Evaluation of a decision-making framework to scale-back vitamin A supplementation programs:

A situation analysis in Sri Lanka

March 2014

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1. Introduction

1.1 Background

Approximately 80 countries considered to be at elevated risk of vitamin A deficiency are currently implementing programs to ensure that children under five years of age receive vitamin A as a child survival strategy in the form of high dose vitamin A supplements. In addition, although not as widespread as vitamin A supplementation, many countries have implemented programs to fortify commonly consumed foods, such as sugar and oil and some countries are distributing micronutrient powders containing vitamin A that are added at household level to children's usual complementary foods. While all of these approaches can impact positively on child survival and reduced risk of xerophthalmia, it is recognized that only improved dietary intakes of vitamin A will shift a population's vitamin A status towards sustained adequacy. As the documented impact of high dose vitamin A supplementation on child mortality occurs among those who are vitamin A deficient, the impact and cost-effectiveness of supplementation on child survival will be reduced as dietary vitamin A intakes improve and deficiency is reduced.

Some recent debates have questioned the need to continue with universal vitamin A supplementation programs in settings where the prevalence of vitamin A deficiency is declining and country managers are seeking guidance on when and how to begin scaling back these supplementation programs without putting children under-five at undue risk. In February 2012, the Global Alliance for Vitamin A (GAVA[1]) convened an informal technical consultation to address these issues.

1.2 The decision-making framework

A framework is under development to support countries with their decision-making process for shifting from universal vitamin A supplementation delivered to all children 6-59 months of age every 4-6 months, towards a targeted approach to reach only those who remain at elevated risk, or scaled back completely if there is evidence that sustained usual intakes of vitamin A are adequate among this age group and deficiency is no longer a problem (1). The framework proposes to make use of available population-based data on vitamin A status, intakes, program coverage, and other ecological indicators of relative risk to determine, with a high burden of proof, the readiness of countries to shift strategies in a responsible manner.

Prior to implementing this decision-making framework, it will need to be tested and adjusted in country contexts where sufficient population-based data are available. This is a critical step to determine the usefulness and reliability of available indicators in the decision-making process.

1.3 Evaluation of the framework and development of its application

To assist this research and development exercise, three countries have been identified as potential candidates for evaluating and developing the application of the framework - Guatemala,

[1] The Global Alliance for Vitamin A (GAVA) is an informal partnership between the Centers for Disease Control and Prevention, Canadian International Development Agency (CIDA), Helen Keller International (HKI), Micronutrient Initiative (MI), and the United Nations Children's Fund (UNICEF).

Sri Lanka, and South Africa. These countries were selected due to their history of vitamin A deficiency, previously high under-five mortality rates and diarrheal morbidity, implementation of vitamin A programs, geographic and socio-economic diversity, and a large pool of serial survey data deemed useful to test the framework. Each of these countries was approached to solicit their participation in this activity.

1.4 Content and purpose of this report

This report is a country-level evaluation of the framework application in Sri Lanka. First, the report includes a comprehensive situation analysis of vitamin A status and intakes among the target age group (children 6-59 months of age) in Sri Lanka and of vitamin A programs, their design, coverage, and contribution to adequacy of vitamin A intakes. Second, the report reviews the application of the decision-making framework and associated Policy Guidance by applying the findings of the situation analysis to the framework, and by reviewing the Policy Guidance options with public health nutrition professionals at the interface of nutrition program design, implementation, monitoring, and evaluation in Sri Lanka and eliciting their views and implications of the Policy Guidance.

The primary purpose of the report is to provide an evaluation of the functionality and appropriateness of the decision-making framework based on the experience and current circumstances in Sri Lanka. Recommendations for any adjustments to the framework and Policy Guidance as a result of this country-level evaluation are also provided. Upon completion of the evaluation in all three proposed countries, a general report and recommendations will be compiled.

As a secondary purpose, the findings in this report may provide useful guidance for continued evaluation of the vitamin A situation in Sri Lanka and identify information gaps that may be considered in future surveillance activities to assist vitamin A related program decision-making.

3. Methods

The evaluation process began by identifying a focal person in Sri Lanka to assist in providing an overview of the vitamin A situation in the country, acquiring data sources, making contact with organizations and individuals responsible for the design, implementation, and evaluation of vitamin A related programs, and actively participating in the application and evaluation of the decision-making framework. In Sri Lanka, the focal person for this evaluation was Dr. Renuka Jayatissa, Program Officer, UNICEF – Sri Lanka, with oversight by Dr. Sayed Ezatullah Majeed, Chief, Health and Nutrition, UNICEF – Sri Lanka. Interviews with identified contacts and the principal analysis presented in this report were led by Dr. Christine Hotz, consultant to the Micronutrient Initiative and GAVA.

3.1 Situation analysis

In the decision-making framework document for scaling back vitamin A supplementation, the situation analysis is noted to be a prerequisite or catalyst for applying the decision-making framework. The main objectives of the situation analysis were to: *"1) compile, analyze, and interpret available information on vitamin A intakes and status at the country-level and in select population subgroups, and; 2) to take stock of all interventions or activities that may have an influence on vitamin A nutrition, including target groups, coverage, quality control/regulatory monitoring, and other relevant information."*

Prior to and during the country visit, survey reports and other relevant sources of data and information were reviewed and relevant information extracted. All data extracted prior was summarized in the data extraction worksheets (See file: *Data extraction worksheets_v2.xls*).

3.1.1 Survey data on vitamin A status and vitamin A intakes

The categories of indicators considered to be relevant to interpreting vitamin A status and vitamin A intakes included the following:

- biochemical indicators of vitamin A status
- clinical indicators of vitamin A status
- individual level vitamin A intakes
- breastfeeding practices
- under-five mortality rates
- anthropometric status

While not all of these indicators are suggested to be used directly in the programmatic decision-making steps of the framework itself, the list of useful indicators is extended for the purpose of producing a more complete situation analysis, allowing for a general picture of nutritional status to be assessed, including time trends and identification of higher and lower nutritional risk groups.

This analysis involved acquiring all relevant, available data for the noted indicators and determining the context in which they were collected. Aspects of data quality and use of standards will also be considered to evaluate the relative strength of the evidence that the indicators suggest. Key elements of data quality evaluated are included in the data extraction worksheets (See file: *Data extraction worksheets_v2.xls*) and are briefly summarized below. Quality will then be taken into consideration when assessing the strength of evidence of decision-making.

Survey design	Statistical representation, stratification groups, age groups
Data collection methodology	Determining whether methods reflect standards for selection of indicators; staff training; the collection, handling, and analysis of samples; data cleaning, variable construction or calculation; data analysis, and data adjustments
Data interpretation	Design effect; use of appropriate indicators, cut-offs, and age-groups

Emphasis was placed on the extraction and presentation of data for subgroups that may be at higher or lower risk of vitamin A deficiency, particularly among geographical sub-populations. In examining serial surveys, any relevant methodological differences were considered as they may affect the comparability of the data between time points.

3.1.2 Interventions and other activities affecting vitamin A intakes or status

Information was collected on all intervention programs and activities that may affect population vitamin A intakes or vitamin A status among children in the age range of 0-5 years (and in some cases, lactating women). The information sought for each type of intervention was to inform on its general design, target groups or whether it is not targeted, and its coverage, which include both the number/proportion of users and the amount of additional vitamin A delivered. Additional intervention delivery-related information was sought to help interpret the potential impact of the intervention on vitamin A intakes, including information on program monitoring and quality control. Evidence from locally conducted cross-sectional, efficacy, or effectiveness studies was also considered.

Diverse sources of relevant information for these interventions were consulted, depending on the intervention type and availability of data. These data are functionally categorized as reflecting: i) ***coverage***, expressed as the number or percentage of intended users or the individual level intakes of the vitamin A containing food; ii) ***vitamin A content***, determined from manufacturers, monitoring data, or food composition data; iii) ***usage,*** determined as the proportion of the intended amount of vitamin A containing vehicle consumed by targeted children, and; iv) ***contribution to vitamin A intakes***, determined largely by combining the data on coverage, usage, and vitamin A content. Government departments in health, industry, economics, trade and standards, private sector food industries, as well as local and international NGO's were consulted as appropriate for access to relevant data.

A spatial analysis was conducted to account for multiple programs that are targeted to different sub-population groups (determined by age, geography, and/or other individual or household level risk factors, or all of the above). A temporal analysis was also conducted to account for the timing of introduction or expansion of vitamin A programs in relation to past survey data on vitamin A status and vitamin A intakes.

3.2 Application of the framework

After completing the situation analysis, the data were applied by the consultant to the decision-making framework. The recommendations and Policy Guidance resulting from this were evaluated for their appropriateness to the situation and their logic, in terms of functionality of the algorithm.

During the in-country visit, a group of stakeholders was invited to participate in an informal discussion about the decision-making framework. The participants were asked to provide input on:

- the appropriateness and applicability of the framework questions to the country's particular situation or availability of data, and whether the conclusion/recommendations reached is considered to be logical and correct.

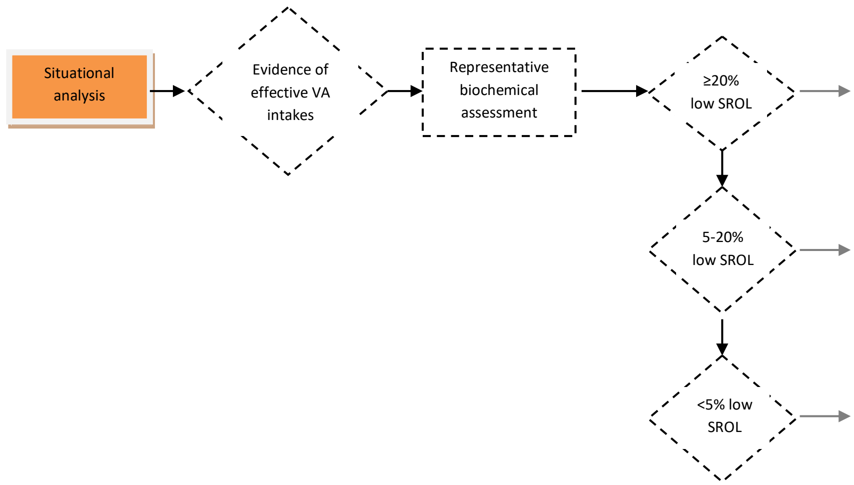
- the degree of subjectivity of applying available data to the framework (e.g., are there many nuances or caveats that must be considered before evidence can be considered definitive? Does data quality appear to play a large or small role in the decision-making process? If quality was considered limited for some information, would a better quality survey change the level of confidence in using the data for decision-making purposes?).

- additional information that might be necessary to facilitate the decision-making process or data presented that appears to be unnecessary or redundant.

- whether the results of the situation analysis and/or application of the framework are expected to be useful to justify implementation of additional surveys (either providing key missing information, or to confirm a sustained low prevalence of vitamin A deficiency in at least some sub-populations), regardless of whether funding may be available or not?

It was emphasized to participants that although this review process may result in a useful update and analysis of population vitamin A status, related interventions and their contribution to eliminating vitamin A deficiency, it is not intended to endorse definitive recommendations for changes to national vitamin A programs, until such time as the framework is adopted for international use.

3. Situation Analysis



A necessary precursor to applying the decision-making framework is the implementation of a situation analysis. The two stated objectives of this analysis are to 1) compiles, analyze, and interpret available information on vitamin A intakes and status at the country-level and in select population groups, and; 2) take stock of all interventions or activities that may have an influence on vitamin A nutrition. These objectives are addressed in the following two sections.

3.1. Surveys of vitamin A status and intakes, and related indicators

3.1.1 Vitamin A status and deficiency

Clinical indicators of vitamin A deficiency: Several national level surveys that included direct and indirect indicators of vitamin A status and vitamin A intakes have been conducted in Sri Lanka. These include surveys of clinical outcomes of vitamin A deficiency (2-4) and sub-clinical vitamin A deficiency as determined from serum retinol concentrations (3-5), a food security survey (6), and intermittent Demographic and Health Surveys (7-10).

Available evidence indicates a history of severe vitamin A deficiency in Sri Lanka. Keratomalacia, a clinical outcome of vitamin A deficiency, was reported as a common cause of blindness among Sri Lankan children from the 1930's through to 1960, as summarized by Jayatissa & Gunathalaka (5). Initially in the 1930's and 1940's, keratomalacia was the reported cause of 60% and 44% of blindness in children, respectively, declining to 29% in 1950, 7% in 1960, and 0.2% in 1970. Although these studies may not have been conducted in representative populations, they are indicative of a dramatic decline in the prominence of severe vitamin A deficiency as a cause of blindness in this population.

The first nationally representative survey of the clinical outcomes of vitamin A deficiency was conducted in rural Sri Lankan children in 1975/1976 (2). The weighted mean prevalence of Bitot's spots was 1.1% among children 6-71 months of age and of night blindness was 1.0% among children 24-71 months of age, prevalences currently considered to be indicative of vitamin A deficiency of a moderate public health concern (11). In a subgroup of children selected from two districts in the same survey (2), the prevalence of low serum vitamin A (<20 µg/100 mL, as determined by microfluorescence from capillary samples) was higher among children with clinical signs of vitamin A deficiency than among those without (28% *vs* 5%, no statistical analysis). This was taken to verify the association of vitamin A deficiency with these clinical ocular disorders. A subsequent national survey of vitamin A status carried out in 1995/1996 among preschool children (3) determined the prevalence of Bitot's spots to be 0.8% (6-71 months of age) and night blindness to be 0.8% (24-71 months of age); this prevalence of night blindness was indicative of a mild public health problem. More recently, both the 2005/2006 national vitamin A status survey (4) and the 2012 national nutrition and micronutrient survey (5) reported a 0% prevalence of Bitot's spots among preschool children (6-60 months of age) and 0% prevalence of night blindness (24-59 months of age). These sequential surveys indicate a steady decline in the prevalence of clinical vitamin A deficiency (**Figure 1**), from what may have been a severe public health problem in the earlier decades to one that is no longer existent.

Biochemical indicators of vitamin A deficiency: The national prevalence of subclinical vitamin A deficiency (excluding parts of Northern and Eastern Provinces due to conflict), as determined by measurements of serum retinol concentration, has been reported from two surveys to date (3,4). The prevalence of vitamin A deficiency defined as serum retinol <0.70 µmol/L was 35.3% in 1995/1996 (3), and 29.3% in 2005/2006 (4), among children 6-59 months of age, indicating a moderate 6.0 percentage point, or 17% decline, in the 10 year interval (Figure 1). However, severe vitamin A deficiency (serum retinol <0.035 µmol/L) declined by 74%, from a prevalence of 9.0% in 1995/1996 to 2.3% in 2005/2006. These latter results are consistent with the disappearance of night blindness during the same period. A National Nutrition and Micronutrient Survey was conducted in 2012, although results are still emerging. The first published report from this survey contains results for anthropometric indicators and anemia (5). Serum retinol analysis is still pending and results are expected in 2014.

With the exception of the forthcoming 2012 survey results (5), survey data to date on clinical and subclinical indicators of vitamin A deficiency have only been statistically representative at the national level (3,4), and hence it is not possible to identify with certainty sub-populations that are at elevated risk. Although usually presented in some disaggregated form, which has varied between surveys, there is no clear pattern of relative risk of vitamin A deficiency across geographical zones. On average, there is a somewhat lower risk among the Southern, North Western, Central, and Uva Provinces, but there is still a high degree of variation among districts within those provinces (4). The 2012 Nutrition and Micronutrient Survey was designed to be representative at the district level and thus should be looked to as the most reliable source of information on relative risk among geographically defined subpopulations.

3.1.2 Dietary vitamin A intakes

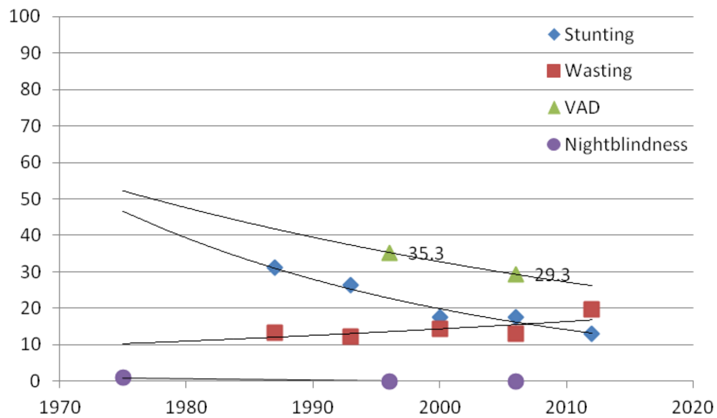
Dietary intake surveys have been carried out intermittently since the 1950's by the Central Bank of Sri Lanka as part of their national socio-economic surveys. The older surveys provide only a per capita level intake data for vitamin A, where adequacy was expressed as a percent of the per capita Sri Lanka Recommended Allowance (12). The last such survey was conducted in 1993, although a report of the survey results was not obtained at the time of writing the present report. While the results of the 1993 survey could be reviewed for context and analysis of trends, it is expert opinion that the national situation has changed greatly in the last 10-20 years in terms of food policies, food prices, food practices, and general economic situation, and that it may not well reflect the current dietary situation. Quantitative information on the current dietary sources of vitamin A and the adequacy of vitamin A intakes are not available.

The Helen Keller Food Frequency Questionnaire method was used to estimate dietary vitamin A intakes and adequacy in the national surveys of 1995/1996 (3), 2005/2006 (4), and 2012 (5). Unfortunately, this method did not account for locally adjusted portion sizes or vitamin A content of food items including fortified foods. It was noted in the 1995/1996 survey report that, in this context, food frequency instruments are inadequately sensitive to predict risk of vitamin A deficiency (3). For example, in the 1995/1996 survey (3) a high proportion of children 6-71 months of age were reported to have received dark green leafy vegetables (85%), yellow fruits or vegetables (86%), and eggs/meat/fish (79%), but the national prevalence of low serum retinol in this survey was still very high (35%). In the same survey (3), application of the Helen Keller Food Frequency method indicated that inadequate dietary vitamin A among children 6-71 months of age was unlikely in Central and Western Provinces; although the prevalence of vitamin A deficiency was lower in these provinces than in the others, it was still >20% and thus it was concluded that the method incorrectly identified adequate vitamin A intake. In the other 5 provinces where vitamin A deficiency was more prevalent (i.e. >30%), in most cases the method correctly identified that vitamin A intake was likely inadequate. It was speculated that inadequate portion sizes and presence of infections that inhibit vitamin A absorption may contribute to the inconsistent conclusions.

In the national vitamin A nutrition survey of 2005/2006 (4), the Helen Keller classification system estimated that 61% of children were likely to have adequate vitamin A intakes, consistent at national level with the 71% prevalence of adequate vitamin A status in the same survey. It is noteworthy that the latter method did not count milk as a food source of vitamin A, which may be reconsidered as some milk powder in Sri Lanka is fortified with vitamin A (**Section 3.2.2.2**).

Results from the 2012 Nutrition and Micronutrient Survey are forthcoming. However, trends in the intake of vitamin A food sources cannot be ascertained as the results are presented using indicators different from those in the previous national surveys. Some disaggregated food frequency results were presented for food sources of vitamin A such as milk and meat, as well as foods that are fortified with vitamin A – margarine and the nutritional food supplement *Thriposha*. The latter results will be discussed in section 3 in relation to those interventions.

Figure 1. Trends in the prevalence of stunting, wasting, vitamin A deficiency, and night blindness among preschool children in Sri Lanka.[1]



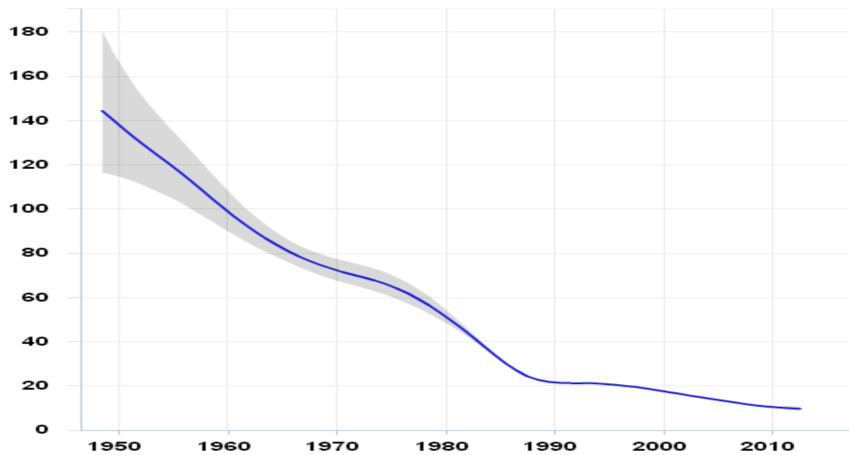
[1]Trend lines are exponentially fitted.

3.1.3 Other indicators

Nutritional status: While linear growth stunting is not a direct outcome of moderate vitamin A deficiency, trends in the prevalence of stunting among children can provide relevant context for the general nutrition and health status of children against which changes in vitamin A status can be interpreted. This may contribute to the broader assessment of the risk of scaling back universal vitamin A supplementation programs and of the general level of support for sustained improvements in child nutritional status in the country. Anthropometric data have been collected in several national-level surveys over four decades, including the aforementioned national nutrition surveys (3-6) and Demographic and Health Surveys (7-10). Collectively, these surveys clearly demonstrate an important and consistent decrease in prevalence of stunting among children under five years of age (Figure 1) from 31% in 1987 to 13% in 2012.

Under five mortality rates: As an outcome of vitamin A deficiency and an indicator of the need for universal vitamin A supplementation programs, under five mortality rates are also considered. The United Nations Interagency Group for Child Mortality Estimates (13) has summarized seven decades of data on under five mortality rates in Sri Lanka from multiple sources (**Figure 2**). In Sri Lanka, under-five mortality rates declined dramatically from the 1950's through the 1990's when it reached a low of 18 by 1999; since then, under five mortality rate has continued to decline, though at a slower rate. The latest estimate of under five mortality rate available from 2012 is 10. The UN IGME child mortality rate estimates compared well with direct estimates of under five mortality rate determined in the Demographic and Health surveys of 1987, 1993, 2000, and 2006.

Figure 2. Trend in estimated under five mortality rates in Sri Lanka, 1948-2012. *Source: UN IGME (13).*



Infant feeding practices: The 2006-07 Demographic and Health Survey (10) reported that at 2-3 and 4-5 months of age, 85.1% and 53.5% of infants, respectively, were exclusively breastfed. While this still falls short of optimal practice, it is more than twice as high as the global average and the average for the region (14). In the national vitamin A nutrition survey of 2005/2006 (4), exclusive breastfeeding for the first 6 months was not ascertained. It was reported, however, that complementary foods were introduced to the majority (83%) of infants diets at 4-6 months of age, with 6.5% having foods introduced prior to 4 months of age, and 8.1% having foods introduced at 7-9 months of age. Breastfeeding was continued for the majority (84%) of infants until 12-23 months of age, with 60% continuing to 24-35 months of age, and 43% continuing after reaching 3 years of age. These data suggest that breast milk may continue to be a source of vitamin A for nearly all infants and for a large number of preschool children, particularly up to 3 years of age. Although not statistically analyzed, data for serum retinol concentration disaggregated by breastfeeding status suggested a trend towards lower serum retinol concentration among non-breastfed children. Similar outcomes were reported in the 2006-07 Demographic and Health Survey report (10).

3.1.4 Summary

Substantial progress has been made in Sri Lanka over several decades to reduce the severity of outcomes of vitamin A deficiency, most notably the occurrence of associated ocular disorders including blindness and other forms of xerophthalmia; child mortality rates have also declined importantly to what may be considered low levels for a low to middle income country. The prevalence of stunting among children under five years of age has also been reduced to a low level of public health concern. These trends are suggestive of an important overall sustained improvement in health and nutrition conditions among children.

At the same time, however, the prevalence of mild to moderate subclinical vitamin A deficiency has declined less dramatically and still remains at a level considered to be of severe public health importance. Results from the most recent national survey conducted in 2012 will provide an updated status on the current situation and will provide a more accurate representation of geographical differences in risk.

Some national level data have been presented on the adequacy of vitamin A intakes as estimated from food frequency data, but these are not considered to be sufficient to characterize in quantitative terms the vitamin A intakes per child per day, the prevalence of inadequate intakes in the population, or the contribution of specific food items to vitamin A intakes.

Vitamin A status and intakes - key findings

- Multiple national surveys have been conducted in Sri Lanka that clearly depict trends in nutrition and vitamin A status among children under five.
- Available surveys do not suggest clearly defined sub-population groups at higher risk of vitamin A deficiency, such as by geographical location, age sub-group, or urban/rural location
- Despite dramatic declines in the prevalence of clinical indicators of vitamin A deficiency and stunting, and in under-five mortality rates, the prevalence of sub-clinical vitamin A deficiency remains persistently high in Sri Lanka (29% in 2005/2006).
- There is an absence of recent national level data on quantitative, individual-level dietary intakes of vitamin A, food sources of vitamin A, and estimates of inadequate vitamin A intakes.

3.2. Interventions for increased vitamin A intakes

3.2.1 Vitamin A supplementation program

The vitamin A supplementation program was initiated in 2001 as part of the national strategy to control vitamin A deficiency developed in 2000. This program provided for a 100,000 IU capsule given at 9 months, 18 months, 3 years, 5 years, 9 years, and 12 years of age, as well as a single post-partum dose of 200,000 IU for women. The recommended bi-annual program with 200,000 IU for all children 12-59 months of age was not adopted as pediatricians in Sri Lanka were concerned about the risk of toxicity.

The continued high prevalence of subclinical vitamin A deficiency of 29% (4) was attributed to the inadequate dosing regime and to the low coverage being achieved, and this provided justification to expand the program to include twice annual dosing for all children between 6 and 59 months of age. To address continued concern for toxicity among some stakeholders, the dosage remained at 100,000 IU. Taking effect in 2009, dosing was scheduled to coincide with routine health service visits for children, either for growth monitoring purposes and/or to receive scheduled vaccinations. Coverage rates of this program are reported to be high (80.5 – 85.5%).

Commented [DH1]: Page 67, Annual Report on Family Health Sri Lanka 2011 – Family Health Bureau – 80.5-85.5%

Commented [CH2]: Is this for one dose or two doses annually? Is it possible to send the reference? Data from National Nutrition Review 2011 suggest much lower coverage for twice annual.....

3.2.2 Mass food fortification

3.2.2.1 National policies and regulations

Policy guidelines for food fortification in Sri Lanka are available (16). These stipulate a maximum amount of nutrient that can be added to allowable foods items, expressed as the maximum amount of nutrient per 40 kcal serving. It was stated that there are currently no commercial food products in Sri Lanka for which fortification is mandatory, but foods can be voluntarily fortified. However, another source indicated that, according to the Laws and Regulations that govern the addition of nutrients to foods in Sri Lanka (which should be contained in the 1980 Food Act) the fortification of locally produced margarine with vitamin A (and vitamin D) was mandatory (17).

The food fortification policy guidelines (16) require that any label claim of the addition of vitamin A or other fortificants to a food product must first be approved by the authorities. A certificate of analysis of the vitamin A content of the food product must be submitted by the producer/supplier and approved. Apart from this, the amount of vitamin A in allowable food products is not monitored by government.

The government does not appear to maintain a list of local or imported food items by brand name that are fortified. Therefore, a cursory review of the scope of fortified commercial food items in Sri Lanka was made through expert interview and limited observations in a Colombo supermarket.

3.2.2.2 Milk powder

Some milk powder in Sri Lankan markets is fortified with vitamin A, and it is generally believed that most retail milk powder products have vitamin A added. However, there are no official sources of information on the brands of milk powder that are fortified, their market share, or the amount of vitamin A added, and no non-governmental reports are known. Therefore supporting information was sought from expert opinion, review of milk powder products available in a chain supermarket (Food City) in Colombo, and other published documents on milk sales and usage.

The Director of Environmental and Occupation Health provided some information on the extent of milk powder vitamin A fortification in the country based on professional knowledge. The milk powder industry has two broad segments. The smaller segment is that of local producers, of which there are presently four to five operating. These currently represent about 30% of the market share. It is believed that these local producers are not voluntarily fortifying milk powder at present. The larger segment is that of milk powder importers, of which there are approximately 17, representing about 70% of the market share. These importers are further segmented into those that sell milk powder in bulk to the food processing industry, and those that sell milk powder as a retail product. It is believed that milk powder sold to the food processing industry is not fortified with vitamin A, but that the majority of milk powder sold retail is fortified, of which there are approximately 10 different brands. The proportion of imported milk powder for resale that is fortified with vitamin A is not known, but based on this information no more than 70% of all retail milk powder is fortified with vitamin A. Fluid milk is locally produced and is not currently fortified.

Market share data for specific brands of milk powder have not been systematically compiled to assess the extent of vitamin A fortified milk being consumed. A 2010 published report for Vavuniya District, Northern Province (18) suggested that 29,318 kg of milk powder was sold per month, or roughly 102,613 kg of fluid milk equivalents (using a reconstitution factor of 1:3.5), whereas 30,300 L of fluid milk was sold per month. This corroborates expert opinion that approximately two-thirds of milk consumed is from imported powder form. The report further noted that Anchor (62%), Nespray (28%) and Laxpray (8%) brands represented 98% of the amount of milk powder sold in the district (18).

The national government is actively promoting the production and marketing of locally produced fluid cow's milk in effort to improve livelihoods and reduce dependency on foreign import of milk powder. As there is no precedent for fortifying fluid cow's milk with vitamin A in Sri Lanka, it is possible that this current source of added vitamin A could diminish in the future depending on how quickly that effort scales up and increases its market share and proportion of total milk consumption.

Vitamin A content of retail milk powder: A survey of milk powder products in a local supermarket provided some information on the amount of vitamin A being added to imported milk powder (**Table 1**). Of the seven milk powder brands observed, three were marketed as specialty milk powders with targeted nutritional formulas (eg, for bone health, for pregnant/lactating women), while the other four were non-specific formulas. Of the five brand name products with decipherable information on vitamin A content, two were not fortified (Ratthi full cream, and Bonlac non fat) and three were fortified; those that were fortified represented the specialty milk powder products. The vitamin A content, expressed per 40 kcal, of all three of the fortified milk powders exceeded the maximum amount stated in the policy guidelines (i.e., 60 µg RE/40 kcal serving). As suggested during expert interviews, retail fluid milk was observed not be fortified with vitamin A (data not shown). It is emphasized that the sample is not representative of all milk powders available on the market in Sri Lanka and hence it is recommended that a more complete listing be compiled.

Table 1. Summary of a non-representative sample of commercial milk powder products and vitamin A content information derived from a supermarket 'Food City' in Colombo

	Brand, product name/description	**Segment**	**Packaged & distributed by**	**Vitamin A listed as ingredient?**	**Vitamin A content per 100 g[1]**	**Vitamin A content (µg RE or RAE) per 40 kcal[2]**
1	Anchor, full cream milk powder, instant	Imported	Fonterra Brands Lanka Ltd.	?	? – reported as 39% RDA/NRV	-
2	Anchor, full cream milk powder	Imported	Fonterra Brands Lanka Ltd.	?	? – reported as 62% RDA/NRV	-
3	Anchor, Shape-Up 99% fat free non-fat milk powder	Imported	Fonterra Brands Lanka Ltd.	Yes	990 µg RAE	110
4	Anchor PediaPro Mama milk powder (formulated for pregnant and breastfeeding mothers)	Imported	Fonterra Brands Lanka Ltd.	Yes	751.8 µg RAE	66
5	Anlene Bone Nutrients, high calcium, low fat milk powder	Imported	Fonterra Brands Lanka Ltd.	Yes	947.0 µg RAE	108
6	Ratthi, full cream milk powder	Imported	Fonterra Brands Lanka Ltd.	No	200.0 µg RE	16
7	Bonlac, non-fat skim milk powder, instant	Imported	Millers Limited	No	Amount not given	-

[1] Non-fortified skimmed (non-fat) milk powder approximately contains 4-15 µg RE or RAE/100 g powder and non-fortified whole (full-fat) milk powder contains approximately 215-260 µg RE or RAE per 100 g powder.

[2] The maximum amount of vitamin A allowable per 40 kcal is 60 µg RE as retinol (16).

? Label information not given in English.

Commented [DH3]: It would be good to include a few more brands as almost all the products listed are Fonterra brands.

Commented [CH4]: Would you be interested to gather a few more examples? I'm not sure if there is any locally produced milk powder but none was available in Food City. It seems that Nespray and Laxpray may be major imported brands in Sri Lanka as well.

Commented [CH5]: Could the label information for these products be verified? They were not given in English so I could not interpret it.

Milk powder consumption and contribution to vitamin A intakes: There are no recent quantitative data available on the consumption of milk powder by children under five years of age that can be used to estimate the contribution of fortified milk powder to dietary vitamin A intakes. Milk is noted as being widely consumed throughout the country. For example, based on the food frequency data from the 2009 Nutrition and Food Security Survey (6), milk products were consumed by 81.2% of households in the previous 24 hours while 54.2% of households consumed milk products on at least five of the last seven days. The FAO Food Balance Sheets, indicate that the *per capita* intake of fluid milk equivalents is 97 grams/day. Neither of these sources distinguish between fluid and powdered milk.

Several assumptions can be made to estimate the mean intake of milk powder by children 6-59 months of age and its contribution to dietary vitamin A intakes (**Table 2**). A food frequency questionnaire from the 2005/2006 national survey (4) indicated that milk was consumed by children 6-60 months of age an average of 4.5 days per week. Based on the estimate that only two-thirds of milk consumed is from milk powder, this frequency was reduced to 3.0 days per week. Quantitative data on mean milk powder intakes are not available. Therefore, it was assumed that an average portion size of fluid milk for children this age is equivalent to the recommended amount of 100 mL (19), or approximately 33 g of milk powder per portion. It was then assumed that milk is consumed by children, on average, twice per day (20). This equates to a mean daily intake of 28.5 grams of milk powder per child per day among all children 6-59 months of age. The amount of vitamin A added to milk powder is quite variable, but an average content was assumed to be 48 µg RE per 100 g diluted, estimated as the amount of vitamin A in the most popular brand of full cream milk powder (Anchor – ~248 µg RE/100 g powder), minus the native amount of vitamin A in milk powder (i.e., approximately 200 µg RE/100 g). Based on these assumptions, milk powder may provide an average of 14 µg vitamin A RE per day. This is equivalent to 3.4% of the mean daily requirement for vitamin A (200 µg RE/day; 21).

Commented [CH6]: Confirm whether this frequency of 1.2 times per week was calculated only for children who reported to have consumed milk powder or if it represents an average of ALL children regardless of whether they consumed milk powder or not (i.e., includes all zero values as well).

Commented [CH7]: Can any data from the nutrition surveys (Nutrition and Food Security Survey 2009) be disaggregated specifically to milk powder?

Commented [CH8]: This needs to be verified, as per Table 1 above.

Table 2. Estimated mean contribution of vitamin A fortified foods to vitamin A intakes by children 6-59 months of age in Sri Lanka

	[1]Coverage estimate (mean days/week consumed)	[2]Assumed portion size (grams/day)	[3]Usage estimate (grams/day)	[4]Additional vitamin A per 100 g (µg RE)	[5]Mean additional vitamin A - all children 6-59 mos (µg RE/day)	[6]Mean additional vitamin A as proportion of EAR (%)
Milk powder						
Sri Lanka	3.0	66.6	28.5	48	14	6.9%
Margarine						
Sri Lanka	1.2	20	3.4	1000	34	17.1%

1. Frequency of milk powder intake for children 6-60 months of age of 3.0 days/week was derived from the 2005-06 national vitamin A nutrition survey (4) indicating that milk was consumed an average of 4.5 days per week; this frequency was multiplied by a factor of two-thirds to account for the estimate that only two-thirds of milk consumed is derived from milk powder. For margarine, frequency of intake for children 6-60 months of age is assumed to be 1.2 days per week as derived from the 2006-06 national vitamin A nutrition survey (4).

2. For milk powder, it is assumed that an average portion size for the fluid equivalent of milk by children 1-5 years of age is the recommended amount of 100 mL (19) and, that on days when consumed, 2 portions of milk are taken per day (19). Based on a 1:3 dilution factor of milk powder to water, this is equivalent to approximately 67 g of milk powder per day on days consumed.

3. The usage estimates for milk powder and margarine are expressed as mean grams per day and were derived by multiplying the mean estimated portion size for days consumed, by the average number of days per week consumed and divided by 7 days/week.

4. For milk powder, an average amount of vitamin A fortificant added was assumed to be 48 µg RE per 100 g powder. The product label for Anchor Full Cream Milk Powder indicated it contained 62% of the RDA for vitamin A, which is equivalent to 400 µg RE x 0.62 = 248 µg RE; subtracting the natural amount of vitamin A in milk powder (200 µg RE per 100 g) from the reported content (248 ug RE per 100 g) provides an estimated amount of fortificants vitamin A of 48 µg RE per 100 g.

5. Mean amount of additional vitamin A/day provided by the product was estimated from the average usage and the estimated amount of additional (fortificant) vitamin A provided per portion.

6. The WHO (21) mean requirement for children 1-6 yrs of age was applied (200 µg RE/day).

3.2.2.3 Margarine

According to expert opinion, most commercially produced margarine in Sri Lanka is fortified with vitamin A. As for the case of milk powder, specific information was not obtained from official or other sources on the brands of margarine that are fortified or the amounts of vitamin A added. Supporting information was thus sought from a review of margarine products available in a chain supermarket (Food City) in Colombo.

The vitamin A content of the margarine brands identified is summarized in **Table 3**. Of the seven margarine products, six were fortified with vitamin A, and five of those included the vitamin A content on the nutrition facts label. Of those five, three had vitamin A content above the maximum guideline of 60 µg/40 kcal. Based on this non-representative sample of available margarine brands, it appears that most margarine is fortified with vitamin A and the most common content was 1000 µg RE/100 g.

Table 3. Summary of a sample of commercial margarine products and vitamin A content information derived from a supermarket 'Food City' in Colombo

	Brand, product name/description	Segment	Company	Vitamin A content per 100 g	Vitamin A content per 40 kcal[1]
1	Vitalite Canola	Imported	(Australia)	Listed as ingredient but content not reported	-
2	Astra Good Start	Imported	Unilever	1000 µg	66
3	Flora	Imported	Unilever	1000 µg	66
4	Meadowlea	Imported	Millers Distributors	1000 µg	66
5	Prime	Local		1000 µg	52
6	Belle	Imported	(Australia)	600 µg	41
7	Olive Gold	Imported	India	Vitamin A not listed as ingredient. Content not reported	-

[1] The maximum amount of vitamin A allowable per 40 kcal is 60 µg RE as retinol (16).

Margarine consumption and contribution to vitamin A intakes: There are no direct quantitative dietary intake data available to verify the contribution of this food source to vitamin A intakes by children under five years of age. Expert opinion suggests that margarine is not a widely consumed food product in Sri Lanka, and that the average amount consumed by children across the population is likely very small to negligible. A food frequency questionnaire applied in the 2006 Vitamin A Nutrition Survey (4) indicated that margarine was consumed by children 6-60 months of age an average of 1.2 days per week, giving support to the latter statement. Using some assumptions about the intake of margarine and its vitamin A content, the contribution of this food product to vitamin A intakes was estimated (**Table 2**). Assuming a single average 20 gram serving size (equivalent to approximately 1 teaspoon) per day consumed, this would equate to a mean daily intake of 3.4 grams of margarine per child per day among all children 6-59 months of age. It was also assumed that all margarine consumed is vitamin A fortified with a content of 1000 µg RE/100 g. Based on these assumptions, margarine may provide an average of 34 µg vitamin A RE per day. This is equivalent to 8.6% of the mean daily requirement for vitamin A (200 µg RE/day; 21).

Commented [CH9]: Confirm whether this frequency of 1.2 times per week was calculated only for children who reported to have consumed margarine or if it represents an average of ALL children regardless of whether they consumed margarine or not (i.e., includes all zero values as well).

3.2.2.4 Fortified commercial complementary foods

Expert opinion suggested that some widely consumed commercial cereal-based products may be fortified with nutrients including vitamin A. However, it was confirmed with the producer, Plenty Foods Inc, Sri Lanka's largest producer of cereal products, that its flagship blended instant cereal product '*Samaposha*' is not fortified with vitamin A.

Some commercially available specialty food products, such as infant formulas, infant foods, and beverage mixes (eg, Milo, Horlicks, and Ovaltine malt beverage mixes), are fortified with nutrients, including vitamin A. According to expert opinion, these products are generally sold in urban supermarkets and are believed to have a limited market. However, as noted, there are no recent consumption data available that quantify the intake of these foods on a brand name basis to estimate their possible contribution to vitamin A intake. No attempt was made to acquire information on the vitamin A content of such food items.

3.2.3 Targeted fortified food supplements

3.2.3.1 Thriposha

Thriposha is a long-standing, nation-wide, government supported supplemental food distribution program (22,23). The Thriposha supplement is a blended, instant cereal product, now produced from maize, dehulled soya beans, and full cream milk powder, with added vitamins and minerals (23). The goal of the program is to address protein-energy malnutrition, poor child growth, pregnancy outcomes, and micronutrient deficiencies, including vitamin A deficiency. The program commenced in 1973 when the food supplement ingredients were initially imported from the USA through a CARE program and packaged in Sri Lanka. By 1976, production commenced in Sri Lanka under the auspices of CARE and the Ministry of Health, and by 1987, production was solely managed by the government. By 1991, the government assumed the full cost of raw materials, nearly all of which were being locally sourced, thus supporting a secondary program objective of providing economic support to local farmers. Finally, in 2011, the Thriposha production plant became a state-owned company.

Eligibility criteria have shifted slightly over the decades, but Thriposha is currently targeted to all pregnant women, lactating women up to six months postpartum, and all infants and children 6-59 months of age with weight-for-age <-2 SD of the WHO reference, including those during hospitalization. The take-home supplement is primarily distributed as part of a Maternal and Child Health package through Ministry of Health clinics, and is also offered through plantation estates, and child care centers. Beneficiaries receive two 750 g packet per month to provide a ration of 50 grams of dry product per day.

Vitamin A content: Thriposha was designed to provide 100% of the Sri Lankan RDA for vitamin A per 50 grams daily ration, equivalent to 850 IU or 255 µg retinol per serving per day. There are strict criteria in place for the control of food quality and safety, as well as the nutrient content, which is verified intermittently by direct analysis. The time between production, distribution, and consumption is likely to be quite short (expert opinion suggests approximately 2 months), therefore the deterioration of retinol in the product is not likely to be a major issue. Nonetheless, verification of the vitamin A content after storage under local temperature and humidity conditions would provide confirmatory information and, in the future, allow for a more accurate estimate of the contribution of this product to vitamin A intakes.

Commented [CH10]: What is the Sri Lankan RDA for vitamin A for children <5 years of age?

Program coverage: As of 2008, the number of approved beneficiaries was approximately 750,000, of which about two-thirds were eligible children 6-59 months of age and one-third were eligible women. In 2012, the approved number of beneficiaries was 1.1 million (women and children combined). Coverage of the program has fluctuated substantially over the years, with a declining trend between 1991 and 2008 (22). Since the program's inception, national annual coverage rates have varied from a high of 90% in 1982 to a low of 22% in 1987 (22). Achieved coverage also varies by district. Several shortcomings in the program were noted, but limitations in coverage were primarily attributed to shortages of raw materials and limited production capacity. Expert opinion suggests that production has covered approximately 85% of demand for the last 3 years. It was separately stated that there are approximately 1.3 million eligible women and children, and production is sufficient for about 1 million, equivalent to 77% supply adequacy. In a nutrition and food security survey of 2009 (6), it was reported that in 10 health districts surveyed, 15.9% of children received Thriposha – using the national rate of underweight of 23%, this would equate to approximately 69% coverage. For the purpose of estimating coverage of the program currently, a figure of 77% will be assumed. In recent years, further effort has been made to improve the operational aspects of production and it is anticipated to finally cover the full target population in the coming years.

Commented [CH11]: Please verify if the fraction of 2/3 is accurate. When calculating the number of eligible children from 2012 census data (6-59 mos of age) multiplied by the percentage of underweight children, the estimated # of beneficiaries is only about 370,000 children, plus an additional 53,000 for estates and child care = ~423,000, whereas the current estimate would 2/3 x 1.1 million total beneficiaries = ~500,000 child beneficiaries. Are there data on # of beneficiaries separated for children and women?

Contribution to vitamin A intakes: The nutrition impact and operational effectiveness of the Thriposha program was not evaluated until 2008 (22). As part of the nutrition impact survey, a 24-hour dietary recall was applied to selected beneficiaries to measure their energy and nutrient intakes and assess the contribution of the Thriposha supplement. When consumed by targeted beneficiaries, the mean portion size of Thriposha was reported as 32 ± 12 grams for infants and 61 ± 69 grams for preschool children; although highly variable, the mean portion size was reasonably close to the recommended 50 grams/day. However, the report also confirmed and quantified anecdotal information that families receiving the supplement for a specific beneficiary share the supplement among other household members; more than 80% of beneficiary households self-reported the sharing of Thriposha supplements. For this reason, the average contribution of Thriposha to vitamin A intakes will be substantially lower than the intended amount from a daily ration. This was supported by food frequency data from the 2006 National Vitamin A Survey (4) that indicated Thriposha was consumed by children 6-59 months of age only 2.2 times per week on average.

Impact of the Thriposha program on vitamin A status has not been determined. It is important to note, however, that the program is primarily targeted to underweight children. In the 2006 national vitamin A nutrition survey (4), vitamin A deficiency was found to be unrelated to underweight, as well as stunting and wasting. Of all children that were vitamin A deficient, only 26% were also underweight, and 74% were of adequate weight-for-age (4). This is similar to the prevalence of underweight for the general population of children under five years of age (i.e., 25%).

Commented [CH12]: How many children who were not VAD were underweight? It would be helpful to see both prevalence estimates to understand the lack of association.

The contribution of this supplement to vitamin A intakes was estimated using several sources of data (**Table 4**). The number of eligible children was estimated from the population of children 6-59 months as derived from the 2012 national census data and the 2012 prevalence of underweight among children 6-60 months of age (5). The number of eligible children was adjusted for the assumed 77% coverage to estimate the number of beneficiary children. The amount of vitamin A per daily ration (i.e., 255 µg RE) was multiplied by 31.4% to give a mean amount of 80 µg RE per beneficiary per day, reflecting the mean number of days Thriposha is consumed based on food frequency data from 2009 (6). The latter was then adjusted for the proportion of children 6-59 months of age who are program beneficiaries, to give an overall mean contribution of 15 µg vitamin A RE per day. This is likely somewhat underestimated as it does not account for intake by non-eligible family members who are 6-59 months of age. While this program could have some nutritional impact on its beneficiaries, it may only have a limited impact on national vitamin A deficiency, as a large proportion of vitamin A deficient children do not qualify to receive the supplement, and only a portion of the supplement is consumed by target children.

Table 4. Estimated contribution of Thriposha supplement to vitamin A intakes by children 6-59 months of age in Sri Lanka

Province	2012 Children 6-59 mos (N)	2012 Underweight children 6-59 mos (%)	[1]Eligible children (N)	[2]Coverage estimate for eligible children (%)	[3]Beneficiaries 6-59 mos (N)	[4]Beneficiaries 6-59 mos (%)	[5]Usage estimate by beneficiaries (%)	[6]Vitamin A per ration (µg RE)	[7]Mean additional vitamin A per beneficiary (µg RE/day)	[8]Mean additional vitamin A - all children 6-59 mos (µg RE/day)
Sri Lanka	**1571038**	**0.235**	**369194**	**0.77**	**284279**	**0.181**	**0.314**	**255**	**80**	**15**
Northern	81960	0.31	25062	0.77	19298	0.235	0.314	255	80	19
North Western	190307	0.22	41430	0.77	31901	0.168	0.314	255	80	13
North Central	113288	0.26	29908	0.77	23029	0.203	0.314	255	80	16
Eastern	144852	0.30	43141	0.77	33219	0.229	0.314	255	80	18
Western	397453	0.18	71341	0.77	54933	0.138	0.314	255	80	11
Sabaragamuwa	142658	0.27	38595	0.77	29718	0.208	0.314	255	80	17
Central	208796	0.27	55544	0.77	42769	0.205	0.314	255	80	16
Uva	102400	0.28	29142	0.77	22439	0.219	0.314	255	80	18
Southern	188888	0.23	42758	0.77	32923	0.174	0.314	255	80	14

1 The number of eligible children was estimated from the total number of children 6-59 mos of age and the prevalence of underweight (weight-for-age <-2 SD)

2 Coverage estimated based on expert opinion statement that approximately 85% of demand for Thriposha has been met by production; roughly 1 million are served while the demand based on eligible beneficiaries is 1.3 million. Note this figure includes Thriposha supplement for both children and women combined and thus assumes that coverage is similar for both products.

3 The number of beneficiaries was estimated from the total number of underweight children (weight-for-age Z-score <-2 SD) and the estimated coverage (%). Coverage data were not available on a district/provincial level so the same average estimated coverage was used for all provinces.

4 The beneficiaries (%) represents the estimated number of beneficiary children as a proportion of the total number of children 6-59 mos of age derived from the 2012 census data.

[5] The usage estimate is based on data from the national vitamin A survey of 2005-06 indicating that Thriposha was consumed by children on 2.2 of the previous 7 days, equivalent to 31.4% of the recommended amount (assumes this was calculated only for those who reported consuming it).

[6] The amount of vitamin A delivered per ration of Thriposha was derived from the product information (510 µg RE per 100 g), and assumes that 50 g of product is consumed per day consumed, equivalent to 255 µg RE per 50 gram daily ration.

[7] Mean amount of additional vitamin A/day provided by the product was estimated from the average usage or frequency of use, and the amount of vitamin A provided in the recommended 50 gram/day ration.

[8] The proportion of all children 6-59 mos of age who are beneficiaries represents the estimated number of beneficiary children as a proportion of the total number of children 6-59 mos of age derived from the 2012 census data.

[9] The WHO (21) mean requirement for children 1-6 yrs of age was applied (200 µg RE/day).

3.2.3.2 Suwaposha

Suwaposha is a more recently introduced (2010) government supplemental food product and represents one component of a larger program to promote agricultural production of local food crops. The program is administered by the Ministry of Agriculture and is implemented by the National Food Promotion Board. Similar to Thriposha, its goals are two-fold, in promoting the use of locally produced foods and improving the nutritional status of children in vulnerable households. The Suwaposha product is made with red rice flour, soya, and green gram and contains added vitamins and minerals. As a no-cost food supplement, it is presently targeted to children in impoverished households (bottom 8.5%) and those living in plantations within two districts (Kegalle and Monaragale); Suwaposha is also available for sale in markets.

Information was obtained on the content of added vitamin A in the product. However, it appears that the amount of vitamin A included in the premix is negligible due to an error in calculating premix needs. In the tender for vitamin and mineral premix for the manufacture of Suwaposha, the suggested composition per 100 g of product was 7.2 g of vitamin A as retinol, equivalent to 7,200,000 µg, which is equivalent to the content of 120 high dose vitamin A capsules (200,000 IU or 60,000 µg retinol per capsule for children 12-59 months of age) and of course would be highly toxic. At least one manufacturer responded to the tender to indicate that it could not provide a quotation due to erroneous content calculations. However, Hexagon Nutrition, the contracted supplier, provided a certificate of analysis for the premix and indicated that it contained 31.00 µg vitamin A per 30 kg of premix; while information on the precise amount of premix to be added to 100 g of Suwaposha product was not obtained, by any reasonable estimation this would provide a negligible amount of vitamin A in the final product.

Some data may be available on intakes of the product among beneficiaries from the Nutrition unit of the Ministry of Agriculture or the Plantation Human Development Trust, but this information was not obtained during the review. There are plans to evaluate impact of the supplement on children's nutritional status. However, until the premix content of vitamin A (and possibly other nutrients) is corrected and resubmitted for tender, the supplement is presently a negligible source of additional vitamin A and thus will have no impact on vitamin A status.

3.2.4 Micronutrient powders

Micronutrient powder distribution commenced in 2008 with a pilot program in 6 of 25 administrative districts and has since expanded to include 6 more administrative districts for a total of 12 (5 in Northern Province, 3 in Eastern Province, 2 in Uva Province, 1 in Central Province and 1 in Southern Province). The standard multi-nutrient formula, as donated by UNICEF, is targeted to all children 6-23 months of age in these areas. The districts were selected on the basis of nutrition profiling and risk, considering the prevalence of stunting, wasting, underweight, anemia and low birth weight. Although the product contains vitamin A (400 µg RE per packet), the program was more specifically intended to address the high rates of anemia among infants and young children. Vitamin A deficiency was not considered as a target for this program because it was felt this was addressed through the universal vitamin A supplementation program.

The micronutrient powders are provided to target children on an intermittent basis, such that they receive a two-month supply of powders for daily use for children reaching 6, 12, and 18 months of age. These age intervals were designed to coincide with age-based clinic visits for other services, such as immunizations. As of 2012, compliance was estimated to be ~90% based on movement of product as summarized from stock forms. Usage by the target group has not yet been verified at field level, which could inform on the individual acceptance and whether it is shared with other family members. Nonetheless, the supply-based information suggests that a large number of young children in the target districts are intermittently accessing additional amounts of vitamin A through this program. Making use of 2012 national census data, it is estimated that there would be nearly 114,000 beneficiary children, which is equivalent to approximately 7.2% of the total population of children 6-59 months of age (**Table 5**). It may be assumed that no more than 30% of those are vitamin A deficient, since vitamin A deficiency is not significantly more prevalent among the targeted age group or among children in the targeted districts.

The mean usage of micronutrient powders and average contribution to vitamin A intakes among beneficiary children was estimated based on the latter information on coverage (i.e., 90%) and number of months they are made available (i.e., 6/18 months between ages of 6 to 23 months) (Table 5). Among beneficiary children, micronutrient powders will contribute an average of 133 µg vitamin A RE per day across the period of 6-23 months of age, equivalent to 66% of the mean vitamin A requirement (200 µg RE/day; 21). However, since the age group of focus for eliminating vitamin A deficiency is 6-59 months, usage was also calculated as a mean for all children in this age group to assess the overall contribution of micronutrient powders to vitamin A intakes. When considered this way, micronutrient powders contributed an average of 11 µg vitamin A RE per child per day overall at national level, equivalent to 5.6% of the mean daily requirement. In the provinces where all districts were targeted (ie, Northern, Eastern, and Uva Provinces), micronutrient powders contributed the equivalent of 20% of the mean vitamin A requirement for children 6-59 months of age.

3.2.5 Lipid-based nutritional supplements

Lipid-based nutritional supplements, in the form of ready-to-use therapeutic food (BP-100), are used in the treatment of severe acute malnutrition in Sri Lanka. As this product is used only as treatment, as needed, it will not be considered as a regular source of additional vitamin A for the general population of children 6-59 months of age.

Table 5. Estimated contribution of Micronutrient Powders to vitamin A intakes by children 6-59 months of age in Sri Lanka

Province	2012 Children 6-59 mos (N)	2012 Children 6-23 mos (N)	[1]Eligible children (N)	[2]Coverage estimate for eligible children (%)	[3]Beneficiaries 6-23 mos (N)	[4]Beneficiaries 6-59 mos (%)	[5]Usage estimate by beneficiaries (%)	[6]Vitamin A per ration (µg RE)	[7]Mean additional vitamin A per beneficiary (µg RE/day)	[8]Mean additional vitamin A - all children 6-59 mos (µg RE/day)	[9]Mean additional vitamin A as proportion of EAR (%)
Sri Lanka	**1571038**	**521990**	**126185**	**0.9**	**113567**	**0.072**	**0.333**	**400**	**133**	**10**	**0.056**
Northern	81960	27403	27403	0.9	24663	0.301	0.333	400	133	40	0.201
North Western	190307	63547	0	0.9	0	0.000	0.000	400	0	0	0.000
North Central	113288	37943	0	0.9	0	0.000	0.000	400	0	0	0.000
Eastern	144852	47894	47894	0.9	43104	0.298	0.333	400	133	40	0.198
Western	397453	131705	0	0.9	0	0.000	0.000	400	0	0	0.000
Sabaragamuwa	142658	47274	0	0.9	0	0.000	0.000	400	0	0	0.000
Central	208796	69937	21025	0.9	18923	0.091	0.333	400	133	12	0.060
Uva	102400	34327	34327	0.9	30894	0.302	0.333	400	133	40	0.201
Southern	188888	62686	16562	0.9	14906	0.079	0.333	400	133	11	0.053

1 The number of eligible children was estimated from the total number of children 6-23 mos of age in Northern, Eastern, and Uva Province, and from Hambantota District in Southern Province.

2 Coverage estimate of 90% is based on expert statement derived from data on movement of supplies (stock sheets). Coverage data were not available on a district/provincial level so the same average estimated coverage was used for all participating districts/provinces.

3 The number of beneficiaries was estimated from the total number of children 6-23 mos of age and the estimated coverage (%).

4 The beneficiaries (%) represents the estimated number of beneficiary children as a proportion of the total number of children 6-59 mos of age derived from the 2012 census data.

[5] The usage estimate is based on the program design where, between the ages of 6 and 23 mos, children receive micronutrient powders for 6 months, equivalent to 6/18 months or 33.3% of all days. Data are not available on actual usage by target children and the possible degree of sharing among non-targeted children, therefore 100% usage is assumed for the days the product is provided.

[6] The amount of vitamin A delivered per day was derived from the product information (400 µg RE per packet), and assumes that 100% of the packet is consumed per day.

[7] Mean amount of additional vitamin A/day provided by the product was estimated from the average usage and the amount of vitamin A provided per daily packet.

[8] The proportion of all children 6-59 mos of age who are beneficiaries represents the estimated number of beneficiary children as a proportion of the total number of children 6-59 mos of age derived from the 2012 census data.

[9] The WHO (21) mean requirement for children 1-6 yrs of age was applied (200 µg RE/day).

3.2.6 Agricultural-based interventions

A large program to promote increased production of local food crops, *Api Wawamu Rata Nagamu*, was funded for the period 2007-2013, some of which include vitamin A rich fruits and vegetables (24). The Food Promotion Board, under the administration of the Ministry of Agriculture, began implementing a comprehensive package of projects nationwide. These projects included the promotion of home gardens and expansion of land for cultivation of these indigenous crops. This promotion is supported by research and development programs to develop, introduce, and disseminate higher quality, higher yielding horticultural crop seeds and planting materials, as well as an improved regulatory system for seed certification and plant protection against pest and disease outbreaks.

The potentially vitamin A rich fruit and vegetable crops promoted include, among many others, pawpaw, mango, and indigenous green leafy vegetables. It is possible that other vitamin A rich vegetables were promoted as well, but specific ones other than green leafy vegetables were not mentioned. While the broad program goals consider population nutrition in general terms, no specific objectives for improving particular aspects of nutrition, such as vitamin A status, were stated in the report (24). To our knowledge, no evaluations were planned to assess impact of the program on consumption of vitamin A rich foods.

3.2.7 Analysis of the association between vitamin A status, vitamin A intakes, and intervention implementation

3.2.7.1. Spatial-analysis and targeting of vitamin A interventions

As noted in **Section 3.1.1**, there are no obvious sub-population groups that experience a substantially higher risk of vitamin A deficiency to which vitamin A related interventions could be usefully targeted. Two of the major interventions delivering a regular or intermittent source of additional dietary vitamin A are the Thriposha nutritional supplement and micronutrient powders. Both of these programs are targeted, where Thriposha is primarily targeted to underweight children and micronutrient powders are targeted to infants and young children 6-23 months of age in selected geographical areas with higher prevalence of poor anthropometric indicators and anemia. While these are logical targeting criteria based on the program priorities for nutritional impact, these selected criteria are largely unrelated to the risk of vitamin A deficiency. Thus, from the perspective of vitamin A nutrition, there are still large and widely dispersed gaps in delivery of daily sources of additional vitamin A to children at risk. Specifically, all children > 23 months of age who are not underweight for age, and all children 6-59 months of age living in the 13 administrative districts not currently receiving micronutrient powders.

3.2.7.2 Temporal analysis of intervention implementation in relation to vitamin A status surveys

The last national survey of vitamin A deficiency among children for which data are available was conducted in 2005-06. Of the noted dietary vitamin A interventions, all but the micronutrient powders program were being implemented by the time of this survey and their impact on population vitamin A status would already have taken effect. A minor increase in the contribution of Thriposha to vitamin A intakes may have occurred since 2005-06 as the coverage increased from 62% in 2005 to 77-85% in 2012. The vitamin A supplementation program also was expanded since the 2005-06 survey, increasing the dosing schedule to every 6 months from 6-59 months though remaining with the 100,000 IU dosage level for all children. Nonetheless, current thinking suggests that vitamin A supplementation programs have only a minimal or temporary impact on the distribution of serum retinol concentrations in a population and hence this program expansion is not expected to have impacted measurably on the prevalence of vitamin A deficiency since the last survey. There are no quantitative data to suggest that the intake of mass fortified foods margarine and milk powder would have changed meaningfully since 2005-06, although it is conceivable to occur with general improvements in the economic status of Sri Lankans.

The estimated contribution of all dietary-based programs to vitamin A intakes has been summarized at a national level and by province (**Table 6**). As the risk of vitamin A deficiency is relatively evenly dispersed throughout the population on the basis of geography and year of age, the estimated contribution to vitamin A intakes by each program was presented as the mean for all children 6-59 months of age, regardless of targeting within those programs. The mean additional amount of vitamin A contributed was also expressed as a percentage of the mean requirement for vitamin A (200 µg RE per day ; 21). Taken together, these programs were estimated to contribute an additional 32 µg vitamin A RE per child per day, equivalent to 36.1% of the mean vitamin A requirement of 200 µg RE per day. Of the individual programs, margarine fortification provided the largest amount of additional vitamin A, followed by Thriposha, fortified milk powder, and micronutrient powders. On a provincial level, Northern, Eastern, and Uva provinces have access to higher amounts of additional vitamin A from these programs, and is likely attributed to targeting criteria. Improved accuracy of data used to produce these estimates would greatly increase confidence in their interpretation.

Since the time of the 2006 survey, it is estimated that the mean increase in vitamin A provided by these programs is equivalent to 10 µg RE per child per day (4.9% of the mean requirement), which is attributed to the introduction of the micronutrient powder program, plus an estimated additional intake of 2 µg RE per child per day (1.5% of the mean requirement) attributed to the increase in coverage by the Thriposha program between 2005 and 2012. Based on this assessment, the national prevalence of vitamin A deficiency may decline by a moderate degree, but is unlikely to have been reduced to levels no longer of public health concern (i.e., <5%). Results from the 2012 national nutrition survey will confirm whether this assessment is correct.

Table 6. Estimated mean contribution of interventions to vitamin A intakes by children 6-59 months of age in Sri Lanka.

	[1]Mean additional vitamin A - all children 6-59 mos (µg RE/day)	[2]Mean additional vitamin A as proportion of EAR (%)
Programs - national		
Thriposha	15	7.3%
Micronutrient powders	11	5.6%
Milk powder	14	6.9%
Margarine	34	17.1%
All programs[3]	72	36.9%
Province - all programs		
Northern	107	53.5%
North Western	61	30.7%
North Central	64	32.1%
Eastern	106	53.0%
Western	59	29.5%
Sabaragamuwa	65	32.3%
Central	64	38.2%
Uva	106	52.9%
Southern	72	36.2%
National - all programs		
Pre-2006 contribution	62	31.2%
Post-2006 contribution	72	36.9%

[1] Mean additional vitamin A intake derived from individual program summaries.

[2] The WHO (21) Estimated Average Requirement (EAR) for children 1-6 yrs of age was applied (200 µg RE/day). As a reference, when the mean intake of a population is equal to the mean requirement, approximately 50% of the population has inadequate intakes.

[3] The amount of additional vitamin A derived from each individual program was calculated as a population mean, or the mean among all children whether or not they are beneficiaries or users of the program. As such, the mean amount of additional vitamin A from all programs combined can be presented as the sum of individual program contributions.

3.2.8 Summary

Apart from the universal vitamin A supplementation program, several interventions in Sri Lanka are in place that contribute to increased vitamin A intake. The targeted nutritional supplement Thriposha and the mass fortification of margarine and some milk powders have been in place for multiple decades, while micronutrient powders were introduced more recently. Although more limited in reach, Suwaposha is another more recently introduced targeted fortified nutritional supplement, but may be regarded as a missed opportunity for getting additional vitamin A into children's diets due to the apparent error in formulating the vitamin-mineral premix.

Targeted nutrition programs, such as Thriposha and micronutrient powders, have used criteria other than risk of vitamin A deficiency as selection criteria for beneficiaries. However, the last national nutrition survey found that risk of vitamin A deficiency was not significantly associated with being underweight, or with children of the age 6-23 months, and did not differ substantially among provinces or districts overall. As such, these programs reach only a fraction of vitamin A deficient children 6-59 months of age, and they will not have a major impact on the adequacy of vitamin A intakes in Sri Lanka at national level.

Of the non-targeted programs, current quantitative data are lacking on mean intakes of fortified milk powder and margarine intakes by children 6-59 months of age, but crude estimates suggest a relatively limited contribution to the mean daily intake of vitamin A by children in this age range, which may be 7% for milk powder and 17% for margarine.

Taken together, these targeted and non-targeted interventions may contribute the equivalent of 36% of the daily mean requirement for vitamin A (**Table 6**). However, since all of these additional sources except for the targeted micronutrient powders were in place prior to the last national survey of vitamin A status in Sri Lanka, only a small additional amount of vitamin A will have been added to the population diet since that time. The adequacy of vitamin A intakes before or since that survey is not known. Also, in the absence of quantitative, individual-level dietary intake survey data, it is not known how secular changes in accessibility to vitamin A containing foods or promotion of vitamin A rich foods for infant and young child feeding through the Maternal and Child Health Program may have impacted on the adequacy of vitamin A intakes. However, unless vitamin A intakes from the base diet have changed substantially since 2006, it is unlikely that a major reduction in the prevalence of vitamin A deficiency will be observed in the 2012 survey.

Commented [CH13]: Yes, - we have no information on possible changes in the base diet as a result of nutrition education. If it has changed since the last survey, it cannot be quantified unless a dietary survey is done. This can be a recommendation.
The premise of the framework is that VA supplements will not affect population vitamin A status. Only changes to daily vitamin A intakes will shift the distribution of serum retinol towards adequacy.

Commented [DH14]: Can we say this as from 2009 onwards the vitamin A supplementation schedule changed to 100 000IU every 6 months from the age of 6 months to 5 years? 12 doses vs 3 before 2009.

Further in the MCH programme vitamin A rich food is very much promoted in complementary feeding of infants and young children while prompting breastfeeding for two years and beyond.

Vitamin A intervention programs –key findings

- Apart from the universal vitamin A supplementation program, there is one mass intervention (voluntary fortification of milk powder and margarine) and two targeted intervention programs (Thriposha supplementary food and micronutrient powders) that provide additional amounts of vitamin A to children 6-59 months of age.
- As an average of all children 6-59 months of age, these programs are estimated to contribute the equivalent of 37% of the Estimated Average Requirement for vitamin A. However, of this amount, only about 6% of requirement has been added since the last survey of vitamin A status in Sri Lanka.
- While the targeted programs likely benefit eligible children, the nutritional goals of these programs were other than reducing vitamin A deficiency. As the risk of vitamin A deficiency is widely dispersed across the population and not closely linked with the indicators used as eligibility criteria, there is a large proportion of vitamin A deficient children not being reached by these programs.
- The estimated contribution of fortified milk powder and margarine are based on very crude estimates. Nonetheless, these are likely indicative of the relatively limited contribution of these food items to population vitamin A intakes.

Key recommendations emerging from the situation analysis

- Estimates of the contribution of milk powder and margarine could be improved by compiling relevant available statistics, such as brand market share information from milk powder and margarine distributors, nutrition label information on voluntarily fortified foods, and further analysis of existing 24- hour recall data to estimate mean intakes of fortified foods.
- Monitoring data for the micronutrient powder distribution program would provide important information on usage of this supplement by target children and improve estimates of its contribution to additional vitamin A intakes.
- National-level survey data of individual-level dietary intakes by children would provide more accurate information on total vitamin A intakes, vitamin A intake adequacy, and food sources of vitamin A, including the contribution of existing targeted programs and mass programs delivering additional vitamin A (including agricultural-based and nutrition education).
  - National level dietary intake data would also inform on appropriate food vehicles to increase the dietary vitamin A supply.
- The vitamin A content of the premix formula used to fortify Suwaposha should be corrected to take full advantage of this intervention to deliver additional vitamin A to vulnerable populations.
- Government activities to promote production and distribution of local fluid cow's milk should be reviewed with regard to its impact on decreasing intake of vitamin A fortified milk powders; fortification of locally produced fluid milk or other food vehicles should be considered.

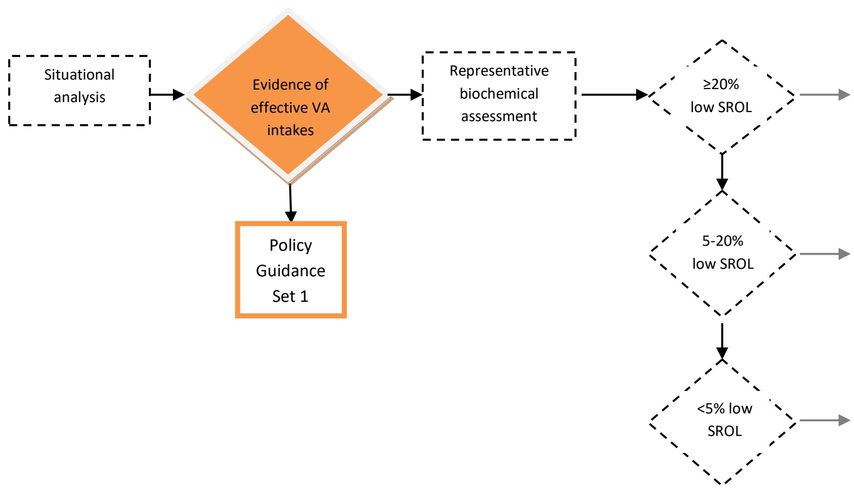
4. Evaluation of the framework

The decision-making framework was evaluated in a number of ways. First, the information derived from the situation analysis was applied to the framework to determine which set(s) of policy guidance would apply (**Section 4.1**). The framework flow was assessed for logic and functionality, and the policy guidance was assessed for its appropriateness and completeness considering the Sri Lankan context. Second, indicators were identified that were most useful in this context to answer the questions posed by the framework and provide the necessary burden of evidence for decision-making (**Section 4.2**). This was of particular relevance for assessing evidence of effective vitamin A intakes, but was as well considered for interpreting available data on prevalence of low serum retinol. In this regard, indicators that would have been necessary to support conclusions and decision making but were not available were also noted. Finally, feedback was sought from local stakeholders and experts on the various elements of the framework, its logic and functionality, as well as anticipated challenges in implementing the resultant guidance (**Section 4.3**).

4.1 Result of application of the framework

Following the situation analysis, the two pivotal questions for applying the decision-making framework are, for children 6-59 months of age: i) 'Is there sufficient evidence of effective vitamin A intakes?', and; ii) 'Is the prevalence of vitamin A deficiency based on low serum retinol concentrations above or below 5%?'.

4.1.1 Is there evidence of effective vitamin A intakes?



In the decision-making framework, evidence that population vitamin A needs are being met through the diet can be a trigger for a biochemical survey of serum retinol to determine if the prevalence of vitamin A deficiency is sufficiently low to safely scale-back a vitamin A supplementation program. Well designed, individual level, quantitative dietary intake surveys are the best source of such evidence. However, coverage data and related information from programs delivering additional vitamin A in the diet may also be used.

There are no recent data available on the dietary sources of vitamin A or the adequacy of vitamin A intakes as derived from dietary intake surveys (**Section 3.1.2**). However, some evidence was available for the delivery of additional dietary vitamin A through different interventions (**Sections 3.2.2 – 3.2.6**). This evidence was based on estimations of coverage and usage of foods delivering additional sources of vitamin A and in some cases, particularly in the case of the mass fortified foods, was heavily based on assumptions.

Nonetheless, when assessing the possible magnitude of increase in vitamin A intakes since the time of the last national survey of vitamin A status (**Section 3.2.7.2**) it was clear that major increases in the intake of additional sources of vitamin A over and above the base diet were rather small in magnitude. Information on program coverage suggests that vitamin A intake adequacy has increased in the last 6-7 years for some vulnerable subgroups of children but will unlikely have improved significantly for the majority of children 6-59 months of age among whom vitamin A deficiency exists. The Micronutrient Powder program presently reaches 25% of all children 6-23 months of age on an intermittent basis or 8% of all children 6-59 months of age, the latter of which is the target group for reducing vitamin A deficiency. As a result, it was estimated that this program, plus some improved coverage in the Thriposha program targeted to underweight children, would have added a mean of 12 µg vitamin A RE per child per day among all children 6-59 months of age, or the equivalent of 6% of the mean vitamin A requirement.

Commented [xdf615]: I'll go back and check but it's this the recommended schedule? Although intermittent, if its recommended then the timing does not have to be emphasized.

Commented [CH16]: I believe this dosing regimen is mentioned in the WHO Guidelines. It is pertinent to the mean contribution to vitamin A intakes across the population. In any case, this is the approach taken in Sri Lanka.

Thus, there is some evidence for increased intakes among a small proportion of the population, but an absence of evidence for an increase across the majority of children 6-59 months of age at risk of vitamin A deficiency. It is possible that secular dietary changes, including through the influence of nutrition education programs to promote vitamin A rich foods for child feeding, or secular increases in consumption of commercially fortified foods, have also led to increased vitamin A intakes across the population but evidence from dietary intake surveys are lacking.

Conclusion: As a result of these estimates from program coverage data, only a very modest decrease in the prevalence of vitamin A deficiency since the last vitamin A survey is predicted. Unless updated national level dietary intake data become available to indicate an important increase in vitamin A rich foods, including currently fortified foods, the available evidence does not justify doing another survey of vitamin A status at this time[2].

Commented [DH17]: As mentioned earlier the Vitamin A schedule has changes to a more frequent dosing and in the national MCH programme vitamin A rich food is very much promoted in complementary feeding - so I wonder whether we can say this??

Because the estimated additional vitamin A intakes were so low, the weakness of some of the data in deriving these estimates may be of limited consequence and it seems justified to recommend not doing another serum retinol survey. However, if the program related evidence suggested a much higher additional vitamin A intake among children, the strength and reliability of these data would need to be improved upon before a survey should be recommended. Recommendations for this were given at the end of **Section 3 (Key recommendations emerging from the situation analysis)**.

Policy Guidance - Set 1: The policy recommendations associated with this step in the decision-making framework do not apply well to the Sri Lankan situation. The recommendations are formulated with the assumption that most countries will have made limited progress in ensuring sufficient vitamin A intakes, and that these are generally countries with high mortality rates, poor health infrastructure, and a heavy reliance on donor support, and that program investments

[2] This analysis assumes that the expansion of the vitamin A supplementation program in 2009 would not have contributed meaningfully to reducing the prevalence of low serum retinol, and this is one of the premises of the framework and associated policy guidance. It is noteworthy that part of the rationale for conducting the national micronutrient survey in 2012 in Sri Lanka was the hypothesis that vitamin A deficiency remained high due to the inadequate dosing schedule of the vitamin A supplementation program (providing only 3 doses of 100,000 IU per child <5 years of age) as implemented prior to 2009, and the expectation that the expanded vitamin A supplementation program would have an important impact on the prevalence of vitamin A deficiency.

should be funneled towards improving coverage of existing vitamin A supplementation programs. However, this is not the case in Sri Lanka, as mortality rates are low and health infrastructure is generally considered to be strong; as such, the Set 1 policy recommendations should be modified to improve their applicability.

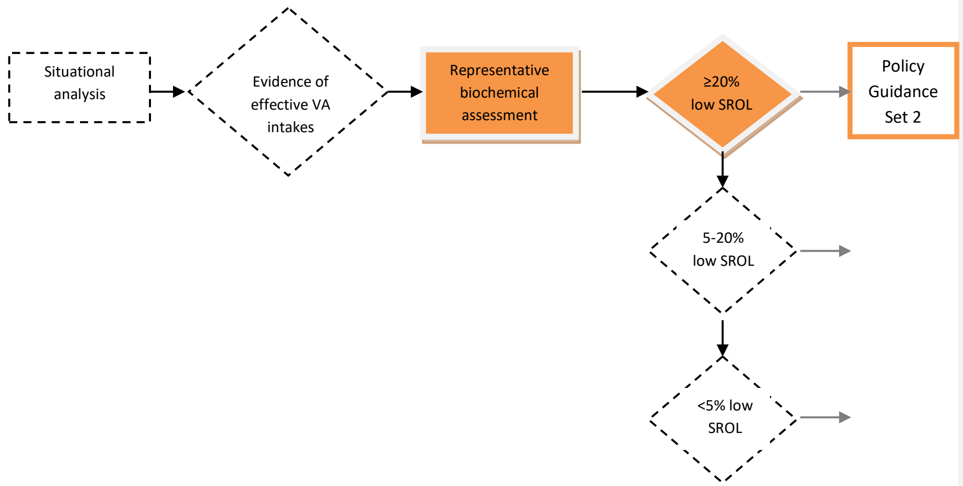
In the case of Sri Lanka, an appropriate set of recommendations will focus on strengthening existing programs to increase the adequacy of daily vitamin A intakes in the general population or in targeted sub-populations shown to be at greater risk of vitamin A deficiency. The situation analysis may be useful to identify priority areas for improving programs, or suggesting new strategies that may be successful.

Framework logic and functionality: It is noteworthy that this section of the decision-making framework accommodates the situation where enough evidence is available to determine whether daily intakes of vitamin A in the population are adequate, which in turn will determine whether a biochemical survey of vitamin A status is justified. However, it would be useful to consider the scenario where a situation analysis is done, and concludes that there is insufficient evidence to determine whether vitamin A intakes are likely to be adequate or not. This case presents the opportunity to offer an alternative set of recommendations for acquiring sufficient data to build up an evidence base – this is the same set of evidence that would be required either to justify a serum retinol survey, or to inform on how to strengthen program design to improve vitamin A intake adequacy further. This also acknowledges that having *inadequate evidence* is different from having *evidence of inadequate vitamin A intakes*, and the former question must be asked before the latter.

While collecting new survey data may provide the most up-to-date and conclusive set of evidence, an acceptable level of evidence could compiled from a variety of existing sources and analyzed for the present purpose with limited investment. Recommendations of this type were given for Sri Lanka at the end of **Section 3.2 (Vitamin A intervention programs – key findings)**.

In terms of adjusting the framework flow chart itself, one suggestion is to insert a diamond in between the 'Situational analysis' box and the 'Evidence of effective VA intakes'. This diamond would ask 'Is there adequate evidence available on VA intakes?'. A 'yes' response would lead to the next diamond, while a 'no' response would lead to recommendations for compiling adequate evidence. The extent of such evidence could be commensurate with the extent of programming that might affect vitamin A intakes.

4.1.2 Serum Retinol Assessment



The prevalence of low serum retinol is a primary factor for decision-making in this framework. The recommended actions are dependent on the prevalence category, where scaling-back vitamin A supplementation programs should not be considered until the national prevalence of vitamin A deficiency among children 6-59 months of age is <5%.

Based on the primary purpose and logic of the decision-making framework, a re-assessment of the prevalence of vitamin A deficiency among children 6-59 months of age need not be considered, as it has unlikely been substantially reduced since the last national survey. Nonetheless, the appropriateness of the policy guidance provided based on the national prevalence of low serum retinol from the last survey (2005-2006) is evaluated here, where the prevalence of low serum retinol among children 6-59 months was found to be 29%.

Policy guidance – Set 2:

In brief, for countries with a prevalence of low serum retinol ≥20%, the policy recommendations are:

1. Maintain vitamin A supplementation coverage.
2. Initiate or strengthen existing fortification programs for vitamin A deficiency control, with investment in monitoring

3. Broaden fortification programs and/or introduce micronutrient powders for children 6-23 months of age.
4. Strengthen or maintain public health nutrition efforts, such as breastfeeding promotion and nutrition education
5. Continue to promote water, sanitation, hygiene and disease control efforts.

In the context of Sri Lanka, the guidance provided based on the current level of vitamin A deficiency is considered to be appropriate for the situation.

The policy guidance (point 1) recommends that the vitamin A supplementation program be maintained but with greater focus on hard-to-reach groups. In the case of Sri Lanka, this guidance would require identification of the 10-20% of children 6-59 months of age who are routinely not being reached by the program.

As per policy guidance point 2, both mass and targeted food fortification programs and a targeted micronutrient powder program are ongoing in Sri Lanka. However, the persistent high prevalence of low serum retinol confirm the conclusions of the situation analysis that some of these programs likely need to be expanded[3]. Given the dispersed nature of vitamin A deficiency across the population of children 6-59 months of age, mass fortification may be the most effective way of reaching all vulnerable children. Consideration could be given to expanding fortification of milk powder to include all local and imported brands, or mandating the fortification of popular food products targeted to children (eg, commercial products similar to Thriposha), or considering new food vehicles. However, additional dietary intake data would still be recommended to make an evidence-based decision. On the other hand, the impact of expanding the micronutrient powder program for the purpose of vitamin A deficiency control may be questionable.

This guidance (point 3) is also consistent with the conclusion in the situation analysis that monitoring of these programs, in terms of compliance, coverage, and usage, needs to be strengthened as well.

Sri Lanka is likely already performing well on policy guidance points 4 and 5. Review of these activities was not included in the situation analysis here; it could be expanded to cover these public health and nutrition education programs more thoroughly to identify any possible areas for strengthening, if needed.

Framework logic and functionality: With regard to the framework flow diagram, the box following Policy Guidance-Set 2 is to 'reassess serum retinol concentrations after evidence of improved intakes', and that box, in turn, loops back to the diamonds on low serum retinol prevalence. Another approach is to directly link the Policy Guidance-Set 2 box all the way back to the 'Evidence of effective VA intakes' diamond. This would reinforce the need to fully re-

[3] It is recognized that the micronutrient powder program was introduced and the coverage of the Thriposha was somewhat increased since the time of the last serum retinol survey. These recommendations are applied retrospectively to the time of that survey.

evaluate potential improvements to vitamin A intake adequacy before justifying another biochemical survey.

It may also be useful to have an alternate entry point into the framework; to be applied by a country where prevalence data from the last available survey can still be usefully applied to seek relevant guidance. In other words, the diamonds representing actions based on prevalence of low serum retinol can usefully serve as an entry point for any country, regardless of whether or not they are contemplating another survey.

4.2 Usefulness of specific indicators for applying the framework

In addition to having reliable national-level data on serum retinol concentrations for decision-making, several specific indicators were considered useful in this context in the context of the situation analysis and in answering the question on evidence of effective vitamin A intakes.

4.2.1 Situation analysis – historical and nutritional context

- Historical data on vitamin A deficiency was useful to understand the context and progress that has been made in reducing risk of vitamin A deficiency and its outcomes. Although not always statistically representative, historical data on xerophthalmia and night blindness, as well as under-five mortality rates, are indicative that earlier efforts in public health, nutrition, and food and economic policies may well have effectively eliminated or greatly reduced the most serious outcomes of vitamin A deficiency. More contemporary data from surveys of serum retinol suggest, however, that further efforts are required to reduce the prevalence of mild to moderate sub-clinical forms vitamin A deficiency which remains of elevated public health concern.

- Although not directly related to vitamin A status, data on trends in stunting, underweight, and wasting were also useful to understand the overall nutritional context in which risk of vitamin A deficiency lies. As noted above, it suggests that enormous success has been observed in improving some aspects of general nutrition, while other aspects remain of public health concern and suggest more efforts are required that specifically address vitamin A. Data on the relationship between underweight, as a key criteria for targeting of the Thriposha program, and vitamin A status, was useful to anticipate the limited impact of that program on national prevalence of vitamin A deficiency.

- The discussion suggested that morbidity data would be important to consider, as this is considered to be a main outcome of vitamin A deficiency and may be improved by an effective vitamin A supplementation program. This was more of a concern than outcome on child mortality rates as these are already quite low.

4.2.2 Situation analysis - Evidence of effective vitamin A intakes

In the absence of comprehensive national level survey data on dietary intakes of vitamin A, the availability of a range of data sources were relied upon to answer the question of effective vitamin A intakes. The critical types and sources of data of use are highlighted below:

- National food frequency data were useful to estimate the potential coverage of the mass fortified foods. These data are still crude however, as they do not distinguish intake frequencies among specific brands that may or may not be fortified with vitamin A, nor were they presented in any disaggregated form for geographical subgroups. Data on usual portion sizes were not available.

- Information on the vitamin A content of the targeted program intervention vehicles (eg, Thriposha, Micronutrient Powders) was useful and easily acquired from government sources. In contrast, information on the vitamin A content of fortified foods was not readily available and remains incomplete. A more complete listing of the vitamin A content of voluntarily mass fortified foods would improve their estimated contribution to vitamin A intakes.

- For the government operated targeted programs, coverage data and eligibility criteria were easily obtained and critical for estimating the overall contribution of these programs to population vitamin A intakes in the general population.

- For the government operated targeted programs, data on usage was useful. Usage was defined as the proportion of the intended amount of vitamin A containing food supplement that the beneficiary child actually consumes. Some usage data were available for the Thriposha supplement, while it is as yet absent for micronutrient powders and 100% usage among beneficiaries was assumed.

As noted, the above mentioned types of data were useful, when available, but it is important to emphasize that the estimated contribution of these programs to vitamin A intakes are still rather crude. National-level surveys on dietary intakes would not only improve those estimates, but would also include the contribution of other vitamin A rich foods such as fruits, vegetables, green leafy vegetables, eggs, etc. These foods are promoted through nutrition education in programs for infants and young children – as such, it is difficult to quantify their contribution to vitamin A intakes without some form of dietary intake data.

4.2.3 Situation analysis – Spatial/temporal analysis

- Having serial survey data on prevalence of low serum retinol was most useful when combined with information on the timing of introduction and coverage achieved by the various programs delivering additional vitamin A. This allowed the clear distinction of the amount of additional vitamin A that was likely delivered prior to, and since the last survey in 2005-2006.

- Having annual data on production and distribution of the Thriposha supplement was useful to detect changes to that program that affect its overall contribution to vitamin A intakes.

4.3 Comments and suggestions on the decision-making framework for scaling back VAS

4.3.1 Participant comments on the framework and its application

This exercise was carried out with a group of national level public health and nutrition professionals representing the national government and UNICEF-Sri Lanka (**Annex 2**). As noted in the previous sections, a national micronutrient survey was conducted in 2012 and data on serum retinol concentrations among children < 5 years of age are forthcoming. In order to elicit specific comments on the decision-making framework, this exercise was carried out under the hypothetical situation that the national prevalence of vitamin A deficiency among children 6-59 months of age in 2012 was <5%. The prospect of scaling back the vitamin A supplementation program was discussed.

The group expressed some concerns about stopping the program, the reasons for which included that:

> i) the dramatic reduction in vitamin A deficiency will be attributed to the expanded vitamin A supplementation program and, if the program is scaled back this progress will be reversed and vitamin A deficiency will increase again.
>
> ii) although child mortality rates are quite low already, vitamin A supplementation has continued importance for reducing morbidity rates among children. If the vitamin A supplementation program is scaled back, child morbidity rates may increase.
>
> iii) although prevalence of low serum retinol is considered the best indicator of subclinical vitamin A deficiency in a population, one should not only consider serum retinol results in isolation. It was emphasized that it is still important to consider the broader health and nutrition context for policy decision-making. One specific example is that of childhood morbidity, for the reasons noted above.

The GAVA decision-making framework emphasizes an emerging concept that vitamin A supplementation programs are unlikely to dramatically shift the distribution of population serum retinol concentrations towards greater adequacy. However, it was noted in discussions that this concept has not yet been widely disseminated and acknowledged, and the evidence in support of it is still somewhat limited in extent and the range of contexts from which it has been derived. In fact, there is a strong belief among these stakeholders that one reason for the high prevalence of vitamin A deficiency in 2006 is that the vitamin A supplementation program did not include an adequate dosing schedule, and the need to reduce the high prevalence of deficiency was a critical justification for expanding the program to be in line with internationally recommended dosing schedules of every 4 to 6 months for children 6-59 months of age. If indeed the prevalence of vitamin A deficiency is shown to be reduced in 2012 compared to 2006, it will likely be attributed to the vitamin A supplementation program. This poses an important programmatic difficulty.

4.3.2 Comments on the logic and functionality of the decision-making framework arising from participatory discussions

- The importance of having an adequate situation analysis was recognized by the group, and that this should be fully accounted for, not only when deciding whether or not to conduct another survey of vitamin A status, but also when considering the interpretation of the prevalence of low serum retinol for decision-making on scaling back a vitamin A supplementation program. It was emphasized that vitamin A deficiency prevalence should not be interpreted on its own, and that understanding the context around that prevalence level was critical to the process and to making an informed programming decision.

  In the decision-making framework, the application of the situation analysis is currently only presented as a means to assess whether or not a biochemical assessment of vitamin A status is justified, and it is not yet suggested to be applied with the results of a serum retinol survey to aid interpretation and decision-making. This comment provides support to the consultant's recommendation that the Policy Guidance Set 2-4 could link back to the situation analysis box.

- The current framework recommends that once the prevalence of low serum retinol is <5%, a survey should be repeated after one year, and, if the prevalence remains stable, universal vitamin A supplementation can be safely scaled back. It also recommends that the situation be monitored to ensure vitamin A intakes remain at the same level after scale-back. This comment may be extended to recommend a repeat serum retinol survey *after* scaling back the vitamin A supplementation program. This suggestion comes in relation to the comment in **Section 4.3.1** on the perceived importance of vitamin A supplementation for reducing the prevalence of low serum retinol, and the limited evidence available to support the contrary situation.

It was specifically suggested that a survey be implemented after the scale back of a vitamin A supplementation program as an internationally supported research activity in multiple countries to gain further experience and validate the framework decision-making criteria.

4.3.3 Anticipated challenges in advocating for application of the framework

Based on the participatory discussion, two main challenges were anticipated in advocating for applying the framework, both of which were alluded to in the preceding sections:

i) The amount of resources and level of effort required to complete repeated surveys of vitamin A status, and the capacity to advocate for repeated surveys within government.

ii) Convincing the national level public health community that scaling back a successful vitamin A supplementation program will not have a roll-back effect on population vitamin A status.

Recommendations on the decision-making framework derived from the Sri Lankan context

- *Provide an additional set of policy recommendations focused on compiling or collecting data to enable assessment of effective vitamin A intakes.* This would specifically apply to countries that currently do not have adequate evidence to assess whether vitamin A intakes are effective.

- *Adjust the framework flow diagram to emphasize repetition of the situation analysis* and/or assessing evidence of effective vitamin A intakes by linking Policy Guidance Sets 2-4 back to the situation analysis box.

- *Produce a peer-reviewed analysis of the evidence for the lack of expected impact of high coverage vitamin A supplementation programs on reducing vitamin A deficiency.* It should be determined whether there is consensus for this concept in the international public health nutrition community and if existing evidence is sufficient. If vitamin A deficiency has been reduced in a country since achieving success in vitamin A supplementation programs, it will be difficult to gain support for a scale-back effort.

- *Engage the international nutrition research community to validate the decision-making framework where opportunities exist.* In countries where these guidelines for scaling back a high coverage vitamin A supplementation program could be applied, a research-based survey could be conducted to determine whether possible negative impacts of withdrawal, such as reversion to lower serum retinol may occur. If no negative outcomes are observed under careful monitoring this would serve to validate the guidelines and provide greater confidence in the safety of its application.

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Annex 1. Population data for children 6-59 months of age in Sri Lanka, derived from the 2012 National Census Data

		VAD District % 2005-06	Prov VAD % 2005-06	Under-weight District % 2012	Underweight Prov % 2012	Pop'n 6-11 mos	Pop'n 12-59 mos	Pop'n 6-59 mos	Pop'n 6-11 mos	Pop'n 12-59 mos	Pop'n 6-59 mos	Pop'n 6-23 mos	
Age group (months)													
6-11				0.122									
12-23				0.222									
24-35				0.234									
36-47				0.267									
48-59				0.256									
Province	***District***												
Northern	Jaffna	-		0.198		4669	33266	37935				12985	
	Kilinochchi	-		0.409		1073	10733	11806				3757	
	Mannar	-		0.282		842	7532	8375				2725	
	Vavuniya	0.404		0.284		1543	12854	14397				4756	
	Mullativu	-	0.40	0.356	0.306	1090	8357	9448	9217	72743	81960	3179	27403
North Western	Kurunagala	0.22		0.247		13693	112767	126460				41885	
	Puttulum	0.24	0.23	0.188	0.218	7601	56246	63847	21294	169013	190307	21662	63547
North Central	Anuradapura	0.36		0.222		8992	69368	78361				26334	
	Polonnaruwa	0.4	0.38	0.306	0.264	3836	31091	34927	12828	100460	113288	11609	37943
Eastern	Ampara	0.367		0.287		6159	53812	59972				19612	
	Batticaloa	-		0.279		5254	42557	47811				15893	
	Trincomalee	0.36	0.36	0.328	0.298	4161	32908	37069	15574	129278	144852	12388	47894

Western	Colombo	0.297		0.163		16171	133988	150159				49668	
	Gamphana	0.302		0.217		17211	139983	157194				52207	
	Kalutara	0.238	0.29	0.158	0.179	9741	80359	90100	43123	354330	397453	29830	131705
Sabaragamuwa	Kegalle	0.32		0.258		6275	53546	59821				19661	
	Ratnapura	0.28	0.31	0.283	0.271	9204	73633	82837	15479	127179	142658	27612	47274
Central	Kandy	0.351		0.247		11647	94547	106194				35284	
	Matale	0.16		0.285		4583	36180	40763				13628	
	Nuwara Eliya	0.16	0.26	0.266	0.266	7421	54418	61839	23651	185145	208796	21025	69937
Uva	Badulla	0.2		0.267		6930	56252	63182				20993	
	Monaragala	0.32	0.26	0.302	0.285	4706	34512	39218	11636	90765	102400	13334	34327
Southern	Galle	0.28		0.224		8473	68839	77312				25682	
	Matara	0.12		0.252		6477	55864	62341				20443	
	Hambantota	0.2	0.22	0.203	0.226	5669	43566	49235	20619	168269	188888	16561	62686
Total		0.293	0.29	0.235	0.235	**172307**	**1398731**				**1571038**	**521990**	522716

Annex 2. Contributors

Commented [CH18]: Please add to the list here – to include individuals that participated in the group meeting.

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