Evaluating the Vitamin A Supplementation Programme in northern Ghana:

Has it contributed to improved child survival?

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Dedication

This report is dedicated to Dr. Paul Arthur, who died on the 9th of March 2002. Paul was a principal investigator for the study, and was instrumental in its design and execution. He obtained the willing collaboration of the many partners in Ghana, and masterminded all aspects of study implementation. He died just as the final phase of data collection was nearing completion.

Despite the many other demands on his time, Paul worked tirelessly to ensure that this study met his high standards. He was the best of collaborators: full of good ideas, balancing multiple demands with equanimity, and always cheerful. He inspired the trust, affection and admiration of all those with whom he worked. This report is greatly diminished by his unforeseen and untimely loss.

Acknowledgements

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Acronym list

CFR   Case fatality rate

CHIM   Centre for Health Information Management

C.I.   Confidence interval

CIDA   Canadian International Development Agency

DHS   Demographic and Health Survey

EA   Enumeration area

EPI   Expanded Programme on Immunization

EPI-INFO   EPI-INFO statistical program

GSS   Ghana Statistical Service

HIS   Health information system

IEC   Information, education and communication

IHNS   Integrated Health and Nutrition Survey

KHRC   Kintampo Health Research Centre

ORS   Oral rehydration for solution

NID   National Immunization Day

NVAP   National Vitamin A Programme

OPD   Outpatient department

USAID   United States Agency for International Development

UNICEF   United Nations Children's Fund

VA   Vitamin A

VAD   Vitamin A deficiency

VAST   Vitamin A Supplementation Trials

WHO   World Health Organization

Executive Summary

"…an evaluation with imperfect data is better than no evaluation at all."[1]

The following case study of Ghana's National Vitamin A Programme (NVAP) as it has been implemented in the three most vitamin A-deficient regions of northern Ghana attempts to answer the question 'has the programme in Ghana resulted in improved child survival?' The study is intended to serve as a logical model of programme evaluation, and makes recommendations that could guide other evaluators and programme managers.

The National Vitamin A supplementation Programme (NVAP) began mass supplementation in the three most vitamin A-deficient regions of northern Ghana (Northern, Upper East and Upper West) in 1996 and 1997. At the time of this evaluation, biannual supplement distributions had been underway for more than 4 years, providing sufficient time to detect an impact on mortality, if one had occurred. The evaluation was designed to compare the health status of children in 1995, before the programme was instituted, with similar information for 2000, after it had been underway for four years.

Rationale for study design
After a programme has been implemented, it may be possible to demonstrate that a change in mortality (or morbidity) has occurred, concurrent with programme operation, but not to rule out the many potential confounding factors that also affect survival. By compiling data to assess the process of implementation, a stronger case might be made for attributing causality, if it can be shown that the programme was effectively implemented. We therefore included both pre- and post-intervention comparisons of certain risk factors for child death as well as a comparison of specific health outcomes that the vitamin A supplementation programme was expected to influence most.

Assessing the impact of programmes to prevent Vitamin A deficiency (VAD) presents special difficulties because Vitamin A supplementation in a deficient population may have a substantial effect on overall mortality, even though its direct effect on specific diseases is small. If the findings from analyses of all the components of our evaluation provide a consistent picture, this will strengthen the plausibility of our interpretation of the programme's effect.

A conceptual framework and selected indicators that were used to guide collection of study data is presented. In the first phase of the study, we extracted, collated and analyzed existing data from National Vitamin A Programme (NVAP) records and reports, and from health facilities in the three regions. The Demographic and Health Surveys conducted in 1993 and 1998 provided baseline mortality data for the impact evaluation and in February and March 2002 a household survey was conducted in the three regions to obtain more recent estimates of child mortality.

Findings
Although imperfect, the data gathered by the NVA programme and process assessments indicates that increasing numbers of children in each region were reached during succeeding distribution rounds. Prior to 1995, in the absence of the programme,

no supplements were available for distribution. The evidence suggests that current coverage probably approaches at least 80% in the three regions, a significant achievement for the NVAP.

An assessment of mortality trends indicates that mortality between ages 1 and 4 fell more rapidly than infant mortality since the programme began operating. The finding that mortality declined more among older children than among infants (children less than a year old) lends some support to the hypothesis that vitamin A supplementation, which should affect children over the age of one more than at younger ages, contributed to improved survival in that age group. Although the mortality changes appear to be more prominent in the age group expected to benefit most from vitamin A supplements, there are many other factors that may have contributed to the observed decline in mortality.

Measures of intermediate health outcomes could provide a critical link between program data showing effective delivery of the intervention and trends in child survival. Clear changes in severe morbidity expected as a result of improved vitamin A status would strengthen conclusions about the contribution of the intervention programme to the decline in death rates we observed. We examined proxy indicators of disease severity for those few specific diseases that improved vitamin A status should benefit.

Outpatient data for Upper West Region provides some support for our hypothesis that vitamin A supplementation reduced the severity of diarrhoea and measles as perceived by caretakers. In that region, attendance at OPD clinics for diarrhoea declined markedly over the study period. An analysis of inpatient data from the three regions found a significant decline in odds of admissions for both diarrhoea and measles, when each disease was compared to all other causes of hospital admission. However, because of what appear to be changes in access to services over the period, our data from health facilities were not able to shed a great deal of light on changes in severity of diarrhea or measles. The firmest evidence these data produced was a significant decline in the odds of cases of diarrhea and measles being admitted to hospital, and a halving of attendance for diarrhoea at OPDs in one region. This suggests a possible decline in the severity of these illnesses over the period of the study.

This study was unable to make any definitive statement regarding the biological indicators of improved vitamin A status. We obtained data to estimate prevalence of night blindness among children between two and five years of age. Little or no change from the pre-intervention years to the present was apparent, but data for comparison is scanty. It may be very difficult to detect changes in night blindness prevalence when it occurs at the very low levels we have seen in northern Ghana. A measure of serum retinol level drawn from a sub-sample of children would have provided clearer physical evidence of improved vitamin A status. Unfortunately, our plan to collect these data had to be abandoned. Because it is difficult to partition out the contribution of the many other factors that influence overall child mortality rates or to rule out some of those influences, it is clear how important such biological data can be for making a link between programme performance and mortality impact.

These findings require further close examination of alternative causes of the trends observed. We examined changes in diarrhoea home treatment, immunization and health service factors that might also contribute to a proportionate reduction in admissions to hospital for these illnesses. These other influences cannot be completely ruled out as contributory causes of the steep decline in child mortality observed in

northern Ghana since 1993. Some improvements may balance out other deterioration. The biggest change that has occurred in factors known to affect child mortality is the provision of vitamin A supplements to a large proportion of children in these regions.

What is difficult to quantify is the relative contribution of changes in non-programme factors compared to the major change that has occurred in vitamin A supplementation. In the absence of biological data confirming that vitamin A status has improved, the most we can say with the data assembled in this study is that it is likely that child health has improved and that the NVAP has probably contributed to this improvement.

Mortality estimates from surveys should be viewed with caution. While our findings regarding the differential rates of decline of infant and later childhood mortality rates probably describe a real change in the age pattern of mortality, the absolute level of both rates may be underestimated as a result of reporting errors. This illustrates the pitfalls inherent in measuring mortality especially in areas with low levels of education, and should be a clear signal to program managers that such surveys pose difficult challenges and should not be undertaken as part of a program evaluation.

Recommendations and conclusions

For vitamin A programme managers who wish to examine the question of impact, it seems that the most important elements of an evaluation plan established at the <u>start</u> of the programme are:

1. Valid, representative population-based coverage data collected periodically, including a baseline measurement, using the same survey methods and questions throughout the programme period, and

2. Collection of serum retinol data on a sub-sample of children during baseline and end-of-programme coverage surveys

With this information, it should be possible to make fairly strong statements about the effectiveness of the program and its impact on the vitamin A status of the children it targets. Such information relates directly to the intervention to supply vitamin A supplements, and would not be confounded by the many other factors that contribute to improve child survival. These data, while stopping short of providing information about changes in child survival, should be sufficient for managers, donors, policymakers, and beneficiaries in the community to make decisions about the effectiveness of the programme and its importance to child health.

A much more elaborate and costly study would be needed in order to rule out the effects of these other factors. For evaluating the impact of a public health programme such as the national vitamin A supplementation programme in Ghana, such a study would be inappropriate. The present study demonstrates that assessing the precise role that an intervention programme plays in "averting deaths" is difficult, if not impossible, unless prohibitively expensive large-scale replication of the methods used in controlled trials is undertaken.

In the context of a national program, careful monitoring of program coverage and small-scale measurement of a biological marker of vitamin A status, serum retinol, should

provide sufficient information to asses the effectiveness of the program, and to make decisions about funding, expansion, contraction or closure.

Trends in other factors affecting child mortality were not nearly as marked as the change in supplementation with vitamin A, and some changes may even have worked to increase mortality slightly. This lends plausibility to the argument that the vitamin A programme has made a major contribution to the decline in childhood mortality in the recent past.   In the evaluation of public health programmes, this is likely to be the strongest statement that can be made about impact.

A larger proportion of evaluation resources could be put toward a more rigorous assessment of coverage with good effect. This could take the form of a routine programme of cluster surveys designed with adequate samples to assess change, conducted every few years across the entire programme area. These surveys could be used to monitor other indicators of programme performance, such as increases in maternal knowledge of the intervention, and changes in physical signs of vitamin A deficiency. Baseline and end-of-programme serum retinol measures might also be made on a smaller sub-sample, if desired. Such a programme of monitoring surveys, conducted every few years, can determine whether the intervention (of known efficacy) is delivered efficiently and reaches the children most in need, identifying the characteristics of those not reached, so that efforts can be better targeted to them. It could be used to obtain other information relevant to programme improvement.

Broad, equitable health programme coverage of all children, especially in families least able to obtain other health care, is what will ultimately determine whether mortality falls and improvements in child survival are sustained.

**EVALUATING THE VITAMIN A SUPPLEMENTATION PROGRAMME
IN NORTHERN GHANA:**

Has it contributed to improved child survival?

INTRODUCTION

Supplementation with Vitamin A has gained a tremendous amount of attention in the past decade as a cost-effective public health intervention that prevents blindness and reduces the risk of childhood morbidity and mortality. In the 1980s and 1990s several studies, including one in northern Ghana, were instrumental in determining the efficacy of VA interventions, particularly high-dose biannual supplementation in preschool children.[2]

Following the report of the Ghana Vitamin A Supplementation Trials research project (VAST), a Micronutrient Task Force was set up to formulate a national plan of action to control the problem of vitamin A deficiency in Ghana[3]. In 1995, the Task Force proposed a four-point plan of action including promotion of Vitamin A as part of standard treatment for measles, and periodic supplementation for children over 6 months of age and mothers within 4 weeks of delivery. This was to be implemented initially in the three savanna regions (Upper East, Upper West, and Northern) where the deficiency was most severe.

An analysis of results of ten major Vitamin A supplementation field trials found that a 23% reduction in overall childhood mortality was achieved in these trials.[4] Yet eVenn when research studies demonstrate that an intervention can reduce mortality, policy makers and donors often want to assess whether similar effects are achieved when large-scale programmes are implemented. The magnitude of the impact vitamin A supplementation can have on childhood mortality in the context of a large programme is not known. Managers may readily undertake evaluations of certain aspects of a programme to enhance service delivery and other operations, but find that assessing the impact of the programme on mortality or morbidity is overly complex, and the cost prohibitive. The funds for impact evaluation are often limited, and plans for such evaluation may not have been laid in advance, restricting the inferences that can be drawn *post hoc*.

The following case study of Ghana's National Vitamin A Programme (NVAP) as it has been implemented in the three most vitamin A-deficient regions of northern Ghana attempts to answer the question 'has the programme in Ghana resulted in improved child survival?'

In this report, we assemble data to assess whether the Ghana National Vitamin A supplementation Programme (NVAP), a programme for biannual mass distribution of vitamin A supplements, has been delivered effectively to children in northern Ghana, and to examine whether an expected decline in mortality has occurred. The report has two aims:
> 1) to provide data on this large-scale programme's effectiveness and impact to funding agencies and managers who wish to make decisions about funding programme continuation or expanding such programmes in other countries; and

2) to illustrate how programme managers might go about answering this key question, highlighting the challenges that face evaluators, planners and policy-makers who wish to make a definitive statement about programme impact.

The National Vitamin A supplementation Programme (NVAP) began mass supplementation in the three most vitamin A-deficient regions of northern Ghana (Northern, Upper East and Upper West) in 1996 and 1997. At the time of this evaluation, biannual supplement distributions had been underway for more than 4 years, providing what we believed to be sufficient time to detect an impact on mortality, if one had occurred.

We employ a conceptual framework to guide the evaluation process. The framework is intended to illustrate the rationale for selecting which key information is needed to evaluate impact. Because the study is a *post hoc* evaluation of an actual programme that relies primarily on existing data, it highlights the obstacles posed by such assessments. The report illustrates what data would best be obtained at the outset. It also illustrates what might be useful supporting information needed to rule out other factors that contribute to reductions in child mortality, including how one might obtain such data and interpret the results. The study is intended to serve as a logical model of programme evaluation, and makes recommendations that could guide other evaluators and programme managers.

In the following pages, we describe the use of data routinely gathered by the health services and data from other existing sources to assess the contribution of this large-scale vitamin A supplementation programme to reducing childhood mortality. However, one element of data that was missing at the time we undertook the evaluation was a post-intervention estimate of childhood mortality rates. A household survey was conducted in early 2002 to provide this important piece of missing information. We assembled data from this and previous surveys, programme records, and the Ghana health service to describe, to the extent possible, the impact of the programme on childhood morbidity and mortality in the three northern regions of Ghana.

DESIGN OF THE EVALUATION

Too often, health programmes must rely on post-hoc studies to assess their effectiveness. While it is preferable to plan an evaluation at an early stage, the questions managers and donors ask are sometimes formulated only when decisions must be made to continue, expand or end the programme[5]. In this situation, baseline measures of expected health outcomes must be sought from existing sources of data. If the relevant measures are available, this is an appropriate approach for programmes to take. Programmes that deliver interventions whose efficacy has been proved in controlled trials need not replicate the intensive data collection that determining efficacy requires. However, it is important that some comparison – either between areas served and not served by the programme, or before and after implementation – is made before asserting that the programme was responsible for a change. Without baseline data, a plausible evaluation of programme effectiveness and impact is rarely possible[i].

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[i] Many different terms are used in the evaluation literature. We have chosen to use the term 'programme effectiveness', to encompass the process of service delivery, including the provision, use and coverage of

The mass distribution of Vitamin A supplements to children in northern Ghana began simultaneously in the 3 regions. The intervention – mass information campaigns and distribution of supplements to 6-59 month olds – was delivered to the entire study area, although it is likely that programme activities varied considerably within the three savannah regions. No data to allow a comparison with similar areas not reached by the programme is possible, nor is it possible to identify, at the individual level, outcomes for those children who did and did not receive the VA capsules. Thus, we are able to design a study that compares only pre-programme (baseline) and post-programme information in aggregate for the three regions where the programme was first implemented.

The evaluation was designed to compare the health status of children in 1995, before the programme was instituted, with similar information for 1998, when mass distribution had become widespread, and in 2000, after it had been underway for four years.

Measuring mortality in countries like Ghana, where vital statistics are incomplete, biased, or otherwise unsuitable for programme purposes, can be a difficult and costly undertaking. We were able to make this comparison only because data on mortality levels just prior to programme implementation were already available. The mortality estimates from the 1998 Demographic and Health and surveys that preceded it, allowed us to describe a trend in mortality in the study area up to about 1993-95, just prior to the start of the programme. More recent estimates of mortality in the region – for post-programme comparison – were not available, and a survey to make these estimates was conducted in February-March, 2002. That survey provides information on mortality rates up to about the year 2000, well after the supplementation programme began.

The problem with such a "pre-post" design[6] is that, while the results may provide evidence that a change in mortality has occurred, such a study is unlikely to yield firm statements about the <u>cause</u> of an observed change. There are many potential confounding factors that make it difficult to attribute changes in mortality to a particular intervention. Ruling out the influence of at least some confounding factors is necessary, but especially difficult when the programme intervention, Vitamin A supplementation, has few specific effects beyond a broad reduction in childhood mortality.[7]

After a programme has been implemented, it is not usually possible to design data collection that would enable one to rule out the many potential confounding factors – economic and social, as well as health service-related– that also affect survival. In the *post hoc* case, it is usually possible to demonstrate only that a change in mortality (or morbidity) has occurred, concurrent with programme operation. [8]

Caution is necessary when interpreting the results of such studies, but as some of the few researchers who have attempted such studies state: "an evaluation with imperfect data is better than no evaluation at all"[9].

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the programme services. We use the term 'coverage' specifically to mean the extent to which the programme reached its intended targets. By 'outcome', we refer to the intermediate factors that lead to changes in mortality – in this case, primarily reductions in morbidity. In this report, we reserve the term 'impact' to mean changes in mortality.

Assessing the impact of programmes to prevent Vitamin A deficiency (VAD) present special difficulties because Vitamin A supplementation in a deficient population may have a substantial effect on overall mortality, even though its direct effect on specific diseases is small.

By compiling data to assess the process of implementation, a stronger case might be made for attributing causality, if it can be shown that the programme was effectively implemented.   And by gathering data on trends in other health behaviours, interventions, and conditions, the influence of some of these factors on health improvements may be ruled out. We therefore include both pre- and post-intervention comparisons of other indicators – risk factors for child death – as well as a comparison of specific health outcomes that the vitamin A supplementation programme was expected to influence most.

Such a study design will rarely allow us to make strong statements attributing observed changes in mortality and morbidity to the programme, but by assembling all available pieces of information, we may achieve a more coherent picture of what the programme has or has not accomplished. If the findings from analyses of all the components of our evaluation provide a consistent picture, this will strengthen the plausibility of our interpretation of the programme's effect.[10] [11]

For example, if we find that child survival has improved, that programme process is strong, and observe little change in other factors affecting child health, this may provide sufficient evidence of impact to make decisions to continue funding. If other factors that could contribute to such improvement cannot be ruled out, or if changes in mortality are not observed over the course of programme implementation, the findings could provide an impetus to commission more detailed evaluations of this and other Vitamin A supplementation programmes.

Framework and Assumptions

Figure 1 illustrates the conceptual framework and selected indicators that were used to guide collection of study data, together with selected indicators. The following section discusses the assumptions underlying this approach.

Programme factors

Mortality rates are unlikely to be affected by a programme that is not delivering the intervention to the groups most in need (those at highest risk of dying). The more evidence that can be compiled about a programme's operations, the easier it will be to substantiate (or dismiss) claims about the impact of the programme. The first step in an impact evaluation is to assess whether measures of service provision, use and coverage show that the process of programme implementation is progressing in the expected direction.[12] Therefore, the following information about programme implementation – service provision, use and coverage – was assembled. First, we compiled information to assess whether provision of Vitamin A supplements was adequate (including timing, supplies, equipment and personnel needed to deliver the supplements).

Service provision:
- the number of capsules provided by the programme;
- the number and timing of mass distribution rounds;
- how the distribution of supplements was implemented, including staff training, and provision of information about Vitamin A
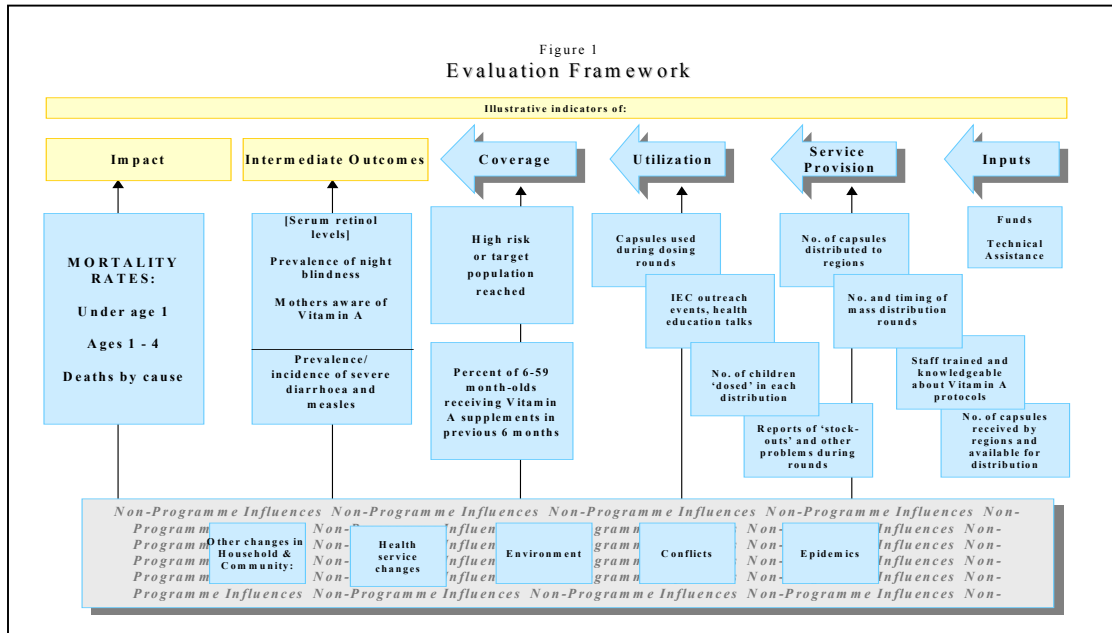
Figure 1 Evaluation Framework

If the vitamin A supplements were made available in a timely manner, we would expect *service utilisation* to increase. We obtained information on capsules used during distribution rounds, the number of children receiving vitamin A doses, how communities were informed of the distribution, and supply chain adequacy.
Service use:
- capsules used by the programme
- the number of children who actually received doses and when

Increases in use must extend to the population most at risk of dying, and so we obtained estimates of *coverage* of the target population (percent of all children 6-59 month olds receiving supplements). Uptake of at least two adequate doses of Vitamin A annually by the target population is needed to improve vitamin A status.

Coverage of more than 65% of the target population may be necessary to detect an impact on morbidity indicators[13], but there is no evidence available to suggest what minimal level of coverage must be achieved to observe a reduction in mortality. This level may vary according to the context in which the programme operates[14]. We must assume that coverage any lower than that reached in the field trials – 90% of children reached – is likely to result in an impact on deaths somewhat less than the 23% reduction averaged in those controlled trials.

Programme coverage:
- proportion of the population of 6-59 month olds reached by the programme.

Assumptions about morbidity and mortality

Assessing the impact of programmes to prevent Vitamin A deficiency (VAD) present special difficulties because Vitamin A supplementation in a deficient population may have a substantial effect on overall mortality, even though its direct effect on specific diseases is small. Most childhood diseases increase *frailty* among survivors (at least temporarily lowering immune status), and leave a child at higher risk of dying from other causes[15]. Reducing vitamin A deficiency (VAD) may contribute a great deal to an indirect reduction in death rates by preventing frailty (e.g. improving immune status). It may reduce case-fatality rates from a range of diseases, while it is only possible to specify an impact on overall mortality.

Impact on mortality

We collected data to examine age-specific mortality and causes of death, the ultimate indicators of impact. We examined trends in childhood mortality, comparing rates pertaining in the three northern regions prior to the start of the NVAP with rates current approximately four years post-intervention. We examined changes in infant mortality (mortality before age one) and in child mortality (mortality between ages one and five) in each region, and in all three regions combined. We expected to see a greater decline in mortality among children aged one to four years of age, since all children of this age were targets of the supplement distribution programme. Among under-ones, we expected any decline to be less marked, since only about half the children under age one are targeted and expected to benefit from supplementation.
Mortality impacts:
- age-specific mortality risks

Intermediate outcomes

If all indications are that the programme has been effectively implemented, we can assess changes in intermediate programme outcomes (morbidity, physical signs of vitamin A deficiency, and mother's knowledge), which could support a link between programme efforts and mortality impacts.

We obtained information about current prevalence of night blindness among children, even though little pre-programme data is available for the programme areas. Night blindness is a physical sign of vitamin A deficiency that can be measured through questioning in surveys and may provide supporting evidence to indicate that VA supplementation reached at-risk children. We can compare current prevalence with what is expected in the absence of a supplementation programme, based on night blindness prevalence in other vitamin A-deficient populations. We intended to obtain serum retinol status for sample of children in the study area, and compare the results with what is known about serum retinol status during pre-program times. Due to factors beyond our control, this component of the study had to be omitted. [16]

The definitive review of the results of Vitamin A supplementation trials concluded that the observed average 23% reduction in mortality following vitamin A supplementation was likely to be due, at least in part, to a reduction in deaths due to measles and diarrhoea.

Vitamin A supplementation is estimated to reduce diarrhoeal mortality rates by up to one-third[17]. A consistent effect of vitamin A on the severity of measles infection has also been documented.[18] These impacts are attributed to a reduction in the severity of cases of these diseases with improved vitamin A status.

Therefore, in addition to examining changes in overall mortality rates, we obtained information about the following intermediate outcomes through which improvement in vitamin A status is believed to act:

Intermediate outcomes:
- Night blindness prevalence
- [Serum retinol status]
- Prevalence of severe diarrhoea and measles
- Diarrhoea-associated mortality rates
- Measles mortality
- Morbidity associated with these conditions.

If positive changes in these intermediate outcomes were observed, this would provide further supporting evidence that the intervention has been effectively delivered to the targeted children.

We examined outpatient attendance and hospital admissions and deaths in selected hospitals in each region, to assess whether a reduction in *severity* of measles and diarrhoea episodes could be detected. Since direct information on severity of cases was not readily available, we used several proxy measures, which are described in a later section.

Non-programme factors

Finally, changes in childhood mortality can, and often are, affected by many influences not directly associated with this health intervention. As the framework in Figure 1 indicates, we also tried to document any major non-NVAP changes that may have occurred over the life of the programme, to attempt to rule out the contribution of these other factors to observed mortality declines. No major social upheavals, natural disasters, or crises affecting human security occurred in northern Ghana over the period under study. However, we examined trends in other factors affecting access to health services, behaviour that could affect diarrhoea and measles morbidity, and prevalence of other illnesses. These factors included measles immunization coverage, home treatment of diarrhoea episodes, household water supply, use of health services for childhood illness, and several socioeconomic indicators. All of these factors are potential contributors to a reduction in childhood mortality rates.

METHODS

Data sources

Phase I data collection
In the first phase of this case study, we extracted, collated and analyzed existing data from National Vitamin A Programme records and reports, and from health facilities in the three regions.

Programme information

The NVAP programme manager was our primary informant for service provision and utilization data. She provided data from national and regional programme and Ministry of Health Central Stores records and conducted key informant interviews with regional programme officers. We also obtained information from reports of previous process evaluations conducted by the national programme at various times after the programme in the north became fully operational[19].

Following the first mass distribution in a NID in November 1998, a detailed evaluation of the programme in the northern regions, including coverage surveys in selected districts, was undertaken. The report of this evaluation was used as a source document for this report[20]. Smaller focused monitoring exercises in selected districts in each region were also conducted following the January 2000 NID[21], the July 2000 "Vitamin A Day" distribution round[22], and May 2001 "Vitamin A day"[23] round. The three monitoring exercises included mini-surveys in selected districts, and an assessment of capsule handling, communication of workers with caregivers, and knowledge of mothers who took their children to the dosing rounds.

We compiled available information on capsule distribution coverage, that is, the extent to which the programme reached children aged between 6 and 59 months of age. Our data sources for this information were statistical reports from the national programme based on tallies of capsules dispensed and the estimated size of the target population group. Following each distribution round, the National Vitamin A Programme routinely calculates such 'coverage' estimates, based on the number of children recorded as receiving capsules and the estimated number of children aged 6-59 months. However, some regions report coverage rates above 100% based on these numbers. This problem is not uncommon, and may be due to inaccurate estimates of denominators based on outdated census information, or incorrect assumptions used to calculate the size of the target population. The improbable estimates may also indicate errors in records of the number of capsules distributed[24].

We also obtained population-based coverage data based on responses to questions asked in household surveys, which are not subject to denominator errors, but rely on the respondents' knowledge and are therefore subject to reporting errors. These data come from programme 'mini-surveys' in selected districts, previous national Demographic and Health Survey conducted in 1998, and the three-region household survey conducted in early 2002 as part of this case study.

Data extraction from clinic and hospital records

The other element of Phase I data collection consisted of compiling and analysing pertinent morbidity and mortality data from the regional health information system (hospital and outpatient service statistics). For the years 1995 (our baseline, pre-programme comparison year), 1998, and 2000, we collected data from the health services in each regional capital and one other district in each region to construct morbidity and mortality profiles.

Data on causes of hospital admissions and deaths among children were not available from routine reports for these regions and years. It was necessary to select certain facilities where we could extract these data directly from hospital records. Given time

and resource constraints, we chose facilities in districts where we would be most likely to detect a change in our proxy indicators of morbidity, if a change had occurred. We selected facilities in the districts with highest programme coverage and therefore most likely to benefit. If no changes were found in these areas, then our conclusions would be weakened.

In each region, data was collected from facilities in two districts. First, the regional hospital was selected as a site for data collection, as well as other facilities in that district. The regional hospitals, located in the regional capital, were the largest hospitals in each region. The second district chosen was the one with the highest average vitamin A capsule coverage, as measured by the NVAP. Districts were ranked based on their coverage statistics and the 'best' district was chosen in each region. If no hospital was located in that district, the closest neighbouring district with a hospital was chosen.

Data on causes of attendance from the outpatient departments of hospitals, health centers and clinics were assembled. These data were taken from the Monthly Outpatient Morbidity Forms, reports on attendance that are aggregated by age and cause.

Completeness of outpatient clinic data varied from region to region and among facilities. For Upper West Region, complete data was obtained for all facilities and for every month but one in1995, and for all months of 1998 and 2000. These data were reported separately for children aged less than one year and aged one to four years[25]. Upper West Region participated in the trials of a new Health Information Management system (HMIS) in 1995. This new HMIS was fully implemented in all regions beginning in 1997, and uses forms that require that outpatient attendance be tallied and reported separately for children under one year, and for children aged 1-4 years, as well as for other age groups. Prior to 1997 in Upper East and Northern Regions, all outpatient data were aggregated and reported by specific diseases, but not for different age groups. For this reason, the analyses dependent upon the outpatient data use only data for Upper West Region.

In each region, we obtained data from hospital in-patient wards on admissions and discharges of children 0-59 months of age for every month of the three years under study, a total of 29,298 admissions. Key items on each individual patient were extracted: age, dates of admission and discharge, discharge diagnosis and outcome (as these appeared in the records). Causes of hospital admission were assigned based on the discharge diagnosis rather than admitting diagnosis, in order to have benefit of fuller observation of the illness, confirmed by ancillary investigation or assessment by senior medical practitioners, during the course of stay.

Regional biostatisticians (Ministry of Health employees charged with compiling health service statistics) were responsible for supervising data extraction from hospital and outpatient registers onto summary forms. Two staff members from each regional health information office were trained in procedures for extracting and recording these data prior to beginning data collection. One of us (PA) paid support visits to each regional office, observed progress, guided resolution of problems, and supervised verification of data for selected months. The data collection procedures are described in further detail in Annex One.

Codes for diseases of interest ('tracer conditions') were assigned to the discharge diagnoses recorded (both principal and secondary diagnoses): diarrhoea, dehydration, measles, malaria, upper respiratory tract infections, pneumonia, and 'other' and 'unknown' causes. These data were then entered into a computer file at the Ministry of Health's Center for Health Information Management (CHIM) headquarters in Accra, supervised by the Center Director. Using EPI-INFO, a research fellow at Kintampo Health Research Center performed statistical analyses of these data.

These individual level in-patient data allowed us to examine trends in a number of proxy indicators for the age groups 0-5 months (where no changes were expected), 6-11 months, and 12-59 months of age. The 'unknown' outcomes were few (n= 348), cases of children whose families were unable to pay for care. Their records had been sent to the health administration for payment of their hospital charges by the government, and were unavailable for inclusion in the outcome analyses.

We encountered problems collecting these data retrospectively. After agreeing to participate in the training and data collection, the staff in one region fell behind schedule almost immediately and held up the process of data entry for the hospital data, occasioning several visits from the study coordinator.

Despite the verification procedures, Tamale Hospital, the largest of all the hospitals, provided very low numbers of admissions for certain months, leading us to suspect that information was incomplete for those months. We compared data on age and sex composition of admissions, diagnoses, outcomes, percent of data missing diagnosis, and average duration of stay, including and excluding data for Tamale Hospital. We wanted to assess whether inclusion of this large hospital's cases, if incomplete, would bias the results of the analysis. No differences were found, and we therefore included the data from Tamale Hospital in the analyses, in order to maximize the number of cases available for study. The distribution of admissions by month and year are displayed in the figure found in Annex One.

Phase II data collection

The only information on mortality available for this evaluation referred to the years preceding the inception of the supplementation programme, the most recent estimate centered abound 1993. These existing sources, the Demographic and Health Surveys conducted in 1993 and 1998, provide baseline mortality data for the impact evaluation. A new household survey was needed to provide estimates of childhood mortality for the period after the supplementation programme was initiated. In February and March 2002, a household survey was conducted in the three regions to obtain up-to-date estimates of child mortality.

The questionnaire

All women of reproductive age (15-49) living in a sample of households in the three regions of northern Ghana were the target respondents for the survey interviews. These women were asked to respond to questions about their births during the previous 10 years, and any deaths that occurred among those children. In effect, these questions elicit data to reconstruct the birth and death registration information for children born during that period.

The survey allowed us to obtain other supporting data for the study, including the coverage of the Vitamin A programme following the most recent distribution round (November 2001). The questionnaire also contained items to estimate night blindness among children 24 – 59 months compared with earlier surveys. To supplement other data sources, we also asked about immunizations of children in the selected households, women's knowledge and sources of information about vitamin A, knowledge and use of oral rehydration solution (ORS) and other potential confounding factors. Except for those about night blindness, all questions were drawn from previous Demographic and Health Survey questionnaires, in order to make comparisons with data from those surveys. The questions about night blindness had been used in previous studies in Ghana.

Sample design and sample size

A sampling statistician from the Ghana Statistical Service (GSS) drew a sample of 300 enumeration areas (clusters), the number of areas proportional to the size of each regional population. A new sample frame based on the March 2000 national census was used. Prior to data collection, separate teams identified and listed households in the selected enumeration areas (EAs), and a sample of 20 households was drawn from each EA.

O the 6000 households sampled, a total of 5,429 households were contacted, and 6542 women of reproductive age (15-49) were identified as eligible for interview. Of these women, 6334 women were successfully interviewed. 123 women were not at home (after re-visit), 31 were incapacitated and not available for interview, one refused interview, and 53 were not interviewed for other reasons. This yielded a response rate of 96.8% of women successfully interviewed.

Complete details of the survey methodology are found in Annex Three.

Training and fieldwork

Kintampo Health Research Centre (KHRC) organized the training of fieldworkers and assisted regional teams with logistics for the survey. The training course was conducted by the principal investigators, with assistance of GSS staff and staff of the regional health administrations. It was held in Tamale, Northern Region, in February 2002, just prior to the start of fieldwork. Three supervisors from Upper West and Upper East regions and 7 supervisors from Northern region were trained, as well as a total of 52 interviewers.

Listing teams of 20 individuals in Northern Region, 11 in Upper East and 10 in Upper West region were also trained separately by GSS staff. These teams visited each EA one or two days prior to the actual data collection, listed households and also provided information about the survey to local chiefs and assemblymen.

Three team leaders from each region also participated in the training course, and were responsible for overseeing fieldwork in their region. A research fellow from KHRC served as overall fieldwork coordinator. Fieldwork took place between 14 February and 12 March 2002.

Data management and analysis

Questionnaires were collated in regional headquarters and sent to KHRC, where data editing, entry and cleaning was performed by an experienced data manager and data entry clerks. This process took longer than anticipated, due to the death of the KHRC principal investigator (PA), but a final cleaned data file was ready for analysis by mid-August, 2002. Data analysis was supervised by one of the principal investigators (PD) and was carried out in Boston and London by two experienced demographers and a research assistant.

FINDINGS

Documenting provision of programme services

The National Vitamin A Programme (NVAP) initially devised a supplement delivery strategy adapted to the resources and needs of each region. Northern Region planned to implement a community-based strategy of dosing using community health volunteers (guinea worm surveillance coordinators). Upper West Region was to deliver supplements through school children (a 'child-to-child' strategy). In Upper East, where guinea worm volunteers were not active, and school attendance was low, doses were to be administered during routine contacts with the health services. UNICEF committed funding to the programme, which was implemented by the Ghana Ministry of Health (Nutrition Division and Health Research Unit). The Micronutrient Initiative (MI)/Canadian International Development Agency (CIDA) provided vitamin A capsules. Later other donors, including the United States Agency for International Development (USAID), the World Health Association (WHO), and Rotary International also provided support to the programme. Kintampo Health Research Centre, in Brong Ahafo Region, served as the base for a programme coordinator from the Ministry of Health's Nutrition Unit, who provided support to health teams in the three northern regions.

Process evaluations

In late November 1998, a workshop was held in Accra to review results from the first years of the distribution programme. The review covered activities beginning in 1997 and continuing through the first vitamin A capsule distribution in a National Polio Immunization Day (NID) in November 1998. The review revealed some difficulties implementing these different regional strategies[26].

In Upper East Region, the opportunistic delivery of supplements at routine service contacts (outpatient departments, child welfare clinics, postnatal clinics, outreach services, school health services) did not operate well, due to infrequent and late provision of capsules and low attendance by the target group at facilities.

Northern Region also experienced difficulties with their community-based approach, attributed to under-staffing, a very large, scattered population, and many areas that were inaccessible during part of the year. Limited resources for transporting supplies and shortages of appropriate number of 100,000 IU capsules (which apparently resulted in over-dosing of 6-11 month olds with 200,000 IU capsules) were also noted as problems. The guinea worm surveillance volunteers also complained about dosing rounds that took place during the rainy or farming seasons, which hindered them from doing other work.

Upper West Region, implementing the child to trial strategy, had difficulty coordinating activities with the Ministry of Education, because initially these activities coincided with end-of-term exams and preparation for holidays. Late arrival of capsules, and difficulties delivering capsules to schools in distant districts were also noted. Over-dosing of isolated cases and poor handling of capsules was also found. Concerns were expressed about the lack of maturity of primary school students and the inappropriateness of using them to identify potential beneficiaries. In some cases teachers decided to distribute the capsules themselves, rather than rely on their students to do so.

In November 1998, all three regions implemented an additional distribution of supplements during National Polio Immunization Days (NIDs). According to programme records, once the NID distribution began, a high proportion of the population was reached in all districts. Based on this review of progress, the initial plans were revised. All three regions would conduct biannual mass distribution campaigns in the community, one of which would occur during the National Polio Immunization Days (NIDs). Based on the experiences reported with the supplementation programme in the three northern regions and the results of a prevalence survey that had just been completed in the remaining southern regions, a recommendation to extend this programme to the rest of the country was made.

Provision of Vitamin A supplement capsules

The distribution through NIDs was extended to all ten regions of Ghana in 1998, beginning with the NID exercise conducted in November 1998. However, lack of funding prevented a second-dose mass distribution in the spring of 1999. According to the NVAP coordinator, some distribution occurred in the spring of 1999, but we were able to confirm only that this took place via 'routine' dosing at health service contact in Northern and Upper West Regions, and to a lesser extent in Upper East Region. A second distribution of Vitamin A capsules in a NID took place in January 2000, postponed from November 1999 due to massive flooding in most parts of the country.

In July 2000, an additional mass distribution round, a National Vitamin A [distribution] Day conducted like the NID, was added to the national programme. Subsequent "Vitamin A Days" were planned to follow each NID, scheduled for November of each year, by about six months. Table 1 summarizes the timing of capsule distribution in the three northern regions.

Table 1. Timing of VA distribution in the regions during period of study			
	Northern	**Upper East**	**Upper West**
Round 0 1996	-	-	ad hoc distribution
Round 1 Oct/Nov.97	-	-	ad hoc distribution
Round 2 Spring 1998	Vitamin A dosing	Intermittent dosing	Vitamin A dosing
Round 3 November 1998	NID	NID	NID
Programme review conducted			
Round 4 Spring/summer 1999*	-	-	-
Detailed process evaluation conducted in entire country			
Round 5 January 2000	NID	NID	NID
Focused monitoring exercise in selected districts			
Round 6 July 2000	Vitamin A Day	Vitamin A Day	Vitamin A Day
Focused monitoring exercise in selected districts			
Round 7 November 2000	NID	NID	NID
Round 8 May 2001	Vitamin A Day	Vitamin A Day	Vitamin A Day
Focused monitoring exercise in selected districts			
Round 9 November 2001	NID	NID	NID

Source: National Vitamin A Programme coordinator.

Distribution of capsules to regional offices

We asked the National Vitamin A Programme coordinator to obtain records of the number of vitamin A capsules dispensed to each region from Central Medical Stores and records of vitamin A capsules received and dispensed during each distribution round from the programme's regional offices. Some records for early years of the programme also could not be located. One regional programme officer had left the MOH, and records could not be located at regional headquarters. Upper West Region was the only region to supply their data in response to a questionnaire sent from the NVAP for this case study. Upper West Region was able to supply some data for 1996, the first year of the programme. The NVAP programme coordinator in Accra compiled the other regional data reported in the table, and also obtained distribution information from Central Medical Stores (CMS) in Accra. Only partial information, shown in Table 2 below, was obtained.

Table 2. Total number of capsules provided from Central Medical Stores (Accra), and number received by regions (blue and red doses combined)

	Northern		Upper East		Upper West	
	Provided by CMS	Received	Provided by CMS	Received	Provided by CMS	Received
Round 0 1996						269,500*
Round 1 Oct/Nov.97						N/A
Round 2 Spring 1998	-		-		195,455	195,455
Round 3 November 1998	389,406		218,837		126,944	
Round 4 Spring 1999	636,000		137,000		202,500	176,000
Round 5 January 2000	486,000		137,000	163,177	239,000	239,000
Round 6 July 2000	720,000	692,000	269,016	269,500	152,400	152,000
Round 7 November 2000	720,000		269,016	224,000	152,400	54,000
Round 8 May 2001	741,600		277,087	277,087	156,972	195,559
Round 9 November 2001	741,600		277,087		156,972	

* The first distribution was recorded by Upper West region, consisting of ad hoc distribution of capsules in routine services. Unused capsules were carried over to subsequent rounds. In the May 1999 assessment of programme activities (MOH, July 1999) Upper West region reported that about 97,300 of these capsules had expired before they could be used.

The empty cells in Table 2 reflect the difficulties our Ministry of Health colleagues experienced in documenting the path of capsules to the regional programme offices, problems especially prominent for earlier years. A close examination of these data discloses some inconsistencies. For example, more capsules were reported received than recorded sent from central stores, and exactly the same number of capsules sent, received and 'used' were reported in one of the more recent rounds in Upper East Region. Since unused capsules were stored and carried over to subsequent rounds, but some expired capsules could not be used, we would not expect a perfect accounting from the regions. Nevertheless, missing data does reflect some problems with the NVAP record-keeping system.

Logistical problems of capsule availability were noted in the monitoring reports for early rounds, but later assessments did not include similar interviews with health teams to ascertain whether timeliness had improved and supply of capsules was sufficient. Although NVAP reports state that no funds were available to provide a mass distribution round in spring, 1999, records show that capsules were sent to each region. Only Upper West Region records reflect receipt of these capsules, although receipts were less than records of capsules sent. An Upper West Region report states that capsule distribution continued during 1999 through health service contacts.

Use of services

The programme also records – or attempts to record – the number of capsules used and 'wasted', and the number of children who actually received a Vitamin A dose during each distribution. Table 3 displays the information available from programme records as of late 2001. Again, some information is missing, especially for the early years, but most regions recorded the number of children dosed during each mass distribution round.

The Programme obtains these data by cumulating the tally sheets used in each district, and calculating district-level coverage based on an estimate of district populations of children 6-59 months of age. These data are then aggregated at regional level and sent to NVAP headquarters in Accra.

Table 3. Total number of capsules used during distribution rounds (including wasted doses) and numbers of children dosed (blue and red doses combined)						
	Northern		Upper East		Upper West	
	Capsules used	Children dosed	Capsules used	Children dosed	Capsules used	Children dosed
Round 0 1996						
Round 1 Oct/Nov.97					116,508	NIL
Round 2 Spring 1998	*281,480**				67,018	
Round 3 November 1998	*302,742**	257,995	*194,437**	167,474	114,563	
Round 4 Spring 1999	-	-	-	-	70,240	
Round 5 January 2000		351,111	143,716	146,604	112,050	*112,050*
Round 6 July 2000	347,034	394,104	194,500	200,355	81,095	*81,095*
Round 7 November 2000		413,561	195,863	201,824	118,379	
Round 8 May 2001		415,680	277,087	219,741	139,529	138,253
Round 9 November 2001	unavailable					

* From Quarshie and Amoaful, 1998. Other data were obtained by the NVAP coordinator from regional programme records.

Overall these tally sheet data indicate that increasing numbers of children in each region were reached during succeeding distribution rounds.

Training

One indication of commitment to the program is the effort expended on training for distribution of vitamin A capsules at the start of the program and before each distribution round. Prior to the first "Vitamin A Day" mass distribution round held in July 2000, a training manual was developed by the NVAP for use in the regions. All of the process evaluations of vitamin A administration during campaigns (1999 through 2001) indicate that the regional teams held training sessions before each round, first training regional and district health teams as trainers, who in turn trained larger numbers of district staff to distribute capsules. At the beginning of the programme, training also included community health volunteers in Northern region, and teachers in Upper West region, reflecting differences in the initial strategies for distribution used in the different regions.

Information, education and communication (IEC) and social mobilization

The supplementation programme included information, education and communication (IEC) activities intended to raise awareness of the distribution programme and to increase parental knowledge of its benefits. Process evaluations and monitoring exercises report that town criers and public address systems in market places were used in all regions to announce dosing periods. Posters, health talks in static and outreach facilities, and in Northern region house-to-house visits by volunteers, were other methods used to announce the place and timing of the dosing rounds. The monitoring reports also mention use of community 'durbars' (a community meeting convened by the

chief or elders for a special purpose, a local symposium) held in some districts to raise community awareness about the upcoming distributions.

In Upper East Region, scripts for radio announcements and radio jingles were produced and aired as part of the mass media awareness-raising activities. Announcements in churches, mosques, schools, markets, and from mobile vans were also made. In Upper West Region radio spots and radio discussions were also used to increase awareness of the upcoming rounds. Reflecting the child-to-child strategy employed in the early rounds in this region, briefings in Upper West were held with parent-teacher associations, and teachers gave talks about vitamin A to their students. Health talks focusing on vitamin A were given at child welfare clinics and to traditional birth attendants with the aim of educating newly delivered women.

National radio and TV IEC messages were developed and transmitted during June 2000. In addition to the usual IEC and community mobilization activities, audiocassettes of the media spots were distributed for use on public address systems from mobile vans. These activities culminated in the national launch of the Vitamin A distribution by the Minister of Health.

The January 2000 monitoring exercise found that many mothers were not aware that their children had received a VA capsule, while awareness of the receipt of polio vaccine was high. Training in IEC and social mobilization techniques and intensified supervision during the next round was recommended.

While logistical problems of capsule supply appear to have been minimal in the July 2000 distribution, and excellent community mobilization attracted caregivers to the distribution sites, awareness of the importance of vitamin A for children remained low. The low coverage estimates in the two regions still implementing child-to-child approaches to distribution – Greater Accra (54%) and Upper West (63%) – called the child-to-child strategy into question.

The May 2001 monitoring exercise reported a general improvement in knowledge of vitamin A among caregivers, and earlier problems with availability of capsules at sites had improved considerably. Nevertheless, knowledge of when the next VA distribution would occur was still very low, according to the mini-survey results, and this was noted as a problem to address in pre-distribution training and supervision during the next round.

From these assessments, we can conclude that IEC activities were carried out in each region, and improvements were made over time. However, at the end of a distribution round most mothers were still unsure about when future capsule distributions would occur.

Coverage of the Vitamin A programme

NVAP coverage estimates based on tallies

The NVAP has been diligent in obtaining estimates of programme coverage from each region, following the mass distribution rounds. As noted earlier, each district estimated coverage based on tallies of children dosed and the estimated proportion of target-age children. As we can see from the data displayed in Table 4, these estimates show very

high coverage of 6-59 month olds with VA capsules. In almost all rounds beginning with the November 1998 NID distribution of VA capsules, coverage estimated by the programme is well over 90% of children.

Coverage levels rose above 100% for many rounds. When the 2000 Census data became available for estimating the population denominators, this inflation of coverage above what is possible increased. Prior to this time, the target group population was estimated by projecting the 1984 census population forward. Figures in parentheses in Table 4 are based on 2000 Population Census estimates for the target age group (6-59 months old). (See also Annex One Figure A1.1.)

Table 4. Trends in vitamin A coverage: percent of 6-59 month olds dosed, according to programme tally sheet reports

	Northern	Upper East	Upper West
Round 1 Oct/Nov.97	84.8	-	90.3
Round 2 Spring 1998	77.3	-	71.0
Round 3 November 1998	(92.4)/84.8*	93.6*	92.4*
Round 4 Spring 1999	93.2**	District range 5-40%**	56.1**
Round 5 January 2000[27]	93.0	67.4	89.6
Round 6 July 2000[28]	100.4	89.4	62.9
Round 7 November 2000	105.3	90.0	104.3
Round 8 May 2001	(119.8)	(117.3)	(129.8)
Round 9 November 2001	(124.9)	(97.1)	(128.5)

*Coverage report (MOH, 1998) appears to be based on total capsules used, rather than children dosed. ** Data from NVAP coordinator, no source attributed.

The May 2001 monitoring report questions the accuracy of the new target group estimates because of reported coverage of over 100%.

This overestimation of coverage is a common problem when population denominators must be estimated from census projections. Errors in estimating target group size can lead to improbable or impossible coverage rates. Another source of error in such calculations is the use of incorrect numbers of ''children dosed''. It is possible that some districts reported the number of capsules used, which includes wasted capsules and use of two low-dose capsules to dose older children when the 'red' capsules are in short supply. The variations in these regional estimates and the obvious over-estimation make these coverage data hard to interpret. These data are not convincing evidence of a consistently high coverage level. For this reason, population-based coverage data, based on responses to survey questions, is preferred for estimating actual programme coverage.

Survey estimates of coverage of the target population

For the early programme periods, population-based survey data is available only for a few selected districts, known by the NVAP as 'mini-surveys'. In the 1999 mini-survey, mothers in selected districts in all three regions were interviewed. Coverage from these reports is close to estimates from the 1998 distribution round tally sheet reports. Since these mini-survey estimates are based on a small number of mothers and children in the selected districts, the margin of error for these estimates is likely to be large. Only one district, Nadowli District, in Upper West Region was included in the 2000 and 2001 mini-surveys, and estimates are not comparable to any of the other data[29].

Table 5. Trends in vitamin A coverage from national and district surveys, 1998 and 2002: Percent of 6-59 month olds reported receiving a vitamin A dose in previous 6 months

	Northern (N)	Upper East (N)	Upper West (N)	All regions combined (N)
1998 DHS	41.0 (283)	64.7 (227)	42.7 (300)	50.3 (810)
1999 mini-survey[30]	94.7 (360)	87.2 (180)	87.8 (180)	-
2000 July mini-survey	-	-	86.5 ( )	-
2001 May mini-survey	-	-	93.2 ( )	-
2002 IHNS	82.2 (2106)	78.3 (912)	64.2 (565)	78.4 (3563)
IHNS – not sure when	4.4	8.6	20.9	8.0
IHNS – ever received	91.6	93.5	89.9	91.8

The programme mini-surveys all used a series of questions directed to the 'person most likely to have taken the child for vitamin A supplementation' – not necessarily the child's mother. The national DHS and 2002 IHNS simply showed the capsules to mothers, and asked whether each child had received such a capsule, and if so, when the last one was received. (Questions used in the different surveys are found in Annex One).

We analyzed the data on vitamin A capsule coverage from the 1998 Demographic and Health Survey to obtain estimates for 6-59 month olds. This survey was conducted from mid-November 1998 to mid-February 1999. A NID/vitamin A distribution round took place in early November 1998. This analysis resulted in far lower coverage estimates

Figure 2. Changes in Vitamin A Capsule Coverage , 6-59 month olds
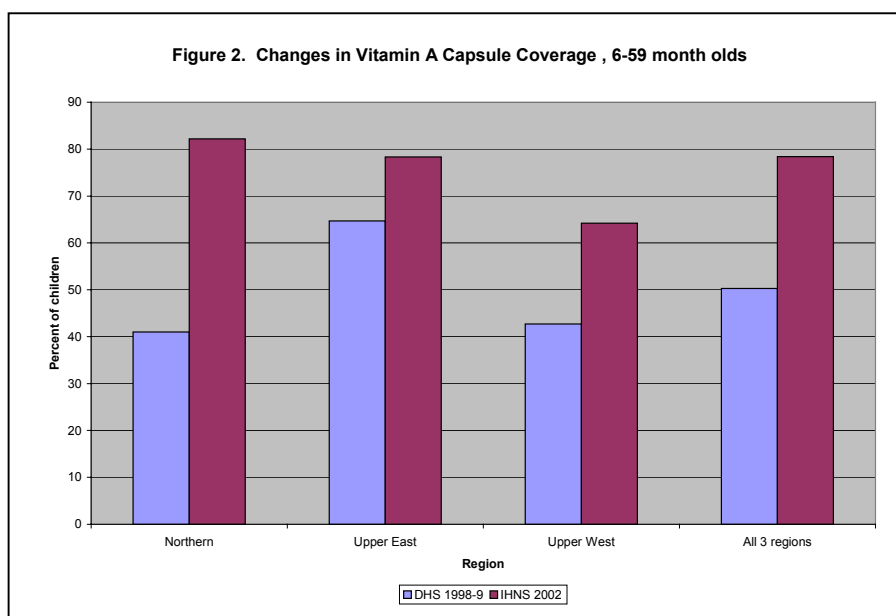
for the three regions than NVAP reports indicate, reaching only 50% coverage for all regions combined. Note also that the sample sizes for the regional DHS estimates are also quite small.

The IHNS survey was conducted less than six months after a NIDS/VA mass distribution held in November 2001. The data in Table 5 that can be compared are shown graphed

in Figure 2. The data from the IHNS survey provides evidence that the coverage of children in the target age range in these regions is indeed very high following the November 2001 round. There is a clear increase from the coverage estimates produced from the DHS survey conducted at about the same time of year in 1998. No programme was operating in 1993, when an earlier DHS survey was conducted and no data was obtained about vitamin A supplementation in that earlier survey.

It is worth noting that the graph shows data for capsule receipt within the previous six months, but a significant portion of children's mothers also responded 'don't know when' the capsule was last received (see Table 5), and this amounted to almost 20% of the respondents in Upper West Region. Mothers in northern Ghana have a difficult time dating specific events. References to dates in these regions are not as precise as those made by women in urban Ghana or in more developed countries. Therefore, it is quite possible that relying only on responses from mothers who provided an answer to the question "when did the child receive his/her last dose?" somewhat underestimates coverage. These survey data corroborate the fact that, while coverage as reported by the NVA Programme is clearly too high to be reasonable, it probably lies somewhere between the IHNS estimates and the programme estimates shown in Table 4. Similarly, the estimate of coverage in 1998 may lie somewhere between the DHS (50%) and NVAP programme estimates.

We know that prior to 1995, in the absence of the programme, no supplements were available for distribution. The two succeeding survey estimates based on the same methodology suggest that an increasing proportion of children are now receiving vitamin A capsules than when the mass distribution rounds were beginning, in 1998. The evidence suggests that current coverage probably approaches at least 80% in the three regions, a significant achievement for the NVAP.

Assessing Impact: Trends in childhood mortality

We now turn to survey data to examine changes in the risk of dying in childhood in the study area. We use data from the 1993 and 1998 Demographic and Health Surveys (DHS) and the Integrated Child Health and Nutrition Survey (IHNS) conducted in early 2002. We examined trends in the risk of dying for children in each age group, with a special interest in the age group most likely to benefit from vitamin A supplementation, the one- to four-year-olds.

In the following discussion infant mortality (IMR) is defined as the probability of dying between birth and the first birthday. Child mortality (risk of dying from age 1 through 4, or $_4q_1$) is the probability of dying between exact age one and the fifth birthday (up to but not including the 5th birthday), and under-5 mortality is the probability of dying between birth and the fifth birthday.

The mortality rates are shown centered around three points in time, 1988, 1993, and mid-1999. These rates are based on person-years of exposure to the risk of death during the ten year intervals preceding the 1993 and 1998 surveys, and the five year interval preceding the 2002 survey. The small samples from these regions in the DHS surveys preclude any more precise time reference.

Survey data provide us with estimates <u>averaged</u> around those points in time. For example, the one to four mortality rate is calculated by counting the number of deaths in

that age group and dividing by the total number of months lived by children at that age during the specified time period. Because of the way survey data are gathered, and the imprecise dating of births and deaths in northern Ghana, it is not possible to provide reliable estimates for specific dates between these points. The trend lines drawn in the figures are not meant to suggest that the trends were linear, but only to show that there are differences between age groups in the rate of the decline.

Mortality estimates from these surveys should be viewed with caution because all survey methods are likely to somewhat under-estimate the actual level of mortality. Also, the number of women and children that enter the analysis for the two DHS surveys is considerably smaller than the sample obtained in the IHNS survey, which leads to much higher sampling errors for estimates for the earlier periods. Sampling errors and confidence intervals for these estimates are found in Annex Three, Table A3.2.

Our evaluation of the quality of the mortality data suggests that some deaths in the most recent calendar period (1997 to 2002) may have been omitted. Some of these omissions are likely to be due to mis-reporting of birth dates. The data show a deficit of births in 1997 and an excess of births in 1996, and the deficit is more pronounced for dead children than for children still alive at the time of survey. The displacement of the dead children suggests that the absolute level of mortality for the most recent period may be somewhat underestimated.

We also detected some heaping of deaths at age 12 months, which would lead to and under estimate of the IMR and overestimate of mortality from age one to four. In sum, our assessment of these data indicates that the age pattern of mortality, that is, the difference between under one and 1-4 mortality risks, is unlikely to be affected by these deficiencies. See Annex Three for a description of the 2002 survey, and the evaluation of the quality of these data.

Findings – Trends in mortality in northern Ghana

Neonatal mortality and conditions surrounding birth contribute heavily to estimates of infant mortality. In less-developed countries between 50 and 60 percent of all deaths in first-year of life occur in the first month. Changes in the rates of dying in the neonatal period are known to be more dependent upon technology and care at the time of the birth, especially care that can only be provided in referral hospitals, than on other factors. Few births in northern Ghana or other regions of the developing world take place in hospitals, and so the IMR would be expected to fall more slowly than at other ages, which are likely to be affected by public health interventions.

When a child reaches age one, and during the next several years, the effects of weaning, the child's increased mobility, and the decline in maternal antibodies that transmit immunity all mean that a child is more likely to be exposed to the risk of contracting infections. Diarrhoea (and in the absence of immunization, measles), as well as other infections, contribute more to death rates at one to four years of age than before age one.

The survey data suggest that mortality at all ages has fallen since before the NVAP began. Estimates (displayed in Table 6) indicate that mortality in the three northern regions has declined to below the level that prevailed for all Ghana, including the more advantaged regions in the south seven years ago. Such a dramatic reduction is unlikely,

and suggests we should view the absolute level of these estimates with caution, until the trend is confirmed by future surveys.

Table 6. Trends in childhood mortality, 1988 – 2000, three northern regions combined				
Data source	Approximate mid-point for estimate	Risks of dying at different ages		
		IMR (Under 1 year)	$_4q_1$ (1 – 4 years)	Under-five
GDHS 93	1988	106.1	118.6	212.1
GDHS 98	1993	74.8	93.4	161.4
IHNS 2002	1999.5	48.2	31.2	77.9
GDHS 98 – all Ghana	1995.5	56.7	53.9	107.6

The trends over the past 15 years for infant, child (1-4) and under-five mortality rates for all regions combined are shown graphically in Figure 3.

From the graph, it is easy to see that mortality between ages 1 and 4 fell more rapidly than infant mortality. Between 1988 and 1993, the infant mortality rate (IMR) declined by almost 30%, and between 1993 and mid-1999 by about 35%, a steady, nearly linear decline since 1988. For children ages 1 to 4, mortality risks appear to

Figure 3. Trends in Childhood Mortality - 3 northern regions of Ghana

decline by 21% between 1988 and 1993, and by more than 65% between 1993 and mid-1999.
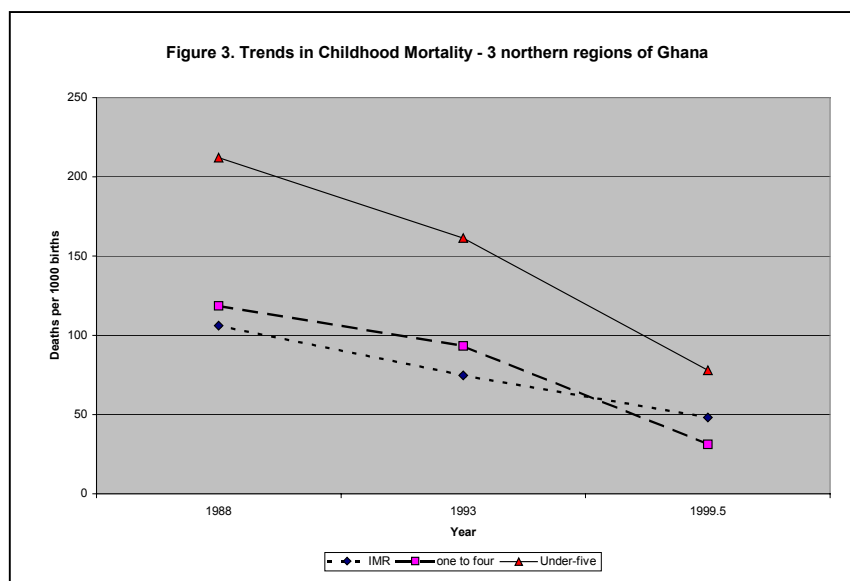
Figure 4 displays the regional data for the age group 1-4. From these data we can see that there were some differences between the regions. All regions experienced a decline in mortality, but in Upper West, the decline in the risk of dying between ages one and four was less rapid than in the other two regions. (Remember that Upper West Region reported the lowest vitamin A coverage rates of the three.)

The finding that mortality declined more among older children than among infants (children less than a year old) lends some support to the hypothesis that vitamin A supplementation, which should affect children over the age of one more than at younger

ages, contributed to improved survival for this age group. However, changes in other health behaviors that could prevent deaths from these causes, such as increased use of home treatment for diarrhoea, a major cause of death at this age, could also explain some of this decline in mortality.

Figure 4. Regional trends in mortality ages 1 to 4
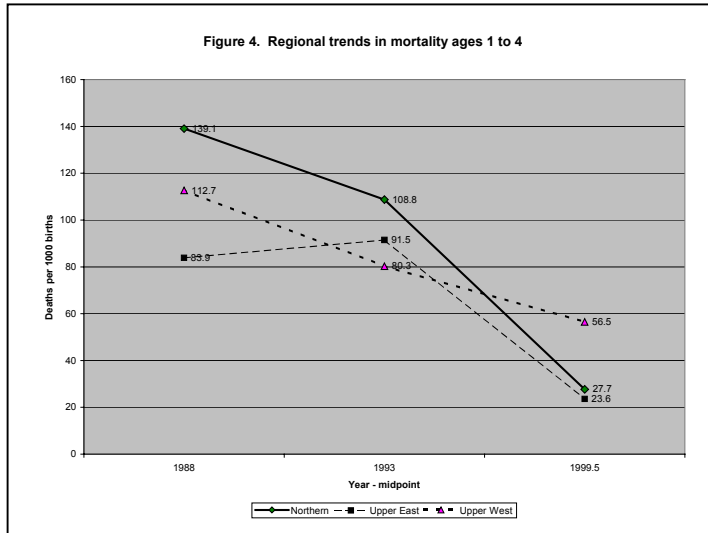
Figure 5 displays the regional trends in infant mortality. It is clear that deaths among under-ones have declined in these regions, too, but the absolute change is smaller and the rate of decline is not as steep as among one to four-year-olds in any of the regions.

The risks of dying in childhood have fallen consistently and steadily in almost all countries in the past 50 years[31]. The exceptions to this are found only very recently in countries heavily affected by HIV/AIDS. HIV incidence has not reached high levels in the three northern regions of Ghana, although it has become a greater problem in the south, including Accra[ii]. At the levels of prevalence thought to prevail in northern Ghana, we would not expect to see an impact of AIDS on child mortality rates. From our data, AIDS does not yet appear to have affected childhood mortality rates.
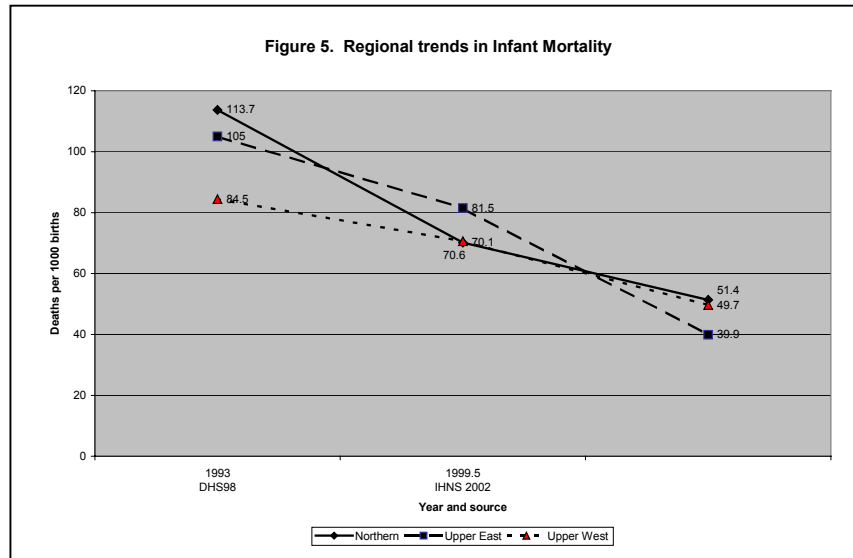
Although the mortality changes certainly appear to be more

Figure 5. Regional trends in Infant Mortality

prominent in the age group where we expect vitamin A supplements to be most beneficial, there are many other factors that may have contributed to the observed decline in mortality. In a subsequent section, we attempt to rule out some of these other factors.

[ii] Sero-prevalence surveys in 2000 revealed the less than 1 percent of the population in Bolgatanga, in Upper East Region, were HIV-positive, while nationwide the prevalence is estimated at between 4 and 5 percent of the general population (Ministry of Health, 2001). This is far lower than the 20 percent prevalences seen in Zambia and other countries where child mortality has risen.

First, we will look for any supporting evidence that might substantiate the hypothesis that the vitamin A supplementation program had contributed to this improved survival by examining some intermediate biological outcomes. If the sharp decline in risk of dying after age one has occurred, what mechanisms might explain it?

Intermediate outcomes: Morbidity and mortality from hospital records

A reduction in vitamin A deficiency is thought to reduce severity of two illnesses – diarrhoea and measles [32]. Using several proxy indicators of illness severity, we attempted to test the hypothesis that vitamin A has reduced the burden of severe diarrhoea and measles in northern Ghana, thereby contributing to a reduction in mortality.

Reasons for attendance at out-patient clinics

We examined whether Vitamin A reduces the perceived severity of diarrhoea and measles, as shown by a declining proportion of children attending outpatient clinics (OPDs) for diarrhoea and measles over time. By interpreting these data, we make the assumption that care-seeking behavior has not changed over the period. That is, illness recognition, patterns of access and use, and adherence to treatment regimens have not changed over the five years of the study, or, if they have, that the change has been the same for all the tracer conditions. If we can make this assumption, then use of outpatient services can serve as a proxy for changes in severity of diarrhoea and measles, at least as perceived by caretakers.

For reasons described earlier, this analysis employs outpatient data from Upper West Region only and is presented in full in Annex Two. Here we show some of the data that indicate that severe diarrhea, at least as perceived by the caretaker, fell markedly in Upper West Region.

These data refer only to the experience of children whose parents brought them to the health services, and do not reflect the experience of illness in the entire population of children in these regions.

The data shown in Table 7 shows that absolute numbers of children attending outpatient clinics for diarrhoea was reduced by two-thirds between 1995 and 2000, while attendance for all other causes more than doubled.

Table 7. Absolute number of attendances at OPD clinics in Upper West Region for diarrhoea and all other causes, by age and year.

|		Reason for attendance at OPD clinics	
Age	Year	Diarrhoea	All other causes
0-11 months	1995	489	4649
	2000	339	11386
1-4 years	1995	681	6942
	2000	443	13555
All ages	1995	1170	11591
	2000	782	24941

If attendance at OPD clinics is a true proxy for perceived severity, our analysis of outpatient statistics provides some evidence that perceived severity of diarrhoea and measles declined in Upper West Region. In addition to the absolute decline in attendance for diarrhoea, the odds that a child aged one to four would be brought to an OPD for diarrhoea fell by almost 75%, when compared with attendance for all other causes combined. (See Annex Two). We will examine other possible causes of these trends in a later section of this report.

<u>Causes of admission to hospital</u>

Secondly, we used several proxy indicators for <u>actual severity</u> of diarrhoea and measles. We examined trends in the <u>proportion of children admitted to hospital</u> for these conditions and <u>outcomes of admission</u> for diarrhoea and measles. We used case fatality rates, average duration of stay, and proportionate mortality for diarrhoea and measles as indicators of outcomes. Our assumption for this analysis is that severity at presentation to a hospital is what drives the outcome, and not the quality of care received, and that the quality of care has not changed over the period (or has changed in ways that affect all tracer conditions equally).

Now, we turn to hospital inpatient data from all three regions to examine whether severity of diarrhoea and measles has declined. We do so by looking at trends in the ratio of hospital admissions for diarrhoea and measles compared to total hospital admissions. Our assumption is that if severity of diarrhoea and measles has declined, then the odds that a child would be admitted for these causes should decline, compared to admissions for all other causes.

We look first at the data in Figure 6 for children aged between 6 and 59 months, the age group where we expect vitamin A to have an impact on disease severity. Diarrhoea admissions declined as a proportion of all admissions among children aged between 6 and 59 months. The decline was small, from 11.8% of all admissions in 1995 to 8.2% in 2000. The proportion of children admitted for measles also declined from 2.1% in 1995 to 1.1% in 2000. Admissions for respiratory illnesses, on the contrary, remained stable, accounting for about 9% of all admissions in 1995 and 8.8% in 1998 and 2000. Malaria increased proportionately as a cause of admission over the study period.

Figure 6. Trends in proportionate admissions to hospital, children 6-59 months old
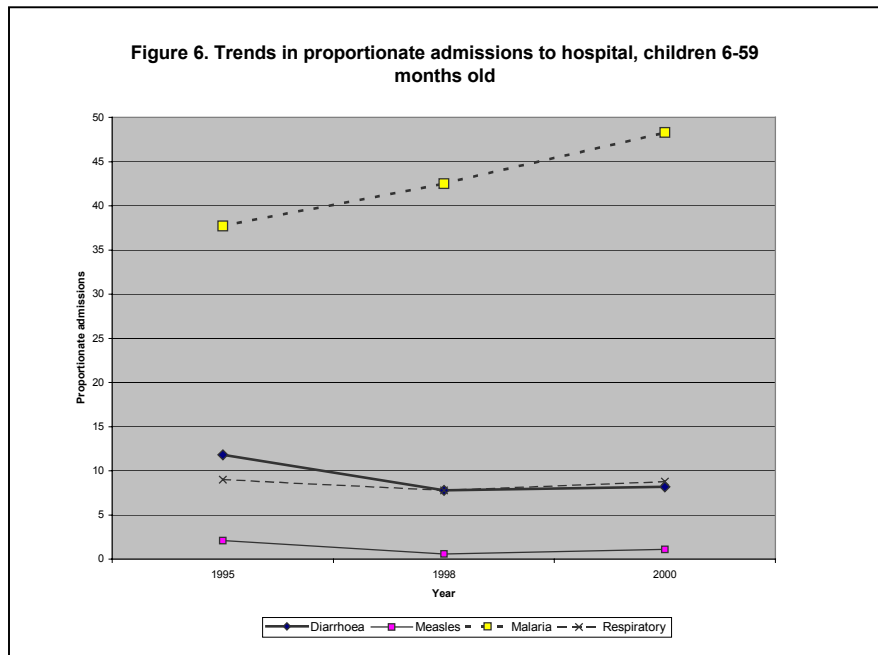
The data in Table 8 test for significance of these trends, comparing the odds of admission for each cause with all other causes combined. These data confirm that a child was 22% more likely to be admitted for malaria in 1998 than in 1995. That child's odds of having malaria as a cause of admission were 56% higher in 2000.

The odds of a child being admitted for respiratory illnesses (upper respiratory tract infections and pneumonia) were unchanged for 6-59 month olds over the same period.

For children ages 6 to 59 months, the odds of being admitted for diarrhoea, as compared with admissions for all other causes declined significantly (Table 8). These odds declined by almost 40% between 1995 and 1998, and by about 33% between 1995 and 2000. No similar decline was found for 0-5 month olds (Data for the younger age group is found in Annex Table A2.3).

Table 8. Odds of admission for diarrhoea and other tracer conditions compared to all other causes, 6-59 month olds				
Diagnosis	1995:1998		1995:2000	
	OR	95% C.I.*	OR	95% C.I.
Diarrhoea: all other causes	0.63	0.56 – 0.71	0.67	0.60 – 0.74
Measles: all other	0.30	0.21 – 0.42	0.51	0.39 – 0.66
Malaria: all other	1.22	1.14 – 1.31	1.54	1.45 – 1.64
Pneumonia: all other	0.98	0.87 – 1.10	0.97	0.87 – 1.08

*Confidence interval (C.I.) around odds ratios. C.I.s containing 1.0 (the reference category) indicate no significant difference.

The odds of a child being admitted for measles also declined significantly between 1995 and 1998 and between 1995 and 2000 by about 70% and 50%, respectively.

If we can assume that a reduction in the odds of admission for diarrhoea or measles signifies a change in the prevalence of severe diarrhoea or severe measles, this analysis has provided further evidence that severity of cases presenting to the health services has decreased. The argument is strengthened by the stability of admissions for pneumonia, a condition not believed to be affected by vitamin A status.

Outcomes of hospital admission

Finally, we examine whether Vitamin A improves the outcome of cases of diarrhoea and measles admitted to hospital. That is, improving trends in these outcomes indicates a reduction in severity of cases reaching hospital, as shown by trends in three proxy indicators:

- case fatality rates for diarrhoea and measles
- duration of admissions for diarrhoea and measles
- proportionate mortality for diarrhoea and measles, and the odds of dying of these diseases in hospital, as compared to all other illnesses

The assumptions underlying these analyses are that that severity at presentation is what determines the outcome, and not the quality of care received, and that quality of care has not changed over the period. The analyses of case fatality rates and duration of

admissions are found in Annex Two. Case fatality rates increased over the study period, but are likely to be affected by an increasing selectivity in admitting practices observed, and therefore are not an adequate proxy for severity. Average duration of stays for measles declined.

Causes of death in hospital

The final test we can apply to the hospital data is to examine whether changes occurred in the proportionate causes of death for tracer conditions. Data for children 6-59 months old is shown graphically in Figure 7, and is also found in Table 9.

Diarrhoea as a proportion of all deaths of children 6-59 months of age declined from 11.1% of all deaths in 1995 to 8% in 2000. Malaria, on the other hand, increased its share of deaths from 27.2 percent in 1995 to 38.7 percent in 2000. The deaths from respiratory causes declined slightly, from 7.2 percent in 1995 to 5.9 percent in 2000.

Table 9: Trends in proportional hospital-based cause-specific mortality, 6-59 month olds by cause and year

Age Group	Cause of death	1995	1998	2000
6 --59 months	Diarrhoea	11.1	9.9	8.0
	Measles	1.4	0.2	1.1
	Malaria	27.2	33.4	38.7
	Respiratory illnesses	7.2	6.4	5.9
	Other causes	53.0	50.1	46.3

Table 10 displays the odds of dying for each cause, as compared to all other causes. Over the study years, the only significant change is in the odds of dying from malaria. These odds increased by 30% between 1995 and 1998, and by almost 70% between 1995 and 2000 (Table 10).

Although the odds of dying of diarrhoea

Figure 7. Trends in proportionate causes of death, 6-59 months all regions combined

38
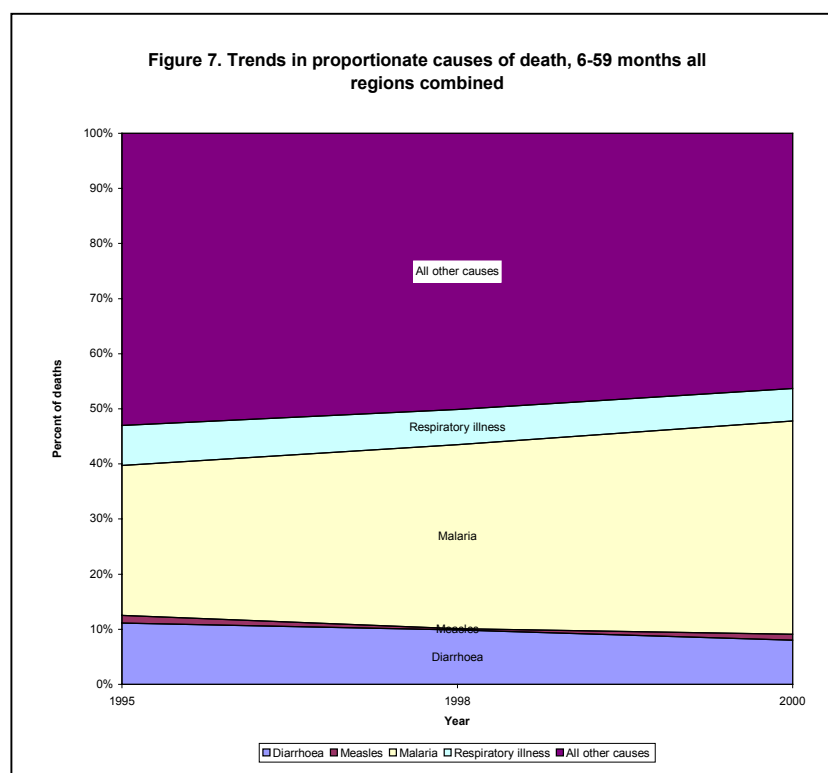
compared to other causes declined slightly, the difference is not statistically significant. The apparent small reduction in the odds of dying of respiratory diseases since 1995 is also not statistically significant.

Table 10. Odds of dying of diarrhoea and other tracer conditions for 6-59 month olds between 1995: 1998 and 1995: 2000				
Diagnosis	**1995:1998**		**1995:2000**	
	OR	**95% C.I.**	**OR**	**95% C.I.**
Diarrhoea: all other causes	0.88	0.53 – 1.46	0.69	0.42 – 1.14
Measles: all other	*		*	
Malaria: all other	1.34	0.96 – 1.88	1.69	1.22 – 2.32
Respiratory: all other	0.88	0.48 – 1.65	0.81	0.45 – 1.48

*Omitted due to small number of deaths per year.

Changes in hospital admissions policies

While hospital admissions in our study area increased over the period of the study, the ratio of hospital admissions to outpatient attendance for all causes actually fell, from almost one quarter of all attendances admitted, to about one-fifth of all attendances. (See Annex Two, Table A2.8.) This pattern could be due to more selective attendance at clinics, parents bringing only more severe cases of diarrhoea as time passed.

Hospital admissions for all conditions as a proportion of OPD attendance declined steadily from 1995 to 2000. (Data are found in Table A2.9, Annex Two). For children between ages one and four, the proportion of outpatient attendances in all Upper West region admitted to hospital was 12.7% in 1995, falling steadily to only 7% admitted (for all causes) in 2000. A similar pattern is seen for children under age one. This lends some support to the suggestion that admission policies have become more restrictive over the period, limited to more severe cases of disease, but not necessarily indicative of a reduction in the incidence of severe disease.

In a later section, we examine DHS and IHNS survey data to assess whether those data provide any insight into the question of changes in care-seeking behavior.

Summary of findings: trends revealed by health service data

The outpatient data for Upper West Region provides some support for our hypothesis that vitamin A supplementation reduced the severity of diarrhoea and measles as perceived by caretakers. In Upper West Region, attendance at OPD clinics for diarrhoea declined markedly over the study period.

But the proportion of children with diarrhoea who were admitted from OPDs to hospitals in Upper West Region actually increased over the study years, suggesting a possible increase in severity of cases seen in outpatient departments. (See analysis in Annex Two.)

From the analysis of inpatient data, we found a significant decline in odds of admissions for both diarrhoea and measles, when each disease was compared to all other causes of hospital admission.

We found that the proportion of all hospital admissions due to diarrhoea and measles has declined since 1995 for children between 6 and 59 months, the age at which they are targets for vitamin A supplementation. For younger children (0-5 month olds), the odds of being admitted for these causes did not change. The likelihood of being admitted for respiratory illness was stable for all age groups. This analysis suggests that if our proxy measure is an appropriate one, the severity of respiratory illnesses – not expected to be affected by vitamin A supplements – did not change over the time period, while diarrhoeal severity and measles severity were reduced.

Turning to outcomes for those admitted to hospital, we learned little from the analysis of case fatality rates, apart from noting a general rise in all rates in 1998, followed by a reduction in 2000. (See Annex Two). Improvement in severity of measles cases admitted was noted in the declining average duration of stay in hospital for this cause. An apparent decrease in the odds of dying from diarrhoea-associated causes, as compared with all other causes, was indicative of reduction in severity of cases, but the change was not statistically significant.

The evidence from these analyses does not present a strong, consistent picture of changes in these illnesses and provide only tentative support for the hypothesis that the burden of severe diarrhoea declined among the children most likely to receive and benefit from the vitamin A supplementation programme.

Although the programme for supplement delivery clearly increased its reach among children in these regions, as evidenced from the data on program coverage, our analysis

of health service statistics provides only weak evidence that the programme effectively reduced cases of severe diarrhoea and measles. This is because changes in patterns of hospital admission, changes in access to services, and possibly, changes in use of services confound our ability to draw firm conclusions.

These findings require further close examination of alternative causes of the trends observed. Other factors not related to the NVAP could explain some of these changes. We will examine changes in diarrhoea home treatment, immunization and health service factors that might also contribute to a proportionate reduction in admissions to hospital for these illnesses.

Other intermediate outcomes: Changes in physical signs of vitamin A deficiency

We asked questions in the 2002 survey to assess the prevalence of night blindness among children between the ages of two and five. While there was little baseline data on night blindness, some small studies conducted in northern Ghana and the results of a prevalence study in the southern regions of the country could be compared with our data for the current period.

Our survey questions yielded a night blindness prevalence of 1.5% among 2-5 year olds.[33] A night blindness prevalence of 1.5% was found in the Ghana VAST Morbidity Trial conducted in Navrongo, Upper East Region.[34] The prevalence survey in the South yielded an estimate for night blindness of 1.0%. A study of 1488 children 24-72 months was also conducted in Upper West Region in 1999. This latter study, which was based on testing performed in a darkened room at day care centers, yielded a prevalence of night blindness of 8.0%[35]. The results of our 2002 survey are thus rather inconclusive.

A measure of serum retinol level drawn from a sub-sample of children would have provided clearer physical evidence of improved vitamin A status.

Other influences on child health in northern Ghana: 1995 – 2002

Next, we examine factors not related to the NVAP that could explain some of this observed decline.

Epidemic diseases

Ghana experienced an epidemic of cholera in 1999, and an epidemic of cerebrospinal meningitis in the three northern regions between November 1996 and May 1997[36]. Scattered outbreaks of rabies have also occurred over the past five years, but these have been small and confined to other regions.

Changes in access and use of services

It is clear from the health service data we obtained that use of outpatient facilities increased over the period of the study, an increase that probably reflects increased access to health facilities. Since 1997, two new regional hospitals were constructed in Ghana, and 56 new health centers were built. Eleven more were upgraded. The number of outreach sites providing child welfare services such as immunizations also increased from 7 per health facility in 1996 to 8.3 in 1999[37]. New facilities were opened in our study areas (See Annex One).

The pattern of increased use of health facilities observed in the health service data may also reflect new awareness of when to seek care, especially for conditions such as malaria and pneumonia. Some of the increases in service use reflected in our data may also be an artifact of improvements in facility record keeping, resulting in more complete reports for more recent years, but we cannot estimate the impact of this factor.

A central strategy of the last Ministry of Health five-year plan was to increase financial access to health care. Public funding was provided for immunizations, and treatment of diseases prone to be epidemic in nature. Exemptions from user fees were established for care of under-fives, among others. However, the exemption policies were subject to administrative problems, and little is known about their actual effects.[38]

Changes in care-seeking behaviour

We used survey data to examine trends in reported use of child health services. One question asked in both DHS and IHNS surveys was about treatment for children who had 'cough and rapid or difficult breathing' – symptoms of acute respiratory infections – in the two weeks preceding the survey.

Figure 8 shows the percent of children with this condition whose mothers said they took the child to a health facility for treatment. (Data for all of the following figures are found in Annex Three.) Little change in reported use of services during the past 10 years is evident. (These data refer to the time of each survey – 1993, 1998, and 2002). Data for Upper West Region indicates a drop in use between 1993 and 1998 (see Annex Three), but the sample of sick children (a two-week prevalence estimate) in these earlier surveys

is small. The sampling error around these estimates is likely to be quite large. When we look at the combined estimates for the three regions, which average the regional figures, it appears that in a representative sample of the population, a very slight drop in use of health services for treatment of acute respiratory illness has occurred in the recent past.

We also looked at the percent of children ill with a fever reported taking to health facility. The 2002 survey shows an increase in service use for children with a fever in the previous two weeks at 46.5%, up from 34.8% in 1998.

Figure 8. Trends in care-seeking and treatment of childhood illness, 3 regions combined 1993-2002
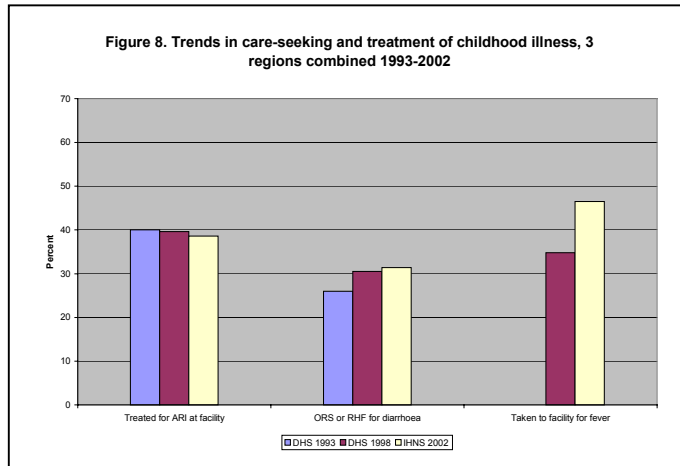
The survey data refer to the coverage of the entire population by the health services. The health service data we examined earlier reflects only the behavior of the segment of the population that uses facilities. The fact that the survey reports do not indicate any striking increase in use of services, at least for upper respiratory illnesses, may indicate that the increased access to health services reflected in the service statistics is merely keeping up with population growth and demand by one segment of the population. The survey data on care of fever may reflect a real increase in attendance and admissions for malaria.

Home treatment for diarrhoea and other influences on mortality from diarrhoea

Home treatment with recommended fluids is the preferred response to episodes of diarrhoea. Changes in home care for diarrhoea could contribute to reductions in child mortality by affecting the outcomes of diarrhoeal episodes, preventing cases from progressing to dehydration and death. If use of approved treatments for diarrhoea – oral rehydration therapy and/or increased fluids and continued feeding – increased, then this would have to be considered another contributor to the observed decline in mortality.

The data also displayed in Figure 8 show that use of oral rehydration therapies (including recommended home fluids) has increased over the past 10 years. Like our other comparisons, it is best to focus on the estimate for the three regions combined, because the small sample sizes of sick children in each region for the DHS surveys lead to some erratic numbers. When we combine the three regions, it appears that home treatment for diarrhea has increased slightly between 1993 and 2002.

We cannot rule out an effect of changes in home care for diarrhoea that may also contribute to mortality reduction, but the magnitude of the change is small, suggesting that this factor would have only a slight impact on death rates, if any.

Changes in household water supply

Another factor affecting diarrhoea-associated mortality is the source of water a household uses. The data on water supply are based on all households in the three regions, and thus provide more stable estimates by region. The availability of piped w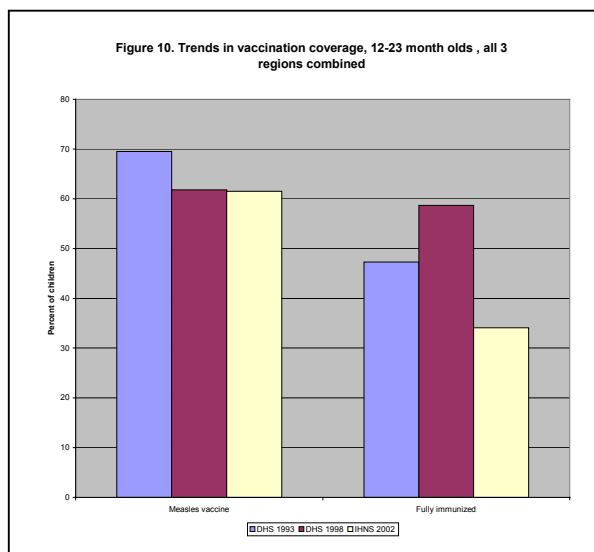ater – a proxy for water quality as well as availability – appears to have improved considerably in Northern Region. The proportion of households in Upper East and Upper West Region who report tap water as their source for drinking is low, and has even declined somewhat since 1993 (Figure 9). We can see that the combined estimate indicating a rise in the proportion of households using tap water is probably due to a large increase in Northern region combined with small decreases in the other two regions. This change could have positively affected child survival in Northern Region, but not in the other regions.

Figure 9. Source of drinking water - tap, private or public
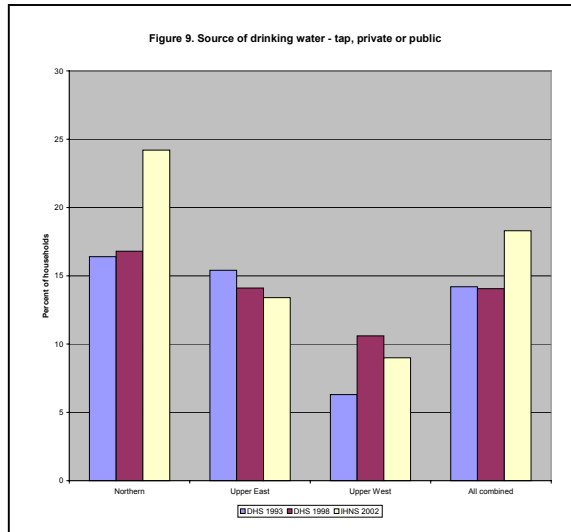
Immunization rates

Immunization coverage is a particularly important influence on child mortality for children between ages 1 and 4. However, coverage with measles vaccine appears to have declined rather than improved since pre-NVAP days. The 1993 DHS showed that nearly 70% of children 12-23 months old had received measles vaccine by their first birthday. But by 1998, this had fallen to only 62%, and in 2002, the IHNS also estimated a measles vaccination rate of 62%. Twelve to twenty-three month olds who had received all the recommended vaccines by the time of the survey is now lower than in 1993, according to estimates from the IHNS. These trends are displayed in Figure 10.

Changes in measles vaccine coverage do not therefore appear to be a factor in the observed mortality decline. IHNS estimates are based on more children than those from the earlier surveys, and are therefore more precise than the DHS estimates for the northern regions, although all estimates are subject to non-sampling error, too. (Confidence intervals are shown in Annex Three, Table A3.3.) The data do suggest that the immunization programme coverage is dwindling, which we would expect to increase, not reduce mortality rates.

Figure 10. Trends in vaccination coverage, 12-23 month olds , all 3 regions combined

Changes in child nutrition

Malnutrition increases a child's risk of dying, so interventions to prevent

malnutrition, such as improved breast-feeding practices and improved diets, are also likely to contribute to improved survival. Children who are poorly nourished are more susceptible to infections, (more frequent and more severe), which can in turn lead to growth faltering, and poor nutritional status. Improving vitamin A status, the intervention of interest in this study, is only one aspect of improved nutritional status.

We have anthropometric data from the 2002 survey for two regions, Northern Region and Upper East Region that can be compared with data from the Demographic and Health Surveys to examine trends in anthropometric status.

Table 11 below displays these data. Those earlier surveys included only about half as many children as the 2002 survey, as the much wider confidence intervals indicate. Caution should be used in interpreting trends from these data, because for each of these three surveys the target group of children measured was slightly different.[iii]

Table 11. Percent of children under five who fall below 2 standard deviations below the mean weight for age and height for age, Northern and Upper East Regions			
Northern	**1993 DHS**	**1998 DHS**	**2002 IHNS**
Under-weight, % <2 SD weight for age	41.3 (34.1-48.5)	38.1 (31-45.2)	35.3
Stunting, % <2 SD height for age	35.9 (27.9-43.9)	39.6 (31.9-47.3)	41.6
Upper East			
Under-weight, % <2 SD weight for age	32.8 (24.9-40.7)	34.0 (30.1-37.9)	37.5
Stunting, % <2 SD height for age	26.9 (20.1-31.8)	35.9 (30.7-41)	35.5

Stunting, a measure of chronic malnutrition, and under-weight, often used as a measure of general health status, do not appear to have changed markedly between 1993 and 1998, nor between 1998 and 2002.

Exclusive breast-feeding

It is difficult to compare rates of exclusive breast-feeding for our three northern regions with data from previous surveys. This is because exclusive breast-feeding rates are usually calculated for children less than six months of age, and children in that target group make up only a small proportion of the total sample of children in the DHS surveys. The small numbers of children in these age groups (386 in 1993, and 295 in 1998) preclude calculation of regional rates from the DHS surveys.

[iii] In 1993, children one to 35 months were weighed and measured; in 1998, 0-59 month olds; and in 2002, 6-59 month olds.

The national data from the two DHS surveys should be comparable, and yet seem to indicate an enormous increase in the percent of children exclusively breast-fed in all Ghana between 1993 and 1998. In 1993 only 5.7 percent of under six-month-olds were reported to be exclusively breast-fed, while in 1998, 31 percent in the same age group were exclusively breast-fed. The 1998 survey report does not discuss this increase, and we cannot comment on the validity of these data, or on the possible reasons for such a change.

The 2002 IHNS survey found, for all three northern regions combined, that 37.7 percent of children in the same age group were reported to be exclusively breast-fed, higher than the 1998 rate for all Ghana. Because we are comparing children from the entire country in the earlier surveys with children from the northern regions only in 2002, it is difficult to say much about the possible effect of changes in exclusive breast-feeding on child mortality rates.

Exclusive breast-feeding would be expected to affect mortality under the age of one more than mortality at older ages. Thus, even if breast-feeding rates had increased considerably over the time period of the vitamin A intervention, we would expect this to affect the infant mortality rate more than the child (1-4) mortality rate.

Socio-economic influences on child mortality

Finally, we turn to several indicators of broader influences on child survival – maternal education and socioeconomic status of the household. We examined trends in maternal education, which is everywhere strongly associated with child survival. If a large increase in women's education had occurred during the period of the study, this, too, might contribute to the decline in childhood mortality. The data for each region are displayed in Figure 11, and are based on all women of reproductive age interviewed in each region, a reasonable sample from the DHS surveys as well as the 2002 IHNS survey.

There has clearly been no major change in the proportion of women who have received any education in these regions of Ghana. It is also apparent that educational levels are very low in these regions, and makes the mortality decline observed over the previous 10 or more years all the more surprising.

Figure 11. Trends in proportion of women with no education, northern Ghana

General trends in socioeconomic indicators also influence child survival. The material of the household floor is often used as a proxy for socioeconomic status in developing countries, especially where income and other indicators of household wealth are difficult to assess. It can also serve as an indirect indicator of a child's exposure to pathogens in the household environment.
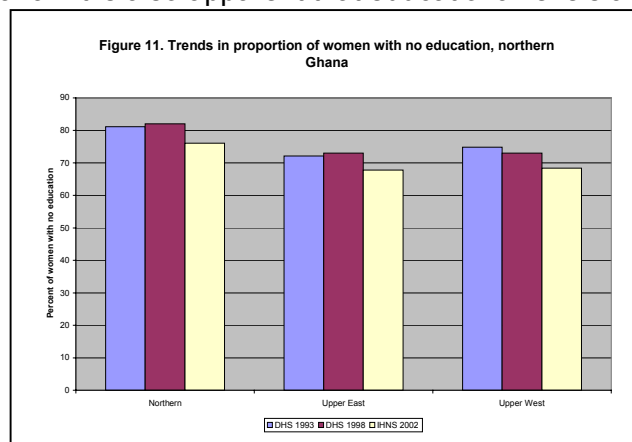
As we see from the data for 1998 and 2002 displayed in Figure 12, there has been a decline in the proportion of households in all three regions that have an earth, mud or dung floor. While there are wide variations between regions, with Upper West having the highest proportion of households with an earth floor, the decline is observed in all three. This change probably indicates some improvement in household living conditions. We cannot rule out the contribution of such improvements in the household environment to the decline in child mortality.

Figure 12. Trends in floor material used in households: earth, mud or dung floor
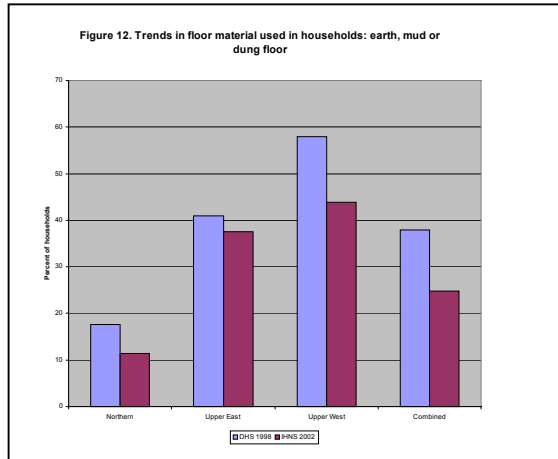
Household assets and other socioeconomic indices

The World Bank Living Standard Surveys in Ghana (GLSS) Round 2 and Round 4 were used to examine poverty trends during the 1990s.[39] Some of these data are shown in Table 12.

The report concludes that while ownership of various durable goods and access to safe drinking water, toilet facilities and electricity increased between the late 1980s and the late 1990s, and were distributed across most areas of the country, the wealthier usually benefited more from these changes. Most of the indicators measured in the GLSS showed that there had been progress in improved living standards over time. However the report concludes that the poorest groups, including those living in the rural savanna region (which includes same three northern regions of interest to our study as well as Brong Ahafo, directly south), have benefited least from these improvements. The rural areas of the north show the least improvement in living standards of any area of the country.

The report states that poverty is disproportionately concentrated in the savannah region, and is true both for rural and urban areas. An index of poverty incidence (percent of households below the poverty line) shows very little change between 1991 and 1999 in these regions: "the decline in poverty in the savannah was much less marked and, indeed, extreme poverty rose in the locality."[40]

Table 12 summarizes the available data on key socioeconomic and health indices. It is fairly certain that the biggest change that has occurred in factors known to affect child mortality is the provision of vitamin A supplements to a large proportion of children in these regions. What is difficult to quantify is the relative contribution of changes in these factors, and others that we have not considered, compared to the major change that has occurred in vitamin A supplementation.

These other influences cannot be completely ruled out as contributory causes of the steep decline in child mortality that appears to have occurred in northern Ghana since 1993, but some improvements may balance out other deterioration. In the absence of biological data confirming that vitamin A status has improved, the most we can say with the data assembled in this study is that it is likely that child health has improved and that the NVAP has probably contributed to this improvement.

Table 12. Summary table: Changes in socioeconomic and health indices, three northern regions combined*

Indicator	Pre-intervention (93)	Mid-intervention (98)	Post-intervention (2002)
Percent of population in poverty[41]			
rural	73.0	70.0	N/A
urban	37.8	43.0	N/A
Female primary school enrollment[42]	46.0	61.0	N/A
% of households obtaining drinking water from a tap	14.2	14.1	18.3
% of households with electricity	10.8	15.0	20.3
Measles vaccine coverage	69.5	61.0	61.0
% 0-5 month olds exclusively breastfed	5.7	31.0	37.7
% of 6-59 month olds who received a vitamin A capsule in the past 6 months	~ 0	50.3	78.4
% moderately stunted			
Northern	35.9	39.6	41.6
Upper East	26.0	35.9	35.5
% of households owning a sewing machine			
rural	15.6	19.3	11.9
urban	23.2	34.7	22.4
% of households owning a refrigerator			
rural	0.4	1.1	0.8
urban	5.2	14.7	18.3
% of households owning a TV			
rural	0.8	2.4	2.0
urban	7.2	25.5	26.3

*(Except where indicated)

DISCUSSION

Measures of intermediate health outcomes could provide a critical link between program data showing effective delivery of the intervention and trends in child survival. Clear changes in morbidity expected as a result of improved vitamin A status would strengthen conclusions about the contribution of the intervention programme to the decline in death rates we observed. However, because of what appear to be changes in access to services over the period, our data from health facilities were not able to shed a great deal of light on changes in severity of diarrhea or measles. The firmest evidence these data produced was a significant decline in the odds of cases of diarrhea and measles being admitted to hospital, and a halving of attendance for diarrhoea at OPDs in one region. This suggests a possible decline in the severity of these illnesses over the period of the study.

It may be that our proxy measures are imperfect, or that our assumptions underlying their use are invalid. Health service data can tell us only about the population actually using services, and if the profile of this population changes then the trends themselves would be invalidated. Our survey data on reported service use, which complement the health service data, seem to suggest increased use of health facilities for children with

fever, but not for other conditions. This increase coincides with the increased reports of OPD attendance and hospital admissions for malaria, as well as with increased availability of the services in these regions.

Difficulties of data collection related to the form in which the data from outpatient clinics was available in Upper East and Northern regions forced us to rely on data for only Upper West Region for several of our proxy measures of severity. An evaluation study designed from the start of the intervention program could tailor its choice of proxy measures more precisely to the data available, which we were unable to do some five years after the intervention began. Time series data could be collected from facilities more efficiently if carefully planned in advance as part of the evaluation of the programme.

A major limitation of the data gathered by the programme was the defective estimates of supplement coverage produced by routine reports on doses dispensed. The approach of scattered 'mini-surveys' in a few districts did not provide enough firm evidence on a population-wide basis to assure that the programme was reaching its intended targets. This is not unusual, nor necessarily the fault of the NVAP, but population denominators are often difficult to obtain with certainty. The experience of the NVAP illustrates that it is not useful to rely on these routine reports or to do 'spotty' surveys in only a few districts when the programme operates across a large area.

Large coverage surveys such as those pioneered by the Expanded Programme on Immunization (EPI) in the 1980s can measure coverage and also provide a vehicle to collect other programmatically useful information. Improved sampling methods and careful supervision of fieldwork can ensure that these estimates are not biased. Guidance for conducting such surveys is available for programme managers[43].

This study was unable to make any definitive statement regarding the biological indicators of improved vitamin A status. We obtained data to estimate prevalence of night blindness among children between two and five years of age. Our data indicated little or no change from the pre-intervention years to the present, but data for comparison is scanty. Furthermore, it may be very difficult to detect changes in night blindness prevalence when it occurs at the very low levels we have seen in northern Ghana.

Serum retinol data could have provided a crucial confirmation or non-confirmation of improved vitamin A status in this population. Unfortunately, our plan to collect these data on a survey sub-sample had to be abandoned, as we mentioned earlier. Because it is difficult to partition out the contribution of the many other factors that influence overall child mortality rates or to rule out some of those influences, it is clear how important such biological data can be making a link between programme performance and mortality impact.

One of the most serious obstacles to assessing mortality impact is the difficulty of obtaining valid and reliable data on mortality trends. The quality of survey-derived mortality estimates depends on the accuracy of reports of dates of birth and ages at death, and the completeness with which child deaths are reported. Questions used to estimate childhood mortality rates refer only to a woman's own, biological, live-born children, whether or not they are still alive and living with her. With respect to childhood mortality estimation, errors in these reports can occur due to:

- Misunderstanding of the questions used to obtain a retrospective listing of births and deaths (due to cultural variations and inexact definitions of such elements as "own" children).
- Errors in reporting associated dates and/or current ages. This happens when the mother does not know the precise age or birth dates (or death dates) of her children with reference to the calendar used.
- Inadvertent omission of children whose deaths occurred very shortly after birth, due to confusion over live births and stillbirths or miscarriages. Or, deliberate omission of children who died, due to reluctance to discuss death, especially those that have occurred recently.
- Poor field techniques used by interviewers, who fail to ask the questions in a way that elicits a complete and correct listing from mothers.
- Deliberate shifts of dates of birth out of the time window under consideration by interviewers trying to reduce their workload.

In surveys of childhood mortality, these known sources of measurement error[iv] associated with obtaining retrospective information can affect estimates even more than sampling error[v]. Measurement error is much more difficult to detect than sampling error, and once it occurs, it is not possible to correct the biases it causes.

The above-mentioned sources of measurement error make considerations of sampling error less important in mortality surveys than would be the case when conducting a longitudinal (follow-up) study, where all vital events among the study population are recorded as they occur and very precise estimates of mortality can be made.

Unlike longitudinal research studies such as the field trials of vitamin A efficacy, the most we can expect from a well-designed and well-implemented survey is estimates of reasonable precision, which are as free from measurement error as possible. These estimates are centered on a given date, but are averages across the specified period. These are then plotted with estimates from previous surveys and other sources to establish trends. However, earlier surveys in northern Ghana produced estimates with much wider sampling errors, and the field work for the 2002 survey may have differed in some respects from the surveys conducted by the Demographic and Health Survey organization, leading to differences in patterns of measurement error in the different surveys.

Mortality estimates from surveys, therefore, should be viewed with caution. While we believe that our findings regarding the differential rates of decline of infant and later childhood mortality rates are real, the absolute level of both rates may be underestimated as a result of reporting errors. Only comparisons with estimates from future surveys will provide convincing evidence of the true magnitude of such a decline.

This illustrates the pitfalls inherent in measuring mortality especially in areas with low levels of education, and should be a clear signal to program managers that such surveys pose difficult challenges and should not be undertaken as part of a program evaluation.

[iv] Measurement error results from imperfectly measuring what you set out to measure with the instruments or questions that you use.
[v] Sampling error arises by chance, because the survey asks questions of a sample of respondents rather than the whole population.

Rather, making use of on-going survey programmes by requesting over-samples of the areas of interest, is more likely to provide good comparative data.

CONCLUSIONS: A MESSAGE FOR PROGRAMME MANAGERS

For vitamin A programme managers who wish to examine the question of impact, it seems that the most important elements of an evaluation plan established at the <u>start</u> of the programme are:

3. Valid, representative population-based coverage data collected periodically, including a baseline measurement, using the same survey methods and questions throughout the programme period
4. Collection of serum retinol data on a sub-sample of children during baseline and end-of-programme surveys

With this information, it should be possible to make fairly strong statements about the effectiveness of the program and its impact on the vitamin A status of the children it targets. Such information relates directly to the intervention to supply vitamin A supplements, and should not, therefore, be confounded by the many other factors that contribute to improved child survival. These data, while stopping short of providing information about changes in child survival, should be sufficient for managers, donors, policymakers, and beneficiaries in the community to make decisions about the effectiveness of the programme and its importance to child health.

Such information could be supplemented by careful collection of data from the health services, planned in advance. These data, like our health service data, may then provide more focused information about possible changes in cases of severe diarrhea in measles, and even evidence of reductions in deaths to these causes. It should be possible to avoid some of the difficulties we experienced in collecting these data retrospectively by careful advance planning. "Triangulating" information about disease severity with representative, population-based coverage data and data for a biomarker, serum retinol, should enable program managers, as well as their donors, to have confidence in their evaluation findings.

It should be obvious from our examination of trends in some of the other potential influences on the risk of dying in childhood that a much more elaborate and costly study would need to be conducted in order to rule out the effects of these other factors. For evaluating the impact of a public health programme such as the national vitamin A supplementation programme in Ghana, such a study would be inappropriate. The research studies have shown that if programme coverage is high and consistent, the intervention will reduce severe morbidity and improve survival, all else equal. This study demonstrates that assessing the precise role that an intervention programme plays in "averting deaths" is difficult, if not impossible, unless prohibitively expensive large-scale replication of the methods used in controlled trials is undertaken.

In the context of a national program, careful monitoring of program coverage and small-scale measurement of a biological marker of vitamin A status, serum retinol, should provide sufficient information to asses the effectiveness of the program, and to make decisions about funding, expansion, contraction or closure.

As we mentioned at the beginning of this report, attributing a decline in mortality to the effects of a programme to prevent vitamin A deficiency is especially difficult because its direct effect on specific diseases is small, while the impact on overall mortality can be substantial.

Vitamin A has been shown to reduce child mortality, but the evidence of how this improvement is actually achieved through reductions in specific causes of death is sparse. The most likely explanation of how vitamin A reduces mortality is cited by Beaton, et al: "…vitamin A status affects the child's ability to respond appropriately and adequately once infection has developed, and so exerts its impact on the course of morbidity". Vitamin A deficiency reduces resistance to infection, not the incidence of disease. Improving vitamin A status affects a child's susceptibility to developing severe illnesses.

Many other factors operating simultaneously influence a child's risk of becoming ill and dying.

This evaluation proceeded in stages to assemble evidence to support the proposition that the NVAP had reduced child mortality in northern Ghana. We first examined whether supplements had been delivered to the population at risk. The one major change that we have been able to document well is the coverage of the target population of 6-59 month olds with vitamin A supplements. The analysis showed that the VA capsule distribution programme seemed to be working effectively and has resulted in important increases in provision of vitamin A supplements since 1995. There was virtually no supplementation with vitamin A in these regions when the NVA Programme began in 1995, and by 2001 approximately 80% of children in these regions were receiving vitamin A capsules. It is likely that a proportion nearly as high has been successfully reached with biannual doses for several years in these regions.

We then looked for evidence of reductions in the few specific causes of death thought to be affected by supplementation. While the limitations of the data available for a *post-hoc* investigation of mortality impact should be obvious, the trends in indicators of severity described by the health service data are indicative of a decline in cases of severe diarrhoea. Our analysis of proxy indicators for trends in severity of diarrhoea provides some evidence that a reduction in diarrhoea-related deaths in the population at large may have occurred that contributed to the overall decline in childhood mortality, especially between ages one and four. These health service data alone cannot confirm that diarrhoea-related mortality has declined. Home treatment, availability of clean water, and other factors could also contribute to such a decline.

We also observed that the rate of decline for infant mortality stayed relatively constant over the 15 years for which we have data, while child mortality declined at a much faster rate. Since the survey data, too, are subject to error, the decline may not be quite as large as the data suggest. Nevertheless it appears that child survival improved more quickly at about the time that the programme took hold across the northern regions, and the improvement was more marked among the children most likely to benefit from the supplements.

We then attempted to rule out the effects of other health interventions on mortality decline. The evidence from surveys indicates that other factors affecting child survival

have not changed very markedly since 1995, and certainly have not changed enough to entirely explain the steep fall in mortality at ages one to four.

Trends in other factors affecting child mortality were not nearly as marked as the change in supplementation with vitamin A, and some changes may even have worked to increase mortality slightly. These trends lend plausibility to the argument that the vitamin A programme has made a major contribution to the decline in childhood mortality measured in the recent past.   In the evaluation of public health programmes, this is likely to be the strongest statement that can be made about impact.

We have seen how difficult it is to make firm statements about programme impact, especially when the data must be assembled well after the programme has begun. This case study has also tried to answer another question: what are the most important measures to make in trying to assess the impact of such a health programme, delivered on a large scale?

Without expending the effort involved in this study, a programme such as the Ghana National Vitamin A Programme could obtain data from the health services on key indicators at baseline, and monitor these periodically as the programme progressed. By planning such data collection to coincide with inception of the programme, the process would not be as onerous as compiling these data after the fact, when we found data missing and not easily retrieved from records.

It seems that a larger proportion of evaluation resources could be put toward a more rigorous assessment of coverage with good effect. This could take the form of a routine programme of cluster surveys designed with adequate samples to assess change, conducted every few years across the entire programme area. These surveys could be used to monitor other indicators of programme performance, such as increases in maternal knowledge of the intervention, and changes in physical signs of vitamin A deficiency. Baseline and end-of-programme serum retinol measures might also be made on a smaller sub-sample, if desired. The Expanded Programme of Immunization employed similar coverage surveys in the 1970s and 80s. Such a programme of monitoring surveys, conducted every few years, can determine whether the intervention (of known efficacy) is delivered efficiently and reaches the children most in need, identifying the characteristics of those not reached, so that efforts can be better targeted to them. Broad, equitable coverage of all children, especially in families least able to obtain other health care, is what will ultimately determine whether mortality falls and improvements in child survival are sustained.

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[1] Victora, CG, Olinto, MT, Barros, F and Nobre, LC, Falling diarrhoea mortality in Northeastern Brazil: did ORT play a role?" Health Policy and Planning 11(2): 138.

[2] Beaton, *et al*, (1992), *Effectiveness of Vitamin A Supplementation in the Control of Young Child Morbidity and Mortality in Developing Countries*, Toronto: ACC/SCN of the United Nations.

[3] UNICEF Ghana (1995) Proposal for National Vitamin A Deficiency Control Programme in Ghana, March, mimeo.

[4] The probabilities that a large vitamin A supplementation programme will achieve a real mortality reduction of differing magnitudes has been estimated by Beaton, et al, op cit., p. 64.

[5] Habicht, J.P., Victora, C.G., and Vaughn, J.P. A Framework for Linking Evaluation Needs to Design Choices, (1997), NY: UNICEF.

[6] That is, a design with only a historical control group (the area pre-intervention), without randomization, and without individual data on those who 'accepted' and did not accept the intervention.

[7] Beaton, et al, 1992

[8] David, PH (1997) "Monitoring and Evaluating Health Programmes from the Perspective of Health Providers and Donors: Identifying appropriate indicators and methods of data collection", in Khlat, M (ed.) Demographic evaluation of health programmes. Paris: Committee for International Cooperation in National Research in Demography (CICRED), United Nations Population Fund, French Ministry of Cooperation, pp. 29-51.

[9] Victora, CG, Olinto, MT, Barros, F and Nobre, LC, Falling diarrhoea mortality in Northeastern Brazil: did ORT play a role?" Health Policy and Planning 11(2): 138.

[10] The design of this evaluation relies heavily on the seminal paper by Habicht, J.-P., Victora, C., and Vaughn, P. referenced above in fn 5, on presentations made by Dr. Cesar Victora to a workshop on the evaluation of vitamin A supplementation programmes in 1995, and to discussions with Dr. Victora.

[11] Kirkwood, B.R., Cousens, S.N, Victora, C.G. and deZoysa, I.(1997) Issues in the design and interpretation of studies to evaluate the impact of community-based interventions, *Trop.Med.and Hygiene,* 2(11): 1022-1029, November.

[12] Habicht, Victora and Vaughn, 1999.

[13] IVACG, 1984, cited in Gadomski and Kjolhede, 1988

[14] Populations shown to be most severely malnourished have shown the greatest impact of VA supplements (Beaton, et al, 1993).

[15] Mosley, WH and Becker, S (1991) Demographic models for child survival and implications for health intervention programmes, *Health Policy and Planning* 8(3): 218-233.

[16] Changes in the extent of VAD in the study area from biochemical data (serum retinol) would provide important additional evidence to strengthen the study's conclusions. We also intended to collect finger-prick blood samples from a sub-sample of children 6 to 59 months of age to assess their serum retinol status. This would have provided data on one intermediate outcome of the Vitamin A supplementation programme in these regions, that might have strengthened inferences made about programme impact. This additional data collection was not possible due to the death of one of the principal investigators (PA).

[17] Huttly, et al, 1997

[18] Villamor and Fawzi, 2000.

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[24] Ibid., p. 4.

[25] Despite assurances from the regional biostatisticians in Upper East and Northern Regions that outpatient data for 1995 that was not available by age of patient could be obtained by extracting directly from the consulting room registers, this was not possible. Registers for some facilities and some months were missing, and even when present, meant that data collectors had to identify children of the appropriate ages from registers that contained outpatients of all ages. The task of retrieving this information proved to be too onerous, and data for 1995 successfully abstracted in Upper East and Northern Regions was scanty.

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[27] from MOH, October 2000 report

[28] Ibid

[29] *Vitamin A Supplementation Ghana, July 2000: Report on the first non-NIDS distribution* (draft, 13/10/00).

[30] From July, 1999 evaluation. Regional estimates are based on reports from 90 mothers in each of 2 Upper East and 2 Upper West and 4 Northern Region districts. Due to the sample design, they are not necessarily representative of the entire region. The mini-survey also used a different, more complex, series of questions than the DHS and IHNS to ascertain whether the child received a vitamin A capsule. It appears that there were problems with the administration of the night blindness questions in the IHNS survey, since mothers of 24 children reported that their child had no problem seeing during the night, yet suffered from night blindness.

[31] Ahmad, Lopez and Inoue (2000)

[32] Beaton et al, *op cit.*

[33] Out of a total of 2095 children ages two to five whose mothers gave valid responses, 32 children were reported to suffer night blindness (of those who had no problem seeing during the day). 80 children (3.8%) were reported to have trouble seeing during the daytime.

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[36] Ministry of Health (August 2001) *The Health of the Nation: Reflections on the First Five Year Health Sector Programme of Work 1997-2001,* p.16*.*

[37] Ministry of Health (2001), op cit p. 22.

[38] Ministry of Health (2001), op cit p. 22.

[39] Ghana Statistical Service (2000) *Poverty Trends or in Ghana in the 1990s,* Accra.

[40] *op cit*, p.11.

[41] Ghana Statistical Service (2000) *Poverty Trends or in Ghana in the 1990s.* Estimates computed from Ghana Living Standards Surveys Rounds 3 and 4.

[42] Ibid.

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