63% for post-partum women and from 45 to 91% of children ever received vitamin A. The same provinces have the lowest supplementation rates for children and women (Phnom Penh, Preah Vihear/Stung Treng, Mondolkiri/Rattanakiri (table 5).

Women and children in Preah Vihear and Stung Treng are at greatest risk for vitamin A deficiency and are the least likely to receive supplementation. Women in Kampong Thom were also found to have the highest rates of maternal night blindness. Post-partum supplementation rates in this province only reached 34% leaving a majority unprotected by the intervention. Although some provinces have higher supplementation rates than others, supplementation rates are unacceptably low throughout the country.

Table 5. Post-partum vitamin A coverage and vitamin A utilization in children 6-59 months of age by province, CDHS 2005

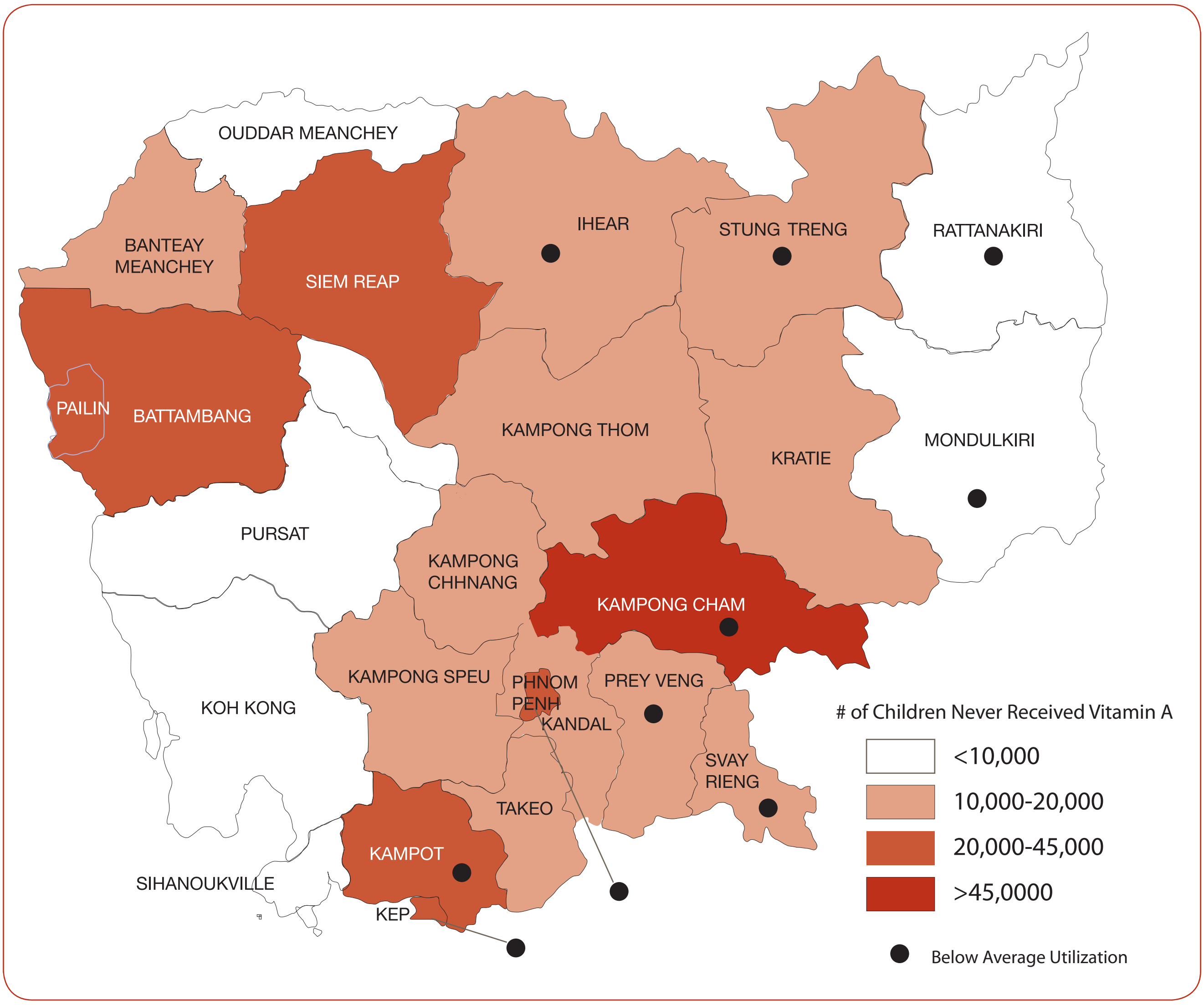
Vitamin A Supplementation Post-Partum Women	
Province	Vitamin A Coverage
Phnom Penh	6.4
Preah Vihear/Stung Treng	9.3
Mondolkiri/Rattankiri	14.9
Oddar Meanchey	17.3
Krong Preah Sihanouk/Koh Kong	19.6
Svay Rieng	19.9
Kampot/Krong Kep	21.7
Kampong Speu	22.4
Banteay Mean Chey	25.1
Kampong Cham	25.7
Takeo	27.1
Kratie	28.2
Battambang/Krong Pailin	28.7
Kandal	30.4
Kampong Chhnang	30.6
Siem Reap	31.8
Kampong Thom	33.5
Prey Veng	46.4
Pursat	63.3
Overall	**27.3**

Children Age 6-59 Months Ever Received Vitamin A	
Province	Vitamin A Coverage
Phnom Penh	56.4
Preah Vihear/Stung Treng	45.4
Mondolkiri/Rattankiri	53.1
Oddar Meanchey	91.7
Krong Preah Sihanouk/Koh Kong	91.4
Svay Rieng	58.8
Kampot/Krong Kep	56.7
Kampong Speu	75.9
Banteay Mean Chey	86.3
Kampong Cham	68.5
Takeo	88.3
Kratie	70.8
Battambang/Krong Pailin	79.4
Kandal	85.8
Kampong Chhnang	74.6
Siem Reap	74.9
Kampong Thom	82.7
Prey Veng	82.8
Pursat	88.7
Overall	**73.3**

On the map below (figure 15) the number of children 6-59 months of age who never received vitamin A supplementation are plotted by province and the provinces with below average utilization rates are marked with a black circle. The methods used to calculate the number of children can be found at the end of the report in the methodology section.

The provinces with no shading and the lowest number of children who have never received vitamin A have low population counts and population density. The provinces with the darkest shading and the highest numbers of children who have never received vitamin A have high populations with high population density. One might assume that the more densely populated provinces would have more effective supplementation activities as the children would be easier to reach, but this is not the case. In Kampong Cham (with the darkest shading) over 49,000 children have never received vitamin A.

Figure 14. Number of children 6-59 months of age who never received a vitamin A supplement and below average utilization by province, CDHS 2005



The map also shows that below average utilization does not identify the provinces that have the highest numbers of children who have never received vitamin A.

In order to improve the vitamin A supplementation rate, the intervention needs to reach larger numbers of the population. The map shows key provinces where more coordination and/or resources are needed. If all the children who never received vitamin A in Kampong Cham, Phnom Penh and Kampot/Krong Kep, were supplemented in a timely manner, the vitamin A supplementation rate would increase 25 percent. Nutrition programmers need to take into account not only supplementation rates, but also the target number of children to cover when planning for supplementation activities.

Which populations have the lowest coverage?

Post-partum vitamin A supplementation and child level utilization varied greatly by province as shown above, and targeting certain provinces can help to improve coverage. Within provinces, it is necessary to know which populations have the lowest coverage in order to ensure that they receive specific attention in future supplementation rounds.

Post-partum supplementation

Table 6. Postpartum vitamin A supplementation by socio-demographic characteristics, CDHS 2005

Background charateristics	Post-partum vitamin A supplementation	Number
Education		
No Schooling	22.0	1,356
Primary	27.9	3,482
Secondary +	32.2	1,028
Wealth Quintile		
Lowest	24.2	1,477
Second	27.5	1,320
Middle	32.0	1,077
Fourth	29.3	1,003
Highest	24.2	988
Place of Residence		
Rural	27.9	5,039
Urban	**23.5**	**827**
Overall	**27.3**	**5,865**

Maternal education appeared to be the factor that caused the largest variation in post-partum supplementation. Thirty-two percent of women who had completed one year of secondary schooling received vitamin A compared to only 22% who had no schooling. Women from the poorest wealth quintile had the lowest rate of supplementation (24%), while women from the middle wealth quintile had the highest rate of supplementation (32%). Women in the highest wealth quintile had a similar rate of supplementation as the poorest quintile (24%), but also were at the lowest risk of vitamin A deficiency.

When the results above are considered with the rates of maternal night blindness (table 2), it is evident that the populations who have the highest need for vitamin A supplementation have the lowest chance to receive the intervention.

Bivariate analysis cannot determine exactly which conditions cause post-partum vitamin A supplementation to be lower in some populations compared to others as it cannot control for confounding. In order to clarify the conditions that affect supplementation in women, probit regression of post-partum vitamin A supplementation was run on expected determinants (table 7). Interactions and collinearity between all independent explanatory variables were tested and found not significant.

Table 7. Marginal effects of probit regression on post-partum vitamin A supplementation by selected determinants

Variable	Marginal Effect	Z	P>z	Significant (P<0.05)
Age of Child in Months	-0.001	-2.62	0.01	*
Urban/Rural				
Urban	-0.033	-1.21	0.22	
Rural		Reference category		
Mother's education				
No Education	-0.057	-3.22	<0.01	*
Primary		Reference category		
Secondary Education	0.066	2.94	<0.01	*
Mother's age				
Mothers Age 15-19	-0.017	-0.44	0.66	
Mothers Age 20-29	0.027	1.73	0.08	
Mothers Age 30-39		Reference category		
Mothers Age 40-49	-0.023	-0.98	0.33	
Wealth quintiles				
Poorest Wealth Quintile	-0.061	-3.18	<0.01	*
Poorer Wealth Quintile	-0.033	-1.7	0.09	
Middle Wealth Quintile		Reference category		
Richer Wealth Quintile	-0.036	-1.54	0.13	
Richest Wealth Quintile	-0.093	-3.51	<0.01	*

Note: *The predicted probability of post-partum supplementation in the model was 0.269. The estimate of post-partum supplementation from the CDHS 2005 is 0.273.*

In probit like logistic regression, continuous linear variables (such as age in months) can be used as explanatory independent variables. The marginal effect in probit regression is interpreted as the percent change in the probability of an individual being supplemented (the dependent variable) for every unit increase of the explanatory (independent) variable. As an example from the above table, for every additional month of child's age, the probability of supplementation decreases by 0.1 percent.

In probit regression when using categorical variables (such as wealth quintiles) as explanatory independent factors, one category has to be defined as the reference category. When interpreting the outcomes from these variables the marginal effect is not a unit increase, but a measure of change in the outcome variable when starting from the reference category and changing to the category of interest. For example, the marginal effects show changing from the middle wealth quintile (the reference category) to the richest wealth quintile decreases the probability of supplementation by 9.3 percent.

The analysis above shows that age of child in months is significant as an explanatory factor for post-partum vitamin A supplementation, but the marginal effect is small (+0.1 percentage points per each month of child's age) Urban/rural residence and mother's age were not significant.

The effect of wealth and education on supplementation was found significant in the regression. Women with no education were 6 percent less likely to be supplemented post-partum compared to the reference group. Women of the lowest wealth quintile were also 6 percent less likely to be supplemented compared to the reference group.

While the general low rate of supplementation in all women show that dramatic improvements are needed for the entire population, these results show that special efforts have to be made to reach the poorest and least educated. Those creating behavior change strategies that are designed to raise awareness and provoke specific actions around vitamin A supplementation need to take special care to ensure that the materials and messages communicate clearly to these underserved populations.

Utilization of vitamin A in children

Bivariate analysis of utilization of vitamin A in children shows similar associations as found above with post-partum supplementation. Utilization increases as maternal education improves. With household wealth, utilization is lowest in the poorest wealth quintile. It improves to the highest levels in the middle and fourth wealth quintiles before it drops in the highest wealth quintile. Urban/rural residence does not appear to affect supplementation.

Table 8. Utilization of vitamin A in children 6-59m by socio-demographic characteristics, CDHS 2005

Background charateristics	vitamin A utilization	Number
Education		
No Schooling	67.6	1,529
Primary	76.2	3,772
Secondary +	78.9	1,107
Wealth Quintile		
Lowest	70.4	1,723
Second	75.6	1,460
Middle	78.5	1,114
Fourth	79.2	1,041
Highest	71.3	1,070
Place of Residence		
Rural	74.6	5,501
Urban	74.5	907
Overall	**74.6**	**6,408**

As with post-partum supplementation, a probit regression was run on utilization of vitamin A in children to more accurately determine what background characteristics cause the populations to have lower utilization. Interactions and collinearity of explanatory variables were tested and found not to be significant.

The age of child in months was significant (table 9) and for each increase of month of age, the probability of ever receiving vitamin A increases by 0.3%. This finding is to be expected as the older a child becomes, the greater chance he or she has to ever receive the supplement.

The effects of wealth and education on utilization were found significant in the regression. Children of women with no education were 9 percent less likely to be supplemented compared to the reference group. Children from the poorest wealth quintile were 6 percent less likely to be supplemented compared to the reference group.

Mother's age was also found to be significant in the model only for mothers aged 15 to 19 years. Children of these youngest mothers are 12 percent less likely to be supplemented compared to the reference group. Cambodian women do not marry early, so mother's aged 15 to 19 years made up only 2% of the population included in the regression. This finding is not so relevant as this group represents such a small percent of the population.

There is no data on children with vitamin A deficiency from 2005. It is likely that children of mothers who are vitamin A deficient also are deficient. If this is the case then the children most at risk for vitamin A deficiency are the least likely to ever receive vitamin A.

Table 9. Marginal effects of probit regression on utilization of vitamin A in children by selected determinants

Variable	Marginal Effect	Z	P>z	Significant (P<0.05)
Age of Child in Months	-0.003	6.8	0.01	*
Urban/Rural				
Urban	-0.019	0.71	0.48	
Rural		Reference category		
Mother's education				
No Education	-0.085	-3.8	<0.01	*
Primary		Reference category		
Secondary Education	0.053	2.46	<0.01	*
Mother's age				
Mothers Age 15-19	-0.121	-3.34	0.02	*
Mothers Age 20-29	0.001	0.09	0.93	
Mothers Age 30-39		Reference category		
Mothers Age 40-49	-0.002	0.11	0.91	
Wealth quintiles				
Poorest Wealth Quintile	-0.059	-2.44	<0.02	*
Poorer Wealth Quintile	-0.021	-0.88	0.38	
Middle Wealth Quintile		Reference category		
Richer Wealth Quintile	-0.004	-0.16	0.87	
Richest Wealth Quintile	-0.118	-3.43	<0.01	*

Note: *The predicted probability of vitamin A utilization in the model was 0.752. The estimate of vitamin A utilization from the CDHS 2005 is 0.733.*

What is the trend for vitamin A supplementation?

The exact trend of vitamin A supplementation in children cannot be determined from the CDHS surveys. This was due to changes in the questions and subsequently in the responses. Estimates based on adjustments for recall bias and imputation to adjust for "don't know" when responses give an estimate of 50% coverage in 2005. This represents a 72% improvement from the under-five supplementation rate of 2000. While the HIS coverage rates are difficult to believe when they range over 100%, the trends from HIS data collected according to the same methods over time should be valid for trend analysis. The HIS displays a 55% improvement in child supplementation rates between 2000 and 2005 (figure 5).

The coverage rate for vitamin A supplementation of post-partum women from the CDHS has almost tripled from 11% in 2000 to 27% in 2005. This great improvement is largely due to the very low cove rage rate in 2000. According to the HIS, the trend in post-partum vitamin A suplementation has increased by 277% from 13% in 2000 to 49% in 2005.

Anemia

Oxygen is the life giving element that allows all humans and animals to survive and thrive on earth. The deprivation of oxygen causes death. Anemia is the condition where the body's capacity to use oxygen is reduced and health is put at risk.

The health consequences of anemia include:

- increased risk of maternal and perinatal mortality (Stoltzfus et al 2004),
- impaired cognitive and psychomotor development,
- reduced cognitive performance,
- reduced work productivity and endurance (Stoltzfus, 2001) and
- decreased economic potential (Horton & Ross, 2003).

It is important to note that recent meta analysis research (Stoltzfus et al, 2004) has shown that it is not only severe anemia but also mild and moderate anemia that increases a pregnant woman's risk of mortality.

Anemia Summary Points

Prevalence: In 2005, 47% of women aged 15-49 years were anemic and 11% had moderate or severe anemia. 62% of children aged 6-59 months were anemic and 33% had moderate or severe anemia.

Geographic Distribution: In 2005, anemia in children aged 6-59 months was greater than 40% in all provinces. For women of reproductive age, anemia prevalence in all provinces except Phnom Penh was greater than 40% in 2005.

Populations at Risk: Anemia is most common in pregnant women and children from 6 to 24 months of age. Poor uneducated women and their children are more likely to be anemic than educated wealthier populations.

Trend: From 2000 to 2005 the prevalence of anemia in children has not changed. In women of reproductive age, the prevalence of anemia decreased by 11 percentage points between 2000 and 2005.

Anemia is a severe public health problem among all women and children in Cambodia. There is an urgent need to prevent anemia in these two target populations, but also to determine the etiology of anemia in the general population to effectively address the exact causes when and where they are found.

The first three sections on anemia focus on coverage and trends in the subpopulations currently targeted in Cambodia. This is followed by an analysis of preventable causes of anemia in Cambodia and an analysis of the issues surrounding the IFA supplementation indicator. Preventive treatment is covered below. Curative treatment of anemia with iron supplementation and intestinal helminths is not covered in this document.

Table 10. Prevalence of Anemia in South-east Asia by Country

Country	Population Group & Sample Size	Date & Source	Prevalence and Cut-Off reported
Women			
Cambodia	Pregnant women 15-44.9 years (N=486)	2005, CDHS	57.1 (<11g/L)
Vietnam	Pregnant women 15-44.9 years (N=2,744)	2000, National Su rvey	32.2 (<11g/L)
Thailand	Pregnant women 15-44.9 years (N=242)	1995, National Survey	22.3 (<11g/L)
Cambodia	Non-pregnant non-locating women 14-44.9 years (N=6,408)	2005, CDHS	44.3 (<12g/L)
Lao PDR	Women 15-49.9 years (N not reported)	2000, National Survey	31.3 (<11g/L)
Vietnam	Non-pregnant women 14-44.9 years (N=7,135)	2000, National Survey	24.3 (<12g/L)
Thailand	Non-pregnant non-locating women 14-44.9 years (N=1,077)	1995, National Survey	16.8 (<12g/L)
Children			
Cambodia	Children 5-59 months (N=3,158)	2005, CDHS	61.9 (<11g/L)
Lao PDR	Children - No Data	No Data	No Data
Thailand	Children 0-5.9 years (N=3,260)	1995, National Survey	25.2 (<11g/L)
Vietnam	Children 0-4.9 years (N=7,024)	2000, National Survey	34.1 (<11g/L)
Men			
Cambodia	Men - No Data	No Data	No Data
Lao PDR	Men 15-49.9 years (N not reported)	2000, National Survey	22.8 (<11g/L)
Thailand	Men 15-59.9 years (N not reported)	1995, National Survey	15.6 (<13g/L)
Vietnam	Men age not reported (N=3,230)	2000, National Survey	9.4 (<13g/L)

Sources: Cambodian Demographic and Health Survey (CDHS), Phnom Penh, NIPHL and NIS, 2005.
Ministry of Public Health, Department of Health. The Fourth National Nutrition Survey of Thailand 1995. Bangkok, Ministry of Public Health, Department of Health, 1998.
National Institute of Nutrition. Report on Vietnam National anemia Survey, 2000. Hanoi, 2001.
Ministry of Health [Lao People's Democratic Republic]. Report on national health survey: health status of the People of LAO PDR. Vientiane, Ministry of Health, 2001.

Conditions of Anemia

Anemia is a significant problem worldwide and particularly in SE Asia. In table 10, the prevalence of anemia in Cambodia and neighboring countries are presented, and shows:

- Anemia in pregnant women is twice as high in Cambodia (57%) compared to Vietnam (32%) and three times higher than pregnant women in Thailand (22%),
- Anemia in non-pregnant, non-lactating women is highest in Cambodia (44%) compared to non-pregnant, non-lactating women in Vietnam (24%) and Thailand (17%) and compared to all women in Lao PDR (31%),
- Anemia in children under five is twice as high in Cambodia (62%) compared to Vietnam (34%) and Thailand (25%),
- There is no data for anemia in men in Cambodia but it is likely to be an issue as the prevalence ranges from 9% in Vietnam to 22% in Lao PDR.

Cambodia has the most recent data but national level conditions of anemia do not change rapidly unless effective national level programs are implemented and sustained. There is no national level data for children aged 5-15 years in Cambodia. In a study on weekly iron folate supplementation in two school districts of Kampot province, the anemia prevalence in children aged 5-15 years was 64% (Longfils et al, 2005). WHO recommends that anemia prevalence of 40% be used as the cut-off to describe a severe public health problem in populations (WHO, 2001). According to these criteria, anemia is a severe public health problem in Cambodian women, children under five and possibly in children from 5-15 years of age as well.

Causes of Anemia

On average iron deficiency is estimated to cause 50% of anemia worldwide (WHO/UNICEF/UNU, 2001, Stoltzfus, 2003). Determination of the exact causes of anemia is difficult as there are multiple conditions that can cause anemia. The main causes of anemia are:

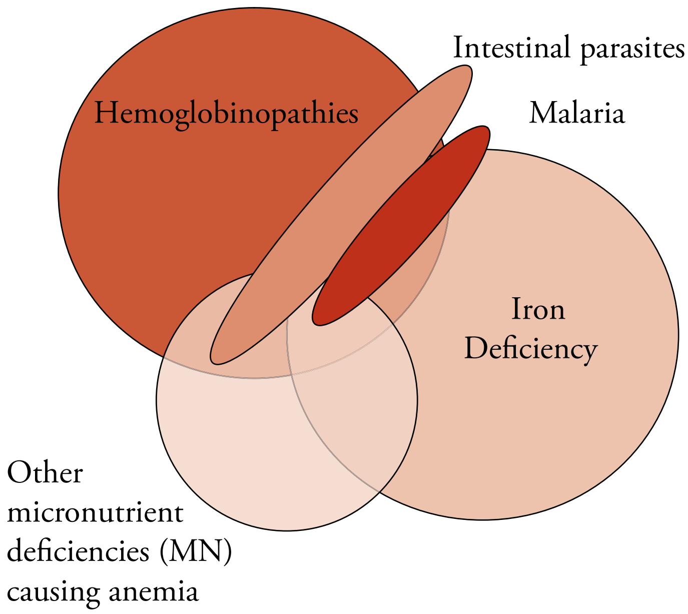
- Dietary iron deficiency
- Infectious diseases such as malaria, hookworm infections, schistosomiasis, HIV/AIDS, tuberculosis and other chronic diseases including almost any inflammatory illness that lasts several months or longer, and some malignancies
- Deficiencies of other key micronutrients including folate, vitamin B12, vitamin C, vitamin A, protein, copper and other minerals
- Inherited conditions that affect red blood cells, such as thalassemia
- Severe acute hemorrhage (occurring in childbirth)
- Chronic blood losses (as with peptic ulcers) and
- Trauma

In Cambodia, the country specific causes of anemia have been estimated and are shown in figure 16 below. Iron deficiency (30%), hemoglobinopathies (30%) and other micronutrient deficiencies (20%) are considered the most common causes of anemia. A Venn diagram is used to demonstrate that the causes of anemia are not exclusive. It is assumed that these estimates are for the general population but the population group represented by these estimates was not defined. As the estimates are largely based on two studies of pre-school children, it is likely that they represent conditions in pre-school children rather than adult men or women.

It should be noted that there is no national level data on the prevalence of iron or other micronutrient deficiencies, malaria, intestinal parasites or hemo-globinopathies so all the presented percent contributions are unsupported estimates. In populations known to have high rates of anemia (women of reproductive age and children under-five), it is probable that the contribution of iron deficiency is underestimated. Similar conditions of iron deficiency may be found in children age 5-15 years. The small area studies measuring iron status are discussed below. The contribution of malaria to anemia in Cambodia is likely overestimated and also discussed below.

Current provincial or regional level studies are underway to help define the causes of anemia in children in Cambodia. This will help to clarify the conditions, but national level data is needed on both populations considered at risk and not at risk.

Figure 16. Venn diagram of the overlapping causes of anemia and estimated percent contribution



Overlapping Causes of Anemia:	
Hemoglobinopathies	~30%
Iron Deficiency	~30%
Other MN deficiencies	~20%
Intestinal parasites	~15%
Malaria	~10%

Source: CESVI study, GTZ study and rough estimates -Dr S Jack-WHO/TASK

Low Birth Weight

Low birth weight is one cause of anemia in young infants. Children born with low birth weight (LBW) often have low iron stores and develop iron deficiency anemia before reaching six months of age. There is some evidence that anemia is common in LBW breastfed infants as early as 8 weeks of age. International experts recommend the administration of supplemental oral iron to low birth weight infants starting from 6 to 8 weeks of age (Edmond & Bahl, 2006). Low birth weight is defined as an infant weighing less than 2.5 kg at birth. Cambodia has two sources of national level data on low birth weight: the HIS (not shown) and Demographic and Health Surveys. The HIS is considered to have poor quality data as it is based only on facility based births and not all facilities have scales.

Both the CDHS 2000 and CDHS 2005 have poor quality data on low birth weight for the following reasons:

- 78% of births take place at home (CDHS 2005)
- Only 17% and 40% of children in 2000 and 2005, respectively were weighed at birth (Table 9)
- For the children who were weighed but born at home, they were likely weighed too late (the child should preferably be weighed in the first hour of life)
- The data are taken from records on the vaccination card or from maternal recall. Only one fifth of data is taken from the vaccination card (CDHS 2005). Data from maternal recall have been demonstrated to be of poor quality,
- Heaping or preference for certain numbers is very common (not shown).

Table 11. Prevalence of Low Birth Weight in Cambodia, Thailand and Bangladesh by year and source of data

Country and Year	% Low Birth Weight	% of births weighed	N
Cambodian DHS 2000	6	17	8,175
Cambodian DHS 2005	8	40	7,789
Cambodian DHS 2005 (Adjusted)	15	40	7,789
Thailand MICS 2006	9	99	9,409
B'desh MICS 2006	27	16	11,899
B'desh Low Birth Weight Study 2003-04	36	80	3,085

Table 11 above compares data on low birth weight from Cambodia, Thailand and Bangladesh in order to demonstrate that the indicator reported in DHS and Multiple Indicator Cluster Surveys (MICS) will often underestimate the true prevalence of low birth weight. It should be noted that MICS surveys use the same methodology and have the same problems as the DHS surveys. The prevalence of low birth weight of weighed children has increased in Cambodia from 6 to 8 percent as more women reported their child was weighed at birth from 2000 to 2005. In Thailand, the MICS methodology did not underestimate the prevalence of low birth weight babies as 99% of the children were weighed at birth. Thailand, where women are considered to be significantly more healthy than in Cambodia was found to have a higher prevalence of LBW (9%) than Cambodia (8%). This indicates that Cambodia's reported estimate is most likely an underestimate.

In Bangladesh, the Multiple Indicator Cluster survey reported 27 percent of children had low birth weights. This is compared to the Bangladesh Low Birth Weight Study where 80% of live births in a national sample were weighed and the prevalence of low birth weight was 36%. The study found the prevalence of low birth weight was 33% higher than the MICS data.

Methods to improve the estimates of low birth weight from the DHS/MICS methods were developed and find on average the adjusted estimates are 24% higher than the DHS/MICS estimates. These methods make adjustments for relative birth size and heaping (of reported weight) (Blanc and Wardlaw, 2004). These adjusted estimates are not robust when they are based on a small percentage of the population weighed at birth.

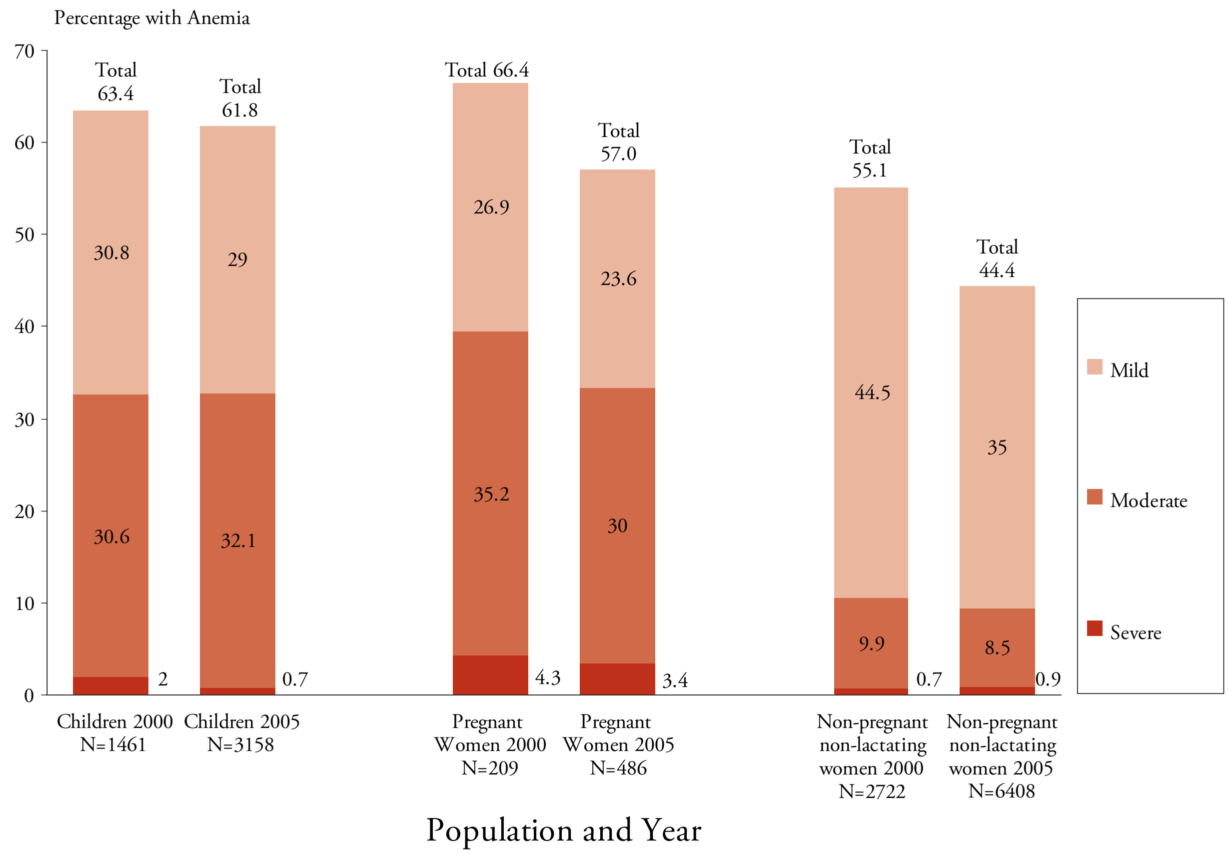
Using these methods, the adjusted rate of low birth weight calculated from the CDHS 2005 was 15%. This appears closer to what would be expected given the high rates of stunting (8% with height < 145cm) and undernutrition (21% with low Body Mass Index - CDHS 2005) among women of child bearing age. The true conditions of low birth weight are not known nor addressed in Cambodia. It is clear that low birth weight increases the risk of death and anemia in young children. There is a critical need for more accurate measures and effective interventions to reduce the rate of low birth weight.

Prevalence of Anemia

Anemia data were collected in both the CDHS 2000 and 2005. In both surveys, Hemocue machines were used. The same trainings and standardization procedures were used and in many cases the same interviewers were hired to do the interviews and blood testing. Figure 17 below presents the national prevalence of anemia in three populations considered to have the highest risk for anemia. Eight percent of children and five percent of women had missing data for hemoglobin concentration.

On the national level, the prevalence of anemia in young children did not change significantly between 2000 and 2005. No real change was evident in children in the anemia categories by severity. For pregnant women, the prevalence of anemia decreased by 9 percentage points. This change was largely due to a decrease in the moderate anemia category. In non-pregnant, non-lactating women the prevalence of anemia declined by 11 percentage points. In this population group the change was caused by a ten percentage point decrease in mild anemia.

Figure 17. Prevalence of anemia in women and children by severity and year, CDHS 2000 and 2005



The provincial prevalence of anemia shows considerable variation (Table 12). The data are sorted by anemia prevalence in 2005. The domains of the CDHS 2000 were recategorized to match those of the CDHS 2005. Only one province (Oddar Meanchey) had insufficient sample to represent reliable data, and its results are not shown. The provincial data presented is based on children of interviewed mothers from the CDHS 2000.

In 2005, close to three-quarters of children or more were anemic in Pursat, Siem Reap, Kampong Thom, Sihanoukville/Koh Kong and Oddar Meanchey. The lowest provincial estimates were in Phnom Penh (52%) and Kampot/ Krong Kep (49%). The prevalence of anemia increased by 10 percentage points or more in Pursat, Sihanoukville/Koh Kong, Battambang/Krong Pailin, Preah Vihear/Stung Treng and Phnom Penh. Six provinces showed no real change in anemia prevalence (a difference less than 3 percentage points). Anemia decreased by more than 10 percentage points in Kampong Speu, Kampong Cham and Kampot/Krong Kep. The greatest changes of anemia prevalence in either direction were found in Battambang/Krong Pailin (+19 percentage points)and Pursat (+15 percentage points). For Battambang/Krong Pailin, it appears that the prevalence in 2000 (36%) was an underestimate. For Pursat the prevalence in 2005 (85%) appears inaccurate. Both of these outcomes could be due to poor anemia testing technique.

The most important point demonstrated by the provincial prevalence is that conditions remained above the cut-off defined as a severe public health problem.

Table 12. Prevalence of Low Birth Weight in Cambodia, Thailand and Bangladesh by year and source of data

Province	Prevalence of Anemia in Children		Difference (2005-2000)
	2000	2005	
Pursat	69.2	84.6	15.4
Siem Reap	76.8	78.1	1.3
Kampong Thom	78.7	75.1	-3.6
Sihanoukville/Koh Kong	57.3	73.7	16.4
Oddar Meanchey	*	73.2	*
Banteay Mean Chey	61.8	70.6	8.8
Svay Rieng	68.1	68.5	0.4
Preah Vihear/Stung Treng	56.9	67.4	10.5
Kampong Speu	75.7	63.4	-12.3
Mondolkiri/Rattanakiri	67.1	63.4	-3.7
Kampong Chhnang	67.1	60.2	-6.9
Prey Veng	58.8	59.6	0.8
Kratie	52.8	58.9	6.1
Kampong Cham	73.2	56.5	-16.7
Takeo	65.0	55.9	-9.1
Battambang/Krong Pailin	36.0	54.9	18.9
Kandal	58.3	54.9	-3.4
Phnom Penh	41.8	52.2	10.4
Kampot/Krong Kep	61.8	48.5	-13.3
Overall	**63.6**	**61.8**	**-1.8**
Number	**1,420**	**3,158**	**-1.8**

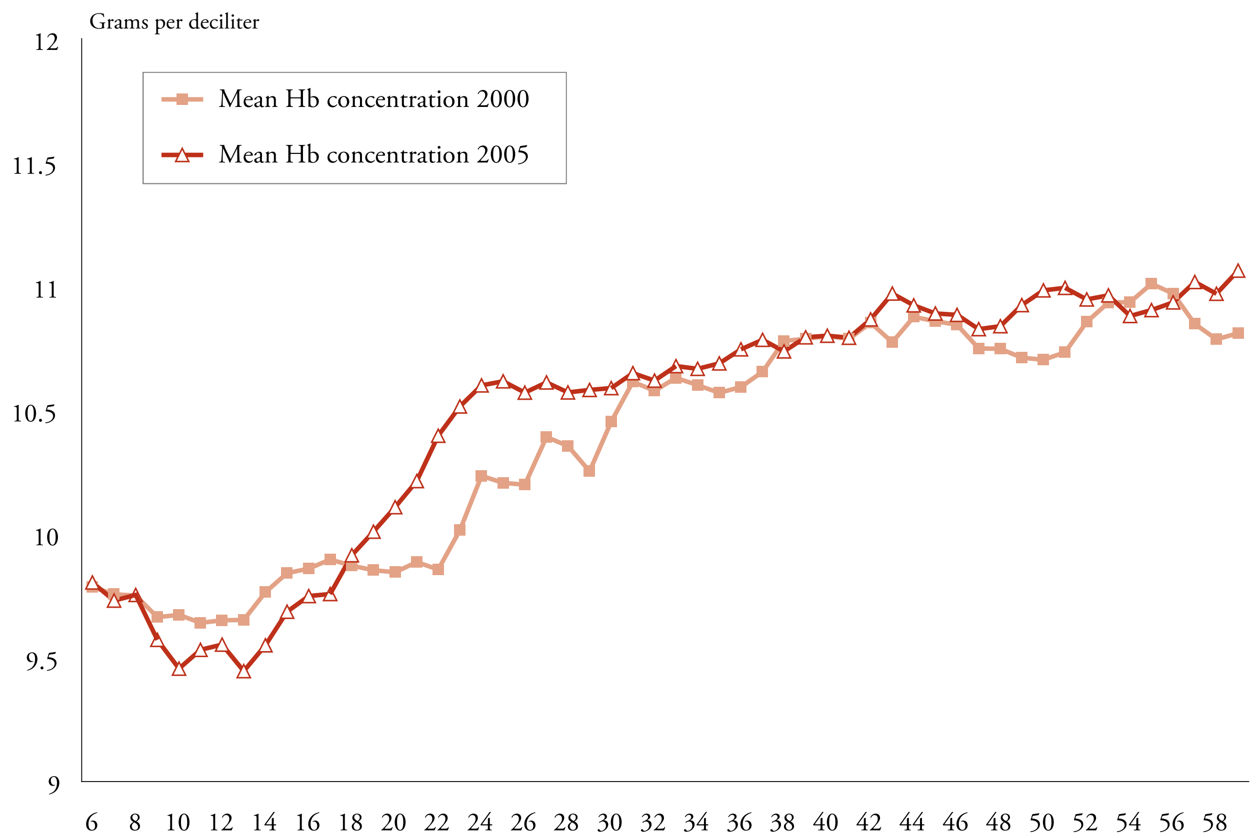
Note: Percentages based on less than 30 unweighted counts are not shown.

Analysis of hemoglobin concentration in children by age in months and year (figure 18) showed the conditions changed only slightly between 2000 and 2005. When the mean hemoglobin concentrations from the two surveys are analyzed by age in months, a variation can be seen. In 2000 the child's mean hemoglobin concentration did not fall as low as that of year 2005 during the age of 10 to 15 months. In 2005, the mean hemoglobin concentration climbed above 10.5 g/dl by 24 months of age, where it took until 31 months of age in the year 2000. After 31 months of age, there is little difference between the mean hemoglobin concentration in 2000 and 2005.

Anemia is caused by many factors, but children have their highest iron needs between the age 6 and 24 months due to their rapid growth. Eighty-one percent of children 6 to 8 months of age in Cambodia are anemic (CDHS 2005) indicating that the majority of children did not have adequate iron stores to last until 6 months of age. After 6 months of age, children are fed complementary foods. The iron gap or insufficiency of iron in the complementary feeding diet has been found to exist in Cambodia just as in more developed countries (Anderson, 2004). Children are also more likely to be exposed to disease and intestinal parasites causing diminished appetite, poor absorption and/or iron losses.

Currently there is no national policy or commonly implemented intervention to treat or prevent iron deficiency in children under 24 months of age.

Figure 18. Mean hemoglobin concentration in children 6-59 months by age in months and year, CDHS 2000 and 2005



Note: Points are smoothed with a five month moving average.

For women of reproductive age, anemia prevalence varied considerably by province. The data in table 13 are sorted by anemia prevalence in 2005. The three provinces with the highest prevalence of anemia were Preah Vihear/Stung Treng, Kampong Speu, Kampong Thom and Banteay Mean Chey (57% or higher). Two of these three provinces also had among the highest prevalence of anemia in children. The province with the lowest prevalence of anemia in women was Phnom Penh (29%). Phnom Penh had the second lowest prevalence of anemia in children. Phnom Penh was the only province that fell significantly below the cut-off of a severe public health problem (40%).

The prevalence of anemia in women decreased in 16 of the 19 of domains. The only two provinces where anemia increased were Kampong Chnnang and Battambang/Krong Pailin (5 percentage points). The provinces with the largest decreases in anemia were Phnom Penh (24 percentage points), Mondolkiri/Rattanakiri (21 percentage points), Takeo and Kampong Cham (about 17 percentage points). The decrease in anemia in women in Phnom Penh is likely due to the large increases in socio-economic status and quality and access to health care in the capital city. It is interesting to note that the conditions identified in child anemia in Pursat and Battambang/Krong Pailin are not evident in the measures of anemia in women.

The decrease of the overall anemia prevalence in women was driven by the changes of the populous provinces of Kampong Cham, Phnom Penh, Takeo and Prey Veng.

Table 13. Prevalence of anemia in women 15-49 years of age by province and year, CDHS 2000 and 2005

Province	Prevalence of Anemia in Children		Difference (2005-2000)
	2000	2005	
Pursat	68.7	62.6	-6.1
Siem Reap	59.6	58.0	-1.6
Kampong Thom	66.8	57.4	-9.4
Sihanoukville/Koh Kong	65.4	57.1	-8.3
Oddar Meanchey	*	57.1	*
Banteay Mean Chey	51.4	55.9	4.5
Svay Rieng	69.9	55.9	-14.0
Preah Vihear/Stung Treng	47.5	52.8	5.3
Kampong Speu	63.3	52.4	-10.9
Mondolkiri/Rattanakiri	60.2	49.4	-10.8
Kampong Chhnang	64.6	46.8	-17.8
Prey Veng	50.8	46.3	-4.5
Kratie	54.2	45.9	-8.3
Kampong Cham	63.0	42.3	-20.7
Takeo	52.8	42.3	-10.5
Battambang/Krong Pailin	58.2	41.0	-17.2
Kandal	54.6	40.3	-14.3
Phnom Penh	55.9	36.6	-17.3
Kampot/Krong Kep	52.6	29.1	-23.5
Overall	**57.8**	**46.6**	**-11.2**
Number	**3,634**	**8,219**	

Note: Percentages based on less than 30 unweighted counts are not shown.

Table 14 below shows anemia conditions in children by background characteristics. Children of uneducated mothers and those in the lowest and second lowest wealth quintile have the highest prevalence of any anemia. Anemia also is highest in the 6-8, 9-11 and 12-17 month old age groups.

Table 14. Prevalence of anemia in women 15-49 years of age by province and year, CDHS 2000 and 2005

	Anemia status by level				
	Mild (Hb conc. 10-10.9g/dL)	Moderate (Hb conc. 7.0-9.9 g/dL)	Severe (Hb conc. <7.0 g/dL)	Any anemia (Hb conc. <11g/dL)	Number
Age in months					
6-8	26.0	54.2	0.3	80.5	163
9-11	24.5	61.7	0.9	87.1	170
12-17	24.8	59.2	1.8	85.8	370
18-23	32.6	36.8	1.2	70.7	376
24-35	32.7	25.7	0.2	58.6	679
36-47	28.8	21.5	0.8	51.1	721
48-59	27.8	19.5	0.4	47.7	679
Mother's education					
No Schooling	30.1	37.6	0.8	68.5	726
Primary	29.3	32.1	0.8	62.3	1,765
Secondary and higher	28.1	24.2	0.2	52.5	489
Wealth quintile					
Lowest	28.1	40.4	0.9	69.4	811
Second	29.9	35.1	1.0	65.9	700
Middle	27.5	32.8	1.0	61.3	602
Fourth	29.2	26.1	0.5	55.9	550
Highest	31.0	20.1	0.0	51.0	494
Overall	**29.0**	**32.1**	**0.7**	**61.9**	**3,158**

The most interesting point from table 14 is that mild anemia does not change greatly over the different background characteristics. This provides a hint that hemoglobinopathies may be a major cause of mild anemia. Hemoglobinopathies are not expected to cluster by maternal education or socio-economic status. Moderate anemia (Hb concentration from 7.0 – 9.9 g/dL) is the type of anemia that responds to the changes in characteristics. While there is anemia found throughout the entire child population, this more detrimental level of anemia (moderate to severe) should be immediately addressed through specific targeting of interventions.

Table 15. Prevalence of anemia in women by background characteristics, CDHS 2005

	Anemia status by level				
	Mild (Hb conc. 10-10.9g/dL)	Moderate (Hb conc. 7.0-9.9 g/dL)	Severe (Hb conc. <7.0 g/dL)	Any anemia (Hb conc. <11g/dL)	Number
Number of children ever born					
0	34.5	8.7	1.3	44.5	2,998
1	36.9	9.9	0.9	47.7	953
2-3	34.0	10.4	0.6	45.1	1,905
4-5	35.4	10.6	0.9	46.9	1,339
6+	38.9	14.2	1.0	54.1	1,024
Mother's education					
No Schooling	36.4	15.0	1.5	52.9	1,636
Primary	36.3	9.9	0.9	47.2	4,622
Secondary and higher	32.2	6.9	0.8	39.9	1,960
Wealth quintile					
Lowest	37.0	17.1	1.4	55.5	1,452
Second	37.9	11.7	1.2	50.8	1,540
Middle	37.1	9.9	1.3	48.3	1,639
Fourth	38.8	7.9	0.9	47.5	1,599
Highest	28.0	6.2	0.4	34.7	1,988
Overall	**35.4**	**10.2**	**1.0**	**46.6**	**8,219**

The prevalence of anemia in women by background characteristics is shown in table 15. Women who have had six children or more had significantly higher prevalence of anemia compared to those who had less children. The majority of change is found in moderate anemia, as it increases with each child born. Women with no schooling (53%) or primary schooling (47%) had a significantly higher prevalence of anemia compared to women with secondary education or higher (40%). Again the majority of change is found in moderate anemia.

Socio-economic status presents the largest variation of anemia prevalence in women. In the highest wealth quintile only 35% of women were anemic, while in the lowest, 56% were found anemic. The difference is explained by large changes in both moderate and mild anemia. With moderate anemia, as the wealth quintile rises the prevalence of moderate anemia falls. With mild anemia, the prevalence remains the same across the first four quintiles and only decreases when reaching the highest wealth quintile.

Iron Supplementation

In September 2007, the new National Guidelines for Iron/Folic Acid supplementation in pregnant and post-partum women were disseminated. The iron/folic acid tablets are available from hospitals, health centers, or outreach activities (MoH, 2007). Pilot projects have been conducted on providing weekly iron folate (WIF) supplements to secondary school girls, factory women and rural women of reproductive age and fortification of fish sauce, but neither are national programs.

Iron Supplementation Summary Points

Coverage: In 2005, only 18% women received the recommended number (90+ tablets) of iron supplements during their last pregnancy. Only two-thirds of women reported that they received any iron supplementation during their last pregnancy.

Geographic Distribution: Svay Rieng and Takeo had the highest coverage of any iron supplementation, while Kratie, Sihanoukville, Koh Kong, and Oddar Meanchey had the lowest rate of any supplementation.

Low Coverage Populations: Uneducated women and those in the lowest wealth quintile were the least likely to receive iron supplementation.

Trend: There has been a 42 percentage point increase in women receiving at least one iron supplement between 2000 and 2005. Every province improved over that time, with Prey Veng increasing coverage by 62 percentage points. The rate of women who received the recommended number of iron supplements increased from 3% to 18% from the year 2000 to 2005.

There is no policy for preventive supplementation of children, despite anemia in children being a documented long-term severe public health problem in Cambodia. The resistance to implementation of anemia prevention/treatment programs including iron supplementation for infants and young children is an international problem. Many MOH leaders and health planners do not appear to know that effective and practical interventions are available for addressing anemia (Kapil, 2003).

The safety concerns pertaining to iron supplementation in children in areas where malaria and infectious diseases are common have caused many countries to move cautiously with anemia reduction programs in children. Many dangerous pathogens need iron for survival and thrive when it is present in sufficient quantities. Anemia of chronic inflammation stems from the body storing iron to make it unavailable to pathogens. A WHO expert consultation on prevention and control of iron deficiency found that iron deficient children should be treated with iron supplements, but caution exercised in areas where the prevalence of malaria and other infectious diseases are high (WHO, Jan 2006). This statement was released after expert consultation reviewed the topic. One large study in particular conducted in Tanzania that found that children who received iron and folic acid with or without zinc were significantly more likely to be hospitalized and had a non-significant trend towards increased mortality. The same study demonstrated that iron supplementation in children with iron deficiency significantly reduced the rate of adverse events (hospitalizations or deaths) (Sazawal et al, 2006; Lynch et al, 2007). The sister study in Nepal with similar methods and sample size did not report outcomes in children stratified by presence of iron deficiency anemia (Tielsch et al, 2006).

The WHO statement made it clear that findings should not be extrapolated to food fortification or food based approaches. Large scale trials of in-home fortification with multiple micronutrient demonstrated that it is safe and effective (Zlotkin et al, 2005; IRIS Study Group, 2005). Efficacy trials of in-home fortification in infants and young children in Cambodia found the same results (Giovannini et al, 2006; Schumann et al, 2007). An effectiveness trial on delivery of in-home fortification through the health system is underway. If this is a success, the Cambodian government will consider a nationwide implementation of the intervention.

Hand-out on iron supplementation distributed to outreach workers, 2007

Current recommendations in Cambodia state that pregnant women should receive at least 90 tablets of iron during their pregnancy. The target put forth by the NNP for iron/folate supplementation of pregnant women is that 50% take at least 90 tablets by 2010. To monitor supplementation the NNP is using the indicator of the percentage of women that received 90+ tablets during their last pregnancy.

Issues with the Indicator from the CDHS

This indicator of women receiving 90 or more iron tablets during their last pregnancy has the same problem as vitamin A in that respondents reply "don't know," but the calculation of the two indicators is different. As previously discussed, the vitamin A indicator treats all of the people replying "don't know" as No. With iron supplementation the women who responded "don't know" remain separated. As in the vitamin A questions, the data on IFA supplemented is collected with two questions. The same question was used in the 2000 and 2005 surveys.

Figure 19. Prenatal iron supplementation questions, CDHS

421	During this pregnancy, were you given or did you buy any iron tablets? SHOW TABLETS.	YES .... 1 NO .... 2 (SKIP TO 422 A) DON'T KNOW 8
422	During the whole pregnancy, for how many days did you take the tablets? IF ANSWER IS NOT NUMERIC, PROBE FOR APPROXIMATE NUMBER OF DAYS.	NUMBER DAYS [ ][ ][ ] DON'T KNOW 998

Interviewers asked the first question about ever receiving IFA tablets and while showing iron tablets used for demonstration. Sixty-three percent of women responded "yes" and less than half a percent responded "don't know" (table 16).

Table 16. Percent distribution ever received iron tablets during last pregnancy (First Question), CDHS 2005

Ever received iron tablets	Percent	Number
Yes, received	62.8	3685
No, never received	36.8	2160
Don't know	0.3	20
Total	**100.0**	**5864**

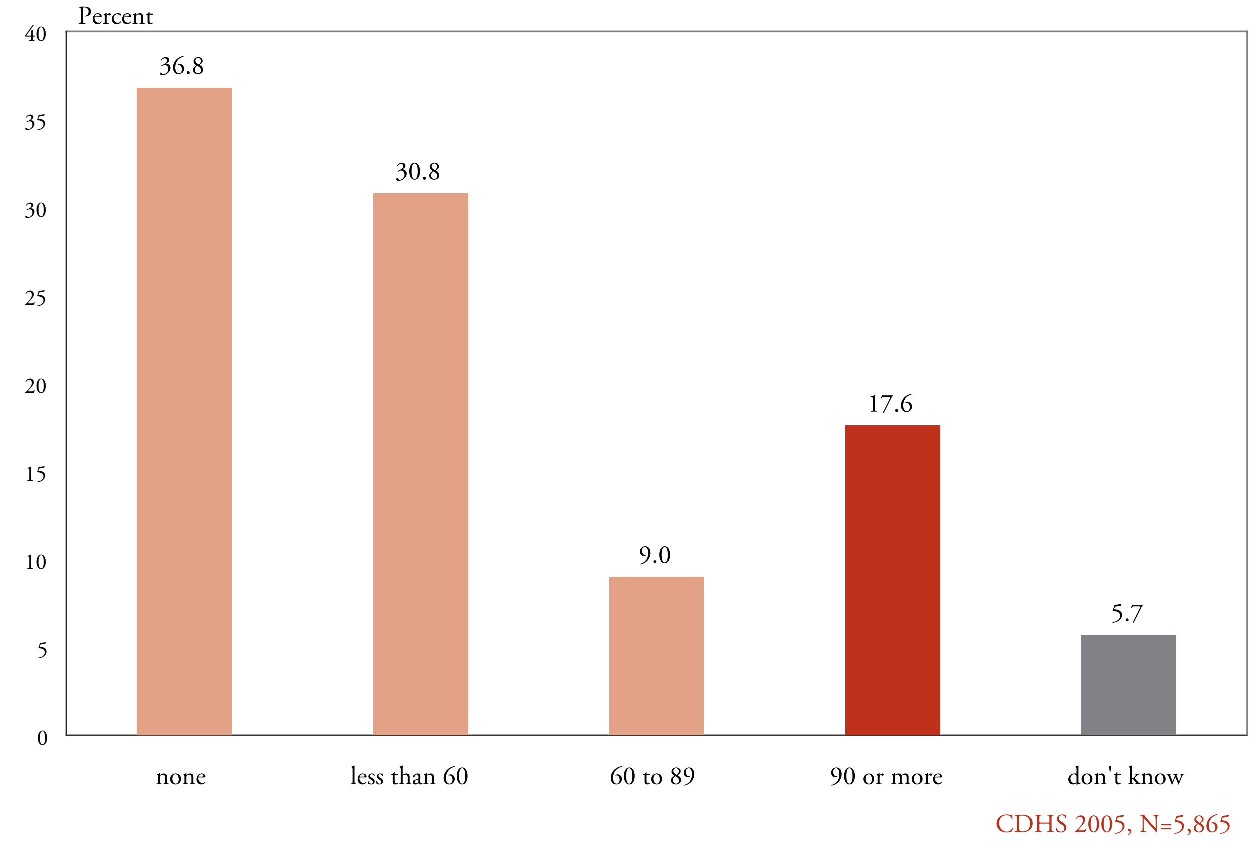
Those women who answered that they received IFA tablets, were asked how many days during the entire pregnancy did they take the tablets. Only 28% of the women took IFA tablets for 90 days or more. About 9% responded "don't know" to the question on number of days of iron tablets.

Table 17. Percent distribution of number of days women took IFA tablets during last pregnancy out of women who received any IFA tablets during pregnancy (Second Question), CDHS 2005

Number of days took IFA tablets	Percent	Number
less than 90 days	63.4	2238
90 days or more	28.1	1035
Don't know	8.5	312
Total	**100.0**	**3685**

In calculation of the indicator of percentage of women who took the recommended number of IFA tablets during pregnancy, the women who responded "no" to the initial question were put into the received "none" category. Those who responded "yes" to the first question and a number of days were categorized (<60 days, 60-89 days and 90 or more days). The "don't know" responses from the first and second questions were put into the "don't know" category. The results are reported in figure 20 below.

Figure 20. Number of days women took IFA tablets during last pregnancy, CDHS 2005



The inclusion of the "don't know" category in the results gives a more accurate representation of IFA supplementation. While the percent of women reporting "don't know" is relatively low, there is a possibility to have underestimated the percent of women who took IFA tablets for 90 days or more. As the CDHS 2005 had a large sample size, those who reported "don't know" represented 312 women in the weighted sample, which is a sufficient number for further analysis.

Analysis was done to determine if these women who reported "don't know" how many days were different than the average women in the sample. Table 18 below shows that women from urban areas are twice as likely to report "don't know" number of days compared to rural women. Women of the richest wealth quintile are five times as likely to report "don't know" how many days compared to those in the poorest wealth quintile. Even women in the richest wealth quintile had a prevalence of anemia of 35%, showing that iron supplementation is needed.

Table 18. Percent of women reporting "don't know" how many days of IFA tablets taken by background characteristics, CDHS 2005

	Percent "don't know" number of day	Number
Education		
No Schooling	2.9	1,355
Primay	5.6	3,482
Seconday +	7.6	1,082
Wealth Quintile		
Poorest	2.3	1,476
Poorer	3.8	1,320
Middle	4.7	1,077
Richer	6.2	1,003
Richest	11.7	988
Place of Residence		
Rural	4.4	5,038
Urban	10.8	827
Overal	**5.3**	**5,865**

Trends and Conditions of Iron Supplementation

Iron supplementation during pregnancy is a well established intervention to improve the health of women and newborn children. The conditions of iron supplementation in Cambodia are presented below. Table 20 shows the percentage of women who received the recommended supplementation of IFA tablets for 90 days or more in 2005 by province. The results are sorted by the percentage of women who took 90 days or more of IFA tablets.

The three provinces with the highest rates of women taking 90 days or more of IFA tablets (28% or higher) were Pursat, Svay Rieng and Prey Veng. The rate in Pursat (53%) is 14 percentage points above the next highest province. These results appear significantly higher than the results from other provinces and may be an overestimate. The provinces with the lowest rates of women taking 90 days or more of IFA tablets (7% or lower) were Kampong Thom, Kampong Cham, Preah Vihear/Stung Treng and Mondolkiri/Rattanakiri. Two of these domains (Kampong Thom and Preah Vihear/Stung Treng) were found to have the highest prevalence of anemia in women (Table 13). Kampong Cham and Mondolkiri/Rattanakiri were found to have large decreases in anemia in women (17 and 22 percentage points, respectively). The negligible recommended supplementation rates found in these provinces show that iron supplementation during pregnancy did not cause the decrease in anemia.

There was significant provincial variation in the percent response of "don't know" number of days took IFA tablets (from a low of 0% to a high of 19%). The provinces with the highest reported rates of "don't know" number of days were Phnom Penh, Takeo, Sihanoukville/ Koh Kong, Banteay Mean Chey and Kampong Cham (9% or more). These "don't know" answers cause the data to become less robust for provincial and temporal comparisons. For this reason, comparisons at the provincial level with this indicator are not presented. Provincial comparisons are made below with the indicator of IFA tablet utilization (any IFA tablets during last pregnancy). Rates of utilization are not significantly affected by "don't know" answers and span a greater range as compared to recommended supplementation rates.

Table 19. Percent of women who took IFA tablets for 90+ days by province, CDHS 2005

	Percent who took IFA tablets for 90 days or more				
Province	Yes	No	Don't know	Total	Number
Pursat	53.0	47.1	0.0	100	167
Svay Rieng	39.3	60.7	0.0	100	202
Prey Veng	28.1	71.6	0.3	100	485
Kampot/Krong Kep	26.7	71.9	1.3	100	290
Banteay Mean Chey	23.1	67.8	9.1	100	254
Battambang/Krong Pailin	21.9	78.1	0.0	100	404
Takeo	18.9	66.8	14.4	100	372
Siem Reap	18.4	81.1	0.5	100	472
Kampong Chhnang	16.6	80.0	3.4	100	218
Phnom Penh	16.0	66.2	17.9	100	476
Kampong Speu	16.0	78.7	5.3	100	335
Oddar Meanchey	15.6	84.4	0.0	100	76
Kratie	12.6	80.7	6.8	100	137
Kandal	11.9	87.2	0.9	100	531
Sihanoukville/Koh Kong	10.0	71.0	19.0	100	146
Kampong Thom	6.5	92.0	1.5	100	299
Kampong Cham	6.2	84.8	9.0	100	738
Preah Vihear/Stung Treng	5.2	92.4	2.4	100	153
Mondolkiri/Rattanakiri	1.5	97.4	1.2	100	107
Overall	**17.6**	**77.1**	**5.3**	**100**	**5865**

The comparison of utilization of IFA tablets by year and province is presented in table 20 below. The data are sorted by utilization rates in 2005. The national utilization rate of taking any IFA tablets increased threefold from 21% in 2000 to 63% in 2005. The provinces with the highest IFA tablet utilization rates were Pursat, Svay Rieng and Takeo (80% or higher). Again Pursat is found to have the highest rate. While this result does not appear out of range, it should be interpreted with care. The domains with the lowest IFA tablet utilization rates were Preah Vihear/Stung Treng and Mondolkiri/Rattanakiri (36 and 22%, respectively).

The provinces with the largest improvements in IFA tablet utilization from 2000 to 2005 were Prey Veng, Takeo and Kampot/Krong Kep (50 percentage points or more). The provinces with the lowest improvements in utilization were Kratie, Preah Vihear/Stung Treng and Mondolkiri/Rattanakiri (26 percentage points or less).

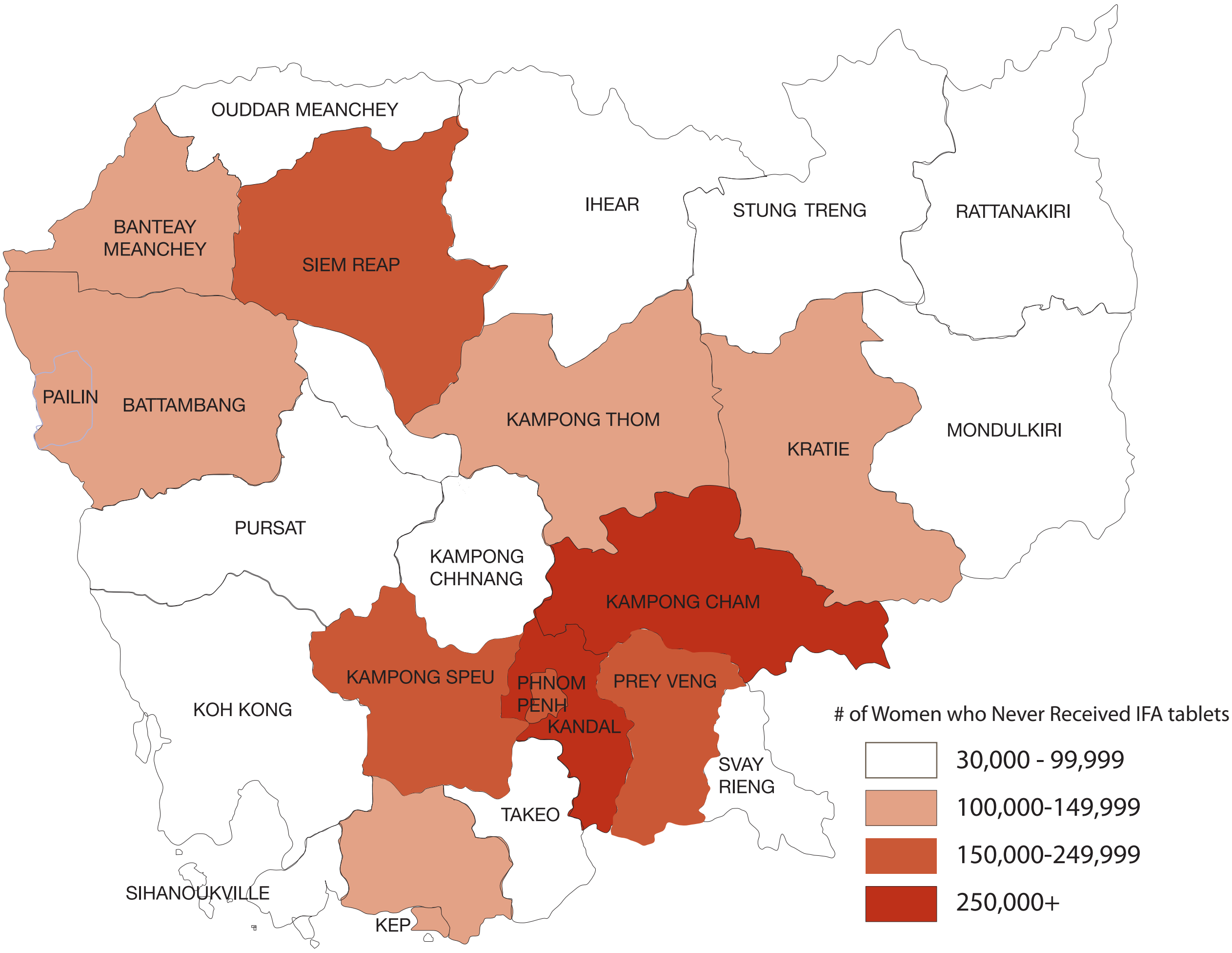
Table 20. Ever received IFA tablets during last pregnancy by province and year, CDHS 2000 and 2005

Ever received IFA tablets during pregnancy			
Province	**2000**	**2005**	**Difference (2005-2006)**
Pursat	38.1	87.5	49.4
Svay Rieng	39.6	80.9	41.3
Takeo	23.7	79.8	56.1
Battambang/Krong Pailin	33.4	76.6	43.2
Kampong Chhnang	28.3	75.6	47.3
Phnom Penh	38.6	72.5	33.9
Prey Veng	6.1	68.3	62.2
Banteay Mean Chey	23.8	61.5	37.7
Siem Reap	17.7	61	43.3
Kandal	16.9	60.1	43.2
Kampot/Krong Kep	9.7	59.4	49.7
Kampong Thom	15.6	56.9	41.3
Kampong Cham	16.1	54.5	38.5
Kampong Speu	18.1	52.5	34.4
Oddar Meanchey	9.8	49.9	40.1
Sihanoukville/ Koh Kong	15.2	45.3	30.1
Kratie	21.0	44.1	23.1
Preah Vihear/Stung Treng	9.2	35.5	26.3
Mondolkiri/Rattanakiri	8.1	22.2	14.1
Overall	**20.8**	**62.8**	**42.0**
Number	**5,694**	**5,865**	

The rate of recommended IFA supplementation (90 tablets) is low with less than one in five women taking the recommended number of tablets. The rate of utilization of IFA tablets is also low with less than two-thirds of women ever receiving any IFA during pregnancy. Immediate measures are needed to improve pregnant women's use of iron supplements. Despite the fact that universal iron supplementation is the recommendation in Cambodia, these measures should take into account the numbers of women not being served when dedicating resources for improving the anemia reduction program.

In the map below (figure 21) the numbers of women who never received any IFA tablets during pregnancy are presented by province. It is evident that the provinces with the lowest rates of utilization (Preah Vihear/Stung Treng and Mondolkiri/ Rattanakiri) have low numbers of women who have never received any IFA tablets compared to other provinces. The provinces with higher population density were found to have a higher number of women who do not utilize the IFA intervention. The two provinces with the worst conditions were Kampong Cham and Kandal provinces with 400,000 and 260,000 women, respectively who never used any IFA tablets during pregnancy

Figure 20. Number of days women took IFA tablets during last pregnancy, CDHS 2005



The map helps to illustrate the problem that the intervention is not reaching high numbers of its target population. The reason for this is not because the population lives in inaccessible areas or is poor. There are several factors on the delivery side that cause utilization to be low including stock-outs of IFA tablets, poor knowledge about responsibilities of outreach work, staffing problems with the outreach and ANC personnel, no community mobilization for attending outreach activities. On the receiving side, problems include inadequate interest or difficult access to ANC, poor knowledge about anemia and its dangers during childbirth. These problems need to be clearly identified and addressed to improve program performance.

Table 21. Percent of women who took IFA tablets for 90 days or more by timing of first ANC check, CDHS 2005

Timing of first ANC visit by month of pregnancy	Percent of women who took IFA tablet for 90 days or more	Number
No ANC visits	2.4	1652
1st month	31.5	153
2nd month	32.4	353
3rd month	30.1	849
4th month	29.3	600
5th month	25.3	912
6th month	20.0	528
7th month	10.2	445
8th month	5.1	244
9th month	2.7	101
Don't know	8.8	27
Overal	**17.6**	**5865**

Currently, 69% of pregnant women get at least one ANC check (CDHS 2005). These women are normally given 60 tablets at their first ANC check and 30 tablets at their second or later ANC check. Analyzing the percentage of women who took IFA tablets for 90 days or more by timing of ANC shows a strong relation between early ANC visits and the highest rates of compliance with recommended supplementation of IFA tablets. About 30% of women who reported their first ANC visit in the first four months of becoming pregnant took IFA tablets for 90 days or more during their pregnancy. Women probably are not perfectly accurate with reporting the month of pregnancy when they first received ANC but the results show the importance of getting an ANC check in the first trimester for improving rates of IFA supplementation.

The rate of compliance with recommended supplementation of IFA tablets during pregnancy was analyzed by maternal education and socio-economic status (table 22). The wealth quintiles had very little effect on supplementation rates. From the poorest quintile (14%) to the richest quintile (20%) the rate only changed by 6 percentage points. This result could be related to the condition shown above that women of higher wealth quintiles are more likely to report "don't know" how many days took IFA tablets.

Maternal education was found to have a strong effect on compliance with the recommended IFA supplementation. Women with no schooling had supplementation rates of only 12% compared to 27% in women with secondary or more education.

Table 22. Percent of women who took IFA tablets for 90 days or more by background characteristics, CDHS 2005

	Percent of women who took IFA tablet for 90 days or more	Number
Education		
No Schooling	12.0	1,356
Primary	16.9	3,482
Secondary +	27.4	1,028
Wealth Quintile		
Lowest	14.0	1,477
Second	19.4	1,320
Middle	17.0	1,077
Fourth	18.9	1,003
Highest	20.0	988
Overal	**17.6**	**5,865**

Post-partum IFA Supplementation

Cambodia's Iron Supplementation Guidelines from the National Nutrition Program recommend that all women receive 42 IFA tablets during the post-partum period. The question used in the CDHS 2005 asks mothers if they received any IFA tablets within the 2 months of their last delivery, thus the indicator is utilization of post-partum IFA tablets. This indicator is presented in table 23 below and the provincial rates are sorted in descending order. No question was included on post-partum IFA tablets in the CDHS 2000.

Only 11% of women reported receipt of any IFA tablets post-partum. The provinces with the highest rates of utilization were Pursat, Prey Veng and Siem Reap (over 15%). The utilization rate from Pursat is over twice that of the next highest province and should be interpreted with caution. The provinces with the lowest utilization rates were Oddar Meanchey, Mondolkiri/Rattanakiri and Kampong Cham. This is particularly concerning for Kampong Cham as the province has the highest numbers of women who do not utilize IFA supplementation during pregnancy (shown above).

Table 23. Post-partum utilization of IFA tablets by province, CDHS 2005

Province	Percent ever received IFA tablets post-partum	Number
Pursat	37.7	166
Prey Veng	17.5	485
Siem Reap	15.4	472
Kampong Thom	14.3	299
Kampong Chhnang	13.9	218
Sihanoukville/Koh Kong	11.9	146
Kratie	11.8	137
Banteay Mean Chey	11.2	256
Battambang/Krong Pailin	11.1	404
Takeo	10.4	372
Kampong Speu	8.0	335
Phnom Penh	7.9	475
Kandal	7.6	531
Preah Vihear/Stung Treng	7.2	153
Kampot/Krong Kep	6.2	290
Svay Rieng	5.8	202
Oddar Meanchey	4.5	76
Mondolkiri/Rattanakiri	4.3	106
Kampong Cham	3.0	738
Overall	**10.5**	**5865**

Preventive Deworming

Preventive Deworming Summary Points

Coverage: 10% of pregnant women and 30% of children 12-59 months of age received deworming medicine in 2005.

Geographic Distribution: In some provinces, such as Mondolkiri and Rattanakiri, deworming is virtually non-existent for pregnant women. The highest coverage rates for pregnant women in any province are about 20%.

Trend: As no data was collected on deworming in the CDHS 2000, no trend can be assessed.

In 2004, the National Task Force for Helminth Control in Cambodia published policy and guidelines recommending deworming of preschool children (12-59 months) twice a year, pregnant women (after 1st trimester), post-partum women and children in primary school. For pre-school children the distribution of deworming medicine is given concurrently with vitamin A supplementation. The national program uses mebendazole, one of two available deworming medications promoted by the WHO (WHO/UNICEF, 2004).

The CDHS 2005 includes questions on deworming for women during their last pregnancy and for children age 6-59 months. There is no record left in the household, such as the yellow card, where child deworming is recorded. For women, there is space to record deworming on the mothers health record book, but this record is not commonly used throughout the country. No data on post-partum deworming was collected in the CDHS.

Overall, only 1 out of 10 women received deworming medication during the pregnancy of their last born child in the past five years (table 24). The low coverage may be related to the recent introduction of deworming during pregnancy. The survey asked women about deworming during the last pregnancy in the five years prior to the survey, but the national policy was not finalized until the year before the survey, 2004. Results for deworming in the year prior to the survey are also presented for women who gave birth in the year before the survey. The overall percent of women dewormed was only slightly higher (13%) showing that even during 2004 deworming was not a common intervention for pregnant women.

In the three provinces (Siem Reap, Mondolkiri/ Rattanakiri and Banteay Mean Chey) with the lowest prevalence of deworming (3%) in the one year before the interview, it appears that the deworming intervention of pregnant women has not begun. Five provinces (Prey Veng, Kampot/ Krong Kep, Sihanoukville/Koh Kong, Pursat and Kampong Speu) had 23% or more of pregnant women who received deworming medication in the year before the interview. The largest change in percent of women dewormed in the five years compared to the one year before survey was in Prey Veng where the prevalence increased by 10 percentage points.

The CDHS 2005 reported a deworming coverage of 27% in children 6-59 months. The child indicator is not affected by the recent adoption of a national policy as the survey asks only about supplementation in the last six months, compared to the last five years for deworming during pregnancy.

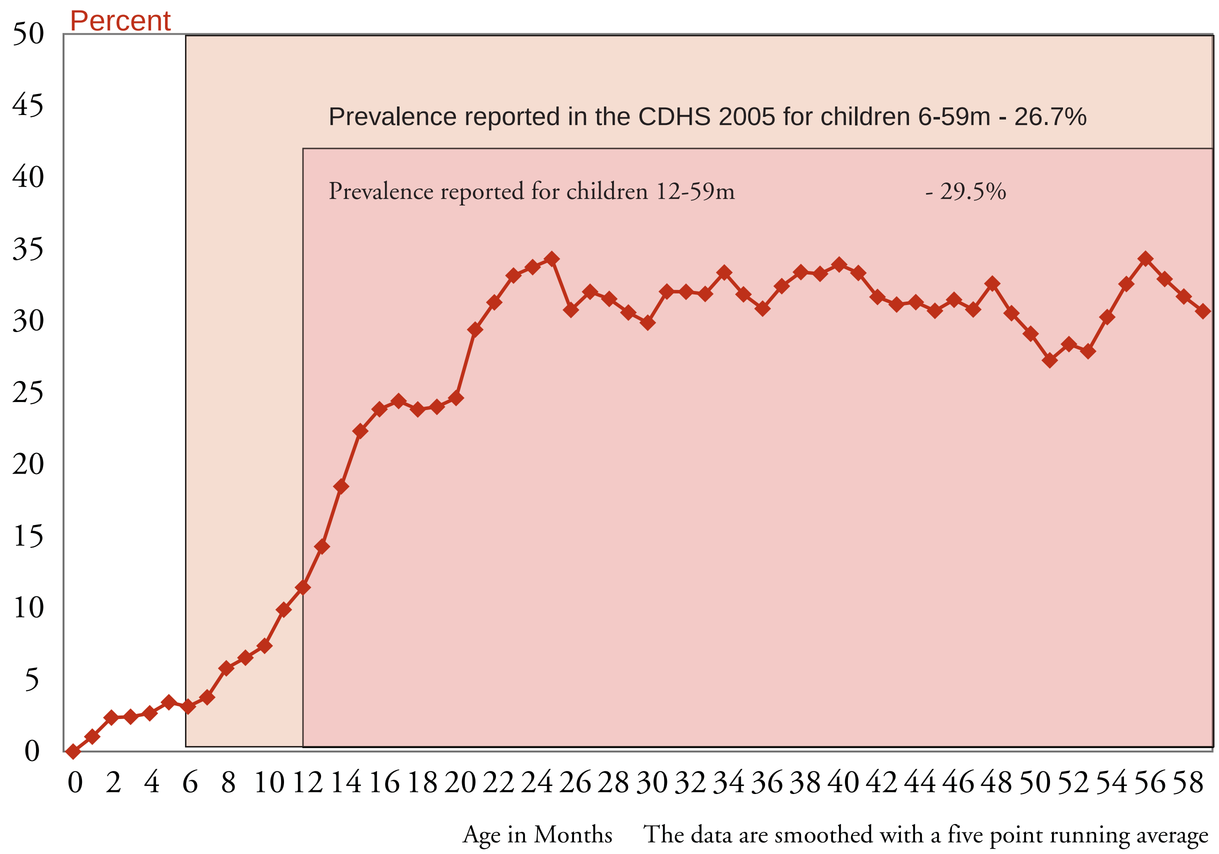
An issue with the indicator for children is that it is reported for children 6-59 months of age when the national policy stipulates that only children older than 1 year should receive supplementation. In the target age group (12-59 months) 30% of children received deworming medication in the last six months.

Table 24. Percent of women who received deworming during pregnancy during the last 5 years and last one year, CDHS 2005

	Deworming during pregnancy	
Province	**Percent in the past 5 year**	**Percent in the past 1 year**
Kampot/Krong Kep	23.7	27.5
Sihanoukville/Koh Kong	20.3	23.4
Pursat	16.8	23.5
Kampong Speu	16.5	23.4
Battambang/Krong Pailin	16.4	16.9
Oddar Meanchey	15.3	18.5
Kratie	13.5	17.2
Phnom Penh	13.3	17.5
Prey Veng	13.3	23.0
Kandal	12.7	8.9
Svay Rieng	9.6	10.0
Kampong Thom	8.3	9.6
Takeo	7.1	11.5
Kampong Chhnang	6.8	10.1
Preah Vihear/Stung Treng	4.1	5.8
Kampong Cham	4.1	5.5
Siem Reap	3.9	2.9
Mondolkiri/Rattanakiri	3.7	3.4
Banteay Mean Chey	3.2	3.0
Overall	**10.6**	**12.7**
Number	**5,864**	**2,049**

Analysis of deworming by the age of child in months (figure 22) shows that deworming is most commonly given after the child reaches 2 years of age. From age 2 to 5 years the rate of deworming mostly remains above 30%. Vitamin A coverage is very similar in this age group. This timing of receipt of deworming treatment may be related to the child showing symptoms of parasitic infection that caregivers recognize. Knowledge of worms and their treatment with medicine is common in the Cambodian rural population. It is possible that most children receiving deworming do not receive it from outreach, but instead from the health center or pharmacy for treatment. Despite these points, preventive treatment with mebendazole has not become common practice yet in Cambodia.

Figure 22. Child deworming in the six months before interview by age in months, CDHS 2005



Deworming in children (30%) is three times more common than deworming in pregnant women (11%). Deworming in children by province (table 25) shows that the intervention is commonly given in many provinces. The provinces with the highest coverage of deworming are Battambang/Krong Pailin, Pursat, Prey Veng, and Sihanoukville/Koh Kong (all over 40%). The provinces with the lowest coverage of deworming were Siem Reap and Mondolkiri/Rattanakiri with 16% and 6%, respectively. These two provinces also had the lowest deworming coverage in pregnant women.

The percentage responding "don't know" (2.1%) is not large enough to affect the national estimate. Kampong Speu has the highest percent of "don't know" responses (12%) and the deworming coverage in that province should be interpreted with care.

No trend in child deworming can be assessed as no data on deworming were collected in the CDHS 2000.

Table 25. Percent distribution of children aged 12-59m who received deworming in the 6 months prior to interview, CDHS 2005

	Deworming in children in the past 6 months				
	Yes	No	Don't know	Total	Number
Battambang/Krong Pailin	51.7	48.3	0.0	100	250
Pursat	42.5	57.2	0.3	100	690
Prey Veng	42.1	57.5	0.4	100	228
Sihanoukville/Koh Kong	41.8	54.8	3.4	100	345
Kampong Speu	38.5	49.7	11.8	100	296
Kandal	38.5	57.6	3.9	100	493
Banteay Mean Chey	33.8	63.7	2.5	100	136
Svay Rieng	31.7	67.5	0.9	100	458
Kampong Thom	25.8	73.1	1.1	100	448
Kampong Cham	25.5	73.8	0.8	100	160
Oddar Meanchey	25.1	74.9	0.0	100	493
Phnom Penh	24.4	72.8	2.8	100	189
Kampong Chhnang	22.8	74.9	2.4	100	377
Kampot/Krong Kep	22.7	75.5	1.9	100	74
Preah Vihear/Stung Treng	22.3	77.2	0.4	100	384
Kratie	18.9	79.8	1.4	100	305
Takeo	16.5	82.4	1.1	100	153
Siem Reap	15.8	83.8	0.5	100	150
Mondolkiri/Rattanakiri	6.4	93.1	0.5	100	113
Overall	**29.5**	**68.4**	**2.1**	**100**	**5740**

Estimates of Iron Deficiency and other causes of Anemia

In the past, interventions providing iron supplements to address anemia achieved significant rates of adherence but found little impact. This caused many experts and policy makers to believe that anemia interventions did not work in developing countries. To implement a successful program, it is important to know the proportion of anemia that is preventable.

Anemia is caused by many factors, but iron deficiency is considered the most common. Iron deficiency is commonly caused by:

- Little to no foods from animal sources in diet (insufficient iron) and
- Disease related malabsorption of iron

The graph of hemoglobin concentration by age above (figure 18) suggests that iron deficiency contributes significantly to anemia in Cambodian children. The rapid growth in children from 6 to 24 months of age demands a higher concentration of iron in the diet than most other ages. When these iron demands are not met, hemoglobin concentration falls below 11 g/l. The low hemoglobin concentration in this age group that improves by two years of age is strong evidence that iron deficiency is the cause.

Two micronutrient supplementation studies in Cambodia collected blood samples from pre-school children. Serum ferritin results in the control groups provide estimates of iron deficiency in the Cambodian context (Table 16). The CESVI study shows that at 6 months of age iron deficiency was only 13%, but by 18 months the prevalence rose above 50%. The GTZ study shows that in children 6-24 month of age, 49% are iron deficient. After five months, the prevalence decreases slightly to 42%. The concentration of serum ferritin is known to increase when inflammation is present. The CESVI study accounted for this by controlling for inflammation as measured by C-reactive protein in their analysis. The GTZ study found high rates of inflammation at endline (19%) but found no change in results of serum ferritin when these cases were excluded from analysis.

Children in both studies received vitamin A and deworming, which likely reduced the prevalence of iron deficiency. As the majority of Cambodian children do not receive vitamin A or deworming, the figure of 50% of children with iron deficiency could be an underestimate in the general pre-school population.

Table 26. Iron deficiency in control group children measured by serum ferritin, CESVI 2006 and GTZ 2007

Study	CESVI Study	GTZ Study
Baseline		
Percent with iron deficiency	13%	49%
Age of sample children	6 months	6-24 months
Number	49	68
Endline		
Percent with iron deficiency	52%	42%
Age of sample children	18 months	11-29 months
Number	45	64

Note: Percentages based on less than 30 unweighted counts are not shown.

The response to iron treatment in anemic subjects is another measure of iron deficiency anemia. The two studies are used again to provide data not exactly on iron deficiency anemia but preventable anemia in pre-school children as children received iron/multi-micronutrient supplementation, deworming and vitamin A supplementation. It is not possible to determine the impact of the specific preventable causes such as vitamin A deficiency and intestinal parasitic infections as they were not measured.

The studies showed that iron/multi-micronutrient supplementation, deworming and vitamin A reduced the prevalence of anemia from 70 to 80% at baseline to 30 to 40% at endline. The pooled estimates from these two studies show that the interventions reduced anemia prevalence by 50% of anemia in pre-school children (Table 27).

Table 27. Prevalence of anemia in pre-school children before and after iron or multi-micronutrient supplementation in two studies in Cambodia, CESVI 2006 and GTZ 2007

	Fe-Folate supplementation	Multi-micronutrient supplementation	Control group
CESVI Study			
Baseline anemia prevalence	79.9	70.3	73.5
Number	100	101	49
Follow-up anemia prevalence	31.1	42.7	66.7
Number	90	96	45
Children were 6 months of age at baseline and study followed children for 12 months			
GTZ Study			
Baseline anemia prevalence	79.7	80.0	76.6
Number	68	68	68
Follow-up anemia prevalence	38.5	37.5	71.0
Number	64	65	60
Children were 6-24 months of age at baseline and study followed children for 5 months			

Helminths

Helminths are common in developing countries. Hookworms, in particular are known to cause to iron deficiency anemia through blood loss. Other helminths can contribute to anemia through their negative effects on vitamin A absorption, diarrhea, and chronic inflammation (Crompton et al, 2003).

There are no nationally representative studies on helminths in Cambodia. Small studies from 1997 to 2001 have shown that hookworm (N. americanus, A. duodenale), whipworm (T. trichuria), and roundworm (A. lumbricoides) are present in the country and infestation is common across many age groups (MoH, 2004). To more effectively implement national programs, a comprehensive survey is recommended to determine the distribution of helminth species by geography, season and age. In Cambodia, children under 12 months of age are not treated for helminths. Prevalence of helminths is not known in this age group. A study from Uttar Pradesh state in India documented that similar high prevalence of hookworm and other helminths was found in children under 12 months of age and their mothers (A2Z, 2007b). These conditions also could be found in Cambodia.

Although current WHO recommendations promote the use of both mebendazole and albendazole to treat intestinal parasites (WHO/UNICEF, 2004), a review of studies suggests albendazole is more effective against hookworm and equally effective against other helminths when compared to the other treatment options (Crompton et al, 2003). A recent study in neighboring Vietnam showed similar findings with respect to hookworm (Flohr et al, 2007), but consensus on this topic has not been reached due to a lack of quality efficacy studies. Research on the most effective parasite treatment in Cambodia would contribute important information to the anemia program. Regular efficacy monitoring advised by the WHO is also needed to track drug resistance (WHO, 2005).

Malaria

In endemic areas, malaria can be a major cause of anemia as the parasite destroys red blood cells. Malaria has been considered a significant problem in Cambodia and the Ministry of Health established the National Malaria Center dedicated to its control. When the National Malaria Center was founded, malaria was considered responsible for a significant number of child deaths. After the high rates of deforestation that have occurred over the past 15 years, malaria appears to have largely disappeared as a serious cause of morbidity and under five mortality.

In 2004, the Cambodia National Malaria Baseline Survey (CNMBS) was conducted. The sample was designed to collect data from villages in three domains (0-250m from forest, 250-1,000m from forest and 1-2km from forest) and was not nationally representative. Villages were identified as "less than 2 kilometers from forest" with forest-cover maps derived from remote sensing using satellite data from 1995-96 and 1998-2001. As the most recent Food and Agriculture Organization assessment of global forest cover shows that Cambodia lost 29% of its primary tropical forest between 2000 and 2005 (FAO, 2005), it is probable that the forest cover maps used for the sample do not represent current conditions.

According to the CNMBS survey report, 11% of all villages in Cambodia were within 2 km of forest. In the three malaria endemic domains, the highest prevalence of slide positive malaria was 3.6%, which is low compared to conditions of sub-Saharan Africa. The three domains consisted of marginal areas of low population density. In order to convert these results into provincial and national malaria prevalence estimates, the malaria prevalences from the CNMBS 2004 were used with the WHO 2005 document (counts of) "endemic villages and population at risk of malaria.xls".

Table 28. Estimate of national malaria prevalence in 2005, CNMBS 2004 and WHO 2005

Area	Malaria slide positive rate %	Count of population living in zone	Percent of population in zone	Number estimated to have malaria
CNMBS risk zones				
< 250 m to forest	3.4	792,998	5.9	26,962
250 m to < 1km from forest	3.6	819,962	6.1	29,519
1km to < 2km from forest	1.4	0	0.0	0
Non-risk zones				
more than 2km from forest	0	11,887,040	88.1	0
Overall	0.4	13,500,000	100.0	56,481

Source: CNMBS 2004 and WHO document "Endemic villages and population at risk of malaria".

The national malaria prevalence was estimated to be 0.4% (table 29). These estimates could slightly underestimate the prevalence as the WHO document of population counts only covered the CNM risk zones, which cover only 0 to 1000 meters from the forest. The last risk zone (1-2km from forest) of the CNMBS 2004 was given a population count of zero as no data was available. The prevalence could be overestimated as the population less than 1km from forest included in the WHO document made up 12% of the population, not 11% as stated in the CNMBS report. Sensitivity analysis showed that it would take one million people living in the risk zone 1-2km from forest zone to raise the malaria prevalence by 0.1 percentage point. This would equal 20% of the population living 2km or less from the forest, which is almost double the total amount of population estimated by the malaria survey researchers to live within 2km of the forest.

In 2005, there were 355 deaths and in 2006, 396 deaths were attributed to malaria (WHO and CNM Malaria experts quote). These deaths were likely to be children. Assuming that all malaria deaths occurred in children under five, then malaria would account for less than 1.4% of all deaths of children under five.

These data are not robust, but demonstrate the conditions of lack of information that persists despite the substantial financial support given to address malaria in Cambodia. A new National Malaria Survey was conducted in 2007, but results have not been released. HIS data shows declining trends in reported malaria cases since 2000, but it is difficult to determine a prevalence figure from the HIS as cases not seen by the health system are not recorded and there are data quality issues.

Genetic Causes of Anemia

Hemoglobinopathy and thalassemia are two terms used to describe a variety of genetic abnormalities, some of which cause anemia. Five studies were identified that collected data on hemoglobinopathies. These studies are presented in table 29.

Four studies were conducted on population based samples (Kandal study, Zinc study, CESVI study and GTZ) but the Zinc study collected information only from children who were severely stunted (-3SD Height for Age). The Zinc study should only be considered representative of this sub-group of the population. The Angkor Children's Hospital study was a hospital based sample and should be interpreted with care. The Kandal study was never written up in detail, so it is difficult to evaluate the sample or the study. Both the CESVI and GTZ studies tested for hemoglobinopathies at baseline. For the CESVI study, the children were 6 months of age at baseline and the concentration of fetal hemoglobin may have still been high obscuring their mature blood profile. For the GTZ study, the children were 6-24 months of age and this issue may have affected testing in some children, but probably did not affect the population outcomes.

Table 29. Percent distribution of hemoglobinopathies and percentage of hemoglobinopathies by type in children, various studies

Study	Angkor Children's Hospital Study	Kandal Study	Zinc Study	CESVI Study	GTZ Study
Presence of Hemoglobinopathy					
Any hemoglobinopathy (%)	51.5	49.7	33.8	71.2	35.0
No hemoglobinopathy (%)	48.5	50.3	66.2	28.8	65.0
Total	100.0	100.0	100.0	100.0	100.0
Number	260	159	286	191	250
Location	Siem Reap region	Village(s) in Kandal province	Phnom Penh slum	Kampong Chnnany, Tuk Phos district	Kampot province
Age of children	5-16 years	8-72m	12-35m	6m	6-24m
Hemoglobinopathy by type					
HbE (%)	28.8	24.5	28.8	56.5	32.0
HbE Heterozygous (%)		20.1	26.1	47.6	28.4
HbE Homozygous (%)		4.4	2.7	8.9	3.6
Alpha Thalassemia (%)	35.4	29.6	not tested	not tested	not tested
Beta Thalassemia (%)	0.8	not tested	6.8	not tested	not tested

Note: All studies on population based samples except Angkor Children's Hospital study based on hospital based sample. The Zinc study sampled only children who were -3 SD stunted.

Sources: Angkor Children's Hospital Study (Carnley et al, 2006), Kandal Study (one page findings 2002), Zinc Study (Jack, 2005), CESVI study (CESVI, 2006) GTZ study (GTZ, 2007)

The prevalence of any hemoglobinopathy ranged from 34 to 71% in children from 6 months to 16 years of age. The highest prevalence was found in Kampong Chnnang province and the lowest was found in Kampot province and the severely stunted children of Phnom Penh.

When reviewing the hemoglobinopathies by type, beta thalassemia was the least common. The prevalence ranged from 1 to 7% but testing for beta thalassemia was not done in 3 out of the 5 studies. Hemoglobin E (HbE) and Alpha Thalassemia are the most common hemoglobinopathies found. Alpha thalassemia was found in 30 to 35% of children but was only tested for in 2 out of 5 studies. The prevalence of HbE ranged between 25 to 57% in children. The severity of the HbE hemoglobinopathies was presented and between 3 and 9% of children had homozygous HbE. In the GTZ and CESVI studies children with HbE were shown to have anemia and those with homozygous HbE had lower hemoglobin concentrations.

These children with HbE hemoglobinopathy when treated with iron or multiple micronutrient supplementation demonstrated measureable improvements in hemoglobin concentration

(CESVI, 2006; GTZ, 2007; Jack, 2005). It can be concluded that hemoglobinopathies contribute to cause anemia in Cambodian children but are rarely the only cause of anemia. These children can be affected by any combination of hemoglobinopathies, nutritional deficiencies and/or infection.

Single and multiple hemoglobinopathies can be diagnosed. Multiple hemoglobinopathies usually are more severe in terms of negative impact. Most studies could not comment on the prevalence of two or more hemoglobinopathies in the study populations as they did not test for all thalassemia. The Zinc study found that 2% of children in the severely stunted child population had multiple hemoglobinopathies. Future studies need to collect and present information on the prevalence of multiple hemoglobinopathies.

The data on hemoglobinopathies is not representative on the national level. Despite that fact, it is evident that the Cambodian population has a high prevalence of abnormal hemoglobin traits. The Angkor Children's Hospital study reports that majority of abnormalities were mild and it is unlikely that thalassemia represents a major health burden in this region of Cambodia (Carnley et al, 2006). In the review of all studies, the conclusion was given that the majority of hemoglobinopathies were clinically benign (Jack, 2005). National level data is still needed on the prevalence and impact of hemoglobinopathies in men, women and children. This information will help to clarify the etiology of anemia and allow more accurate determination of success within anemia prevention and reduction interventions.

Iodine

Iodine is found naturally in earth and deficiency is a result of low soil-concentration of iodine. These conditions are commonly found in areas of high altitude, river plains, and locations far from the sea (Delange, 1994). The negative effects of iodine deficiency range from impaired cognitive function to goiter, cretinism, low birth weight, stillbirth and increased perinatal and infant mortality.

Iodized salt production began in Cambodia in 1999. In 2003, the law on universal salt iodization was signed into effect. Fortification of salt is the only iodine intervention in Cambodia. Health workers are supposed to conduct a bi-annual assessment of iodized salt use in their catchment area. Training has begun on salt testing with liquid drops test and iodized salt promotion (MoH, 2007) but the extent of implementation is not known.

Iodine Deficiency

Iodine Deficiency Summary Points

Prevalence: The most current data on iodine deficiency (The 1996-97 National Goiter Survey) found 17% of school-aged children with goiter.

Geographic Distribution: Siem Reap, Rattanakiri, Banteay Mean Chey, and Svay Rieng were the four provinces found to have the highest prevalence of iodine deficiency in 1997. Currently the provinces bordering Vietnam are the most likely to have iodine deficiency.

Trend: There is no data to analyze the trend of iodine deficiency but the national prevalence has likely decreased rapidly after producers and distributers began to comply with the universal salt iodization law of 2003.

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Table 30. Prevalence of total goiter rate by province, National Goiter Survey 1996-97

Province	Total Goiter Rate	Category of Iodine Deficiency
Siem Reap	39.4	Severe
Rattanakiri	37.9	Severe
Banteay Mean Chey	36.2	Severe
Svay Rieng	31.4	Severe
Kratie	24.2	Moderate
Stung Treng	24.1	Moderate
Kampong Speu	21.0	Moderate
Pursat	20.5	Moderate
Preah Vihear	20.1	Moderate
Kampong Chhnang	10.4	Mild
Battambang	10.2	Mild
Kep	9.2	Mild
Kandal	8.3	Mild
Sihanoukville	7.5	Mild
Prey Veng	7.0	Mild
Takeo	6.9	Mild
Phnom Penh	4.6	None
Kampong Thom	3.7	None
Kampot	1.3	None
Overall	**17.0**	**Moderate**

Note: The categorization of iodine deficiency is defined according to WHO classification: Severe >30, Moderate 20-30, Mild 5-20, None <5 (WHO, 2001)

The 1996-97 National Goiter Survey found an overall goiter rate of 17% in school-aged children (table 30) and 12% in children 8-12 years of age (not shown). The survey did not include the provinces of Kampong Cham, Mondolkiri, Koh Kong, Oddar Meanchey and Krong Pailin. Kampong Cham was the most populous province at that time (containing 14% of the total population – National Census 1998) and its exclusion likely biased the overall goiter rate. The four provinces that were found to have severe conditions of goiter were Siem Reap, Rattanakiri, Banteay Mean Chey and Svay Rieng. in 2008.

Figure 23. Mother and child in Rattanakiri, 2006

Two of these provinces were on the Vietnamese border and Banteay Mean Chey is on the Thai border with Siem Reap as the neighboring province. It is not known if salt coming from Thailand or Vietnam at the time of the survey was iodized or not. All of the remaining excluded provinces were on the borders and could have been useful to answer this question.

Rattanakiri was found to have the second highest prevalence of iodine deficiency in 1997. The population in Rattanakiri and Mondolkiri provinces are likely to have high risk of iodine deficiency as the provinces are difficult to access, highland areas bordering Vietnam and Lao PDR. The woman from the photo had a visible goiter (figure 23) and was living in Rattanakiri. It is interesting to note that her child is eating junk food produced outside of Cambodia. This snack probably contains iodized salt.

UNICEF plans to conduct a national survey of iodine deficiency in school children in 2008.

Iodine Fortification

Iodine Fortification Summary Points

Coverage: In 2005, 29% of all households (about 600,000) did not have adequately iodized salt. No information was collected on fish sauce which may contain iodine and is used commonly in Cambodian households.

Geographic Distribution: The provinces with the lowest coverage of fortified salt in households were along the Vietnamese border and in Kampot/Krong Kep. Salt production is carried out almost exclusively in Kampot and Krong Kep. Iodine deficiency is not considered an issue in these two production areas.

Low Coverage Populations: Households in the lowest wealth quintile are the least likely to have fortified salt.

Trend: The percent of households without iodized salt decreased from 86% in 2000 to 29% in 2005. The only provinces where use of non-iodized salt increased (Svay Rieng, Mondolkiri/Rattanakiri) are along the border with Vietnam.

The NNP has set a target that 90% of households use adequately iodized salt by 2010. The CDHS 2005 reported that 74% of salt was fortified with iodine in households with salt. This figure does not account for households where salt is not used. On the national level, 2% of households did not have salt (table 31). The low percentage of households without salt does not significantly affect the national estimate, but has more impact in provinces like Kratie and Mondolkiri/Rattanakiri where 4 and 8% of households, respectively do not have salt.

There were four domains where over 40% of households did not have salt or iodized salt (Svay Rieng, Mondolkiri/Rattanakiri, Prey Veng and Kampot/Krong Kep). The domain of Kampot/Krong Kep is home to the salt flats where the majority of Cambodian salt is produced. This area bordering the sea is not considered to be at risk of iodine deficiency. Kampot was found to have the lowest levels of iodine deficiency in school children in 1997 (table 30).

On the other hand, Svay Rieng and Rattanakiri had high risk of iodine deficiency in 1997. Svay Rieng, Mondolkiri/Rattanakiri and Prey Veng had the lowest percentage use of iodized salt in 2005. Calculations of number of households affected per province showed that Prey Veng and Svay Rieng had a combined number of over 200,000 households without iodized salt. Mondolkiri/Rattanakiri had a combined number of only 15,000 households without iodized salt, but this represented 44% of the total households in the two provinces.

Iodized salt is available in markets, but the cost is a disincentive for use. In Svay Rieng and Prey Veng, non-iodized salt in the market costs about 150-200 riels a kilogram (4-5 US cents). Iodized salt costs from 800-1,000 riels a kilogram (20-25 US cents). Often, households in rural areas do not buy salt from markets, but exchange part of their rice harvest for a one year supply of salt (about 20kg). This salt is brought from Vietnam to Cambodian border provinces. In 2000, Vietnamese salt was iodized and the border provinces had high percentages of iodized salt use. In 2005 compliance has fallen and the salt brought over the border to Cambodia is not iodized (Dr Kieng Navy, personal communication).

Vietnam has led the way with the innovation of fortifying fish sauce with iron. What has gone largely unnoticed is that fish sauce probably is fortified with iodine since the introduction of iodized salt law. Fish sauce is produced in Cambodia by a few large producers and large numbers of small artisan producers. Many households use fish sauce instead of salt when cooking, so it is possible that iodine is effectively delivered through this vehicle to a large majority of the population. Further efforts should be made to ensure that fish sauce is made with iodized salt.

Commercially produced food often contain iodized salt. Commercially produced snack food consumption is high in young children in Cambodia (Anderson, 2006; Johnston, 2006). To know definitively whether iodine is delivered by these products, they should be tested for iodine content. Food consumption studies (proposed in Cambodia) would help greatly to determine the quantity of foods consumed by different groups in the population. From that information, the iodine content delivered could be estimated to clarify who may still be at risk of iodine deficiency.

Table 31. Percentage of households with no salt and with salt not containing iodine and number of households without iodized salt by province, CDHS 2005

Province	Percentage of total households: with salt not containing iodine	without salt	Total	Number of households without iodized salt
Prey Veng	51.7	1.2	52.9	114,524
Kampot/Krong Kep	62.3	1.1	63.4	87,965
Svay Rieng	80.5	0.3	80.8	85,207
Kandal	30.7	1.5	32.2	81,409
Kampong Cham	15.8	1.7	17.5	58,785
Takeo	25.6	1.1	26.7	48,773
Banteay Mean Chey	30.2	1.1	31.3	45,186
Kampong Speu	28.2	2.2	30.4	43,069
Siem Reap	18.4	1.3	19.7	31,323
Kampong Thom	19.9	1.2	21.1	26,510
Phnom Penh	8.9	1.7	10.6	23,651
Kampong Chhnang	17.7	1.1	18.8	21,822
Battambang/Krong Pailin	8.9	0.3	9.2	20,417
Mondolkiri/Rattanakiri	35.2	8.3	43.5	14,826
Sihanoukville/Koh Kong	17.7	3.1	20.8	14,275
Pursat	9.9	0.6	10.5	10,347
Preah Vihear/Stung Treng	16.0	1.9	17.9	9,942
Kratie	9.5	4.1	13.6	9,695
Oddar Meanchey	16.5	0.1	16.6	5,004
Overall/Total	**27.1**	**15**	**28.6**	**600,301**
Number		**14,243**		

Note: Percentages are based on total number of households interviewed.

On the national level households in the lowest and second lowest wealth quintiles are the least likely to have fortified salt (table 32). In Kampot/Krong Kep, iodized salt is easily available and there is little difference between wealth quintiles. In Svay Rieng, the difference in coverage between the lowest and highest wealth quintiles is almost 40 percentage points. A similar association is found with use of iodized salt and socio-economic status in Prey Veng although not to the same extent.

Table 32. Percentage of households using iodized salt by wealth quintiles by national domain and selected provinces, CDHS 2005

	Province			
Wealth Quintile	**National**	**Prey Veng**	**Svay Rieng**	**Kampot/ Krong Kep**
Lowest	65	40	10	37
Number	2,845	378	133	137
Second	66	44	12	28
Number	2,884	368	152	163
Middle	71	47	14	39
Number	2,884	293	154	188
Fourth	76	66	24	41
Number	2,715	145	124	160
Highest	87	65	59	45
Number	2,706	78	54	69
Total	73	47	18	37
Number	14,034	1,263	617	716
Overall				**Moderate**

Note: Denominator includes households with salt tested for iodine.

Before universal fortification was mandated in Cambodia, 86% of households did not use iodized salt (table 33). Three provinces had significantly better coverage with iodized salt than the national average (Svay Rieng, Mondolkiri/Rattanakiri and Phnom Penh). In Svay Rieng and Mondolkiri/Rattanakiri, these conditions were considered due to imports of iodized salt from Vietnam.

By 2005, the situation reversed for Svay Rieng and Mondolkiri/Rattanakiri. The percentage of households not using iodized salt increased in these two domains while it has dropped in all other provinces. The lowest numbers of households not using iodized salt were found in Phnom Penh, Pursat and Battambang/Krong Pailin (11% or less).

Table 33. Percentage of households not using iodized salt by province, CDHS 2000 and 2005

Province	Households without iodized salt or no salt				
	2000		2005		Difference (2005-2000)
	Percent	Number	Percent	Number	
Banteay Mean Chey	96.1	581	31.3	595	-64.9
Kampong Cham	92.8	1,724	17.5	2,012	-75.3
Kampong Chhnang	93.7	477	18.8	544	-74.9
Kampong Speu	97.3	671	30.4	775	-66.9
Kampong Thum	95.8	621	21.1	689	-74.7
Kandal	90.4	1,146	32.2	1,384	-58.1
Kratie	68.9	268	13.6	289	-55.4
Phnom Penh	54.1	993	10.6	1,180	-43.6
Prey Veng	87.4	1,090	52.9	1,278	-34.5
Pursat	91.6	364	10.5	430	-81.1
Siem Reap	94.4	704	19.7	927	-74.7
Svay Rieng	63.3	566	80.8	619	17.5
Takeo	88.5	898	26.7	991	-61.7
Oddar Meanchey	93.6	66	16.6	146	-77.0
Battambang/Krong Pailin	93.2	819	9.2	891	-84.1
Kampot/Krong Kep	87.9	635	63.4	724	-24.5
Sihanoukville/Koh Kong	96.1	289	20.8	320	-75.3
Preah Vihear/Stung Treng	74.3	198	17.9	262	-56.4
Mondolkiri/Rattanakiri	24.4	127	43.5	186	19.1
Overall	**86.2**	**12,236**	**28.6**	**14,243**	**-57.6**

Note: Denominator is all households interviewed.

Zinc

Zinc is a critical nutrient for immune function, growth, and development. The effects of zinc deficiency range from increased risk of mortality, growth retardation, diminished immune function, skin disorders and cognitive dysfunction (Keusch et al, 2006). Zinc is commonly the most deficient nutrient in complementary foods fed to infants (Shrimpton et al, 2005).

Zinc treatment in children with diarrhea has been shown to reduce the duration of the illness and prevent subsequent re-infection. While some studies have shown similar positive effects of zinc treatment with respiratory infections, conclusions from reviews find the evidence insufficient or inconsistent (Brown, 2007). WHO consensus currently recommends zinc for the treatment of diarrhea in children (WHO, 2005) and evidence is growing for more extensive preventive supplementation and fortification with zinc.

In March 2006, Population Services International – Cambodia began a pilot project in Pursat and Siem Reap provinces of social marketing a diarrhea treatment kit of oral rehydration salts (ORS) packaged with a 10-day treatment of zinc supplements. This ground breaking project distributed the diarrhea treatment kit through market channels and through health volunteers of RACHA and Red Cross. While the project was not evaluated with rigorous quantitative methods, it was considered a very successful method to deliver ORS plus zinc to caregivers of sick children. The pilot ended and national implementation of ORS plus zinc was planned, but the 2007 national budget approved by Ministry of Finance did not include zinc (included on the essential drug list) and the intervention has stalled.

The updated Integrated Management of Childhood Illness (IMCI) guidelines for Cambodia (2006), prescribe oral rehydration salts (ORS) and a 10-day treatment of zinc supplements for diarrhea treatment. Health workers are supposed to give the initial treatment at the health center and have caregivers give the remaining tablets at home. There is no policy on preventive zinc supplementation, but it is likely that zinc will be included in multi-micronutrient supplements for women and children in the future.

There is no population data on zinc deficiencies in Cambodia. The risk of zinc deficiency in children is estimated through proxy measures. The next section on zinc treatment provides analysis on diarrhea prevalence and the quantities of zinc needed.

Zinc Deficiency

Zinc Deficiency Summary Points

Prevalence: Cambodia is estimated to have among the highest rates of zinc deficiency in children in SE Asia (prevalence of stunting - 43%). An estimated 647,000 children under five years of age are zinc deficient.

Geographic Distribution: Every province in Cambodia is at a high risk for zinc deficiency (>20% stunting). The provinces with the highest estimated rates of zinc deficiency are Pursat, Siem Reap and Mondolkiri/Rattanakiri. The provinces with the most children with zinc deficiency are Kampong Cham, Battambang/Krong Pailin, and Siem Reap.

Populations at Risk: Children from 6 to 18 months of age are considered to have the greatest need for zinc treatment as this is when the combined effects of malnutrition and disease cause permanent damage or death in children. Zinc deficiency is higher among children from the poorest households and of mothers with no education.

Trend: Zinc deficiency is likely to have decreased slightly as the prevalence of stunting declined from 50 to 43% from 2000 to 2005. This shows a slight improvement but is over two times the prevalence given as a cut-off for high risk of zinc deficiency (20%).

In Cambodia, only one study has measured serum zinc in severely stunted children (-3 SD Height for Age) in a Phnom Penh slum. Despite expectations for all children to be deficient, only three-quarters of the children were found to have low serum zinc concentrations (<9.9 µmol/L - Jack, 2005).

Globally, there is little biochemical data available to assess the prevalence of zinc deficiency. There is no ideal measure for assessment of small changes of zinc status in individuals but serum zinc concentrations can be used for population zinc status measures (Brown, 2007). Iron deficiency is often found along with zinc deficiency as both minerals are found in the same food sources and absorption is modified by the same dietary components. Iron and zinc deficiencies are expected to follow similar patterns in a population (IZiNCG, 2004). New guidelines for assessing population zinc status suggest that stunting can be used as a proxy indicator of zinc deficiency where serum zinc concentrations or dietary zinc intake data is not available.

The International Zinc Nutrition Consultative Group (IZiNCG) used national prevalence of stunting and dietary assessment to estimate the risk of zinc deficiency. This assessment stated that Cambodia had the highest percentage of population at risk of zinc deficiency in SE Asia (44% - IZiNCG, 2004). This analysis was based on population counts from the early 1990's and an unnamed source of national data on zinc and phytate content in Cambodian foodstocks.

Use of current estimates of stunting is more likely to provide accurate conditions of zinc deficiency in children. All provinces had a prevalence of stunting above 20%, which is the cut-off point for high risk of zinc deficiency (table 34). The provinces with highest prevalence of children at risk of zinc deficiency were Pursat, Siem Reap and Mondolkiri/Rattanakiri, and Siem Reap (58% or higher). The results from Pursat province should be interpreted with care, and further detail is given in the anthropometry section in the Annex. The provinces with the most children at risk are Kampong Cham, Prey Veng, and Siem Reap with almost 60,000 children or more at risk per province. In total, close to 650,000 children under five are stunted and at high risk of deficiency.

Table 34. Prevalence and counts of number of children aged 0-59 months at risk of zinc deficiency by province, CDHS 2005

Province	Percent of children at risk of zinc deficiency	Number	Number of children at risk of zinc deficiency
Kampong Cham	43.3	305	77,202
Siem Reap	58.1	135	60,844
Battambang/Krong Pailin	46.7	93	56,718
Prey Veng	41.0	175	48,312
Takeo	44.7	104	46,947
Kandal	31.1	303	39,990
Pursat	64.1	197	35,509
Kampong Thom	45.1	223	33,444
Kampot/Krong Kep	38.6	88	33,176
Kampong Speu	39.6	236	32,308
Banteay Mean Chey	37.9	370	31,531
Kampong Chhnang	41.8	252	29,262
Svay Rieng	45.6	137	23,818
Phnom Penh	24.1	188	21,003
Kratie	42.0	88	19,687
Preah Vihear/Stung Treng	51.4	68	18,726
Sihanoukville/Koh Kong	39.5	87	16,372
Mondolkiri/Rattanakiri	57.8	40	12,907
Oddar Meanchey	50.8	266	8,835
Overall/Total	**42.6**	**3,356**	**646,591**

Note: Percent at risk of zinc deficiency is percent stunted (-2 SD HAZ).

The risk of zinc deficiency (stunting) is affected by age but cannot be interpreted straight-forward by the rates by age groups below (table 35). For children from 6 to 18 months of age, the risk is highest while the numbers are lowest (less than 15%). Although the risk increases rapidly until 18 months of age (51%), by the time that the child reaches 18 months, the damage is underway. It is very difficult for children to recover from stunting without strong, well managed effective treatment of malnutrition programs, which are rare.

The risk of zinc deficiency is associated with maternal education. The least educated mothers have children with the highest risk of zinc deficiency (52%) while the best educated have children with the lowest risk (27%). Zinc deficiency also is likely twice as common among children from poor households (23%) compared to rich households (52%).

The risk of zinc deficiency is at or above 20% in every maternal education and socio-economic category. This can be interpreted that all Cambodian children are at high risk for zinc deficiency and blanket supplementation is needed. While small studies have demonstrated positive effects of zinc supplementation in children, the two largest studies of zinc supplementation in children in Pemba, Tanzania and southern Nepal with sample sizes of 25,000 and 29,000, respectively have not shown any significant effects on morbidity or mortality (Sazawal et al, 2007: Tielsch et al 2006).

Table 35. Prevalence of children aged 0-59 months at risk of zinc deficiency by background characteristics, CDHS 2005

Percent of children at risk of zinc deficiency		
Age in months	**Percent**	**Count**
<6m	14.7	319
6-8m	12.7	172
9-11m	22.5	177
12-17m	39.9	349
18-23m	50.5	376
24-35	47.9	654
36-47m	53.1	684
48-59m	50.7	626
Mother's education		
No education	51.6	806
Primary	43.5	1960
Secondary or higher	27.4	590
Wealth index		
Poorest	52.4	838
Poorer	47.3	748
Middle	44.6	638
Richer	39.4	561
Richest	23.1	570
Total	**42.6**	**3356**

Note: Percent at risk of zinc deficiency is percent stunted (-2 SD HAZ).

Zinc treatment of diarrhea has been demonstrated to be effective. Distribution of zinc tablets packaged with ORS in diarrhea treatment kits began in two provinces of Cambodia. This combined treatment was well received in these provinces, often replacing the misuse of antibiotics or intravenous fluids given by public and private health providers. This intervention desperately needs to be made available on the national level along with education on treatment of diarrhea to caregivers and health providers.

Zinc Treatment for Diarrhea

Diarrhea Summary Points

Prevalence: In 2005, the prevalence of diarrhea in children in a two-week period was 20%, representing almost 300,000 children under 5 years of age.

Geographic Distribution: Children in Kampong Cham, Preah Vihear/ Stung Treng, and Prey Veng had the highest prevalence of diarrhea. The provinces with the largest numbers of children under 5 with diarrhea were Kampong Cham and Prey Veng.

Populations at Risk: The prevalence of diarrhea was highest among children 6 to 23 months of age. Children of more educated mothers and from households of higher socio-economic status had slightly lower prevalence of diarrhea, but it was common among all children.

Trend: No change in the prevalence of diarrhea was identified between 2000 and 2005. The two DHS surveys were done at different times of the year. The month of the year clearly affected the prevalence of diarrhea.

The CDHS provides information on the geographical distribution of diarrhea. The question on diarrhea in the DHS asks about the two weeks prior to the interview; results can be viewed as the prevalence/number of children that have diarrhea in a two-week period. The national prevalence of diarrhea in a two-week period is 19.5% according to the CDHS 2005; this is virtually unchanged from the 2000 prevalence of 18.9% and corresponds to ~ 300,000 children under-5. Kampong Cham, Preah Vihear, Stung Treng, and Prey Veng have the highest prevalence of diarrhea. Provinces with the most cases of diarrhea include Kampong Cham, Prey Veng, and Kandal.

In Cambodia, there is a great need for improved water and sanitation services and hygiene practices to prevent diarrhea. An enormous number of children are continually becoming sick with diarrhea in any given two week period. In Kampong Cham, over 50,000 children under 5 have diarrhea in a two week period. These children would benefit from the use of diarrhea treatment including zinc tablets.

Table 36. Prevalence and counts of diarrhea in children under five in the two weeks preceding the survey by province, CDHS 2005

Province	Percent of children with diarrhea in the two weeks preceding the survey	Number	Number of children with diarrhea
Kampong Cham	30.0	880	53,513
Prey Veng	27.2	562	32,073
Battambang/Krong Pailin	18.3	492	22,210
Kandal	17.2	635	22,147
Banteay Mean Chey	22.3	316	18,539
Kampong Thom	25.0	369	18,527
Phnom Penh	18.4	598	16,059
Siem Reap	14.3	626	14,986
Pursat	24.8	205	13,746
Kampong Speu	16.4	433	13,368
Kampong Chhnang	16.9	293	11,845
Takeo	11.2	460	11,755
Kratie	22.6	178	10,584
Preah Vihear/Stung Treng	28.0	194	10,207
Kampot/Krong Kep	11.0	363	9,466
Svay Rieng	9.8	236	5,115
Mondolkiri/Rattanakiri	21.1	147	4,713
Sihanoukville/Koh Kong	8.8	191	3,647
Oddar Meanchey	13.8	92	2,398
Overrall/Total	**19.5**	**7,271**	**294,898**

In 2005, caregivers did not regularly contact health centers for treatment of diarrhea in their children. Only just over one third of children under 5 were taken to a health provider for treatment and of these children, only one third went to the public sector (CDHS 2005). For the 300,000 children with diarrhea only about 38,000 received treatment from the public health sector. The challenge of achieving high coverage rates through the public sector with diarrhea treatment kits with zinc tablets supplementation is formidable, and is only one way to reach sick children. A successful social marketing campaign of the diarrhea treatment kit that PSI developed would be the type of public-private partnership that would deliver the product to the caregiver and child and change treatment behaviors in caregivers and health care providers.

Where the risk of zinc deficiency (stunting) by age in months does not clearly identify when zinc is lacking, the prevalence of diarrhea is more useful. Table 37 shows that the prevalence of diarrhea is high at less than 6 months of age (18%) but it reaches its highest point at 6 to 11 months of age (32%). Zinc treatment for diarrhea is critical for children 6 months and older. Studies have shown that zinc treatment before 6 months of age does not provoke the same positive outcomes (Brown, 2007).

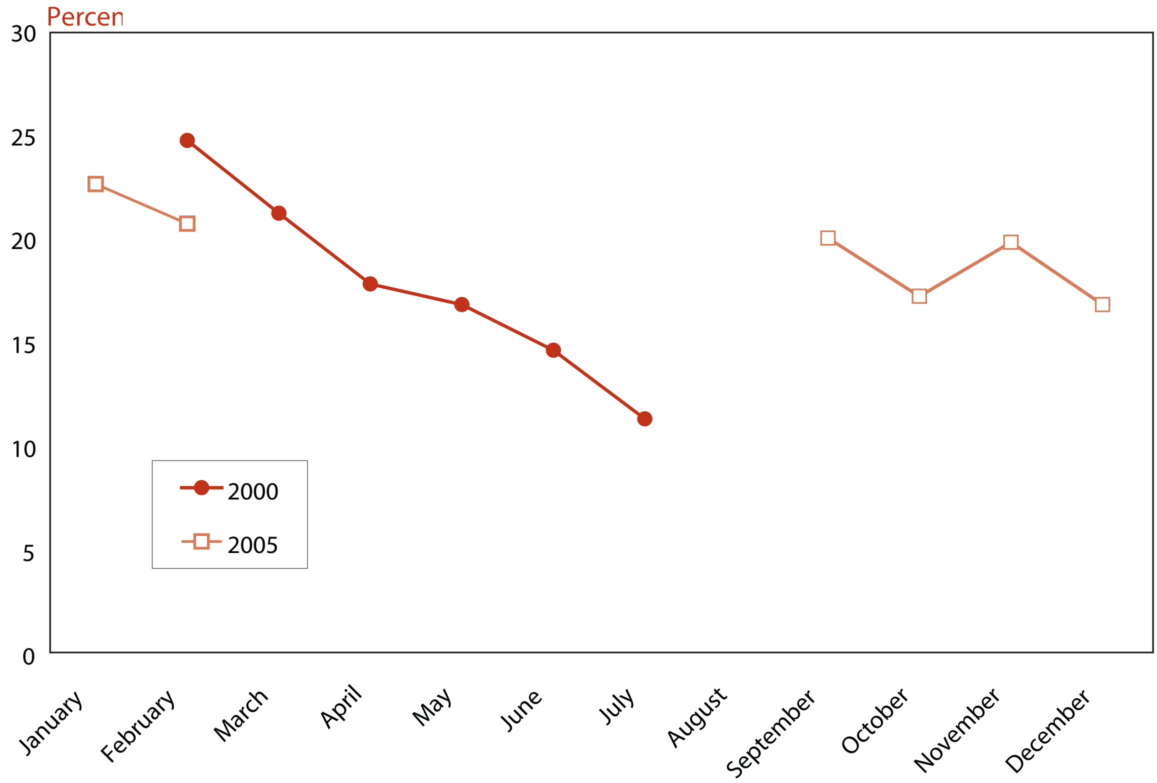
Table 37. Diarrhea Prevalence of Children Under-5 Years by Socio-Economic Characteristics

	Percent of children with diarrhea in the two weeks preceding the survey	Number
Education		
No Schooling	21.4	1,730
Primary	19.9	4,288
Secondary +	15.7	1,253
Wealth Quintile		
Lowest	22.4	1,945
Second	20.8	1,646
Middle	19.8	1,276
Fourth	18.3	1,176
Highest	14.1	1,228
Age in Months		
0 to 6	17.7	743
6 to 11	31.8	773
12 to 23	27.9	1,517
24 to 35	20.4	1,418
36 to 47	13.6	1,430
48 to 59	9.8	1,389
Overall	**19.5**	**7,271**

It is interesting to note that maternal education and socio-economic status affect the prevalence of diarrhea, but not as strongly as the child's age in months. Children of uneducated mothers are one-third more likely to have diarrhea than children of mothers with secondary or higher education. Children from households of the lowest wealth quintiles are about two-thirds more likely to have diarrhea compared to children from households of the highest wealth quintile. Children aged 6 to 11 months are more than 3 times as likely to have diarrhea compared to children aged 48 to 59 months. Diarrhea is a common problem in the majority of children in Cambodia and special attention is needed to address the devastating interaction of disease and malnutrition when exclusive breastfeeding ends at six months of age.

The prevalence of diarrhea is strongly affected by seasonality. This has the potential to affect trend estimates as the CDHS 2000 and 2005 were carried out at different times of the year. The prevalence of diarrhea by month (figure 18) shows the highest rates in the dry season (from January to March). The seasonal trend is not complete due to a lack of data in August, but shows a decline from the highest rates in the dry season (January and February) to the lowest rates in the rainy season (May and June). The highest rates of diarrhea in the dry season may be related to the low quantity and poor quality of water in the dry season. Similar trends with diarrhea have been found in community based surveillance of measles and diarrhea in four Cambodian provinces (Oum, 2005) and in neighboring Thailand (Jiraphongsa, 2005). Both of these studies show diarrheal disease peaks in January and is least common in July.

Figure23. Diarrhea prevalence by month and year of survey, CDHS 2000 & 2005



Stocks of zinc tablets packaged with with ORS are not currently available in Cambodia for diarrhea treatment. This treatment method has been well documented and advocated for strongly in its own WHO statement. Now Cambodia desperately needs to procure zinc tablets and begin effective implementation of this intervention. Considering the seasonality of diarrhea, the stocks should be secured by June or July to prepare for the increasing incidence of diarrhea as the year comes to an end. Strong advocacy should be made to the governmental sections who allocate budget for essential medicines to ensure that zinc tablets are procured in 2008 to avoid the lost opportunities for child survival that occurred in 2007.

The section on cross-cutting issues is followed by recommendations for issues affecting individual topics.

Cross- Cutting Issues

a) Improving the Quality of Information

Cambodia Demographic and Health Survey

The analysis of the two CDHS surveys showed that the methods used to calculate and report indicators on micronutrient interventions were not consistent. The survey question for some indicators changed from 2000 to 2005. In addition to this inconsistency, there are also problems with "don't know" responses for the following indicators:

- Vitamin A Supplementation in children in the past 6 months
- Recommended IFA supplementation (90+ tablets) during pregnancy
- Deworming in children in the past 6 months

With vitamin A supplementation in the CDHS 2005, we found that not adjusting for the answer "don't know" when and issues of maternal recall led to a significant underestimation of the coverage.

Other indicators were not significantly affected by the "don't know" when or how many responses because of low coverage. This situation could change as coverage of the interventions improves over time. This is made more likely by the finding that the subpopulation of women most likely to receive iron supplementation are also the most likely to respond "don't know."

The three indicators above have a common problem of respondents responding "don't know". The "don't know" category is treated differently in calculation in each of the three indicators. For vitamin A, the "don't know" when responses are added to the "No" category. For iron supplementation, the "don't know" how many responses are kept separate for indicator calculation and are present in the report table. For deworming the "don't know" when responses are not included in calculation of the indicator and not included in the report table.

The different methods used with the "don't know" responses could greatly affect coverage estimates. The changing of methods complicates intepretation. A common method for calculating indicators with "don't know" responses is needed.

In the next CDHS special training to interviewers on nutrition indicators could help to reduce the number of "don't know" answers from respondents. The questionnaire can be shortened to reduce the answer fatigue that the respondent suffers during a 60 to 90 minute interview. The CDHS also should be focused more on the known documented causes of morbidity and mortality and their interventions and away from the donor driven agenda evident in the past.

Health Information System

Currently, the Cambodian Health Information System does not accurately measure delivery of interventions. While not detailed extensively here, evidence of HIS data quality issues raises serious questions of its validity. Every month, the HIS collects large amounts of data related to nutrition and is currently the only regular source of data that is representative below the provincial level. To improve data quality, the data should be used and reviewed on a regular basis. A new analysis database currently under development by A2Z and RACHA will provide the NNP with routine nutrition indicators calculated from HIS data. This will put the data into use and consistent review and feedback will help to improve data quality. External validation of HIS data is also needed to improve data quality.

This research shows that the HIS likely overestimates vitamin A supplementation coverage. Three possible causes of overestimation (inaccurate target populations, double counting, supplementing outside the target group) are presented in this report. Results from the planned census will help to improve the target population numbers.

The issue of double counting could be addressed if all supplementation was completed in the same month throughout the country. This is difficult as some health operational districts begin the month before or finish the month after the planned vitamin A supplementation month. Reducing the allotted time for supplementation activities could help, but there is concern that this would put a heavy burden on the outreach workers who normally work as public health providers in the morning and private providers in the afternoon.

Supplementation outside the target group is difficult to address. High dose vitamin A supplementation of women outside the target time period is dangerous. Further research is needed to determine the extent of vitamin A supplementation outside of target groups for both children and post-partum mothers. New national and international recommendations recommend post-partum mothers receive a high-dose vitamin A supplement only up to six weeks after delivery to prevent the chance of vitamin A related birth defects. Research on deworming during prescribed periods is also important. If problems are identified, improved training of health workers with appropriate materials should immediately address the issue.

Monitoring Biannual Interventions

Even if the CDHS were to provide an accurate estimate for all indicators, it is only representative down to the province or province group level and is conducted only every five years. It is not designed to monitor biannual interventions. To monitor biannual interventions, a low-cost, accurate measure on the appropriate level is needed.

Lot Quality Assurance Sampling (LQAS) methods using a questionnaire with improved questions on vitamin A supplementation implemented immediately after the supplementation round would fit this need. A standardized method can replace the more expensive survey tools that NGOs have used to monitor individual programs. The data collected from a standardized LQAS method could also be used to validate and strengthen the HIS.

b) Inequity and Low Coverage

This analysis shows great variation in delivery of interventions by province and socio-economic status. The most disturbing finding is that the Cambodian women and children who are most in need of micronutrient and deworming interventions are the least likely to receive them. The great inequities in the delivery of child survival interventions were first documented in the data from 2000 and continue to be evident today. The micronutrient interventions in this report are promoted for all women and children but it is critical to realize that anemia and micronutrient deficiencies will not decrease unless the population in need receives the appropriate interventions.

In addition to focusing on those most in need, programs must strive to reach as many people as possible in order to achieve the best possible improvements in health outcomes. The coverage of almost all interventions reviewed is unacceptably low. Only half of children and one-third of post-partum women receive vitamin A. Two-thirds of all targeted populations do not receive deworming or iron supplementation. The easiest way to increase universal coverage is to provide for the easy-to-reach populations, but the populations that will benefit the most from preventive interventions often are not those who are easy-to-reach.

As resources permit, the best solution is to focus on both maximizing coverage and ensuring prevention in the most vulnerable populations. This can be achieved by setting dual target goals, standardizing implementation and removing barriers to access and use.

The current MoH target goals for vitamin A, iron supplementation and deworming focus on overall coverage. This does not help to target the individuals who have the strongest need for these interventions. A dual target goal, that is a second goal of reaching a set percentage of those in the lowest wealth quintiles could help to target those most in need.

The lack of a standard system for implementation contributes to the provincial variation of coverage. There is a strong need for the National Nutrition Program to produce a standard implementation plan with all government partners and begin implementation in all operational districts according to the plan. A key to the standardized implementation, the communication strategy on vitamin A and iron supplementation is currently being developed by the NNP, WHO, and A2Z. As demand from the household and community level increases and is coupled with regular provision of services from health providers, coverage will improve. From that point, efforts can begin to focus on maintenance of high rates of coverage.

Barriers to high coverage exist on supply-side and receiving-side. On the supply side stock-outs, poor knowledge on work responsibilities and staffing problems has been identified. Research on the supply chain and distribution of vitamin A, iron and mebendazole can help to address stock-outs. Standardized implementation plans and improved ownership on the operational district and health center level is needed to address staffing and job responsibility issues.

On the receiving side, barriers to high coverage include difficult access to health services, insufficient community mobilization, poor knowledge about the interventions and reduced contact with health providers after a child reaches one year of age. Community health volunteers could significantly address these issues if given the responsibility.

c) Formalizing the Role of Community Health Volunteers

As more household and community level interventions are recommended and adopted, the requirements for implementation are less in the hands of facility based workers. Curative zinc treatment for diarrhea and daily in-home multi-micronutrient fortification of complementary food must be done in the household. These interventions require new delivery strategies.

One strategy is to formalize the roles and responsibilities of community health volunteers. This process is beginning. The 2007 revised vitamin A policy defined a role for community health volunteers in the delivery of vitamin A capsules. Integrating community health volunteers as paid staff of the health system and increasing their accountability through monitoring could have a large impact to improve programs. The costs of this strategy would be more expensive than the current system, but the investment in successful programs would reap large returns in terms of health, development and economic gain.

d) Preventable Anemia

The terms used in regular discussion of anemia (and micronutrient deficiencies) can marginalize the issue to the hands of a few persons working in nutrition. The label of iron deficiency anemia or nutritional anemia implies that the problem can be solved by nutrition interventions alone. This is not the case. A comprehensive integrated approach to anemia prevention (and child health) needs commitment from more than the National Nutrition Program and a condition that is framed as a nutritional issue is not likely to get the attention it deserves from other ministries and departments.

Programs need to focus on preventable causes of anemia within child health programs and secure involvement from both the government and the general public. The interventions including improved sanitation, access to potable water, ORS plus zinc treatment of diarrhea, rotavirus vaccine, bed nets and proper antibiotic treatment of ARI should be integrated into the health actions. For progress to be made with nutrition, strong collaboration is needed between health workers, national programs and organizations working in child survival, rural development, water and sanitation, food safety, education and several other sectors. To secure the involvement of all these different sectors, clear and understandable terms to define the issues must be used.

Annexes

The number of households in each province was calculated by dividing the NIS population estimates by the mean household size from the CDHS 2005.

The population of each province is an average of NIP estimates of 2005 and 2006 because the CDHS 2005 was conducted from September 2005 to February of 2006. Population estimates for specific age groups of children are based on the NIS population estimates and percentage of population in the specific age groups from the CDHS 2005.

	January 2006
Province(s)	**Population Estimates**
Banteay Mean Chey	722,897
Kampong Cham	1,682,799
Kampong Chhnang	579,228
Kampong Speu	708,778
Kampong Thom	628,048
Kandal	1,262,377
Kratie	357,492
Phnom Penh	1,118,942
Prey Veng	1,081,780
Pursat	494,889
Siem Reap	793,907
Svay Rieng	527,229
Takeo	912,664
Oddar Meanchey	151,127
Battambang/Krong Pailin	1,113,449
Kampot/Krong Kep	693,982
Sihanoukville/Koh Kong	342,531
Preah Vihear/Stung Treng	278,275
Mondolkiri/Rattanakiri	170,497
Total	**13,620,889**

Methods used for vitamin A analysis

Imputation and selecting cases from one month post supplementation round

The three issues related to calculation of child vitamin a supplementation within the last six months include: "don't know" response, recall bias, and date heaping. These issues are addressed by limiting analysis to mothers responding in December and imputation.

The 2005 CDHS was carried out from September of 2005 to March of 2006. There was one vitamin A supplementation month during this time period, and it took place in November of 2005. December is selected to reduce the time between interview and supplementation, which will help to limit the effects of recall bias and date heaping.

Approximately 1/3 of mothers reply "don't know" to the second question of a series of two questions used to calculate the indicator of child vitamin A supplementation within the last 6 months. These children are then included in the "no" category for indicator calculation, which under-estimates coverage because some of these children are likely to have been supplemented in the last six months. Imputation, predicting a response for those mothers who reported "don't know," is used to correct this problem.

Selecting only mothers interviewed in December and imputing values for those that reply "don't know" provides an estimate of coverage. The number of months since the last supple-mentation is predicted for all of the mothers interviewed in December responding "yes" to the first question (has (child) ever received a vitamin A dose like this?) and "don't know" to the second question (how many months ago did (child) take the last dose?).

For the entire survey 6,525 mothers were asked the first question on child vitamin A supplementation. Selecting only mothers interviewed in December reduces this number to 1,160. Of these mothers, 882 reply "yes" and are asked the second question. The remaining 278 mothers are included in the denominator for calculation of the indicator and are not asked the second question. Of the 882 mothers asked the second question in December, 515 give a month within the last six months, 166 give a month more than six months ago, and 201 reply "don't know." The number of months since the last supplementation is predicted for the 201 mothers responding "don't know." The following determinants are used for prediction:

child's age, child's sex, breastfeeding status, urban/rural residence, mother's education, mother's age, socio-economic status, mother received vitamin A, last visit to health center.

After imputing, 63 of the 201 predicted values are within the last six months. These are added to the 515 that gave a month within the last six months to form the numerator for indicator calculation. This makes a total of 578 within the last six months over the total number of child cases - 1160. For 2005, this method increases the coverage from 34% the reported in the CDHS to a new estimate of 50%.

A limitation to imputation is that it does not control for the necessary assumption that women who respond "don't know" are different from those that give a figure. Another limitation to predicting values is that much of the variability in supplementation can not be explained. In this case, the selected determinants used for imputation only explain 10% of the variation (not shown).

A limitation to only using interviews from December is that despite including mothers from all provinces, the survey is less robust in terms of national representation. Domains that collected data from groups of provinces will show only data from the province where data was collected in December. The domains of groups of provinces are those with low population so the outcomes do not strongly affect the national estimates. December respondents are not statistically different from those interviewed in other months with respect to age, wealth, and education (table 39) as shown by probit regression on the month of December (table 40).

Table 39. Mean age of child, household wealth quintile, respondent's age and education by month of interview categorized into December and all months of data collection, CDHS 2005

	Mean	Number
Age of Child in Months		
December	29.2	1,592
Other Months	29.4	6,698
Wealth Quintile		
December	2.66	1,592
Other Months	2.73	6,698
Age of Respondent		
December	9.6	1,592
Other Months	29.9	6,698
Years of Education		
December	3.45	1,592
Other Months	3.46	6,696
Total		**8,288**

Table 40. Probit Regression of the Month of December on Child's Age, Wealth, Respondent's Age and Education

Independent Variables	Coefficient	P-Value
Age of Child in Months	<-.01	0.76
Wealth Score	<.01	0.94
Age of Respondent	<-.01	0.31
Year of Education	<.01	0.89
Dependent Variable = Months of December		
Number		,288

Testing for Interactions and Collinearity in Regression Analysis

Regression analysis used to evaluate the associations between individual characteristics and vitamin A supplementation included analysis on interactions and collinearity of the independent variables. Interaction variables were created by multiplying each predictor variable with every other predictor variable. These interactions variables were then included in a regression and none were found to be significant. Collinearity was tested for using a STATA postestimation command, collin, provided by the Academic Technology Services of UCLA. No independent variables had a VIF value meriting further attention (above 10).

Anthropometry

The anthropometry indicators below were calculated according to WHO Child Growth Standards (WHO, 2007) using data from both the CDHS 2000 and CDHS 2005.

Table 1. Percent distribution of valid anthropometry Z- scores by province, CDHS 2005

	Valid data	Child died	Invalid/ missing data	Total	Weighted	Un-weighted
Province	Percent	Percent	Percent	Percent	Count	Count
Pursat	76.4	7.7	15.9	100.0	115	195
Banteay Mean Chey	80.9	6.8	12.4	100.0	167	204
Krong Preah	83.8	3.9	12.3	100.0	104	223
Sihanouk & Koh Kong	88.0	4.7	7.3	100.0	302	171
Phnom Penh	86.0	7.2	6.8	100.0	79	335
Mondolkiri/Rattanakiri	82.1	11.6	6.3	100.0	127	157
Svay Rieng	85.4	8.8	5.8	100.0	276	169
Prey Veng	89.6	4.8	5.6	100.0	338	179
Kandal	90.3	4.5	5.2	100.0	338	274
Siem Reap	86.6	8.4	5.0	100.0	217	242
Kampong Thom	79.0	16.1	4.9	100.0	51	238
Oddar Meanchey	83.6	11.6	4.8	100.0	105	292
Preah Vihear & Steung Treng	85.7	10.0	4.3	100.0	432	162
Kampong Cham	87.1	9.8	3.1	100.0	157	220
Kampong Chhnang	89.6	7.3	3.1	100.0	104	263
Kratie, Kampot & Krong Kep	88.5	8.5	3.0	100.0	198	204
Battambang & Krong Pailin	90.3	7.2	2.6	100.0	279	223
Kampong Speu	92.5	5.1	2.4	100.0	213	215
Takeo	93.9	5.4	0.7	100.0	238	191
Total	**87.4**	**7.3**	**5.3**	**100.0**	**3841**	**4157**

For accurate measures of anthropometry, it is important to demonstrate that a high percentage of children selected were successfully measured. Half of all households were selected for anthropometry. In those households, an average of 7.3 % of children had died. An average of 5.3 % had invalid or missing data. Most provinces have an acceptable percentage of invalid or missing data, except for three. Pursat has three times the percentage of invalid or missing data (15.9%) compared to the national average while Banteay Mean Chey, and Sihanoukville/Koh Kong (12%) have over twice the national average. These data should be considered less representative of these provinces than the other provinces on the whole.

Another method to review data quality is to observe the mean and standard deviation of the Z-scores. The standard deviation of the height for age Z-score for Pursat province (1.9) is the highest of all provinces and significantly higher than the national total standard deviation (1.3) indicating a greater variety of height measures in the distribution and poorer quality data. The height measures of Pursat province also affect the weight for height and BMI Z-scores. The standard deviations for the weight for height and BMI Z-scores (1.9 and 1.8 consecutively) are almost twice the national average (both 1.1) also indicating poor quality data.

Table 2. Mean and standard deviation of valid anthropometry Z scores by province. CDHS 2005

Province		Standard Deviations (SD)			
		Weight for age SD	Weight for age SD	Weight for height SD	BMI for age SD
Banteay Mean Chey	**Mean**	**1.3**	**-1.6**	**-0.5**	**-0.3**
	Std. Deviation	1.0	1.1	0.9	0.9
Kampong Cham	**Mean**	**-1.5**	**-2.0**	**-0.6**	**-0.3**
	Std. Deviation	1.1	1.2	1.1	1.0
Kampong Chhnang	**Mean**	**-1.5**	**-1.8**	**-0.7**	**-0.5**
	Std. Deviation	1.0	1.2	0.9	0.9
Kampong Speu	**Mean**	**-1.4**	**-1.7**	**-0.7**	**-0.5**
	Std. Deviation	0.9	1.1	1.0	1.0
Kampong Thom	**Mean**	**-1.6**	**-1.9**	**-0.7**	**-0.5**
	Std. Deviation	1.0	1.2	1.0	1.0
Kandal	**Mean**	**-1.4**	**-1.4**	**-0.8**	**-0.7**
	Std. Deviation	1.0	1.4	1.0	1.1
Kratie	**Mean**	**-1.5**	**-1.9**	**-0.6**	**-0.4**
	Std. Deviation	1.1	1.4	0.9	0.9
Phnom Penh	**Mean**	**-1.0**	**-1.2**	**-0.4**	**-0.3**
	Std. Deviation	1.1	1.3	1.2	1.2
Prey Veng	**Mean**	**-1.6**	**-1.7**	**-0.9**	**-0.7**
	Std. Deviation	1.1	1.2	1.1	1.1
Pursat	**Mean**	**-1.6**	**-2.5**	**-0.2**	**0.0**
	Std. Deviation	1.1	1.9	1.9	1.8
Siem Reap	**Mean**	**-1.7**	**-2.2**	**-0.6**	**-0.4**
	Std. Deviation	1.0	1.3	1.1	1.1
Svay Rieng	**Mean**	**-1.6**	**-1.8**	**-0.7**	**-0.5**
	Std. Deviation	0.9	1.3	1.2	1.3
Takeo	**Mean**	**-1.5**	**-1.8**	**-0.6**	**-0.5**
	Std. Deviation	1.0	1.3	1.2	1.2
Oddar Meanchey	**Mean**	**-1.6**	**-1.9**	**-0.7**	**-0.5**
	Std. Deviation	1.0	1.3	0.9	1.0
Battambang & Krong Pailin	**Mean**	**-1.3**	**-1.7**	**-0.5**	**-0.3**
	Std. Deviation	1.0	1.4	1.2	1.1
Kampot & Krong Kep	**Mean**	**-1.3**	**-1.6**	**-0.6**	**-0.4**
	Std. Deviation	1.0	1.2	0.9	0.9
Sihanoukville & Koh Kong	**Mean**	**-1.5**	**-1.8**	**-0.6**	**-0.4**
	Std. Deviation	1.1	1.5	0.9	1.0
Preah Vihear & Stung Treng	**Mean**	**-1.8**	**-1.9**	**-0.9**	**-0.8**
	Std. Deviation	1.0	1.2	0.9	1.0
Mondolkiri/Rattanakiri	**Mean**	**-2.0**	**-2.5**	**-0.7**	**-0.5**
	Std. Deviation	1.2	1.5	1.0	1.1
Total	**Mean**	**-1.5**	**-1.8**	**-0.6**	**-0.5**
	Std. Deviation	1.0	1.3	1.1	1.1
	N	3356	3356	3356	3356

Figure 1. Histogram of Height for Age Z-scores (Stunting), CDHS 2005

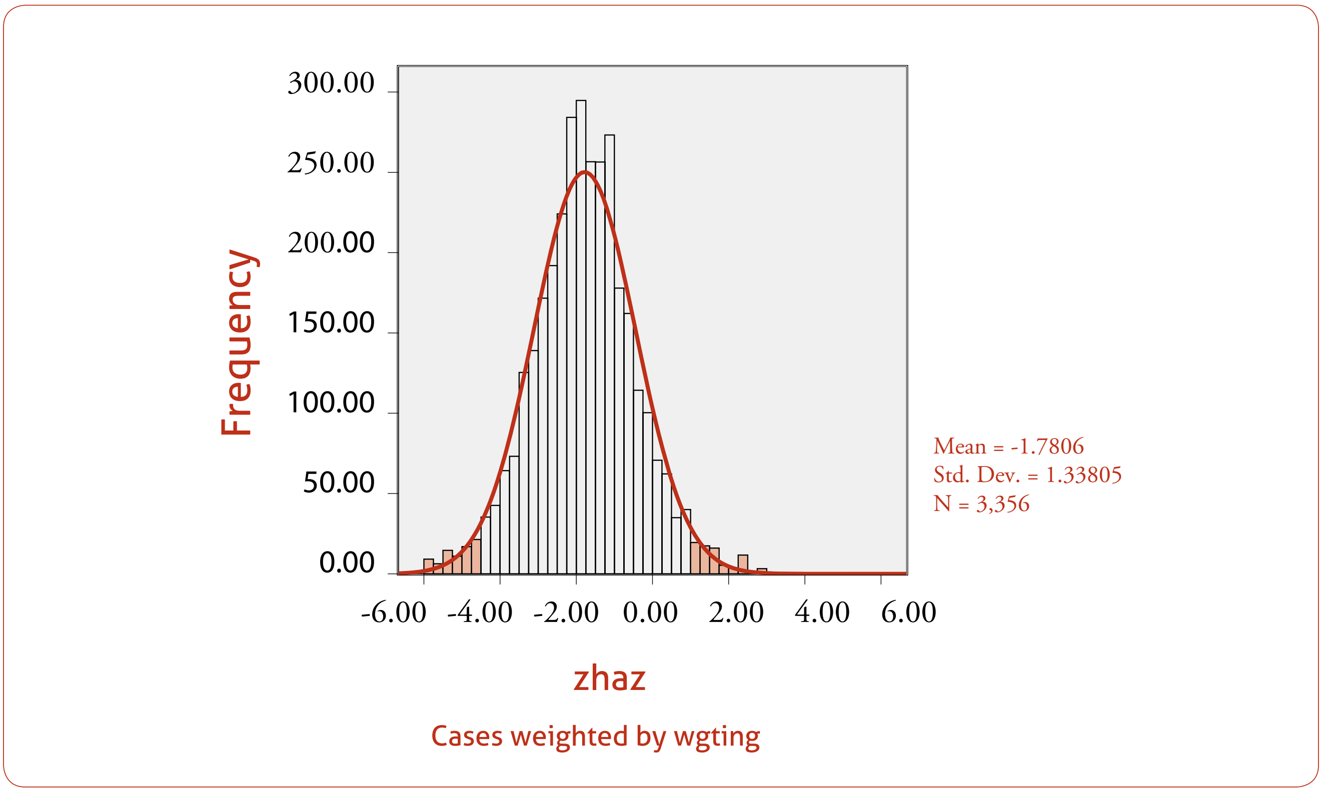


Figure 2. Histogram of Weight for Age Z- scores (Underweight), CDHS 2005

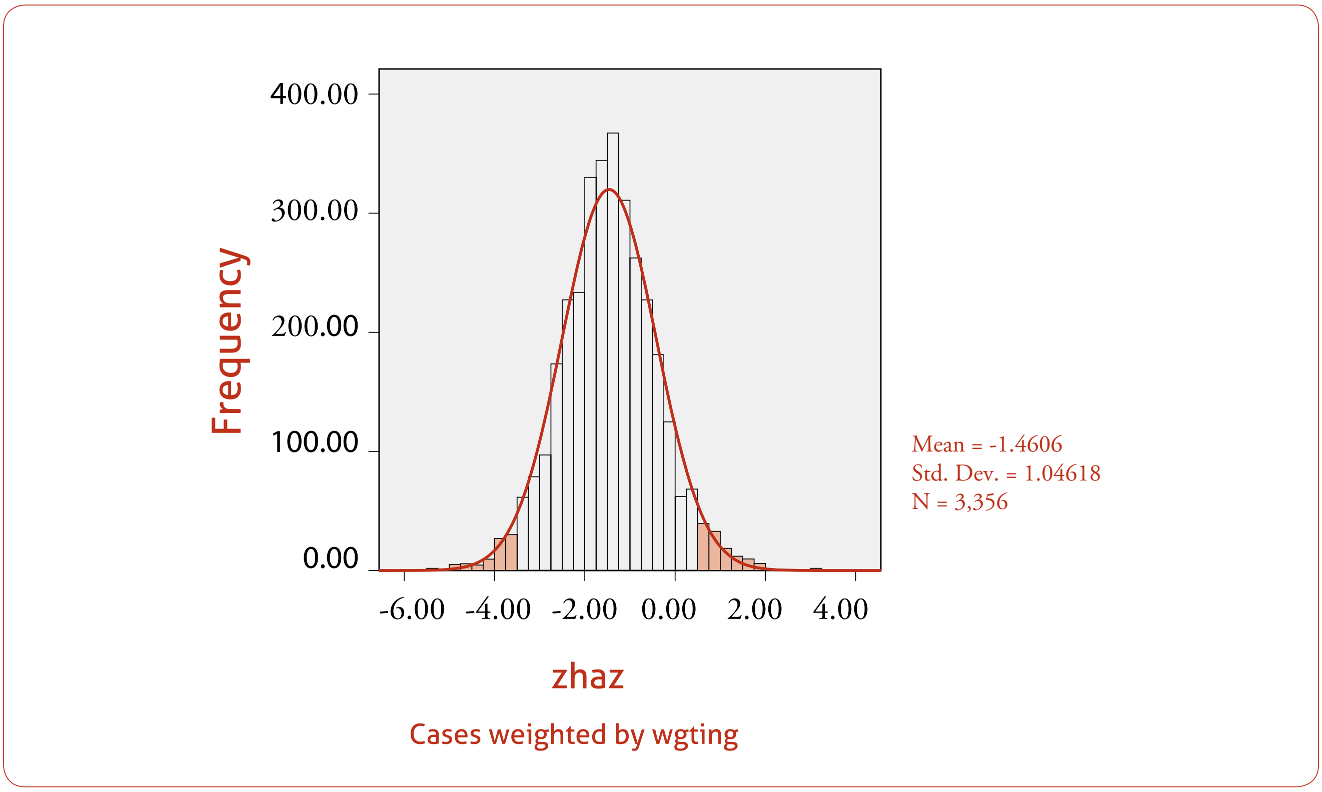


Figure 3. Histogram of Weight for Height Z - scores (Wasting), CDHS 2005

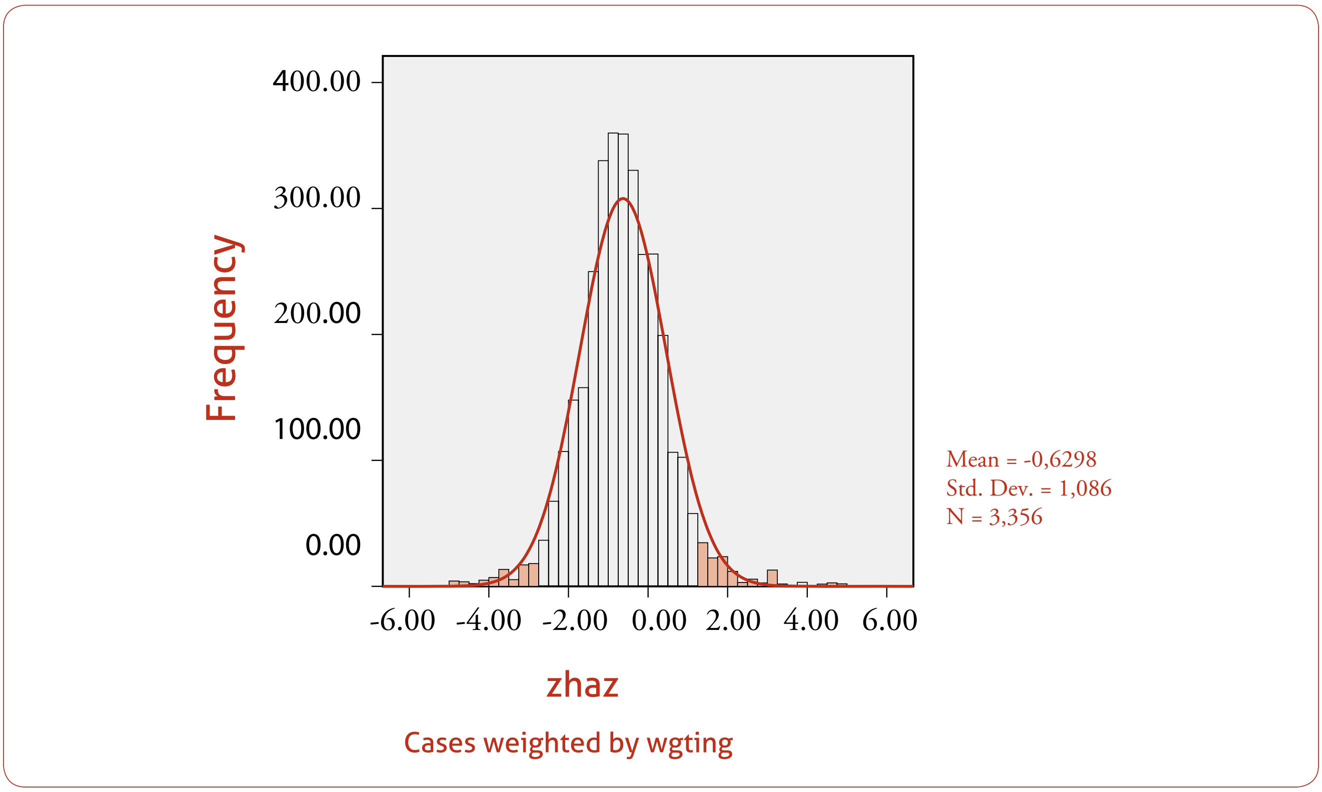


Figure 4. Histogram of Body Mass Index Z -Scores, CDHS 2005

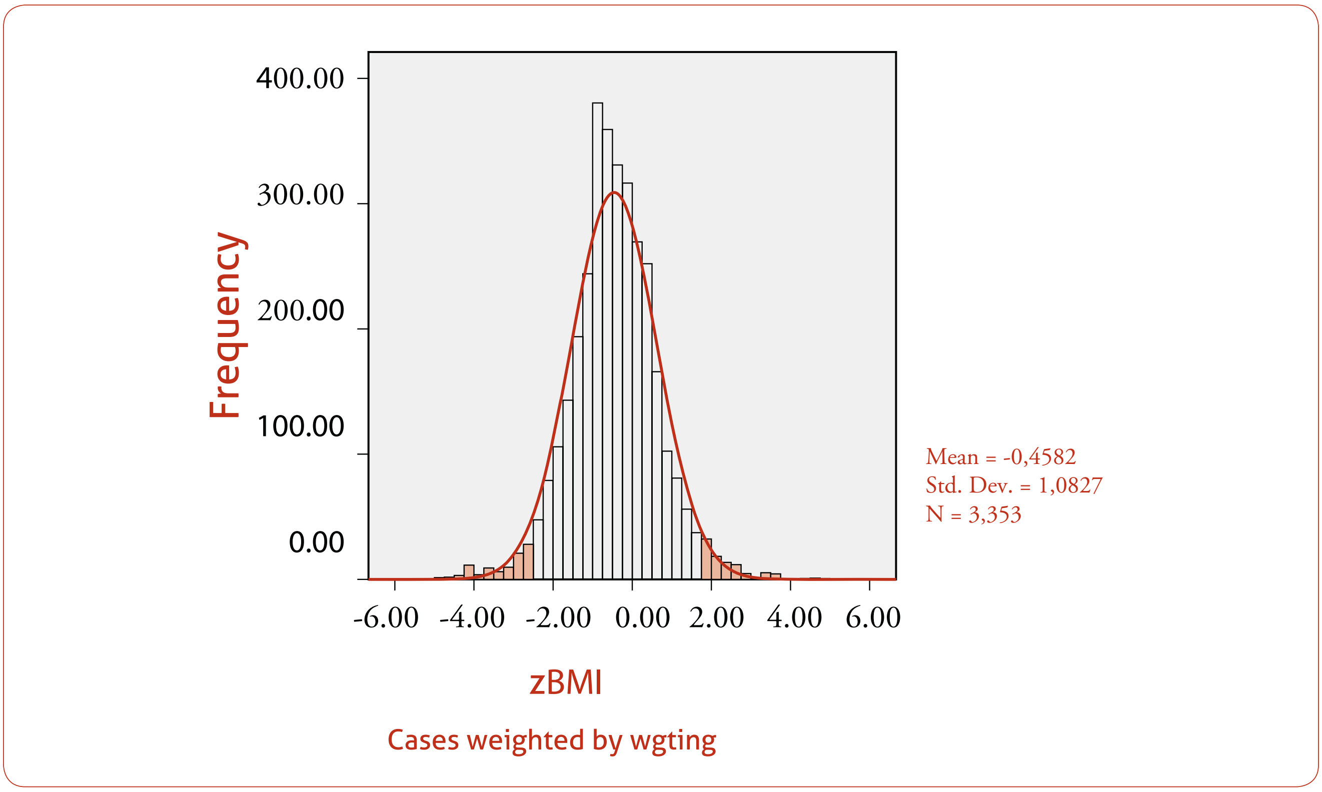


Table 3. Prevalence of malnutrition indicators by background characteristics, CDHS 2005

	Stunted (<-2SD HAZ)	Underweight (<-2SD WAZ)	Wasted (<-2SDWHZ)	Low Body Mass Index (<-2SD Z-BMI)	
Age in months	**Percent**	**Percent**	**Percent**	**Percent**	**Count**
<6 m	14.7	13.5	13.3	13.8	319
6-8m	12.7	10.7	9.1	11.0	172
9-11m	22.5	28.4	17.1	15.7	177
12-17m	39.9	24.0	10.7	8.7	349
18-23m	50.5	31.2	8.1	5.0	376
24-35m	47.9	28.1	6.4	4.0	654
36-47m	53.1	34.9	7.9	4.2	684
48-59m	50.7	35.3	5.5	4.3	626
Sex of child					
Male	45.4	29.9	8.8	6.6	1630
Female	40.1	27.2	8.3	6.6	1726
Size of child at birth					
Average or larger	40.7	25.8	7.6	5.9	2864
Smaller than average	53.5	44.1	13.2	9.9	355
Very small	53.6	45.0	16.3	12.4	109
Don't know	59.7	46.6	13.8	13.4	27
Mother's body mass index					
Low BMI (<18.5)	45.5	41.8	15.1	11.3	643
Normal BMI (18.5-24.9)	423	25.8	7.3	5.6	2438
Overweight/Obese (>=25)	39.0	21.0	4.3	4.2	271
Residence					
Phnom Penh	24.1	14.4	7.0	7.0	266
Other urban	39.9	31.1	8.5	7.2	319
Rural	44.7	29.6	8.7	6.5	2771
Total	**42.6**	**28.5**	**8.6**	**6.66**	**3356**

Table 4. Prevalence of malnutrition indicators by background characteristics, CDHS 2005

	Stunted (<-2SD HAZ)	Underweight (<-2SD WAZ)	Wasted (<-2SD WHZ)	Wasted Low Body Mass Index (<-2SD Z-BMI)	
Province	**Percent**	**Percent**	**Percent**	**Percent**	**Count**
Banteay Mean Chey	37.9	22.0	5.9	3.9	135
Kampong Cham	43.3	29.3	8.7	5.8	370
Kampong Chhnang	41.8	29.3	7.7	5.5	137
Kampong Speu	39.6	23.8	8.1	4.0	197
Kampong Thom	45.1	31.9	6.0	5.9	188
Kandal	31.1	28.6	10.9	9.8	303
Kratie	42.0	27.7	6.2	5.3	93
Phnom Penh	24.1	14.4	7.0	7.0	266
Prey Veng	41.0	30.0	12.5	11.3	236
Pursat	64.1	34.5	16.6	13.1	88
Siem Reap	58.1	37.6	8.0	6.1	305
Svay Rieng	45.6	27.9	11.4	9.7	104
Takeo	44.7	31.9	7.1	5.4	223
Oddar Meanchey	50.8	26.9	7.3	6.7	40
Battambang & Krong Pailin	46.7	23.2	7.5	4.7	252
Kampot & Krong Kep	38.6	23.8	4.2	1.0	175
Sihanoukville & Koh Kong	39.5	29.1	7.7	5.8	87
Preah Vihear & Stung Treng	51.4	41.3	13.4	11.7	88
Mondolkiri/Rattanakiri	57.8	46.4	11.3	7.0	68
Mother's education					
No education	51.6	32.5	9.3	7.2	806
Primary	43.5	29.7	8.4	6.5	1960
Secondary or higher	27.4	18.9	7.9	6.1	590
Wealth index					
Poorest	52.4	34.8	10.5	7.5	838
Poorer	47.3	32.6	10.2	7.0	748
Middle	44.6	26.3	7.2	5.8	638
Richer	39.4	28.6	6.1	5.2	561
Richest	23.1	16.2	7.5	7.0	570
Total	**42.6**	**28.5**	**8.6**	**6.6**	**3356**

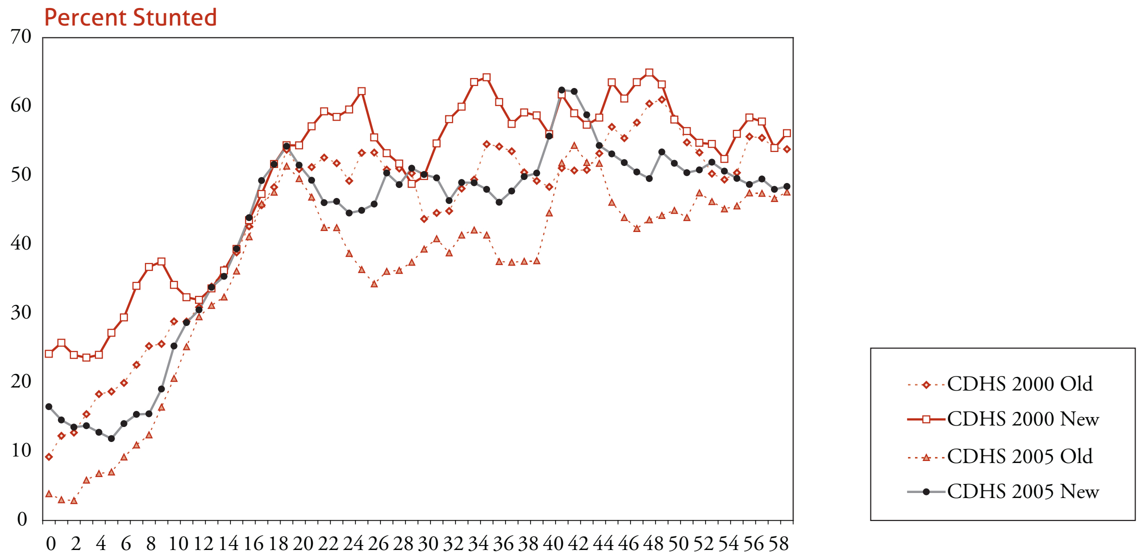
Table 5. Sample sizes for anthropometry (in graphs by age) by different growth standards from CDHS 2000 and CDHS 2005

	Old Standards	Percent	New Standards	Percent
CDHS 2000				
Not selected for anthropometry	4072	49.8%	4072	49.8%
Selected for anthropometry	4103	50.2%	4103	50.2%
Total	8175	100%	8175	100%
Selected for anthropometry CDHS 2000				
Valid cases	3257	79.4%	3285	80.1%
Invalid cases	446	10.9%	418	10.2%
Child dead	400	9.7%	400	9.7%
Total	4103	100%	4103	100%
CDHS 2005				
Not selected for anthropometry	3948	50.7%	3948	50.7%
Selected for anthropometry	3841	49.3%	3841	49.3%
Total	7789	100%	7789	100%
Selected for anthropometry CDHS 2005				
Valid cases	3338	86.9%	3356	87.4%
Invalid cases	223	5.8%	205	5.3%
Child dead	280	7.3%	280	7.3%
Total	3841	100%	3841	100%

Note: includes only children of interviewed mothers.

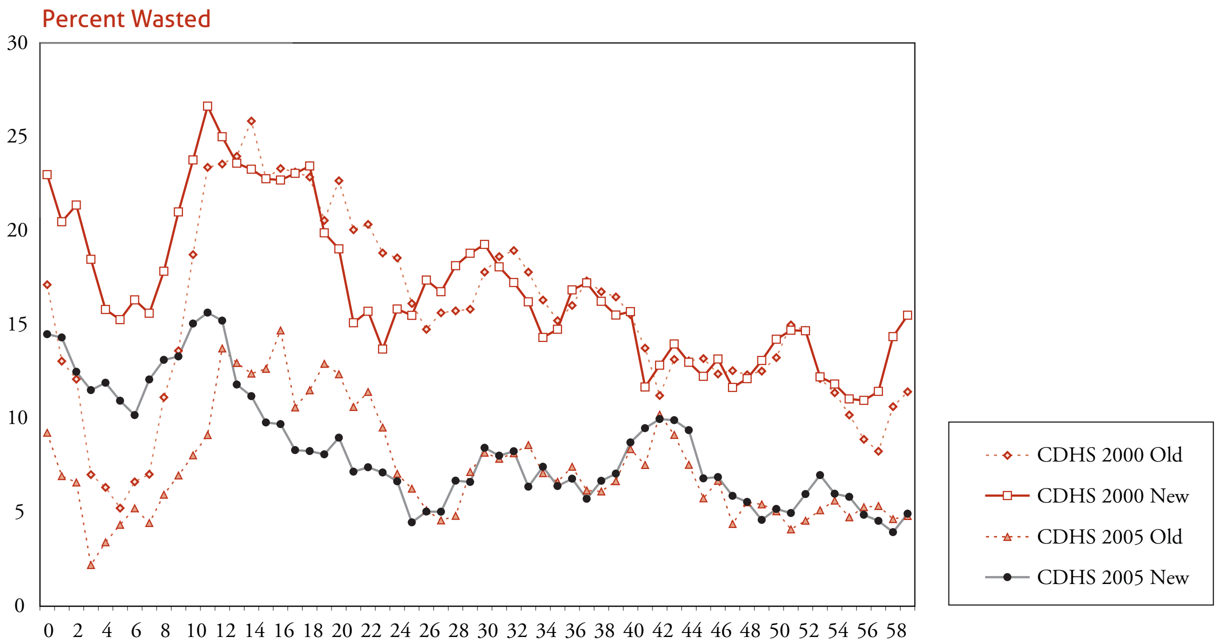
During the data collection, all children who resided in the household were weighed and measured. In the presentation of the data, children of non-interviewed mothers are excluded. The birth dates of these children are often not recorded or incorrect invalidating the analysis of their z scores.

Figure 5. Percent of children stunted by age in months and different growth standards, CDHS 2000 and CDHS 2005



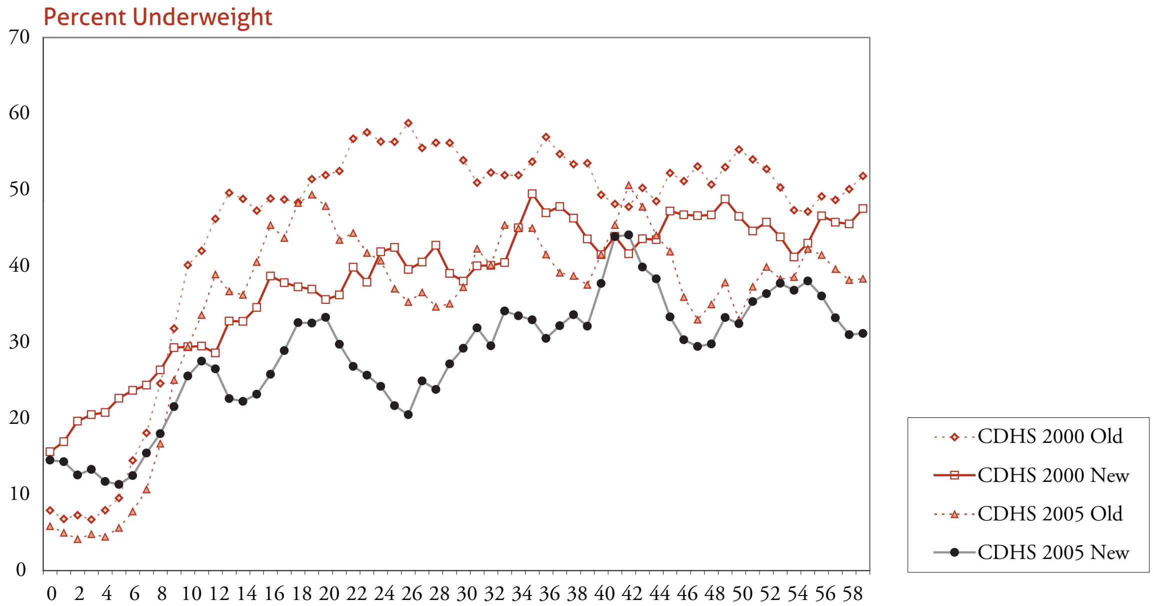
Note: Points are smoothed with a 5 month moving average.

Figure 6. Percent of children wasted by age in months and different growth standards, CDHS 2000 and CDHS 2005



Note: Points are smoothed with a 5 month moving average.

Figure 7. Percent of children underweight by age in months and different growth standards, CDHS 2000 and CDHS 2005



Note: Points are smoothed with a 5 month moving average.

References

international estimates and an update estimation procedure. Bulletin of the World Health Organization. March 2005, 83 (3) 178-185.

Brown KH, 2007. Information Gaps for scaling-up programs to improve zinc nutrition. A2Z Gap Analysis. A2Z Micronutrient Project. Washington DC.

Carnley BP, JF Prior , A Gilbert , E Lim , R Devenish , H Sing , E Sarin , R.Guhadasan, SG Sullivan , CA Wise , AH Bittles , K Chan , MS Wong , V Chan , WN Erber 2006. The prevalence and molecular basis of hemoglobinopathies in Cambodia. Hemoglobin. 2006, 30 (4) 463-470.

CDHS, 2005. (National Institute of Public Health, National Institute of Statistics [Cambodia] and ORC Macro. 2006). Cambodia Demographic and Health Survey 2005. Phnom Penh, Cambodia and Calverton, Maryland, USA: National Institute of Public Health, National Institute of Statistics and ORC Macro.

CESVI, 2006. (Giovannini M, Debora Sala, Michele Usuelli, Luca Livio, Gaia Francescato, Marta Braga, Giovanni Radaelli, and Enrica Riva. 2006. Journal of Pediatric Gastroenterology and Nutrition. Double-Blind, Placebo-Controlled Trial Comparing Effects of Supplementation with Two Different Combinations of Micronutrients Delivered as Sprinkles on Growth, Anemia, and Iron Deficiency in Cambodian Infants. Journal of Pediatric Gastroenterology and Nutrition. March 2006, 42:306-312.

CNMS, 2000. Cambodian National Micronutrient Survey – Helen Keller International – Cambodia. Phnom Penh, Cambodia.

CNMBS, 2004. (B Mao, V Saphonn) Report of the Cambodia National Malaria Baseline Survey 2004. National Institute of Public Health, Cambodia (NIPH) 5 August 2005 National Institute of Public Health, Cambodia (NIPH) Malaria Consortium Phnom Penh, Cambodia.

Christian P, 2002. Recommendations for indicators: night blindness during pregnancy-a simple tool to assess vitamin A deficiency in a population. Journal of Nutrition. 2002 Sept, 132 (9 Suppl): 2884S-2888S.

Conkle J, 2007. Exclusive Breastfeeding in Cambodia: Survey Comparability & Explaining Change. UNICEF. Phnom Penh, Cambodia.

Crompton DW et al, 2003. Controlling disease due to helminth infections. Geneva: World Health Organization.

Delange F, 1994. The disorders induced by iodine deficiency. Thyroid, 4: 107-128.

Edmond K and R Bahl, 2006. Optimal feeding of low-birth-weight infants: technical review. WHO. Geneva.

FAO, Global Forest Resource Assessment 2005, Annex 3 – Global Tables, p. 233, ftp://ftp.fao.org/docrep/fao/008/A0400E/A0400E14.pdf. (Last downloaded 18 March 2007).

Fishman SM, P Christian and KP West Jr, 2000. The role of vitamins in the prevention and control of anemia. Public Health Nutrition. 3(2): 125-150

Flohr C et al, 2007. Low efficacy of mebendazole against hookworm in Vietnam: two randomized controlled trials. American Journal of Tropical Medicine and Hygiene. 2007 April, 76(4): 732-736.

GAVA, 2007. Global Vitamin A Alliance. Monitoring Vitamin A Supplementation. Technical Advisory Group Meeting Report. New York, 19-20 July 2006.

Hix J et al, 2006. Validation of a rapid enzyme immunoassay for the quantitation of retinol-binding protein to assess vitamin A status within populations. European Journal of Clinical Nutrition (2006) 60: 1299–1303.

Horton S and J Ross, 2003. The economics of iron deficiency. Food Policy (2003) 28: 51–75.

IRIS Study Group, 2005. Efficacy of a Foodlet-Based Multiple Micronutrient Supplement for Preventing Growth Faltering, Anemia, and Micronutrient Deficiency of Infants: The Four Country IRIS Trial Pooled Data Analysis. International Research on Infant Supplementation (IRIS) Study Group: Journal of Nutrition 2005. 135: 631S–638S.

IVACG, 2002. Maternal Night Blindness: A New Indicator of Vitamin A Deficiency International Vitamin A Consultative Group Statement. Washington D.C.

IZiNCG, 2004. International Zinc Nutrition Consultative Group (IZiNCG). Assessment of the risk of zinc deficiency in populations and options for its control. Hotz C and Brown KH, eds. Food and Nutrition Bulletin 2004. 25: S91-S202.

Jack S, 2005. Comparison of Cambodia Trials. Presented at the 3rd National Anaemia Workshop: 5-6 May 2005. Phnom Penh, Cambodia.

Jiraphongsa C et al, 2005. Epidemiology and burden of rotavirus diarrhea in Thailand: results of sentinel surveillance. Journal of Infectious Disease. 2005 Sept 1;192 Suppl 1:S87-93.

Johnston R, 2006. The Twelve Key Family Practices for Health Survey Report - 2006. National Center for Health Promotion. Phnom Penh, Cambodia.

Johnston R and S Ly, 2007. Recording and Reporting Nutrition Interventions on the Community and Health Center Level in Rural Cambodia, Qualitative Study, A2Z Micronutrient Project, Phnom Penh, Cambodia.

Kapil U, 2003. Prevention and Control of Iron Deficiency Anemia Amongst Young Children. Indian Pediatrics 2003, 40:293-295.

Keusch GT et al, 2006. Diarrheal Diseases. Disease Control Priorities in Developing Countries 2006 (2nd Edition) ed. 371-388. New York: Oxford University Press.

Kheng H, 2007. Presentation on Scaling Up the Use of Zinc for Treating Diarrhea in Cambodia, Population Services International- Cambodia 2007. Phnom Penh, Cambodia.

Longfils P, Ung KH, Hay S, and Muth S, 2005. Weekly Iron and Folic Acid Supplementation as a Tool to Reduce Anemia among Primary School Children in Cambodia. Nutrition Reviews. December 2005: (II) S139–S145.

Lynch Sean, Betsy Lozoff, Chessa Lutter, Peter Ranum and Phil Harvey 2007. Gap Analysis – Information needed for consensus on policies and programs to improve iron nutrition. A2Z Micronutrient Project. Washington DC.

Miller M, Jean Humphrey, Elizabeth Johnson, Edmore Marinda, Ron Brookmeyer and Joanne Katz (2002). Why Do Children Become Vitamin A Deficient?, Supplement: Proceedings of the XX International Vitamin A Consultative Group Meeting. Journal of Nutrition. 132:2867S-2880S, September 2002.

MoH, 2004. National Policy and Guideline for Helminth Control in Cambodia. National Task Force for the Control of Soil-Transmitted Helminthiases, Schistosomiasis, and for the Elimination of Lymphatic Filariasis, Phnom Penh, Cambodia.

MoH/WHO/UNICEF, 2006. Integrated Management of Childhood Illness Guidelines. Phnom Penh, Cambodia.

MoH, 2007a. Vitamin A Supplementation Policy. National Nutrition Program. Cambodian Ministry of Health. Phnom Penh, Cambodia.

MoH, 2007b. National Nutrition Program - Annual Operational Plan 2007, National Maternal and Child Health Center. Phnom Penh, Cambodia.

National IDD Control Program, 2000. Report on IDD Control Activities. 2000, Hanoi, Vietnam.

MOARD, 2005., The 5-Year Plan for the Agricultural and Rural Development Sector Period 2006 -2010, Ministry of Agriculture and Rural Development. Hanoi, Vietnam.

MOST, 2005. Diarrhea Treatment Guidelines for Clinic-Based Healthcare Workers. The MOST Project, 2005.

Oum S et al, 2005. Community-based surveillance: a pilot study from rural Cambodia.

Tropical Medicine and International Health. 2005 Jul;10(7):689-97.

Rice AL, 2007. Post-partum vitamin A supplementation: evaluating the evidence for action. Technical Brief. A2Z Micronutrient Project. Washington DC. January 2007.

Sazawal S, Black RE, Ramsan M, Chwaya HM, Stoltzfus R, Dutta A, Dhingra U, Kabole I, Deb S, Othman MK, Kabole FM. Effect of routine prophylactic supplementation with iron and folic acid on admission to hospital and mortality in preschool children in a high malaria transmission setting: a community-based, randomized, placebo-controlled trial. Lancet, 2006; 367:133-43.

Sazawal S et al, 2007. Effect of zinc supplementation on mortality in children aged 1–48 months: a community-based randomised placebo controlled trial. Lancet 2007; 369: 927–34.

Shrimpton R et al, 2005. Zinc deficiency: what are the most appropriate interventions? British Medical Journal. 2005; 330:347-349 (12 February).

GTZ, 2007. Efficacy and safety of twice-weekly administration of three RDAs of iron and folic acid with and without complement of 14 essential micronutrients at one or two RDAs: a placebo-controlled intervention trial in anemic Cambodian infants 6 to 24 months of age. European Journal of Clinical Nutrition (2007): 1–14.

Stoltzfus RJ, L Mullany and RE Black, 2004. Chapter 3. Iron Deficiency Anemia. Comparative Quantification Of Health Risks: Global and Regional Burden of Diseases Attributable to

Selected Major Risk Factors. Geneva, World Health Organization, 2004.

Stolzfus, RJ. 2004. Iron deficiency anemia: reexamining the nature and magnitude of the public health problem. Summary: implications for research and programs. Journal of Nutrition, 2001, 131 (Suppl. 2): 697S-701S.

Tielsch J.M., Khatry S., Stoltzfus R., Katz J., Le Clerq S., Adhikan R., Mullany L.C., Shresta S., Black R.E. Effect of routine prophylactic supplementation with iron and folic acid on preschool child mortality in Southern Nepal: community based, cluster-randomised, placebo-controlled trial. Lancet, 2006; 367:144-52.

Victora, C.G.; Fenn, B.; Bryce, J.; Kirkwood, B.R.; Co-coverage of preventive interventions and implications for child-survival strategies: evidence from national surveys. Lancet, 2005; 366 (9495): 1460-6.

Wedner SH, DA Ross, N Congdon, R Balira, V Spitzer and A Foster, 2004. Validation of night blindness reports among children and women in a vitamin A deficient population in rural Tanzania. European Journal of Clinical Nutrition (2004) 58, 409–419.

West CE, Ans Eilander and Machteld van Lieshout (2002) Consequences of Revised Estimates of Carotenoid Bioefficacy for Dietary Control of Vitamin A Deficiency in Developing Countries. Supplement: Proceedings of the XX International Vitamin A Consultative Group Meeting. Journal of Nutrition. 132:2920S-2926S, September 2002.

WHO (1982) Control of vitamin A deficiency and xerophthalmia. Report of a joint WHO/UNICEF/ USAID/Helen Keller International IVACG Meeting. WHO Technical Report Series 672. Geneva: World Health Organization 1982:1-70.

WHO, 1996. Indicators for assessing vitamin A deficiency and their application in monitoring and evaluating intervention programmes. Geneva, World Health Organization, 1996 (WHO/NUT/ 96.10).

WHO, 1998. Integration of vitamin A supplementation with immunization: policy and programme implications. Report of a meeting, 12-13 January 1998. Global programme for vaccines and immunization. Expanded programme on immunization. UNICEF, New York.

WHO/UNICEF/UNU, 2001. Iron deficiency anemia: assessment, prevention and control. Geneva, World Health Organization, 2001 (WHO/ NHD/01.3).

WHO/UNICEF, 2004. Prevention and control of schistosomiasis and soil-transmitted helminthiasis. WHO/UNICEF Joint Statement. Geneva, World Health Organization.

WHO, 2005. Deworming for health and development: Report of the third global meeting of the partners for parasite control. Geneva, World Health Organization, 2005.

WHO/UNICEF/USAID, 2005. Diarrhoea treatment guidelines including new recommendations for the use of ORS and zinc supplementation for clinic-based healthcare workers. WHO/ UNICEF/USAID Joint Statement. Geneva, World Health Organization.

WHO, 2006. Iron supplementation of young children in regions where malaria transmission is intense and infectious disease highly prevalent. January 2006. WHO Statement, Geneva.

WHO, 2007. New international growth standards – Multicentre Growth Reference Study. Geneva, World Health Organization, 2007.

Zlotkin SH, Schauer C, Christofi des A, Sharieff W, Tondeur MC, et al. (2005) Micronutrient Sprinkles to control childhood anaemia. PLoS Med 2(1): e1.

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