Global prevalence of vitamin A deficiency in populations at risk 1995–2005

WHO Global Database on Vitamin A Deficiency

World Health Organization

Global prevalence of vitamin A deficiency in populations at risk 1995–2005

WHO Global Database
on Vitamin A Deficiency

World Health Organization

WHO Library Cataloguing-in-Publication Data

Global prevalence of vitamin A deficiency in populations at risk 1995–2005: WHO global database on vitamin A deficiency.

1.Vitamin A deficiency – epidemiology. 2.Vitamin A deficiency – etiology. 3.Vitamin A deficiency – complications. 4.Child. 5.Eye manifestations. 6.Databases as topic. I.World Health Organization.

ISBN 978 92 4 159801 9 (NLM classification: WD 110)

Suggested citation: WHO. *Global prevalence of vitamin A deficiency in populations at risk 1995–2005. WHO Global Database on Vitamin A Deficiency*. Geneva, World Health Organization, 2009.

Cover photographs by WHO/P. Virot, L. Rogers, and T. Stanley
Designed by minimum graphics
Printed in France

Contents

Figures

Preface

Part of the World Health Organization's mandate is to provide information on the health status of the population at the global level. In this respect, since 1991, the Department of Nutrition for Health and Development (NHD) has been maintaining the Vitamin and Mineral Nutrition Information System (VMNIS), which includes three databases related to three micronutrient disorders of public health significance globally: iodine deficiency, iron deficiency and anaemia, and vitamin A deficiency. The objectives of VMNIS are to assess the status of the population at the global level in order to increase the awareness of the public health community and policy makers, evaluate the impact of interventions and measure progress towards the goals endorsed by the international community, to compare data between countries, track changes over time, and increase the capacity of countries to manage health data related to micronutrients.

WHO estimates of the global prevalence of vitamin A deficiency were first published through its Micronutrient Deficiency Information System in 1995. Since then, large programmes on vitamin A deficiency control have been implemented in several countries where vitamin A deficiency was a public health problem – many of these programmes involved vitamin A supplementation and were strengthened by being combined with polio eradication campaigns. Additionally, vitamin A status indicators, especially symptomatic reporting of night blindness and serum retinol concentrations, have been assessed in many more national surveys than reported for previous estimates. As a result, most data collected in the present report are based on reported histories of night blindness and serum retinol concentrations.

Vitamin A deficiency is one of the most important causes of preventable childhood blindness and is a major contributor to morbidity and mortality from infections, especially in children and pregnant women, affecting the poorest segments of populations, particularly those in low and middle income countries. The primary cause of vitamin A deficiency is lack of an adequate intake of vitamin A, and may be exacerbated by high rates of infection, especially diarrhoea and measles. Its consequence is most apparent during stages of life of high nutritional demand (e.g. early childhood, pregnancy and lactation). A variety of interventions are being used to improve the vitamin A status of populations: dietary diversification, vitamin A supplementation and fortification.

In 1987, WHO estimated that vitamin A deficiency was endemic in 39 countries based on the ocular manifestations of xerophthalmia or deficient serum (plasma) retinol concentrations (<0.35 µmol/l). In 1995, WHO updated these estimates and reported that vitamin A deficiency was of public health significance in 60 countries, and was likely to be a problem in an additional 13 countries. The current estimates reflect the time period between 1995 and 2005, and indicate that 45 and 122 countries have vitamin A deficiency of public health significance based on the prevalence of night blindness and biochemical vitamin A deficiency (serum retinol concentration <0.70 µmol/l), respectively, in preschool-age children.

In this present edition, estimates of vitamin A deficiency are provided for preschool-age children as in the previous edition, and also for pregnant women. They are based on an increasingly assessed history of night blindness and a now more widely adopted serum (plasma) retinol concentration, using a cut-off of <0.70 µmol/l (<20 µg/dl) to define deficiency. Despite a marked increase in submitted data, there are still numerous countries lacking national prevalence data. There is a need to inform and motivate governments and agencies to collect, and report to WHO, national and subnational data on the prevalence of deficiency and, whenever possible, vitamin A programme coverage conditions prevailing at the time that population assessment data were collected. At the same time, there is also a need for the development of new field methods with which to assess vitamin A status that are cost effective and that can take into consideration the potential influences of infection.

In this report, the prevalence of vitamin A deficiency is presented by country and by WHO regions. Because these prevalence data may be used to identify programme needs by other United Nations agencies, we have also presented the estimates classified by United Nations regions in the annexes.

This document is divided into three chapters. The first provides an overview of vitamin A deficiency, the second describes the criteria used to identify, revise, select, and interpret the findings of the surveys, and the methodology developed to generate national, regional, and global estimates, while the third discusses the results.

This report is written for public health officials, nutritionists, and researchers. We hope that readers find it useful and feel free to share any comments with us (micronutrients@who.int). We also hope that this information will contribute to our common goal to eliminate vitamin A deficiency as a public health problem.

Acknowledgements

This report utilized data from the WHO Global Database on Vitamin A Deficiency, which is part of the WHO Vitamin and Mineral Nutrition Information System (VMNIS), developed by the Reduction of Micronutrient Malnutrition Unit in the Department of Nutrition for Health and Development.

This report is the result of the hard work and collaboration of several individuals. We would especially like to thank Lisa M. Rogers, who took the lead on the development of this report, Daniel Wojdyla of the Universidad Nacional de Rosario, Argentina for performing the statistical analyses, Keith P. West Jr of Johns Hopkins Bloomberg School of Public Health for his extremely valuable scientific input on vitamin A, and Bruno de Benoist for his technical expertise in this area. Grace Rob and Ann-Beth Moller also provided valuable assistance in data management. Additionally, WHO wishes to thank the numerous individuals, institutions, governments, nongovernmental, and international organizations for providing data for the database. Without continual international collaboration in keeping the database up-to-date, this compilation on the global situation and trends in the prevalence of vitamin A deficiency would not have been possible. Special thanks are due to ministries of health of the WHO Member States, WHO regional offices, and WHO country offices.

This report was made possible by the financial support of the Micronutrient Initiative, the Government of Luxembourg, the Centers for Disease Control and Prevention, and Sight and Life.

Abbreviations

GDP	Gross domestic product
HDI	Human Development Index: a composite indicator of wealth, life expectancy and education developed by the United Nations Development Programme.
MDIS	Micronutrient Deficiency Information System
PreSAC	Preschool-age children
PW	Pregnant women
SD	Standard deviation
UN	United Nations
VAD	Vitamin A deficiency
VADD	Vitamin A deficiency disorders
VMNIS	Vitamin and Mineral Nutrition Information System
WHO	World Health Organization
XN	Night blindness

1. Introduction

1.1 Vitamin A deficiency: a public health problem

Vitamin A deficiency (VAD) is a major nutritional concern in poor societies, especially in lower income countries. Its presence as a public health problem is assessed by measuring the prevalence of deficiency in a population, represented by specific biochemical and clinical indicators of status. The main underlying cause of VAD as a public health problem is a diet that is chronically insufficient in vitamin A that can lead to lower body stores and fail to meet physiologic needs (e.g. support tissue growth, normal metabolism, resistance to infection). Deficiency of sufficient duration or severity can lead to disorders that are common in vitamin A deficient populations such as xerophthalmia (xeros = dryness; -ophthalmia = pertaining to the eye), the leading cause of preventable childhood blindness, anaemia, and weakened host resistance to infection, which can increase the severity of infectious diseases and risk of death. A poor diet and infection frequently coexist and interact in populations where VAD is widespread. In such settings, VAD can increase the severity of infection which, in turn, can reduce intake and accelerate body losses of vitamin A to exacerbate deficiency. The prevalence and severity of xerophthalmia, anaemia and the (less-measurable) "vicious cycle" between VAD and infection in vulnerable groups (notably young children and pregnant or lactating mothers) represent the most compelling consequences of VAD and underlie its significance as a public health problem around the world.

1.1.1 Etiology

Vitamin A is an essential nutrient needed in small amounts for the normal functioning of the visual system, and maintenance of cell function for growth, epithelial integrity, red blood cell production, immunity and reproduction. Essential nutrients cannot be synthesized by the body and therefore must be provided through diet. When dietary intake is chronically low, there will be insufficient vitamin A to support vision and cellular processes, leading to impaired tissue function. Low vitamin A intake during nutritionally demanding periods in life, such as infancy, childhood, pregnancy and lactation, greatly raises the risk of health consequences, or vitamin A deficiency disorders (VADD).

Dietary deficiency can begin early in life, with colostrum being discarded or breastfeeding being inadequate, thereby denying infants of their first, critical source of vitamin A (*1*). Thereafter, into adulthood, a diet deficient in vitamin A lacks foods containing either preformed vitamin A esters, such as liver, milk, cheese, eggs or food products fortified with vitamin A or lacking its carotenoid precursors (mainly beta-carotene), such as green leaves, carrots, ripe mangos, eggs, and other orange-yellow vegetables and fruits. Where animal source or fortified foods are minimally consumed, dietary adequacy must rely heavily on foods providing beta-carotene. However, while nutritious in many ways, a diet with modest amounts of vegetables and fruits as the sole source of vitamin A may not deliver adequate amounts, based on an intestinal carotenoid-to-retinol conversion ratio of 12:1 (*2*). This ratio reflects a conversion efficiency that is about half that previously thought, leading to greater appreciation for why VAD may coexist in cultures that heavily depend on vegetables and fruits as their sole or main dietary source of vitamin A.

Usually, VAD develops in an environment of ecological, social and economical deprivation, in which a chronically deficient dietary intake of vitamin A coexists with severe infections, such as measles, and frequent infections causing diarrhoea and respiratory diseases that can lower intake through depressed appetite and absorption, and deplete body stores of vitamin A through excessive metabolism and excretion (*3*, *4*). The consequent "synergism" can result in the body's liver stores becoming depleted and peripheral tissue and serum retinol concentrations decreasing to deficient levels, raising the risks of xerophthalmia, further infection, other VADD and mortality.

1.1.2 Health consequences

Vitamin A deficiency impairs numerous functions and, as a result, can lead to many health consequences, to which infants, young children and pregnant women appear to be at greatest risk. Xerophthalmia is the most specific VADD, and is the leading preventable cause of blindness in children throughout the world (*5*). Night blindness often appears

during pregnancy, a likely consequence of preexisting, marginal maternal vitamin A status superimposed by nutritional demands of pregnancy and intercurrent infections (*6*). Anaemia can result from VAD in children and women, likely due to multiple apparent roles of vitamin A in supporting iron mobilization and transport, and hematopoiesis (*7*). Preexisting VAD appears to worsen infection (*8*) and vitamin A supplementation has been shown to reduce the risk of death in 6–59 month old children by about 23–30% (*9–11*). Three trials from southern Asia have reported that neonatal vitamin A supplementation reduced mortality by 21% in the first six months of life (*12*) while two other studies conducted in Africa showed no impact of this intervention (*13*, *14*). One study has reported an approximate 40% reduction in maternal mortality following routine dietary supplementation with vitamin A during pregnancy (*15*).

1.1.3 Assessing vitamin A status and deficiency

The main objective of assessing vitamin A status is to determine the magnitude, severity and distribution of VAD in a population. Most surveys assess its prevalence in young children and, with increasing frequency, in pregnant or lactating women, as reported here. Although VAD is likely to be widespread following the preschool years, few data exist to reveal the extent of VAD in school-age and young adolescent children (*16*). Estimating the national prevalence is to be encouraged as such data aids in targeting regions for interventions, and provides baseline values for monitoring population trends and intervention programme impact over time.

Two sets of indicators of VAD are commonly used for population surveys: clinically assessed eye signs and biochemically determined concentrations of retinol in plasma or serum. The term xerophthalmia encompasses the clinical spectrum of ocular manifestations of VAD, from milder stages of night blindness and Bitot's spots, to potentially blinding stages of corneal xerosis, ulceration and necrosis (keratomalacia) (*17*), as listed in **Table 1**. The stages of xerophthalmia are regarded both as disorders and clinical indicators of VAD, and thus can be used to estimate an important aspect of morbidity and blinding disability as well as the prevalence of deficiency. As corneal disease is rare, the most commonly assessed stages are night blindness, obtainable by history, and Bitot's spots, observable by handlight examination of the conjunctival surface. Standard procedures exist for assessing xerophthalmia (*17*). Although night blindness and Bitot's spots are considered mild stages of eye disease, both represent moderate-to-severe systemic VAD, as evidenced by low serum retinol concentrations (*19*), and increased severity of infectious morbidity (i.e. diarrhoea and respiratory infections) and mortality in children (*5*) and pregnant women (*6*, *20*).

Table 1 ***Classification of xerophthalmia***

XN	Night blindness
X1A	Conjunctival xerosis
X1B	Bitot's spot
X2	Corneal xerosis
X3A	Corneal ulceration/keratomalacia (< $^1/_3$ corneal surface)
X3B	Corneal ulceration/keratomalacia (≥ $^1/_3$ corneal surface)
XS	Corneal scar
XF	Xerophthalmic fundus

Source: reference (*18*)

Measuring serum retinol concentrations in a population constitutes the second major approach to assessing vitamin A status in a population, with values below a cut-off of 0.70 µmol/l representing VAD (*21*), and below 0.35 µmol/l representing severe VAD. Although there is not yet international consensus, a serum retinol concentration below a cut-off of 1.05 µmol/l has been proposed to reflect low vitamin A status among pregnant and lactating women (*22*). While the distribution of serum retinol concentrations below appropriate cut-offs are considered to reflect inadequate states of vitamin A nutriture, a low biochemical concentration of retinol in circulation is not considered a VADD. Also, while an inadequate dietary intake of vitamin A or beta-carotene likely reveals an important and preventable cause of VAD in a population, it is not an indicator of vitamin A status.

1.2 Control of vitamin A deficiency

Three types of community interventions can reduce VAD in affected populations. Improving the availability and intake of vitamin A through dietary diversification should be viewed as an activity for all communities in order to enhance the overall nutritional status of the population. This requires nutrition education to change dietary habits, as well as providing better access to vitamin A or provitamin A-rich foods, such as mangoes, papaya, or dark green leafy vegetables. Encouraging home gardening or local cooperatives to grow such foods may be necessary in regions where they are not locally available or are too expensive.

A second approach to increasing the dietary intake of vitamin A is through fortification of a staple food or condiment with vitamin A. This has been the primary strategy for reducing VAD in Central and South America, where sugar began to be fortified with vitamin A three decades ago (*23*). Although many food items such as fats, oils, margarine and cereal products have long been fortified with vitamin A in high income countries, few other vitamin A fortification programmes with national reach currently exist in lower income countries. It can be expected that this approach will gain momentum as increasing numbers of potentially fortifiable foods become centrally produced or processed under controlled conditions and penetrate markets of the poor in many countries (*24*).

Thirdly, the most widely practiced approach to control-

ling VAD in most high risk countries is the periodic delivery of high-potency supplements, containing 200 000 IU of vitamin A, to preschool-age children (<5 years), with half this dose given to infants 6–11 months of age (*25*). In the past decade, vitamin A supplementation gained momentum as it was added to the annual Expanded Programme for Immunization (EPI) visits, especially within the poliomyelitis eradication campaign, that has since continued as national child health week campaigns during which high-potency vitamin A is distributed twice yearly in many countries (*26*). While periodic vitamin A delivery in the community has been shown to reduce the risks of xerophthalmia (by ~90%) and mortality (by ~23–30%) in young children, the reasons for the modest and transient effect in raising population serum retinol concentrations (*5*), remain unclear. Many high-risk countries have also adopted the WHO policy of supplementing mothers with a 200 000 IU oral dose of vitamin A within six weeks after delivery (*25*) to enrich their breast milk content of vitamin A, although in practice coverage remains quite low.

These three broad approaches are largely viewed as complementary and should be combined, where it merits to do so, to achieve the greatest reductions in the prevalence and consequences of VAD. In addition, other public health and nutrition strategies that promote breastfeeding, use of oral rehydration therapy to treat diarrhoea, higher vaccine coverage (especially against measles), and adoption of family planning (to space the birth of children) can all be important in contributing to the control of VAD and its disorders.

2. Methods

2.1 Data sources – The WHO Global Database on Vitamin A Deficiency

The current estimates are based on data available in the WHO Global Database on Vitamin A Deficiency (*27*); a part of the Vitamin and Mineral Nutrition Information System (VMNIS), maintained at WHO Headquarters in Geneva, Switzerland. This database compiles information on the prevalence of night blindness, other ocular signs of VAD, and blood retinol concentrations, regularly collected from the scientific literature and through collaborators, including WHO regional and country offices, United Nations organizations, ministries of health, research and academic institutions, and nongovernmental organizations. MEDLINE and WHO regional databases (African Index Medicus, Index Medicus for the WHO Eastern Mediterranean Region, Latin American and Caribbean Center on Health Sciences Information, Index Medicus for South-East Asia Region) were systematically searched. These resources were augmented by manual searching of articles published in non-indexed medical and professional journals. Data were extracted from reports written in any language.

For inclusion in the database, a complete and original survey report providing details of the sampling method used is necessary. Serum or plasma retinol levels measured in capillary, venous, or umbilical cord blood using quantitative methods are reported, usually together with the prevalence of VAD. Measures of clinical VAD may have included the prevalence of current night blindness (XN), history of maternal night blindness during a previous pregnancy (pXN), conjunctival xerosis (X1A), Bitot's spot (X1B), corneal xerosis (X2), corneal ulceration/keratomalacia affecting <1/3 of the corneal surface (X3A) or ≥1/3 of the corneal surface (X3B), or corneal scarring (XS). Data are included in the database if they are representative of any administrative level within a country, including nationally representative data and surveys representative of a region within a country. Surveys conducted at the first or second administrative level boundary, or local surveys are also included. As of December 31, 2006, a total of 683 surveys were available in the database. Of these, 405 surveys were conducted between 1995 and 2006. Most surveys assessed nutritional status in women or preschool-age children.

2.2 Selection of survey data

The time frame for the current estimates is 1995–2005 and survey data for WHO's Member States were extracted from the database. Available data on both biochemical (serum/plasma retinol) and clinical (current or history of night blindness) VAD were selected for each country based on the administrative level for which the survey was representative and on the population group surveyed.

All countries with a 2005 gross domestic product (GDP) ≥US$ 15 000 were assumed to be free from VAD of a public health significance and were therefore excluded. None of these 37 countries had retinol or night blindness data reported for either preschool-age children or pregnant women.

2.2.1 Administrative level

Surveys were first selected according to the administrative level they represented. Surveys were considered as national when they were based on a nationally representative sample of the population surveyed. Subnational surveys were selected only if a nationally representative survey was not available for the years 1995–2005. Subnational surveys are classified based on the population they represent: regional (multiple states), state (representative of the first administrative level boundary), district (representative of the second administrative level boundary), or local surveys.

Seven surveys were included as national even though some areas within the country had been left out for security or other concerns. In one of these surveys, data available from an originally missing area was pooled with the national data and weighted by the area's general population estimate to provide a national estimate for that country. This proportion was determined by using the most recent census data. Three additional surveys were accepted as national even though they were only representative of either the rural (Bangladesh, Cambodia) or urban (Cuba) populations.

For the majority of countries with subnational data,

surveys were representative of at least the first (state) level boundary. Exceptions to this were second (district) level boundary surveys used for Sao Tome and Principe, and Ghana. Most countries that used subnational surveys were represented by at least two states (first level boundaries). Exceptions to this principle were the surveys for Tajikistan and Uzbekistan, for which only one state was covered by the survey. When two or more surveys at the subnational level were available for the population group and country concerned within the acceptable time frame, the results were pooled into a single summary measure and weighted by the total population that the survey represented. The most recent population census data available between 1995 and 2005 was used for this. No local level surveys and most district level surveys were used in these estimates to reduce potential bias in the estimates.

In general, surveys with prevalence data based on a sample size of less than 100 subjects were excluded. This sample size, along with a confidence level of 95%, would result in an error ±10% if the prevalence estimate was 50% and the design effect was 1.0. If the sample size was less than 100, a larger error would result. However, a few exceptions were made. National surveys with a sample size of less than 100, but greater than 50, were considered as nationally representative only when the results were being applied to a total population of less than 500 000 people (n=1 in preschool-age children), or to pregnant women (n=3) since the numbers in this group are frequently small, especially in populations with a lower rate of reproduction. One national survey (Mexico) of pregnant women was excluded because the sample size was less than 50. One survey for retinol in pregnant women (Zimbabwe) and three surveys for night blindness in preschool-age children (Gambia, India, Sri Lanka) did not report a sample size. In these cases, a sample size of 100 was used only to approximate variances and derive confidence intervals.

2.2.2 Population groups

Two population groups were evaluated: preschool-age children (<5 years) and pregnant women (no age range defined). Where possible, children ≥5 years were excluded from the estimate for preschool-age children. However, there were 27 surveys with serum retinol data that used an alternative upper age limit ranging from 5 to 6 years, and one country (China) provided no disaggregated data and an upper age limit of 12 years had to be used. For night blindness, there were 17 surveys that used an alternative upper age limit ranging between 5 and 6 years, and one country (Mali) provided no disaggregated data and an upper age limit of 9 years had to be used.

Where possible, children less than 6 months of age were excluded for the estimates of biochemical VAD in preschool-age children and children <2 years were excluded for the estimates of night blindness in preschool-age children.

For pregnant women, all ages and trimesters were included. However, for the data on night blindness, the majority of surveys were conducted by Measure Demographic and Health Surveys (DHS) and reported women's history of night blindness during their most recent pregnancy in the previous 3–5 years that ended in a live birth. All prevalence figures for pregnant women that were unadjusted for daytime visual problems were used. All surveys in pregnant women that provided only an adjusted value or a figure for current night blindness rather than a history of night blindness were excluded. The purpose for using unadjusted values only is that otherwise the data would imply that (a) women with daytime visual problems (presumably mostly representing myopia) would not be night blind; b) recall of daytime vision problems is 100% accurate, and (c) a positive history of night blindness among women with daytime vision problems is 100% inaccurate, for which there is no clear evidence that these assumptions hold true in the present data.

2.3 Defining vitamin A deficiency

2.3.1 Serum or plasma retinol threshold

The WHO serum retinol threshold of <0.70 µmol/l was used to classify those at risk for biochemical VAD (*28*). For the studies that classified individuals by using the serum retinol threshold of <0.70 µmol/l, as recommended by WHO, the reported actual prevalence data were used without any additional calculations. When the prevalence was either not reported, or was reported for a non-WHO cut-off, the prevalence was estimated by one of the following methods in order of preference:

1. When the mean and standard deviation (SD) of the retinol concentration were available (n=1 for children, n=2 for pregnant women), the prevalence of serum retinol <0.70 µmol/l was calculated using these variables and assuming that the serum retinol concentration is normally distributed. To validate this approach, the correlation between the estimated prevalence of serum retinol <0.70 µmol/l and the predicted prevalence of serum retinol <0.70 µmol/l was assessed in situations where a mean, a SD and a prevalence of serum retinol <0.70 µmol/l was provided. For the available data, which included multiple points for some surveys because data were disaggregated, the relationship between actual and predicted prevalence was plotted (n=71 for children; n=20 for pregnant women). For the majority of studies, the two prevalence figures were extremely close (children: R^2=0.97, P <0.001; pregnant women: R^2=0.91, P <0.001). On average, the predicted prevalence underestimated the actual prevalence by 0.03 percentage points for children and 0.2 percentage points for pregnant women; this may be

taken as slightly conservative. For only two of the 71 values in children, the predicted prevalence overestimated the observed prevalence of retinol <0.70 µmol/l by 10% or more. There were no cases of overestimation or underestimation of more than 10% using the predicted equation in pregnant women.

2. When the SD was not provided, but the prevalence for a non-WHO cut-off and the mean serum retinol concentration were provided, these two figures were used to calculate the SD of the serum retinol concentration by assuming a normal distribution within the population and using the Z score. Using the proportion of values below a provided cut-off, the Z score was derived. The mean was subtracted from the provided cut-off and the resulting absolute value divided by the absolute value of the Z score. This provided an estimate of the SD in the population. Following this calculation, the mean and SD were used as above to derive the prevalence for the non-WHO cut-off. This method was used for two surveys in preschool-age children (Antigua and Barbuda, and Bhutan).

3. For three surveys in preschool-age children and two surveys in pregnant women, a mean, SD or the prevalence at the recommended threshold was not reported. However, these surveys did report a threshold (<0.87 µmol/l, or ~25 µg/dl) that was very close to the WHO recommended cut-off (<0.70 µmol/l) for serum retinol. In these five cases, a SD of 0.35 µmol/l was assumed based on the literature and the prevalence of retinol <0.70 µmol/l was estimated using the reported prevalence of retinol <0.87 µmol/l and a SD of 0.35 µmol/l using the above methodology.

When data were provided for separate groups, such as data for children disaggregated by age, prevalence estimates were combined and weighted by sample size. If sample size information was missing from all data pooled, equal weight was given to each survey.

2.3.2 Estimated prevalence of night blindness and biochemical vitamin A deficiency for countries with no survey data

Some countries did not have any survey data that met the criteria for the estimates. Therefore, a regression model was developed using data from countries with a reported prevalence of VAD and indicators of population health status so that the prevalence of VAD could be predicted for the countries without data. The indicators of population health status considered in the regression model include the following:

- Human Development Index (HDI), 2002 (*29*)
- Individual components of HDI
  - Life expectancy at birth; adult literacy rate; the combined primary, secondary, and tertiary gross enrollment ratio (education); and GDP per capita (*30*)
- Under 5 mortality rate, 2003 (*31*)
- Adult female mortality rate, 2003 (*31*)
- Measles immunization coverage rates, 2003 (*32*)
- Stunting, 2004[1]
- Wasting, 2004[1]
- Population growth rates (*33*)
- Regional indicator variable
- Any interaction term between the regional indicator variable and the remaining variables

Fifteen countries (Afghanistan, Cook Islands, Democratic People's Republic of Korea, Iraq, Kiribati, Liberia, Marshall Islands, Micronesia, Nauru, Niue, Palau, Serbia, Montenegro, Somalia, Tuvalu) did not have an HDI; therefore, HDI was estimated with a regression model using two of the same components and one proxy indicator for education (average years of schooling in adults instead of adult literacy and gross enrollment in school) fitted to the group of countries with HDI estimates. This was used to derive and estimate HDI score for these 15 countries.

For the estimates of the prevalence of deficiency, four separate prediction equations were derived: one each for biochemical VAD in preschool-age children and pregnant women and one each for night blindness in preschool-age children and pregnant women.

The prevalence of biochemical VAD and night blindness was estimated by using the prediction equations (**Tables 2 and 3**) in countries where no information was available and only explanatory variables were known. In all cases, the prevalence was transformed to a logit scale to ensure non-negative predicted values.

2.3.3 Uncertainty of estimates

For estimates based on survey data, each estimate was considered to be representative of the entire country whether from a national or subnational sample, and the variance of the estimate was calculated using the logit transformation. Since most surveys utilized a cluster sampling design, variance estimates were adjusted using a design effect of 2. From the point estimate of the prevalence and its variance, a 95% confidence interval was generated in logit scale and then transformed to the original scale (*35*, *36*).

For regression-based estimates, a point estimate and

[1] Based on analysis of 388 nationally representative studies for 139 countries from the WHO Global Database on Child Growth and Malnutrition (http://www.who.int/nutgrowthdb/). These were used to estimate prevalence of child stunting and wasting for each country in the world according to the new WHO Child Growth Standards (*34*).

Table 2 ***Prediction equations used to generate biochemical vitamin A deficiency estimates for countries without survey data in populations at risk of vitamin A deficiency***

Population group[a]	Number of countries	Equation[b]	R^2	p-value for model
Preschool-age children	64	= -1.41497 – 0.00012074 GDP + 0.01128 Under 5 mortality – 0.25813 Population growth rate	0.334	< 0.0001
Pregnant women	16	= -3.6887 – 0.01450 Stunting + 2.6583 Africa indicator + 2.68685 Asia indicator	0.461	0.0150

[a] Population subgroups: Preschool-age children (<5 years), Pregnant women (no age range defined).
[b] See section 2.3.2 for an explanation of the variables.

Table 3 ***Prediction equations used to generate night blindness estimates for countries without survey data in populations at risk of vitamin A deficiency***

Population group[a]	Number of countries	Equation[b]	R^2	p-value for model
Preschool-age children	29	= -7.57332 + 2.54214 Education component of HDI + 0.01146 Under 5 mortality	0.132	0.0607
Pregnant women	42	= -1.08925 – 1.14404 Education component of HDI – 0.01389 Immunization coverage for measles + 0.12159 Population growth rate	0.290	0.0011

[a] Population subgroups: Preschool-age children (<5 years), Pregnant women (no age range defined).
[b] See section 2.3.2 for an explanation of the variables.

95% prediction interval were computed by using the logit transformations in the regression models and then back-transforming them to the original scale (*37*, *38*).

2.3.4 Combining national estimates

Country estimates for the 156 Member States with a 2005 GDP <US$ 15 000 were combined to provide estimates at the global level, as well as by WHO and UN regions, for preschool-age children and pregnant women, using **Equation 1**, where p_{comb} symbolizes the estimated prevalence for the region, p_i is estimated prevalence for the i^{th} country in the region and w_i is a weight which is proportional to the number of persons in the population subgroup in the i^{th} country. Point estimates were obtained by weighting the country estimates by the population that each estimate represented. Ninety-five percent confidence intervals around the point estimates were constructed from the estimated variance of the weighted average. The variance of p_{comb} was estimated using **Equation 2**, where w_i are the same weights defined previously and $var(p_i)$ represent the variance of the country level estimates. The variance of country level estimates comes from two difference sources. In countries where data is available, the variance is estimated using the usual estimate for the variance of a proportion (*39*) and that variance is inflated by a design effect (DEFF) factor of two. In countries where a model-based estimate was computed, this variance is obtained using the linear regression model, specifically the variance used to derive prediction intervals (*37*).

Equation 1:
$$p_{comb} = \frac{\sum w_i p_i}{\sum w_i}$$

Equation 2:
$$var\,(p_{comb}) = \frac{\sum w_i^2 \, var(p_i)}{\sum w_i^2}$$

2.3.5 Global prevalence of vitamin A deficiency in populations at risk

The global prevalence of night blindness was calculated for preschool-age children and pregnant women by combining the individual country estimates for 156 Member States having a 2005 GDP <US$ 15 000. The remaining 37 Member States with a 2005 GDP ≥US$ 15 000 were excluded from the analysis and were assumed to be free of VAD of public health significance. The global prevalence of biochemical VAD was similarly calculated for preschool-age children and pregnant women by combining the individual country estimates of the prevalence of serum retinol <0.70 µmol/l for the 156 Member States having a 2005 GDP <US$ 15 000.

2.3.6 Classification of vitamin A deficiency as a problem of public health significance

The prevalence of night blindness below various population-specific thresholds was used to classify countries by the level of the public health problem of night blindness (**Table 4**) (*21*, *28*).

Similarly, the prevalence of serum retinol <0.70 µmol/l was used to classify countries by the level of the public health problem of biochemical VAD (**Table 5**) (*28*).

Table 4 ***Prevalence criteria for defining night blindness of public health significance***

Public health importance (degree of severity)	Night blindness (XN)	
	Children[a] (24–71 mo of age)	Pregnant women[b]
Mild	>0%–<1%	≥5%
Moderate	≥1%–<5%	
Severe	≥5%	

[a] Source: reference (*28*)

[b] Based on history of night blindness during a woman's most recent pregnancy in the previous 3–5 years that ended in a live birth. Source: reference (*21*)

Table 5 ***Prevalence cut-offs to define vitamin A deficiency in a population and its level of public health significance***

	Biochemical
Public health importance (degree of severity)	Serum or plasma retinol <0.70 µmol/l in preschool-age children or pregnant women[a]
Mild	≥2%–<10%
Moderate	≥10%–<20%[b]
Severe	≥20%

[a] Source: reference (*28*); Children 6–71 months of age. As there is no WHO recommended cut-off for serum retinol in pregnant women, the cut-off for children was used (<0.70 µmol/l).

[b] The moderate range includes, as its mid-point, the minimum prevalence of 15% currently recommended by the Micronutrient Forum/International Vitamin A Consultative Group (IVACG) as the cut-off at or above which vitamin A deficiency should be considered a problem of public health significance among preschool children (*21*). The distribution of prevalence cut-offs for pregnant women is provisional.

2.4 Population covered by survey data, proportion of population, and the number of individuals with vitamin A deficiency in populations at risk

2.4.1 Population covered

The population covered by survey data at the regional and global level was calculated by summing the number of individuals in the population group in countries with survey data divided by the total number of individuals in the population group in the countries identified at risk of VAD in the entire region or globally for each population group.

2.4.2 Proportion of population and the number of individuals affected in countries at risk for vitamin A deficiency

The number of individuals with VAD was estimated in both population groups for both indicators (night blindness and retinol) for each country considered to be at risk of VAD, each WHO and UN region, and globally based on each country's proportion of the population with VAD. The proportion of the population group with VAD was multiplied by the national population of those considered to be at risk of VAD to provide the number of subjects with VAD at the country level, and the 95% confidence interval was used as a measure of uncertainty. The population figures are for the 2006 projection from the 2006 revision of the United Nations population estimates (*40*). Population figures for pregnant women were derived from the annual total number of births (time period 2005–2010). For 14 countries with a small total population (0.01% of all women), birth data were not provided in tabulations of the UN population division, and the number of pregnant women was estimated by applying a WHO regional average of births per reproductive-age woman (15 to 49 years) to the total number of reproductive-age women.

3. Results and Discussion

3.1 Results

3.1.1 Population covered

Only the 156 Member States which have a 2005 GDP <US$ 15 000 were considered to have populations at risk of VAD (**Table 6**). The 37 countries with a GDP ≥US$ 15 000 represent 9% and 8% of the total global preschool-age population and pregnant women population, respectively, were assumed to be free of VAD of public health significance and were excluded from further analysis. **Table 7** shows the population covered by surveys and their indicator prevalence estimates, globally and by WHO region. Globally, the proportion of preschool-age children and pregnant women covered by night blindness survey data was 54% and 55%, respectively, and by serum retinol survey data, 76% and 19%, respectively. By WHO region, the coverage varied drastically depending on the population group assessed and the indicator used. For night blindness in preschool-age children, data coverage was highest in South-East Asia (82.4%) and the Western Pacific (87.3%) and very low in Europe (1%) and nil in the Americas (0%). Survey coverage for night blindness in pregnant women was the highest in South-East Asia (96.8%) and the lowest in Europe

Table 6 ***Population residing in countries with a 2005 GDP ≥ US$ 15 000 and excluded from estimations, expressed in number and percentage of the total population***

WHO region	Preschool-age children[a]		Pregnant women	
	Population (thousands)	% of total population	Population (thousands)	% of total population
Africa (0)[b]	0	0	0	0
Americas (3)	22 520	29	4 645	29
South-East Asia (0)	0	0	0	0
Europe (24)	21 796	42	4 353	41
Eastern Mediterranean (4)	679	1	150	1
Western Pacific (6)	9 790	8	1 871	8
Global (37)	**54 786**	**9**	**11 019**	**8**

[a] Population subgroups: Preschool-age children (<5 years); Pregnant women (no age range defined).
[b] Total number of countries with a 2005 GDP ≥US$ 15 000.

Table 7 ***Number of countries and percentage of population covered by night blindness and serum retinol prevalence surveys (national or subnational) conducted between 1995 and 2005, by WHO region in countries at risk of vitamin A deficiency[a]***

WHO region	Preschool-age children[b]		Pregnant women	
	Night blindness	Retinol	Night blindness	Retinol
Africa (46)[c]	14 (30.3)[d]	24 (78.8)	24 (69.8)	8 (30.9)
Americas (32)	0 (0.0)	16 (49.8)	6 (14.9)	4 (0.6)
South-East Asia (11)	5 (82.4)	6 (82.4)	8 (96.8)	3 (14.7)
Europe (29)	2 (1.0)	5 (17.8)	2 (1.3)	0 (0.0)
Eastern Mediterranean (17)	4 (33.8)	6 (58.4)	2 (34.4)	2 (39.8)
Western Pacific (21)	7 (87.3)	10 (99.8)	3 (12.4)	2 (10.3)
Global (156)	**32 (54.0)**	**67 (75.7)**	**45 (55.0)**	**19 (18.9)**

[a] Excludes countries with a 2005 GDP ≥US$ 15 000.
[b] Population subgroups: Preschool-age children (<5 years); Pregnant women (no age range defined).
[c] Number of countries in each grouping.
[d] Percentage of population

(1.3%). Survey coverage for serum retinol was the highest in the Western Pacific (99.8%) and the lowest in Europe (17.8%) for preschool-age children; however, for pregnant women, coverage was the highest in the Eastern Mediterranean (39.8%) and virtually nil for both Europe (0%) and the Americas (0.6%).

3.1.2 Proportion of population and number of individuals with vitamin A deficiency in populations at risk

Globally, night blindness affects 5.2 million preschool-age children (95% CI: 2.0–8.4 million) and 9.8 million pregnant women (95% CI: 8.7–10.8 million), which corresponds to 0.9% and 7.8% of the population at risk of VAD, respectively (**Table 8**). Low serum retinol concentration (<0.70 µmol/l) affects an estimated 190 million preschool-age children (95% CI: 178–202 million) and 19.1 million pregnant women (95% CI: 9.30–29.0 million) globally. This corresponds to 33.3% of the preschool-age population and 15.3% of pregnant women in populations at risk of VAD, globally (**Table 9**).

WHO regional estimates indicate that the highest proportion of preschool-age children affected by night blindness, 2.0%, is in Africa, a value that is four times higher

Table 8 ***Global prevalence of night blindness and number of individuals affected in populations of countries at risk of vitamin A deficiency 1995–2005***

Population group[a]	Prevalence of night blindness		Population affected	
	Percent[b]	95% CI	Number (million)	95% CI
Preschool-age children	0.9	0.3–1.5	5.17	1.99–8.38
Pregnant women	7.8	7.0–8.7	9.75	8.70–10.8

[a] Population subgroups: Preschool-age children (<5 years); Pregnant women (no age range defined).
[b] Numerator and denominator exclude countries with a 2005 GDP ≥US$ 15 000.

Table 9 ***Global prevalence of serum retinol concentrations <0.70 µmol/l and number of individuals affected in populations of countries at risk of vitamin A deficiency 1995–2005***

Population group[a]	Prevalence of serum retinol <0.70 µmol/l		Population affected	
	Percent[b]	95% CI	Number (million)	95% CI
Preschool-age children	33.3	31.1–35.4	190	178–202
Pregnant women	15.3	7.4–23.2	19.1	9.30–29.0

[a] Population subgroups: Preschool-age children (<5 years); Pregnant women (no age range defined).
[b] Numerator and denominator exclude countries with a 2005 GDP ≥US$ 15 000.

Table 10 ***Prevalence of night blindness and number of individuals affected among preschool-age children and pregnant women in populations of countries at risk of vitamin A deficiency 1995–2005, globally and by WHO region***

WHO region	Preschool-age children[a]		Pregnant women	
	Prevalence[b] (%)	# affected (millions)	Prevalence (%)	# affected (millions)
Africa	2.0 (0.8–3.2)[c]	2.55 (0.99–4.11)	9.8 (8.4–11.1)	3.02 (2.59–3.44)
Americas	0.6 (0.0–1.3)	0.36 (0.00–0.75)	4.4 (2.7–6.2)	0.50 (0.30–0.70)
South-East Asia	0.5 (0.0–2.0)	1.01 (0.00–3.75)	9.9 (9.5–10.3)	3.84 (3.69–4.00)
Europe	0.8 (0.1–1.5)	0.24 (0.04–0.44)	3.5 (1.8–5.3)	0.22 (0.11–0.33)
Eastern Mediterranean	1.2 (0.6–1.7)	0.77 (0.41–1.12)	7.2 (5.2–9.2)	1.09 (0.78–1.39)
Western Pacific	0.2 (0.0–0.4)	0.26 (0.02–0.50)	4.8 (0.9–8.6)	1.09 (0.20–1.97)
Global	**0.9 (0.3–1.5)**	**5.17 (1.97–8.38)**	**7.8 (7.0–8.7)**	**9.75 (8.70–10.8)**

[a] Population subgroups: Preschool-age children (<5 years); Pregnant women (no age range defined).
[b] Numerator and denominator excludes countries with a 2005 GDP ≥US$ 15 000.
[c] 95% Confidence Intervals.

Table 11 ***Prevalence of serum retinol <0.70 µmol/l and number of individuals affected among preschool-age children and pregnant women in populations of countries at risk of vitamin A deficiency 1995–2005, globally and by WHO region***

WHO region	Preschool-age children[a]		Pregnant women	
	Prevalence[b] (%)	# affected (millions)	Prevalence (%)	# affected (millions)
Africa	44.4 (41.3–47.5)[c]	56.4 (52.4–60.3)	13.5 (8.9–18.2)	4.18 (2.73–5.63)
Americas	15.6 (6.6–24.5)	8.68 (3.70–13.7)	2.0 (0.4–3.6)	0.23 (0.04–0.41)
South-East Asia	49.9 (45.1–54.8)	91.5 (82.6–100)	17.3 (0.0–36.2)	6.69 (0.00–14.0)
Europe	19.7 (9.7–29.6)	5.81 (2.87–8.75)	11.6 (2.6–20.6)	0.72 (0.16–1.29)
Eastern Mediterranean	20.4 (13.2–27.6)	13.2 (8.54–17.9)	16.1 (9.2–23.1)	2.42 (1.38–3.47)
Western Pacific	12.9 (12.3–13.5)	14.3 (13.6–14.9)	21.5 (0.0–49.2)	4.90 (0.00–11.2)
Global	**33.3 (31.1–35.4)**	**190 (178–202)**	**15.3 (7.4–23.2)**	**19.1 (9.30–29.0)**

[a] Population subgroups: Preschool-age children (<5 years); Pregnant women (no age range defined).
[b] Numerator and denominator excludes countries with a 2005 GDP ≥US$ 15 000.
[c] 95% Confidence Intervals.

than estimated in South-East Asia (0.5%). This also means that Africa has the greatest number of preschool-age children affected with night blindness (2.55 million), and corresponds to almost half of the children affected globally (**Table 10**). A comparable and high proportion of pregnant women affected by night blindness are in Africa (9.8%) and South-East Asia (9.9%), each of which is estimated to have over 3 million pregnant women affected, or one third of the pregnant women affected globally.

The estimates show that the Africa and South-East Asia regions also contain the highest proportions of preschool-age children with biochemical VAD, as indicated by a serum retinol concentration <0.70 µmol/l, with South-East Asia having the greatest number of children and pregnant women affected (**Table 11**).

3.1.3 Public health significance of vitamin A deficiency

The prevalence of night blindness is of moderate to severe public health significance in 45 countries for preschool-age children and 66 countries for pregnant women (**Table 12**). According to current estimates, 122 countries are classified as having a moderate to severe public health problem based on biochemical VAD in preschool-age children; while 88 countries are classified as having a problem of moderate to severe public health significance with respect to biochemical VAD in pregnant women (**Table 13**).

The level of the public health problem of both night blindness and biochemical VAD across countries is illustrated by maps for preschool-age children and pregnant women in **Figures 1–4**.

Table 12 ***Number of countries categorized by public health significance of night blindness 1995–2005[a]***

Public health problem[b]	Preschool-age children[c]	Pregnant women
	Number of countries	Number of countries
None	4	90
Mild	107	
Moderate	42	66
Severe	3	

[a] Excludes 37 countries with a 2005 GDP ≥US$ 15 000.
[b] The prevalence of night blindness as a public health problem in preschool-age children is categorized as follows: ≤0%, no public health problem; >0–<1%, mild public health problem; ≥1–<5%, moderate public health problem; ≥5%, severe public health problem. The prevalence of night blindness as a public health problem in pregnant women is categorized as ≥5% (*21*).
[c] Population groups: Preschool-age children (<5 years); Pregnant women (no age range defined).

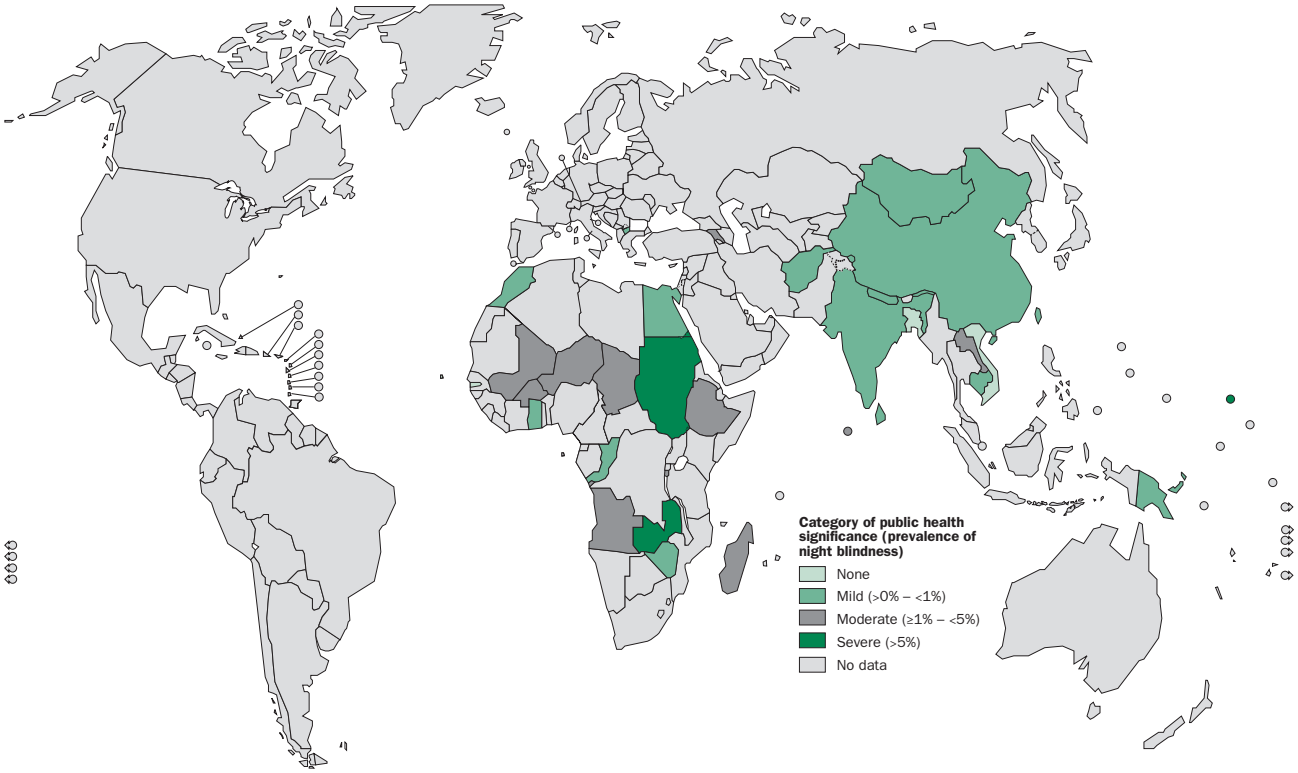
Table 13 ***Number of countries categorized by public health significance of vitamin A deficiency defined by the prevalence of serum retinol concentrations <0.70 µmol/l 1995–2005[a]***

Public health problem[b]	Preschool-age children[c]	Pregnant women
	Number of countries	Number of countries
None	2	20
Mild	32	48
Moderate	49	57
Severe	73	31

[a] Excludes 37 countries with a 2005 GDP ≥US$ 15 000.
[b] The prevalence of serum retinol <0.70 µmol/l as a public health problem in both preschool-age children and pregnant women is categorized as follows: <2%, no public health problem; ≥2–<10%, mild public health problem; ≥10–<20%, moderate public health problem; ≥20%, severe public health problem.
[c] Population groups: Preschool-age children (<5 years); Pregnant women (no age range defined).

Figure 1 ***Night blindness as a public health problem by country 1995–2005: Preschool-age children***

a) Countries and areas with survey data



b) Countries and areas with survey data and regression-based estimates

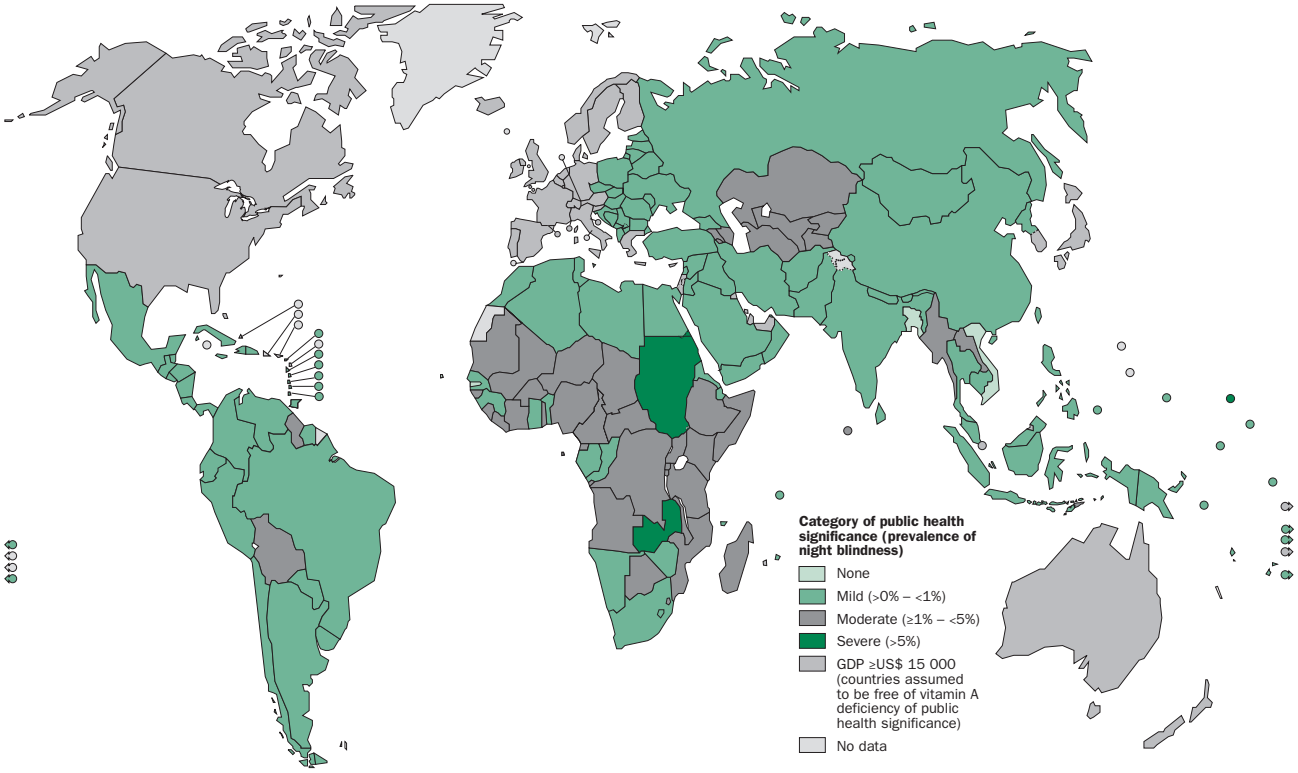
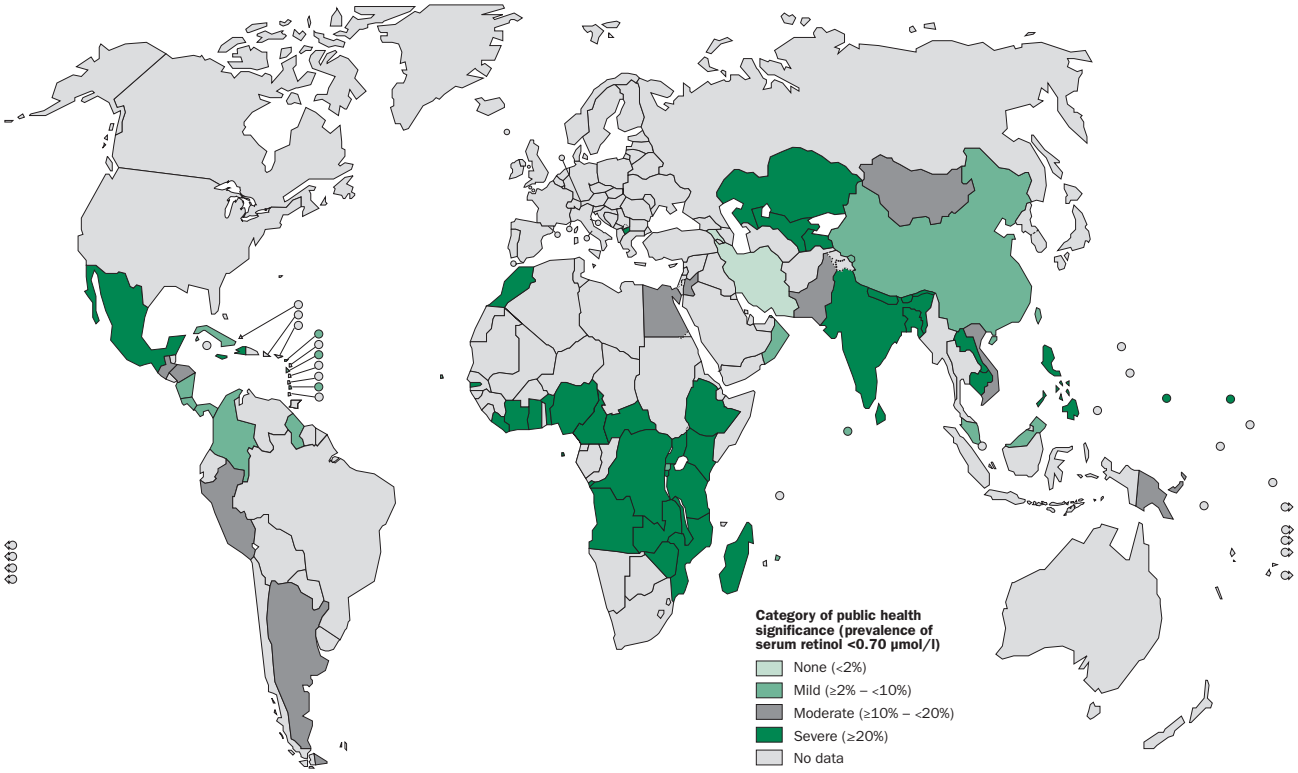


Figure 2 ***Biochemical vitamin A deficiency (retinol) as a public health problem by country 1995–2005: Preschool-age children***

a) Countries and areas with survey data



b) Countries and areas with survey data and regression-based estimates

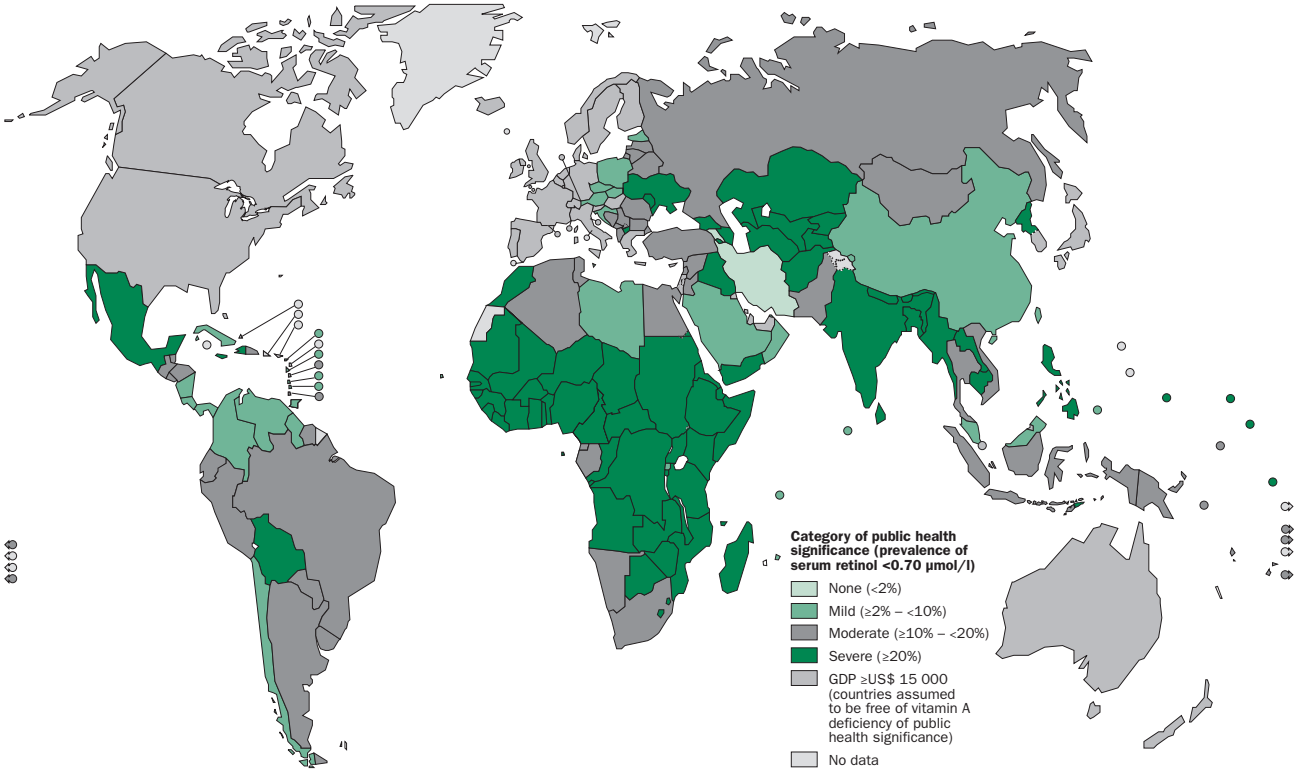
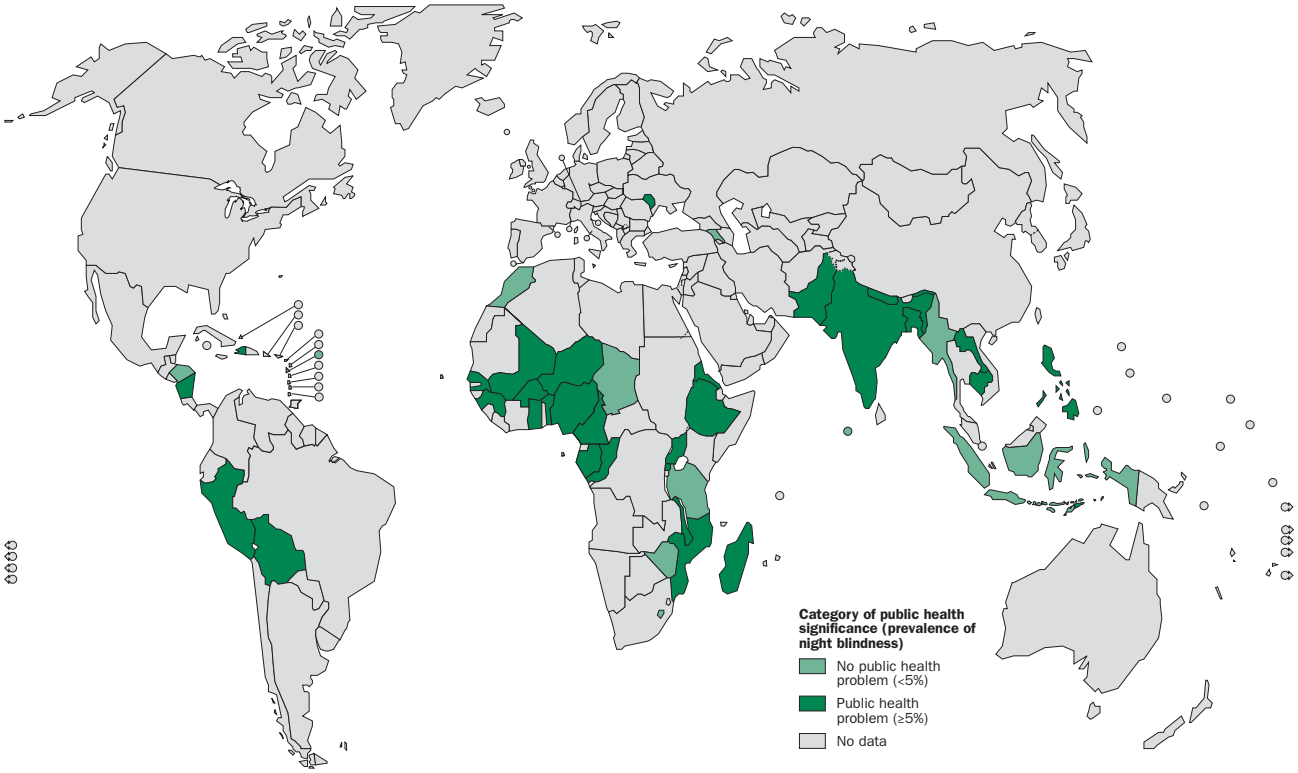


Figure 3 ***Night blindness as a public health problem by country 1995–2005: Pregnant women***

a) Countries and areas with survey data



b) Countries and areas with survey data and regression-based estimates

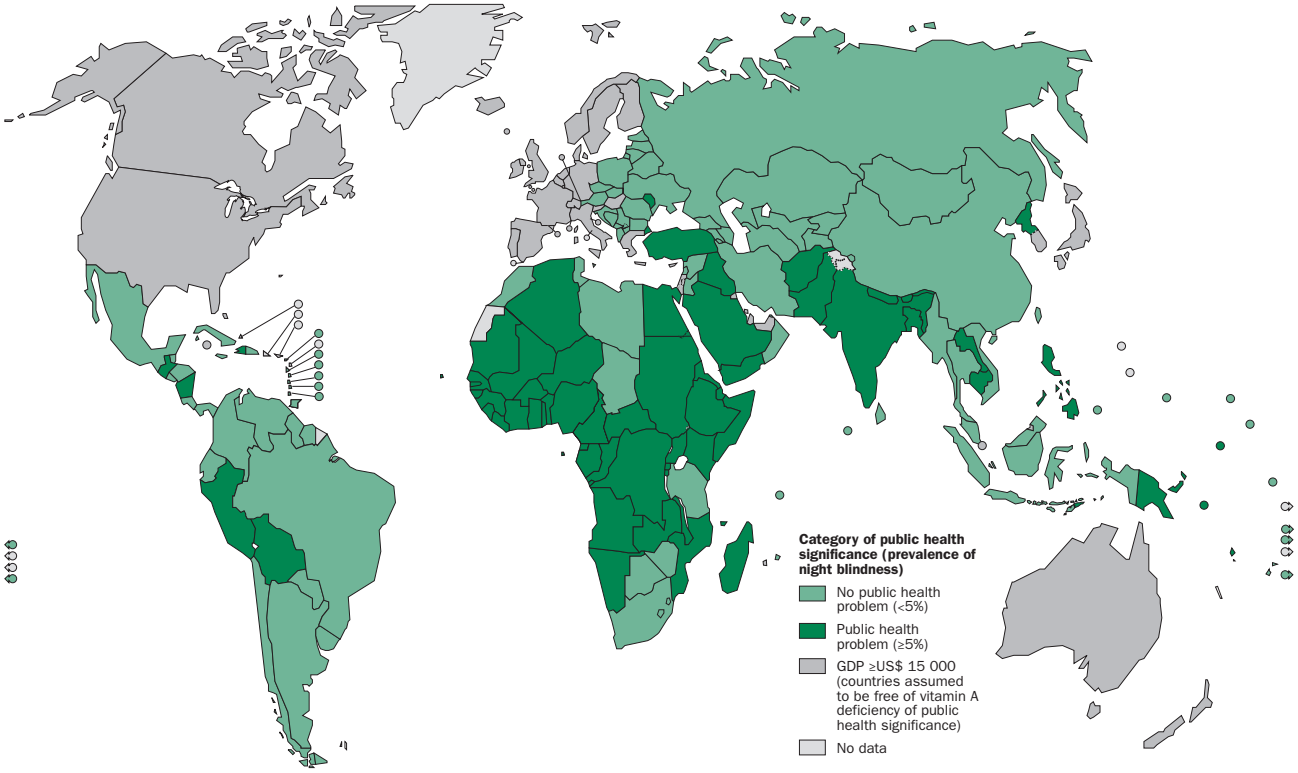
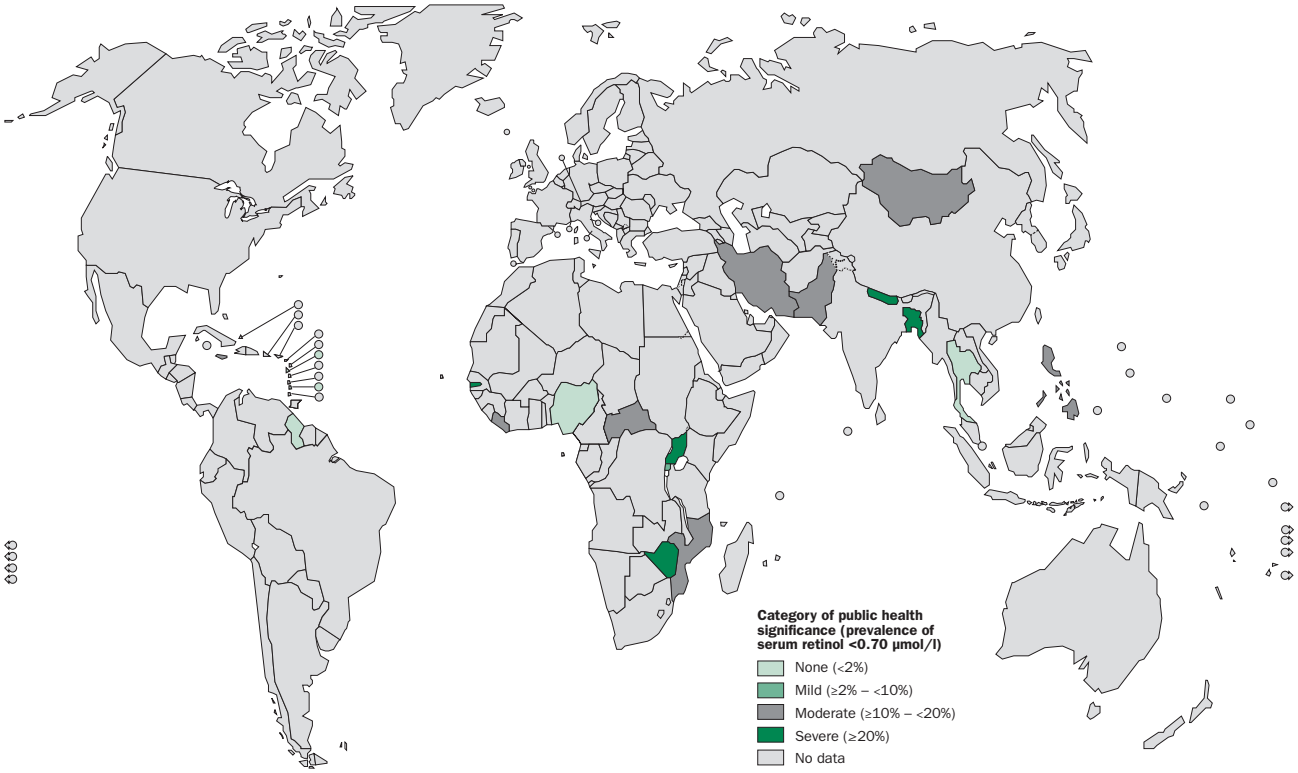
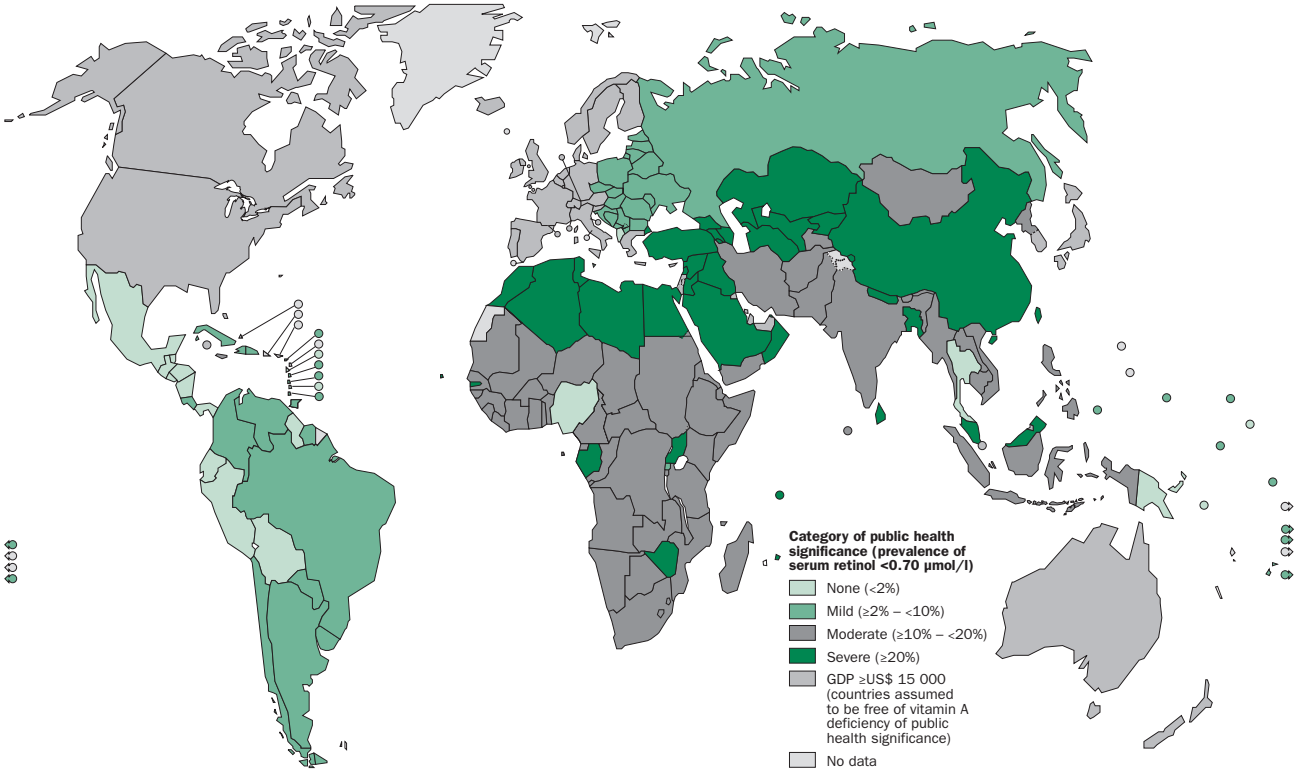


Figure 4 ***Biochemical vitamin A deficiency (retinol) as a public health problem by country 1995–2005: Pregnant women***

a) Countries and areas with survey data



b) Countries and areas with survey data and regression-based estimates



3.2 Discussion

3.2.1 Population covered

Preschool-age children and pregnant women are considered to be populations most at-risk for VAD due to their increased demands for vitamin A and the potential health consequences associated with VAD during these life stages. Thus, the estimates presented here are specific to children under 5 years of age and pregnant women. This report does not address VAD as a public health problem in all other age groups due to lack of adequate data and understanding of the public health importance of VAD at other ages (a research priority). We also assume that VAD is not a public health problem for preschool-age children and pregnant women residing in the 37 countries identified as having a GDP ≥US$ 15 000, who have been excluded from this analysis and consideration.

About half of the global populations of both preschool-age children and pregnant women considered to be at risk of VAD were covered by survey data for this report. Coverage was considerably greater (76%) for serum retinol in preschool-age children than in pregnant women (19%) where, however, it remains low.

3.2.2 Strengths of estimates

This report utilizes the most up-to-date data published as of December 31, 2006 for the years 1995–2005. These estimates are based on the greatest number of VAD surveys conducted in preschool-age children and pregnant women to date. Where probabilistic, representative surveys have not been conducted in the 10 year inclusion period, survey estimates are complemented by regression-based estimates.

Use of GDP ≥US$ 15 000 to classify a country as high income and assuming that they are not at risk of VAD of public health significance is arbitrary. Although there is little survey data available in these countries to support this assumption, the exclusion is supported by a usual tendency for VAD risk to decline with rising socioeconomic status, most clearly evident in its association with xerophthalmia (*41–44*). A second reason for excluding higher income countries from analysis was to improve the predictability of the regression models and to help place focus on areas where VAD is likely to be of public health significance.

3.2.3 Proportion of population and the number of individuals with vitamin A deficiency in populations at risk

Approximately one third of the world's preschool-age population is estimated to be vitamin A deficient, with just less than 1% being night blind at a given time. The WHO regions of Africa and South-East Asia have the highest burden of VAD, reflected by deficient concentrations of the vitamin in circulation, where 44–50% of preschool-age children are affected. Most vitamin A deficient children live in South-East Asia, where 91.5 million preschool-age children have serum retinol concentrations <0.70 µmol/l.

The prevalence of VAD in pregnant women is likely lower than in preschool-age children, though this may in part be attributable to a lingering lack of data in this life stage. Still, the problem is of immense proportion. Globally, approximately 15% of pregnant women are estimated to be vitamin A deficient (biochemically) and 8% are night blind, respectively. Again, the WHO regions of Africa and South-East Asia have the highest risk of deficiency and carry the majority of the burden.

3.2.4 Classification of countries by degree of public health significance of vitamin A deficiency

Vitamin A deficiency, as indicated by either night blindness or biochemical deficiency, is present in a moderate to severe degree in preschool-age children in 45 and 122 countries, respectively, out of the 193 WHO Member States. Vitamin A deficiency in pregnant women is less prevalent than in preschool-age children; however, still either night blindness or biochemical VAD is present as a moderate to severe problem in 66 and 88 countries, respectively. Targeting women to achieve a safe and nutritionally adequate intake of vitamin A during pregnancy could improve the health of both women and their infants.

3.2.5 Comparison to previous estimates

Several estimates of VAD at the global level have been conducted in the past for preschool-age children. However, it is difficult to meaningfully compare these estimates as the methodology used to derive them has varied considerably.

The most recent previous global estimates of VAD conducted by WHO were in 1995, based on both clinical (xerophthalmia) and biochemical (serum retinol concentrations <0.70 µmol/l) evidence of VAD (*44*). At that time, it was estimated that 60 countries had clinical and biochemical forms of severe and moderate degrees of public health significance, and was likely to be a problem in an additional 13 countries. The current WHO global estimates of VAD presented here indicate that 45 and 122 countries have a moderate or severe public health problem of night blindness or biochemical VAD, respectively. In 1995, it was estimated that clinical VAD affected approximately 3 million and biochemical VAD affected approximately 251 million preschool-age children each year (**Table 14**).

Since 1995, several other groups have also generated global estimates of VAD. In 1998, alternative methodology was used for data collected between 1985 and 1995 to estimate that clinical VAD (night blindness and Bitot's spots) affected about 3.3 million preschool children (*45*). These estimates suggested that that biochemical VAD (serum retinol concentration <0.70 µmol/l) affected about 75–140 million preschool children each year. In 2002,

Table 14 ***Comparison of the most recent global estimates of vitamin A deficiency***

		Number affected by xerophthalmia (millions)		Number affected by serum retinol <0.70 µmol/l (millions)	
	Reference year	Preschool-age children	Pregnant women	Preschool-age children	Pregnant women
WHO 2009	2006[a]	5.2	9.8	190	19.1
West 2002 (*22*, *49*)	2001	4.4	6.2	127	7.2
UNICEF/MI 2004 (*45*)	2000	7.0		219	
MI/UNICEF/Tulane 1998 (*44*)	1995	3.3		75–140	
WHO 1995 (*40*)	1994	2.8		251	

[a] Based on data collected between 1995 and 2005, and using population figures from 2006.

West estimated that 127 million preschool-age children are vitamin A deficient, defined as a serum retinol concentration <0.70 µmol/l or abnormal conjunctival impression cytology, in the developing world, of whom 4.4 million have xerophthalmia (including night blindness, Bitot's spots, and corneal xerophthalmia) (*22*). These estimates showed that nearly half of the world's children with xerophtalmia resided in South and South-East Asia, of whom over 85% live in India.

In 2004, the Micronutrient Initiative and UNICEF worked in collaboration with Tulane University to update their 1998 estimates of VAD for the year 2000 (*46*, *47*). They estimated that clinical VAD (night blindness and Bitot's spots) and biochemical VAD (serum retinol concentration <0.70 µmol/l) affected 7.0 and 219 million preschool-age children, respectively.

The first estimates of VAD in pregnant women were made by West (*22*) for the year 2000. He estimated that 19.8 million pregnant women in a given year have low vitamin A status (serum retinol or breast milk concentrations <1.05 µmol/l), of whom 7.2 million were deficient in vitamin A. (<0.70 µmol/l) and 6.2 million experience gestational night blindness. These estimates found that nearly two-thirds of the world's nightblind women lived in South and South-East Asia.

Although these numbers are very difficult to compare due to differences in the methodology used to produce them, considering the growth of the world's population, there appears to be some indication that the number of preschool-age children affected by xerophthalmia may be decreasing, but that the number of preschool-age children and pregnant women with biochemical VAD, based on deficient serum concentrations of retinol, is increasing, possibly due to better methods of assessment and a wider population being assessed.

3.2.6 Limitations of estimates

Estimates of the extent and severity of VAD in this report have practical limitations imposed by the absence, untimely, partially representative, or uncertain technical quality of data. In the current situation, only 12–42% of the countries had survey data (national or subnational) that met inclusion criteria. Other countries suspected to harbour populations at risk of VAD had no population data, requiring estimates to be derived from regression models employing available covariates shown to be predictive in countries with data. Also, a number of countries in specific regions had no data or very little data for one of the indicators. In this respect, modelled estimates of the prevalence of biochemical VAD should be interpreted with caution since they are based primarily on regression-based estimates. These figures should be considered "place holders" until measured survey data become available and should serve to emphasize the "work-in-progress" nature of this report. Although the majority of the survey data was collected in nationally representative samples, the regression-based estimates only explained 13–46% of the variation in VAD prevalence among countries with survey data.

Estimates of prevalence were based on a number of assumptions. All surveys were treated equally, although their methodological quality varied greatly. For example, most surveys used multi-stage cluster sampling proportionate to the population size within the country, but not all did, and in some national surveys, specific areas had to be left out due to security or accessibility issues. Furthermore for some preschool-age children, the population sampled covered only a portion of the desired age range (e.g. children 12–23 months) or covered ages outside the age range. For the purpose of our analysis, these surveys were considered equal to those that covered the entire age range. However, an estimate from children equally distributed among the age ranges would be more appropriate. Additionally, it is very difficult to measure night blindness in children less than 2 years of age, but it was usually not possible to exclude this age group from the analysis.

Depending on the indicator and the population group, there were 1–12 countries for which subnational data were used to generate prevalence estimates in preschool-age children and pregnant women, and these data may result in an over- or under-estimation of the prevalence for those countries.

A limitation of using serum (plasma) retinol concentration as an indicator of vitamin A status is that it is decreased by acute and underlying chronic infections (*8*). The majority of surveys do not utilize an indicator of infection status at the time in which retinol is assessed. Concurrent data on infection status would not alter the indicator-based (i.e. serum retinol) estimates of prevalence but could influence the interpretation of survey findings with respect to cause of apparent deficiency (*48*).

In some cases, the prevalence of serum retinol concentrations <0.70 µmol/l was calculated using the mean retinol concentration and assuming that retinol values were normally distributed, an assumption that appears to be largely supported by existing reports of population-based serum retinol distributions. Additionally, data for night blindness during a women's most recent birth within the previous five years that ended in a live birth was not adjusted for any day time visual problems. Therefore, we may be overestimating the true prevalence of night blindness if there is a high prevalence of women with day time visual problems in these populations. Some initial surveys had to be excluded from analysis because they either only reported a prevalence of night blindness that was adjusted for day time visual problems, and was therefore not comparable to the unadjusted estimates, or a figure was reported only for current night blindness, which did not account for trimester of the pregnancy. Because it is expected that the prevalence of night blindness is highest towards the end of pregnancy, these figures were not comparable to the unadjusted values of a history of night blindness during a previous pregnancy.

3.3 Conclusions

The data available for these estimates are the most representative data to date. The estimates are the most accurate reflection of the global prevalence of night blindness and biochemical VAD up until this point in time. However, some countries have conducted surveys since 2005 but were not included here due to the time frame of 1995–2005 that was established for these specific estimates. Countries without survey data are highly encouraged to collect data on a regular basis (every 3–5 years). Regression-based estimates are appropriate for the regional and global levels, but may not accurately reflect the situation in an individual country given the variation explained by the current models.

The maintenance of the WHO Global Database on Vitamin A Deficiency and the periodic generation of estimates of deficiency provide a valuable tool for tracking the global progress of eliminating VAD and the effectiveness of the current strategies for its control. Hopefully, these estimates will encourage countries to plan routine surveys which assess the prevalence of VAD and the factors that may be contributing to its development, including the incidence of infectious diseases. The understanding of how the prevalence of VAD and the factors related to its development vary by population subgroup, geography, level of development, and other social and economic factors will make interventions easier to select and target to the most appropriate populations.

References

1. Haskell MJ, Brown KH. Maternal vitamin A nutriture and the vitamin A content of human milk. *Journal of Mammary Gland Biology and Neoplasia*, 1999, 4:243–257.
2. US Institute of Medicine, Food and Nutrition Board, Standing Committee on the Scientific Evaluation of Dietary Reference Intakes. *Dietary reference intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc*. Washington DC, National Academy Press, 2000.
3. Alvarez JO et al. Urinary excretion of retinol in children with acute diarrhea. *American Journal of Clinical Nutrition*, 1995, 61:1273–1276.
4. Mitra AK et al. Urinary retinol excretion and kidney function in children with shigellosis. *American Journal of Clinical Nutrition*, 1998, 68:1095–1103.
5. Sommer A, West KP Jr. *Vitamin A deficiency: Health, survival, and vision*. New York, Oxford University Press, 1996.
6. Christian P et al. Night blindness of pregnancy in rural Nepal – nutritional and health risks. *International Journal of Epidemiology*, 1998, 27:231–237.
7. West KP Jr, Gernand A, Sommer A. Vitamin A in nutritional anemia. In: Kraemer K, Zimmermann MB, eds. *Nutritional anemia*. Basel, Sight and Life Press, 2007: 133–153.
8. Scrimshaw NS, Taylor CE, Gordon JE. *Interactions of nutrition and infection*. Geneva, World Health Organization (WHO Monograph Series No. 57), 1968 (http://whqlibdoc.who.int/monograph/WHO_MONO_57_(part1).pdf).
9. Beaton GH et al. *Effectiveness of vitamin A supplementation in the control of young child morbidity and mortality in developing countries*. United Nations (UN) Administrative Committee on Coordination, Sub-committee on Nutrition State-of-the-Art Series: Nutrition Policy Discussion Paper No. 13. Geneva, United Nations, 1993.
10. Glasziou PP, Mackerras DE. Vitamin A supplementation in infectious diseases: a meta-analysis. *British Medical Journal*, 1993, 306:366–370.
11. Fawzi WW et al. Vitamin A supplementation and child mortality. A meta-analysis. *Journal of the American Medical Association*, 1993, 269:898–903.
12. Bhutta ZA et al. What works? Interventions for maternal and child undernutrition and survival. *Lancet*, 2008, 371:417–440.
13. Benn CS et al. Effect of 50000 IU vitamin A given with BCG vaccine on mortality in infants in Guinea-Bissau: randomized placebo controlled trial. *British Medical Journal*, 2008, 336:1416–1420.
14. Malaba LC et al. Effect of postpartum maternal or neonatal vitamin A supplementation on infant mortality among infants born to HIV-negative mothers in Zimbabwe. *American Journal of Clinical Nutrition*, 2005, 81:454–460.
15. West KP Jr et al. Double blind, cluster randomised trial of low dose supplementation with vitamin A or beta carotene on mortality related to pregnancy in Nepal. The NNIPS-2 Study Group. *British Medical Journal*, 1999, 318:570–5.
16. Singh V, West KP Jr. Vitamin A deficiency and xerophthalmia among school-aged children in Southeastern Asia. *European Journal of Clinical Nutrition*, 2004, 58:1342–1349.
17. Sommer A. *Vitamin A deficiency and its consequences: a field guide to detection and control*, 3rd ed. Geneva, World Health Organization, 1995.
18. World Health Organization. *Control of vitamin A deficiency and xerophthalmia*. Report of a Joint WHO/UNICEF/USAID/Helen Keller International/IVACG Meeting. Technical Report Series 672. Geneva, World Health Organization, 1982.
19. Sommer A et al. History of nightblindness: a simple tool for xerophthalmia screening. *American Journal of Clinical Nutrition*, 1980, 33:887–891.
20. Christian P et al. Night blindness during pregnancy and subsequent mortality among women in Nepal: Effects of vitamin A and beta-carotene supplementation. *American Journal of Epidemiology*, 2000, 152:542–547.
21. Sommer A, Davidson FR. Assessment and control of vitamin A deficiency: the Annecy Accords. *Journal of Nutrition*, 2002, 132: 2845S–2850S.
22. West KP Jr. Extent of vitamin A deficiency among preschool children and women of reproductive age. *Journal of Nutrition*, 2002,132:2857S–66S.
23. Arroyave G et al. *Evaluation of sugar fortification with vitamin A at the nutritional level*. Scientific Publication No. 384, Washington DC, PAHO, 1979.

24. Dary O, Mora JO, International Vitamin A Consultative Group. Food fortification to reduce vitamin A deficiency: International Vitamin A Consultative Group recommendations. *Journal of Nutrition*, 2002, 132:2927S–2933S.
25. World Health Organization, UNICEF, IVACG Task Force. *Vitamin A supplements: a guide to their use in the treatment of vitamin A deficiency and xerophthalmia*, 2nd ed. Geneva, World Health Organization, 1997 (http://whqlibdoc.who.int/publications/1997/9241545062.pdf).
26. Report of the XXII International Vitamin A Consultative Group Meeting. *Vitamin A and the common agenda for micronutrients*. Lima, Peru, 15–17 November, 2004, pp 49–59.
27. Vitamin and Mineral Nutrition Information System, WHO Global Database on Vitamin A Deficiency [online database]. Geneva, World Health Organization (http://www.who.int/vmnis/en/, accessed 31 December 2007).
28. World Health Organization. *Indicators for assessing vitamin A deficiency and their application in monitoring and evaluating intervention programmes*. Geneva, World Health Organization, 1996 (WHO/NUT/96.10) (http://whqlibdoc.who.int/hq/1996/WHO_NUT_96.10.pdf).
29. UNDP. *Human Development Report 2002, Deepening democracy in a fragmented world*. New York, United Nations Development Programme, Oxford University Press, 2002 (http://hdr.undp.org/en/media/HDR_2002_EN_Complete.pdf).
30. Human Development Indicators. In: Cait Murphy BRL, ed. *Human Development Report 2004*. New York, United Nations Development Programme, 2004: 139–250.
31. World Health Organization. *The World Health Report 2005. Make every mother and child count*. Geneva, World Health Organization, 2005 (http://www.who.int/whr/2005).
32. World Health Organization. *World Health Statistics 2005*. Geneva, World Health Organization, 2005 (http://www.who.int/whosis/whostat/whostat2005en.pdf).
33. United Nations Population Division. *World population prospects – the 2004 revision*. New York, United Nations Population Division, 2005.
34. World Health Organization. *WHO Child Growth Standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development*. Geneva, World Health Organization, 2006.
35. Wackerly D, Mendenhall W, Scheaffer RL. *Mathematical statistics with applications*, 6th ed. Pacific Grove, CA, Duxbury Press, 2001.
36. Lohr SL. *Sampling: Design and analysis*, 1st ed. Pacific Grove, CA, Duxbury Press, 1998.
37. Neter J et al. *Applied linear statistical models*, 4th ed. New York, McGraw-Hill/Irwin, 1996.
38. Allison PD. *Logistic regression using the SAS system*. Indianapolis, IN, Wiley-SAS, 2001.
39. Fleiss JL, Levin B, Paik MC. *Statistical methods for rates and proportions*, 3rd ed. New Jersey, Wiley, 2003.
40. United Nations Population Division. *World population prospects – the 2006 revision*. New York, United Nations Population Division, 2007.
41. Cohen N et al. Landholding, wealth and risk of blinding malnutrition in rural Bangladeshi households. *Social Science & Medicine*, 1985, 21:1269–1272.
42. Mele L et al. Nutritional and household risk factors for xerophthalmia in Aceh, Indonesia: a case-control study. The Aceh Study Group. *American Journal of Clinical Nutrition*, 1991, 53:1460–1465.
43. Khatry SK et al. Epidemiology of xerophthalmia in Nepal. A pattern of household poverty, childhood illness, and mortality. The Sarlahi Study Group. *Archives of Ophthalmology*, 1995, 113:425–429.
44. World Health Organization. *The global prevalence of vitamin A deficiency. Micronutrient Deficiency Information System (MDIS) Working Paper 2*. Geneva, World Health Organization, 1995 (WHO/NUT/95.3). (http://www.who.int/nutrition/publications/vad_global_prevalence/en/index.html).
45. Micronutrient Initiative, UNICEF, Tulane University. *Progress in controlling vitamin A deficiency*. Ottawa, Micronutrient Initiative, 1998.
46. Micronutrient Initiative, United Nations Children's Fund. *Vitamin and mineral deficiency: a global progress report*. Ottawa, Micronutrient Initiative and New York, UNICEF, 2004 (http://www.micronutrient.org/pdfs/VMD.pdf).
47. Mason J et al. Recent trends in malnutrition in developing regions: vitamin A deficiency, anemia, iodine deficiency, and child underweight. *Food and Nutrition Bulletin*, 2005, 26:59–108.
48. Thurnham DI et al. Effects of subclinical infection on plasma retinol concentrations and assessment of prevalence of vitamin A deficiency: meta-analysis. *Lancet*, 2003, 362:2052–2058.
49. West KP Jr, Rice A, Sugimoto JD. *Tables on the global burden of vitamin A deficiency and xerophthalmia among preschool aged children and low vitamin A status, vitamin A deficiency, and night blindness among pregnant women by WHO region* (http://www.jhsph.edu/CHN/GlobalVAD.pdf; updated August 2002).

ANNEX 1

WHO Member States grouped by WHO region and UN region as of 2007

Table A1.1 ***WHO Member States grouped by WHO region***

Africa

Algeria
Angola
Benin
Botswana
Burkina Faso
Burundi
Cameroon
Cape Verde
Central African Republic
Chad
Comoros
Congo
Côte d'Ivoire
Democratic Republic of the Congo
Equatorial Guinea
Eritrea
Ethiopia
Gabon
Gambia
Ghana
Guinea
Guinea-Bissau
Kenya
Lesotho
Liberia
Madagascar
Malawi
Mali
Mauritania
Mauritius
Mozambique
Namibia
Niger
Nigeria
Rwanda
Sao Tome and Principe
Senegal
Seychelles
Sierra Leone
South Africa
Swaziland
Togo
Uganda
United Republic of Tanzania
Zambia
Zimbabwe

Americas

Antigua and Barbuda
Argentina
Bahamas
Barbados
Belize
Bolivia (Plurinational State of)
Brazil
Canada
Chile
Colombia
Costa Rica
Cuba
Dominica
Dominican Republic
Ecuador
El Salvador
Grenada
Guatemala
Guyana
Haiti
Honduras
Jamaica
Mexico
Nicaragua
Panama
Paraguay
Peru
Saint Kitts and Nevis
Saint Lucia
Saint Vincent and the Grenadines
Suriname
Trinidad and Tobago
United States of America
Uruguay
Venezuela (Bolivarian Republic of)

South-East Asia

Bangladesh
Bhutan
Democratic People's Republic of Korea
India
Indonesia
Maldives
Myanmar
Nepal
Sri Lanka
Thailand
Timor-Leste

Europe

Albania
Andorra
Armenia
Austria
Azerbaijan
Belarus
Belgium
Bosnia and Herzegovina
Bulgaria
Croatia
Cyprus
Czech Republic
Denmark
Estonia
Finland
France
Georgia
Germany
Greece
Hungary
Iceland
Ireland
Israel
Italy
Kazakhstan
Kyrgyzstan
Latvia
Lithuania
Luxembourg
Malta
Monaco
Montenegro
Netherlands
Norway
Poland
Portugal
Republic of Moldova
Romania
Russian Federation
San Marino
Serbia
Slovakia
Slovenia
Spain
Sweden
Switzerland
Tajikistan
The former Yugoslav Republic of Macedonia
Turkey
Turkmenistan

Ukraine
United Kingdom of Great Britain and Northern Ireland
Uzbekistan

Eastern Mediterranean

Afghanistan
Bahrain
Djibouti
Egypt
Iran (Islamic Republic of)
Iraq
Jordan
Kuwait
Lebanon
Libyan Arab Jamahiriya
Morocco
Oman
Pakistan
Qatar
Saudi Arabia
Somalia
Sudan
Syrian Arab Republic
Tunisia
United Arab Emirates
Yemen

Western Pacific

Australia
Brunei Darussalam
Cambodia
China
Cook Islands
Fiji
Japan
Kiribati
Lao People's Democratic Republic
Malaysia
Marshall Islands
Micronesia (Federated States of)
Mongolia
Nauru
New Zealand
Niue
Palau
Papua New Guinea
Philippines
Republic of Korea
Samoa
Singapore
Solomon Islands
Tonga
Tuvalu
Vanuatu
Viet Nam

Table A1.2 ***WHO Member States grouped by UN region and subregion***[1]

Africa

Eastern Africa

Burundi
Comoros
Djibouti
Eritrea
Ethiopia
Kenya
Madagascar
Malawi
Mauritius
Mozambique
Rwanda
Seychelles
Somalia
Uganda
United Republic of Tanzania
Zambia
Zimbabwe

Middle Africa

Angola
Cameroon
Central African Republic
Chad
Congo
Democratic Republic of the Congo
Equatorial Guinea
Gabon
Sao Tome and Principe

Northern Africa

Algeria
Egypt
Libyan Arab Jamahiriya
Morocco
Sudan
Tunisia

Southern Africa

Botswana
Lesotho
Namibia
South Africa
Swaziland

Western Africa

Benin
Burkina Faso
Cape Verde
Côte d'Ivoire
Gambia
Ghana
Guinea
Guinea-Bissau
Liberia
Mali
Mauritania
Niger
Nigeria
Senegal
Sierra Leone
Togo

Asia

Central Asia

Kazakhstan
Kyrgyzstan
Tajikistan
Turkmenistan
Uzbekistan

Eastern Asia

China
Democratic People's Republic of Korea
Japan
Mongolia
Republic of Korea

Southern Asia

Afghanistan
Bangladesh
Bhutan
India
Iran (IslamicRepublic of)
Maldives
Nepal
Pakistan
Sri Lanka

South-eastern Asia

Brunei Darussalam
Cambodia
Indonesia
Lao People's Democratic Republic
Malaysia
Myanmar
Philippines
Singapore
Thailand
Timor-Leste
Viet Nam

Western Asia

Armenia
Azerbaijan
Bahrain
Cyprus
Georgia
Iraq
Israel
Jordan
Kuwait
Lebanon
Oman
Qatar
Saudi Arabia
Syrian Arab Republic
Turkey
United Arab Emirates
Yemen

[1] http://unstats.un.org/unsd/methods/m49/m49regin/htm, as of 31 January 2008.

Europe

Eastern Europe

Belarus
Bulgaria
Czech Republic
Hungary
Poland
Republic of Moldova
Romania
Russian Federation
Slovakia
Ukraine

Northern Europe

Denmark
Estonia
Finland
Iceland
Ireland
Latvia
Lithuania
Norway
Sweden
United Kingdom of Great Britain and Northern Ireland

Southern Europe

Albania
Andorra
Bosnia and Herzegovina
Croatia
Greece
Italy
Malta
Montenegro
Portugal
San Marino
Serbia
Slovenia
Spain
The former Yugoslav Republic of Macedonia

Western Europe

Austria
Belgium
France
Germany
Luxembourg
Monaco
Netherlands
Switzerland

Americas

Latin America and the Caribbean

Caribbean

Antigua and Barbuda
Bahamas
Barbados
Cuba
Dominica
Dominican Republic
Grenada
Haiti
Jamaica
Saint Kitts and Nevis
Saint Lucia
Saint Vincent and the Grenadines
Trinidad and Tobago

Central America

Belize
Costa Rica
El Salvador
Guatemala
Honduras
Mexico
Nicaragua
Panama

South America

Argentina
Bolivia (Plurinational State of)
Brazil
Chile
Colombia
Ecuador
Guyana
Paraguay
Peru
Suriname
Uruguay
Venezuela (Bolivarian Republic of)

Northern America

Canada
United States of America

Oceania

Australia–New Zealand

Australia
New Zealand

Melanesia

Fiji
Papua New Guinea
Solomon Islands
Vanuatu

Micronesia

Kiribati
Marshall Islands
Micronesia (Federated States of)
Nauru
Palau

Polynesia

Cook Islands
Niue
Samoa
Tonga
Tuvalu

ANNEX 2

Results by UN region

Table A2.1 ***Percentage of population[a] at risk of vitamin A deficiency covered by night blindness and serum retinol prevalence surveys (national or subnational) conducted between 1995 and 2005, by UN region***

UN region	Preschool-age children[b]		Pregnant women	
	Night blindness	Retinol	Night blindness	Retinol
Africa (53)[c]	37.8 (17)[d]	75.9 (26)	62.9 (25)	27.0 (8)
Asia (37)	71.7 (12)	83.2 (21)	60.0 (13)	18.8 (7)
Europe (20)	0.7 (1)	0.7 (1)	1.3 (1)	0 (0)
Latin America and the Caribbean (32)	0 (0)	49.8 (16)	14.9 (6)	0.6 (4)
Northern America (0)	0 (0)	0 (0)	0 (0)	0 (0)
Oceania (14)	77.8 (2)	79.1 (3)	0 (0)	0 (0)
Global (156)	**54.0 (32)**	**75.7 (67)**	**55.0 (45)**	**18.9 (19)**

[a] Excludes countries with a 2005 GDP ≥US$ 15 000.
[b] Population subgroups: Preschool-age children (<5 years); Pregnant women (no age range defined).
[c] UN regions: Africa, Asia, Europe, Latin America and the Caribbean, Northern America, and Oceania. Number in parentheses is number of countries in each grouping.
[d] Number of countries with data in parentheses.

Table A2.2 ***Prevalence of night blindness and numbers of affected preschool-age children and pregnant women in countries at risk of vitamin A deficiency 1995–2005, by UN region***

UN region[a]	Preschool-age children[b]		Pregnant women	
	Prevalencec (%)	# affected (millions)	Prevalence (%)	# affected (millions)
Africa	2.1 (1.0–3.1)[d]	3.07 (1.50–4.63)	9.4 (8.1–10.7)	3.30 (2.85–3.76)
Asia	0.5 (0.0–1.3)	1.64 (0.00–4.41)	7.8 (6.6–9.0)	5.83 (4.90–6.76)
Europe	0.7 (0.0–1.5)	0.11 (0.00–0.24)	2.9 (1.1–4.6)	0.10 (0.04–0.15)
Latin America and the Caribbean	0.6 (0.0–1.3)	0.36 (0.00–0.75)	4.4 (2.7–6.2)	0.50 (0.31–0.70)
Northern America	0.0	0.00	0.0	0.00
Oceania	0.5 (0.1–1.0)	0.01 (0.00–0.01)	9.2 (0.3–18.2)	0.02 (0.00–0.04)
Global	**0.9 (0.1–1.8)**	**5.18 (0.38–10.0)**	**7.8 (6.5–9.1)**	**9.75 (8.09–11.4)**

[a] UN regions: Africa, Asia, Europe, Latin America and the Caribbean, Northern America, and Oceania.
[b] Population subgroups: Preschool-age children (<5 years); Pregnant women (no age range defined).
[c] Denominator excludes countries with a 2005 GDP ≥US$ 15 000.
[d] 95% Confidence Intervals in parentheses.

Table A2.3 ***Prevalence of serum retinol <0.70 µmol/l and numbers of affected preschool-age children and pregnant women in countries at risk of vitamin A deficiency 1995–2005, by UN region***

UN region[a]	Preschool-age children[b]		Pregnant women	
	Prevalence[c] (%)	# affected (millions)	Prevalence (%)	# affected (millions)
Africa	41.6 (38.4–44.9)[d]	61.3 (56.5–66.0)	14.3 (9.7–19.0)	5.06 (3.41–6.70)
Asia	33.5 (30.7–36.3)	117 (108–127)	18.4 (5.4–31.4)	13.8 (4.08–23.5)
Europe	14.9 (0.1–29.7)	2.38 (0.02–4.74)	2.2 (0.0–4.3)	0.07 (0.00–0.14)
Latin America and the Caribbean	15.6 (6.6–24.5)	8.68 (3.70–13.7)	2.0 (0.4–3.6)	0.23 (0.04–0.41)
Northern America	0.0	0.00	0.0	0.00
Oceania	12.6 (6.0–19.2)	0.15 (0.07–0.22)	1.4 (0.0–4.0)	0.00 (0.00–0.01)
Global	**33.3** **(29.4–37.1)**	**190** **(168–212)**	**15.3** **(6.0–24.6)**	**19.1** **(7.53–30.8)**

[a] UN regions: Africa, Asia, Europe, Latin America and the Caribbean, Northern America, and Oceania.
[b] Population subgroups: Preschool-age children (<5 years); Pregnant women (no age range defined).
[c] Denominator excludes countries with a 2005 GDP ≥US$ 15 000.
[d] 95% Confidence Intervals in parentheses.

ANNEX 3

National estimates of vitamin A deficiency

Table A3.1 ***Country estimates of the prevalence of night blindness in preschool-age children 1995–2005***

Member State	Population 2006[a]		Survey Information						Proportion of the population with night blindness		Population with VAD (number of individuals)(000)		Public health problem
	0–4.99y (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Afghanistan	4823	26088	2001	F	2.00–4.99	641	3302	Survey covers 22% of population	0.8	0.2–2.7	39	11–129	Mild
Albania	250	3172		R					0.6	0.0–8.6	2	0–22	Mild
Algeria	3213	33351		R					0.5	0.0–6.4	15	1–207	Mild
Andorra	4	74						GDP ≥ US$ 15000					No public health problem assumed
Angola	3082	16557	1999	N	0.00–5.07	920	2839	Two provinces left out due to war	1.4	0.7–3.0	44	21–94	Moderate
Antigua and Barbuda	8	84		R					0.4	0.0–6.3	0	0–0	Mild
Argentina	3346	39134		R					0.7	0.0–10.0	24	2–335	Mild
Armenia	164	3010	1998	N	0.00–4.99	3390	3329	Weighed prevalence	2.9	2.2–3.8	5	4–6	Moderate
Australia	1267	20530						GDP ≥ US$ 15000					No public health problem assumed
Austria	394	8327						GDP ≥ US$ 15000					No public health problem assumed
Azerbaijan	547	8406		R					1.3	0.1–17.3	7	0–95	Moderate
Bahamas	28	327						GDP ≥ US$ 15000					No public health problem assumed
Bahrain	65	739						GDP ≥ US$ 15000					No public health problem assumed
Bangladesh	18951	155991	2006	N	1.50–4.99	51663	5473		0.0	0.0–0.1	8	4–14	No public health problem
Barbados	17	293		R					0.7	0.0–9.4	0	0–2	Mild
Belarus	455	9742		R					0.6	0.0–9.1	3	0–41	Mild
Belgium	561	10430						GDP ≥ US$ 15000					No public health problem assumed
Belize	36	282		R					0.5	0.0–7.2	0	0–3	Mild
Benin	1488	8760		R					0.9	0.1–11.4	14	1–170	Mild
Bhutan	61	649		R					0.5	0.0–6.4	0	0–4	Mild
Bolivia (Plurinational State of)	1243	9354		R					1.0	0.1–12.5	12	1–156	Moderate
Bosnia and Herzegovina	195	3926		R					0.5	0.0–7.3	1	0–14	Mild
Botswana	216	1858		R					1.3	0.1–15.5	3	0–34	Moderate
Brazil	18092	189323		R					0.7	0.0–9.6	129	9–1741	Mild
Brunei Darussalam	40	382						GDP ≥ US$ 15000					No public health problem assumed
Bulgaria	341	7693		R					0.6	0.0–8.6	2	0–29	Mild
Burkina Faso	2605	14359	1996	F	2.00–5.99	2613	5801	Survey covers 34.7% of population	1.5	1.0–2.3	39	25–61	Moderate
Burundi	1461	8173	2005	N	2.00–4.99	4912	5748		1.3	0.9–1.8	19	13–27	Moderate
Cambodia	1690	14197	2000	N	1.50–4.99	10942	5021	National survey in rural areas; weighted prevalence	0.7	0.5–1.0	12	9–16	Mild

Table A3.1 Country estimates of the prevalence of night blindness in preschool-age children 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with night blindness		Population with VAD (number of individuals)(000)		Public health problem
	0–4.99y (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Cameroon	2851	18175		R					1.7	0.1–20.3	49	3–580	Moderate
Canada	1716	32577						GDP ≥ US$ 15000					No public health problem assumed
Cape Verde	73	519	1996	N	0.50–5.99	1118	5630	Two agricultural areas excluded	0.0	0.0–28.4	0	0–21	No public health problem
Central African Republic	668	4265		R					1.2	0.1–14.6	8	1–97	Moderate
Chad	1943	10468	2003P	F	0.50–4.99	1789	5102	Survey covers 14.1% of population	1.2	0.6–2.1	23	12–41	Moderate
Chile	1233	16465		R					0.6	0.0–7.9	7	0–97	Mild
China	84700	1328474	2000	N	2.00–6.07	5914	5788		0.1	0.1–0.4	119	45–310	Mild
Colombia	4438	45558		R					0.6	0.0–7.6	24	2–335	Mild
Comoros	129	818		R					0.5	0.0–6.3	1	0–8	Mild
Congo	587	3689	1999	F	0.50–6.99	5048	5631	Survey reported representative of the Congolese child population as a whole	0.6	0.4–1.0	4	2–6	Mild
Cook Islands	2	14		R					0.5	0.0–7.4	0	0–0	Mild
Costa Rica	393	4399		R					0.5	0.0–7.3	2	0–29	Mild
Côte d'Ivoire	2849	18914		R					1.5	0.1–18.2	43	3–517	Moderate
Croatia	205	4556		R					0.5	0.0–7.7	1	0–16	Mild
Cuba	652	11267		R					0.6	0.0–7.9	4	0–52	Mild
Cyprus	49	846						GDP ≥ US$ 15000					No public health problem assumed
Czech Republic	466	10189		R					0.6	0.0–8.0	3	0–37	Mild
Democratic People's Republic of Korea	1606	23708		R					0.3	0.0–5.1	5	0–81	Mild
Democratic Republic of the Congo	11843	60644		R					1.9	0.1–22.6	229	16–2671	Moderate
Denmark	321	5430						GDP ≥ US$ 15000					No public health problem assumed
Djibouti	107	819		R					0.9	0.1–11.4	1	0–12	Mild
Dominica	6	68		R					0.4	0.0–5.8	0	0–0	Mild
Dominican Republic	1110	9615		R					0.6	0.0–8.2	7	0–91	Mild
Ecuador	1414	13202		R					0.6	0.0–8.2	9	1–116	Mild
Egypt	8634	74166	1995	N	0.50–5.99	1567	103		0.1	0.0–0.9	9	1–78	Mild
El Salvador	775	6762		R					0.5	0.0–7.0	4	0–54	Mild
Equatorial Guinea	81	496		R					1.9	0.1–22.4	1	0–18	Moderate
Eritrea	808	4692		R					0.5	0.0–6.5	4	0–53	Mild
Estonia	67	1340		R					0.7	0.0–9.7	0	0–6	Mild
Ethiopia	13439	81021	1996, 1997	F	0.50–5.99	16333	1910, 5639c	Pooled data from one regional and one state survey; weighted prevalence; surveys cover 86.6% of population	4.9	4.5–5.4	658	598–724	Moderate
Fiji	90	833		R					0.6	0.0–7.9	1	0–7	Mild
Finland	286	5261						GDP ≥ US$ 15000					No public health problem assumed
France	3834	61330						GDP ≥ US$ 15000					No public health problem assumed
Gabon	158	1311		R					0.9	0.1–11.2	1	0–18	Mild
Gambia	261	1663	1999	N	1.00–5.99	NS[d]	2806		0.0	0.0–100	0	0–261	No public health problem
Georgia	237	4433		R					0.8	0.1–11.0	2	0–26	Mild

Table A3.1 Country estimates of the prevalence of night blindness in preschool-age children 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with night blindness		Population with VAD (number of individuals)(000)		Public health problem
	0–4.99y (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Germany	3548	82641						GDP ≥ US$ 15000					No public health problem assumed
Ghana	3195	23008	1997, 2002	F + S	0.50–4.99	3881	5099, 5104b	Weighted prevalence	0.4	0.2–0.8	13	6–26	Mild
Greece	513	11123						GDP ≥ US$ 15000					No public health problem assumed
Grenada	10	106		R					0.6	0.0–7.9	0	0–1	Mild
Guatemala	2066	13029		R					0.5	0.0–6.3	9	1–129	Mild
Guinea	1544	9181		R					0.8	0.1–10.6	13	1–164	Mild
Guinea–Bissau	322	1646		R					1.4	0.1–17.2	5	0–56	Moderate
Guyana	73	739		R					1.1	0.1–14.1	1	0–10	Moderate
Haiti	1244	9446		R					0.7	0.1–9.4	9	1–118	Mild
Honduras	943	6969		R					0.5	0.0–7.2	5	0–68	Mild
Hungary	475	10058		R					0.6	0.0–9.0	3	0–43	Mild
Iceland	21	298						GDP ≥ US$ 15000					No public health problem assumed
India	126843	1151751	2000	N	2.00–4.99	NS	4534	Sample size for 0.00–4.99 year olds =65,741	0.6	0.0–17.9	761	21-22715	Mild
Indonesia	21720	228864		R					0.6	0.0–8.3	136	9–1801	Mild
Iran (Islamic Republic of)	6270	70270		R					0.5	0.0–7.0	33	2–442	Mild
Iraq	4223	28506		R					0.7	0.1–9.4	31	2–399	Mild
Ireland	315	4221						GDP ≥ US$ 15000					No public health problem assumed
Israel	679	6810						GDP ≥ US$ 15000					No public health problem assumed
Italy	2729	58779						GDP ≥ US$ 15000					No public health problem assumed
Jamaica	277	2699		R					0.5	0.0–7.3	1	0–20	Mild
Japan	5622	127953						GDP ≥ US$ 15000					No public health problem assumed
Jordan	718	5729		R					0.6	0.0–8.5	4	0–61	Mild
Kazakhstan	1253	15314		R					1.2	0.1–16.5	16	1–207	Moderate
Kenya	6161	36553		R					1.4	0.1–16.6	84	6–1022	Moderate
Kiribati	10	94		R					0.9	0.1–11.5	0	0–1	Mild
Kuwait	236	2779						GDP ≥ US$ 15000					No public health problem assumed
Kyrgyzstan	504	5259		R					1.1	0.1–15.2	6	0–77	Moderate
Lao People's Democratic Republic	715	5759	2000	N	0.50–4.99	4849	770		3.1	2.5–3.9	22	18–28	Moderate
Latvia	102	2289		R					0.7	0.0–9.4	1	0–10	Mild
Lebanon	363	4055		R					0.6	0.0–8.3	2	0–30	Mild
Lesotho	272	1995		R					0.9	0.1–11.6	3	0–31	Mild
Liberia	690	3579		R					2.6	0.2–29.4	18	1–203	Moderate
Libyan Arab Jamahiriya	676	6039		R					0.6	0.0–7.8	4	0–53	Mild
Lithuania	151	3408		R					0.6	0.0–9.3	1	0–14	Mild

Table A3.1 Country estimates of the prevalence of night blindness in preschool–age children 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with night blindness		Population with VAD (number of individuals)(000)		Public health problem
	0–4.99y (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Luxembourg	27	461						GDP ≥ US$ 15000					No public health problem assumed
Madagascar	3142	19159	2000	N	0.50–4.99	586	5090		1.7	0.7–4.0	53	22–126	Moderate
Malawi	2425	13571		R					2.1	0.1–24.3	50	3–590	Moderate
Malaysia	2758	26114		R					0.5	0.0–6.5	13	1–178	Mild
Maldives	30	300	2001	N	2.00–4.99	640	2987		1.2	0.4–3.2	0	0–1	Moderate
Mali	2247	11968	1997	F	NS–9.99	10559	4195	Survey covers 51.7% of population	1.7	1.4–2.1	38	31–46	Moderate
Malta	20	405		R					0.5	0.0–7.1	0	0–1	Mild
Marshall Islands	6	58	1995	N	1.00–5.99	281	3886		8.5	4.9–14.4	1	0–1	Severe
Mauritania	456	3044		R					1.2	0.1–14.9	6	0–68	Moderate
Mauritius	94	1252		R					0.5	0.0–6.5	0	0–6	Mild
Mexico	10445	105342		R					0.6	0.0–8.3	64	4–866	Mild
Micronesia (Federated States of)	14	111		R					0.5	0.0–7.5	0	0–1	Mild
Monaco	2	33						GDP ≥ US$ 15000					No public health problem assumed
Mongolia	233	2605	1999	N	0.58–6.07	576	5767		0.5	0.1–2.5	1	0–6	Mild
Montenegro	38	601		R					0.6	0.0–8.9	0	0–3	Mild
Morocco	2978	30853	1996	N	0.50–5.99	1470	5496	See also Reference 3971	0.1	0.0–1.0	3	0–29	Mild
Mozambique	3670	20971		R					1.0	0.1–12.1	36	3–444	Moderate
Myanmar	4146	48379		R					1.1	0.1–13.5	45	3–558	Moderate
Namibia	248	2047		R					0.8	0.1–10.3	2	0–25	Mild
Nauru	1	10		R					0.6	0.0–8.0	0	0–0	Mild
Nepal	3626	27641	1998	N	1.00–4.99	15307	1083		0.3	0.2–0.4	10	6–15	Mild
Netherlands	987	16379						GDP ≥ US$ 15000					No public health problem assumed
New Zealand	284	4140						GDP ≥ US$ 15000					No public health problem assumed
Nicaragua	671	5532		R					0.5	0.0–6.8	3	0–46	Mild
Niger	2713	13737	2000	N	2.00–4.99	3004	3392		2.1	1.5–3.0	57	40–80	Moderate
Nigeria	24503	144720		R					2.2	0.1–25.3	534	36–6193	Moderate
Niue	0	2		R					0.6	0.0–8.3	0	0–0	Mild
Norway	284	4669						GDP ≥ US$ 15000					No public health problem assumed
Oman	269	2546		R					0.4	0.0–5.2	1	0–14	Mild
Pakistan	19012	160943		R					0.5	0.0–6.6	88	6–1256	Mild
Palau	2	20		R					0.6	0.0–7.9	0	0–0	Mild
Panama	344	3288		R					0.6	0.0–8.2	2	0–28	Mild
Papua New Guinea	898	6202	1998P	F	0.50–5.99	1020	4140	Survey covers 22.4% of population	0.5	0.1–1.7	4	1–15	Mild
Paraguay	731	6016		R					0.6	0.0–8.4	5	0–61	Mild
Peru	2815	27589		R					0.7	0.0–9.0	19	1–254	Mild
Philippines	11027	86264		R					0.7	0.1–10.0	82	6–1102	Mild
Poland	1765	38140		R					0.6	0.0–9.2	11	1–162	Mild
Portugal	557	10579						GDP ≥ US$ 15000					No public health problem assumed

Table A3.1 Country estimates of the prevalence of night blindness in preschool-age children 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with night blindness		Population with VAD (number of individuals)(000)		Public health problem
	0–4.99y (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Qatar	64	821						GDP ≥ US$ 15000					No public health problem assumed
Republic of Korea	2369	48050						GDP ≥ US$ 15000					No public health problem assumed
Republic of Moldova	213	3833		R					0.7	0.0–9.1	1	0–19	Mild
Romania	1058	21532		R					0.6	0.0–8.3	6	0–88	Mild
Russian Federation	7195	143221		R					0.7	0.0–9.6	49	3–694	Mild
Rwanda	1617	9464		R					2.6	0.2–30.0	42	3–486	Moderate
Saint Kitts and Nevis	5	50		R					0.8	0.1–11.2	0	0–1	Mild
Saint Lucia	15	163		R					0.6	0.0–7.8	0	0–1	Mild
Saint Vincent and the Grenadines	12	120		R					0.5	0.0–6.4	0	0–1	Mild
Samoa	25	185		R					0.6	0.0–8.9	0	0–2	Mild
San Marino	1	31						GDP ≥ US$ 15000					No public health problem assumed
Sao Tome and Principe	23	155		R					1.4	0.1–16.6	0	0–4	Moderate
Saudi Arabia	2879	24175		R					0.4	0.0–5.9	12	1–170	Mild
Senegal	1913	12072		R					0.7	0.0–8.8	13	1–169	Mild
Serbia	605	9851		R					0.6	0.0–8.9	4	0–54	Mild
Seychelles	6	86		R					0.6	0.0–8.3	0	0–1	Mild
Sierra Leone	999	5743		R					3.4	0.2–38.3	34	2–382	Moderate
Singapore	207	4382						GDP ≥ US$ 15000					No public health problem assumed
Slovakia	259	5388		R					0.6	0.0–8.0	1	0–21	Mild
Slovenia	89	2001						GDP ≥ US$ 15000					No public health problem assumed
Solomon Islands	70	484		R					0.4	0.0–5.3	0	0–4	Mild
Somalia	1507	8445		R					2.3	0.2–26.6	35	2–400	Moderate
South Africa	5254	48282		R					0.9	0.1–11.5	47	3–607	Mild
Spain	2268	43887						GDP ≥ US$ 15000					No public health problem assumed
Sri Lanka	1483	19207	1996	N	2.00–5.99	NS	2716	Survey excluded northern & eastern provinces	0.8	0.0–15.3	12	1–227	Mild
Sudan	5483	37707	1995	F	05.0–5.99	3587	1443	Survey covers 33.8% of population	8.5	7.3–9.9	466	400–542	Severe
Suriname	45	455		R					0.7	0.0–9.8	0	0–4	Mild
Swaziland	147	1134		R					1.9	0.1–22.9	3	0–34	Moderate
Sweden	499	9078						GDP ≥ US$ 15000					No public health problem assumed
Switzerland	362	7455						GDP ≥ US$ 15000					No public health problem assumed
Syrian Arab Republic	2500	19408		R					0.4	0.0–6.0	11	1–149	Mild
Tajikistan	858	6640		R					1.9	0.1–24.5	16	1–210	Moderate
Thailand	4514	63444		R					0.6	0.0–8.3	28	2–377	Mild
The former Yugoslav Republic of Macedonia	117	2036	1999	N	0.00–4.99	1272	1609		0.9	0.4–2.0	1	0–2	Mild

Table A3.1 Country estimates of the prevalence of night blindness in preschool–age children 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with night blindness		Population with VAD (number of individuals)(000)		Public health problem
	0–4.99y (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Timor-Leste	190	1114		R					1.1	0.1–13.1	2	0–25	Moderate
Togo	1045	6410		R					1.2	0.1–14.6	13	1–153	Moderate
Tonga	12	100		R					0.7	0.0–9.4	0	0–1	Mild
Trinidad and Tobago	93	1328		R					0.6	0.0–8.1	1	0–8	Mild
Tunisia	823	10215		R					0.4	0.0–6.1	4	0–51	Mild
Turkey	6630	73922		R					0.6	0.0–8.1	40	3–539	Mild
Turkmenistan	491	4899		R					1.7	0.1–22.6	8	1–111	Moderate
Tuvalu	1	10		R					0.8	0.1–9.9	0	0–0	Mild
Uganda	5840	29899		R					1.5	0.1–17.9	87	6–1047	Moderate
Ukraine	2001	46557		R					0.7	0.0–9.8	14	1–195	Mild
United Arab Emirates	315	4248						GDP ≥ US$ 15000					No public health problem assumed
United Kingdom of Great Britain and Northern Ireland	3467	60512						GDP ≥ US$ 15000					No public health problem assumed
United Republic of Tanzania	6953	39459		R					1.6	0.1–19.1	113	8–1330	Moderate
United States of America	20776	302841						GDP ≥ US$ 15000					No public health problem assumed
Uruguay	254	3331		R					0.7	0.0–9.3	2	0–24	Mild
Uzbekistan	2861	26981		R					1.1	0.1–14.9	32	2–427	Moderate
Vanuatu	31	221		R					0.2	0.0–4.1	0	0–1	Mild
Venezuela	2880	27191		R					0.6	0.0–7.9	17	1–229	Mild
Viet Nam	8101	86206	2000	N	0.00–4.99	94469	2976		0.0	0.0–00	1	0–2	No public health problem
Yemen	3639	21732		R					0.7	0.0–8.6	24	2–312	Mild
Zambia	2012	11696	1997	N	2.00–6.07	967	1325		6.2	4.4–8.7	125	88–176	Severe
Zimbabwe	1703	13228	1999	N	1.00–5.99	658	2641		0.3	0.0–2.1	5	1–36	Mild

[a] Population figures are based on the 2006 projection from the 2007 revision from the United Nations Population Division.
[b] Level of survey: N=nationally representative, F=surveys at the first administrative level boundary, S=survey at the second administrative level boundary, R=regression–based estimate.
[c] Corresponds to the numerical reference available in the WHO Global Database on Vitamin A Deficiency (http://www.who.int/vmnis/en/).
[d] NS = not specified

Table A3.2 ***Country estimates of the prevalence of night blindness in pregnant women 1995–2005***

Member State	Population 2006[a]		Survey Information						Proportion of the population with night bindness		Population with VAD (number of individuals)(000)		Public health problem
	Pregnant women (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Afghanistan	1337	26088		R					12.5	3.7–34.5	167	50–461	Yes
Albania	52	3172		R					3.2	0.9–11.1	2	0–6	No
Algeria	710	33351		R					5.3	1.6–16.6	38	11–118	Yes
Andorra	1	74						GDP ≥ US$ 15000					No, assumed
Angola	818	16557		R					10.9	3.3–30.4	89	27–249	Yes
Antigua and Barbuda	2	84		R					3.9	1.1–12.9	0	0–0	No
Argentina	696	39134		R					3.2	0.9–10.9	22	6–76	No
Armenia	38	3010	2005	N	15.00–49.99	1176	5804		3.2	2.0–5.0	1	1–2	No
Australia	257	20530						GDP ≥ US$ 15000					No, assumed
Austria	77	8327						GDP ≥ US$ 15000					No, assumed
Azerbaijan	138	8406		R					3.3	0.9–11.3	5	1–16	No
Bahamas	6	327						GDP ≥ US$ 15000					No, assumed
Bahrain	13	739						GDP ≥ US$ 15000					No, assumed
Bangladesh	3972	155991	2004	N	10.00–49.99	5416	5206		6.5	5.6–7.5	258	224–298	Yes
Barbados	3	293		R					3.2	0.9–11.1	0	0–0	No
Belarus	91	9742		R					2.6	0.7–9.6	2	1–9	No
Belgium	109	10430						GDP ≥ US$ 15000					No, assumed
Belize	7	282		R					4.6	1.3–15.0	0	0–1	No
Benin	369	8760	2001	N	15.00–49.99	3524	3461		9.9	8.6–11.4	37	32–42	Yes
Bhutan	12	649		R					6.8	2.0–20.9	1	0–3	Yes
Bolivia (Plurinational State of)	263	9354	2004	N	15.00–49.99	7261	5095		14.1	13.0–15.3	37	34–40	Yes
Bosnia and Herzegovina	35	3926		R					4.5	1.3–14.4	2	0–5	No
Botswana	47	1858		R					4.3	1.2–14.0	2	1–7	No
Brazil	3698	189323		R					3.5	1.0–11.8	130	36–437	No
Brunei Darussalam	8	382						GDP ≥ US$ 15000					No, assumed
Bulgaria	68	7693		R					2.8	0.7–10.3	2	0–7	No
Burkina Faso	661	14359	2003	N	15.00–49.99	7428	4948		13.0	12.0–14.1	86	79–93	Yes
Burundi	410	8173		R					8.0	2.4–23.7	33	10–97	Yes
Cambodia	386	14197	2005	N	15.00–49.99	5865	5646		8.0	7.1–9.0	31	27–35	Yes
Cameroon	647	18175	2004	N	15.00–49.99	5303	5214		6.0	5.2–7.0	39	33–45	Yes
Canada	341	32577						GDP ≥ US$ 15000					No, assumed
Cape Verde	16	519		R					6.7	2.0–20.3	1	0–3	Yes
Central African Republic	159	4265		R					13.3	3.9–36.9	21	6–59	Yes
Chad	497	10468	2003P	F	NS[d]	1069	5102	Survey covers 14.1% of population	2.7	1.6–4.5	13	8–22	No
Chile	251	16465		R					3.4	0.9–11.4	8	2–29	No
China	17459	1328474		R					4.2	1.2–13.7	738	211–2400	No
Colombia	869	45558		R					4.1	1.2–13.5	36	10–117	No
Comoros	28	818		R					9.4	2.9–26.8	3	1–8	Yes
Congo	134	3689	2005	N	15.00–49.99	3568	5733		8.0	6.8–9.4	11	9–13	Yes
Cook Islands	0	14		R					2.8	0.7–10.7	0	0–0	No
Costa Rica	80	4399		R					4.4	1.3–14.4	4	1–12	No
Côte d'Ivoire	688	18914		R					10.3	3.1–28.9	70	21–199	Yes
Croatia	41	4556		R					3.0	0.8–10.7	1	0–4	No
Cuba	116	11267		R					3.0	0.8–10.5	4	1–12	No
Cyprus	10	846						GDP ≥ US$ 15000					No, assumed
Czech Republic	93	10189		R					2.9	0.8–10.1	3	1–9	No
Democratic People's Republic of Korea	315	23708		R					5.3	1.4–17.7	17	4–56	Yes
Democratic Republic of the Congo	3166	60644		R					10.4	3.1–29.2	328	100–294	Yes

Table A3.2 Country estimates of the prevalence of night blindness in pregnant women 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with night bindness		Population with VAD (number of individuals)(000)		Public health problem
	Pregnant women (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Denmark	61	5430						GDP ≥ US$ 15000					No, assumed
Djibouti	24	819		R					9.1	2.8–26.1	2	1–6	Yes
Dominica	1	68		R					3.6	1.0–12.4	0	0–0	No
Dominican Republic	231	9615	2002	N	15.00–49.99	7866	4739		4.5	3.9–5.2	10	9–12	No
Ecuador	282	13202		R					3.7	1.0–12.2	10	3–34	No
Egypt	1845	74166		R					5.0	1.4–16.0	92	26–296	Yes
El Salvador	158	6762		R					4.3	1.2–14.0	7	2–22	No
Equatorial Guinea	20	496		R					8.3	2.4–25.0	2	0–5	Yes
Eritrea	193	4692	2002	N	15.00–49.99	4175	4639		11.6	10.3–13.0	22	20–25	Yes
Estonia	14	1340		R					2.6	0.7–9.6	0	0–1	No
Ethiopia	3222	81021	2005	N	15.00–49.99	7308	5694		22.1	20.8–23.5	712	670–756	Yes
Fiji	18	833		R					3.8	1.1–12.6	1	0–2	No
Finland	59	5261						GDP ≥ US$ 15000					No, assumed
France	756	61330						GDP ≥ US$ 15000					No, assumed
Gabon	35	1311	2000	N	15.00–49.99	2748	5100		10.5	9.0–12.2	4	3–4	Yes
Gambia	60	1663		R					7.9	2.3–24.2	5	1–15	Yes
Georgia	47	4433		R					3.7	1.0–13.5	2	0–6	No
Germany	675	82641						GDP ≥ US$ 15000					No, assumed
Ghana	703	23008	2003	N	15.00–49.99	2645	4943		7.7	6.4–9.3	54	45–65	Yes
Greece	103	11123						GDP ≥ US$ 15000					No, assumed
Grenada	2	106		R					3.2	0.9–11.1	0	0–0	No
Guatemala	450	13029		R					6.8	2.0–20.4	31	9–92	Yes
Guinea	378	9181	2005	N	15.00–49.99	4447	5726		17.8	16.3–19.4	67	62–74	Yes
Guinea-Bissau	86	1646		R					11.3	3.4–31.2	10	3–27	Yes
Guyana	13	739		R					3.5	1.0–11.9	0	0–1	No
Haiti	270	9446	2000	N	15.00–49.99	4254	3264		9.4	8.2–10.7	25	22–29	Yes
Honduras	200	6969	2006	N	15.00–49.99	7774	5799		4.8	4.2–5.5	10	8–11	No
Hungary	93	10058		R					2.7	0.7–9.8	3	1–9	No
Iceland	4	298						GDP ≥ US$ 15000					No, assumed
India	27077	1151751	1999, 2000	N, F	15.00–49.99	32692	2972, 3780a	Prevalence pooled from national survey and one state survey	12.1	11.6–12.6	3276	3143–3414	Yes
Indonesia	4360	228864	2003	N	15.00–49.99	12760	4538		1.7	1.4–2.0	74	61–89	No
Iran (Islamic Republic of)	1462	70270		R					4.0	1.1–13.1	58	16–192	No
Iraq	931	28506		R					7.0	2.0–21.6	66	19–201	Yes
Ireland	67	4221						GDP ≥ US$ 15000					No, assumed
Israel	137	6810						GDP ≥ US$ 15000					No, assumed
Italy	539	58779						GDP ≥ US$ 15000					No, assumed
Jamaica	54	2699		R					4.5	1.3–14.6	2	1–8	No
Japan	1062	127953						GDP ≥ US$ 15000					No, assumed
Jordan	155	5729		R					4.4	1.2–14.6	7	2–23	No
Kazakhstan	305	15314		R					2.6	0.7–9.7	8	2–30	No
Kenya	1496	36553		R					6.4	1.9–19.5	96	28–291	Yes
Kiribati	2	94		R					4.6	1.3–14.9	0	0–0	No
Kuwait	52	2779						GDP ≥ US$ 15000					No, assumed
Kyrgyzstan	117	5259		R					3.3	0.9–11.4	4	1–13	No
Lao People's Democratic Republic	159	5759	2000	N	15.00–49.99	1186	770		11.9	9.5–14.8	19	15–23	Yes
Latvia	21	2289		R					2.6	0.7–9.5	1	0–2	No
Lebanon	75	4055		R					3.7	1.1–12.4	3	1–9	No

Table A3.2 Country estimates of the prevalence of night blindness in pregnant women 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with night bindness		Population with VAD (number of individuals)(000)		Public health problem
	Pregnant women (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Lesotho	58	1995	2005	N	15.00–49.99	2859	5356		4.4	3.5–5.6	3	2–3	No
Liberia	192	3579		R					13.3	3.8–37.3	26	7–72	Yes
Libyan Arab Jamahiriya	146	6039		R					4.2	1.2–13.7	6	2–20	No
Lithuania	31	3408		R					2.6	0.7–9.6	1	0–3	No
Luxembourg	5	461						GDP ≥ US$ 15000					No, assumed
Madagascar	726	19159	2004	N	15.00–49.99	3894	5190		7.5	6.4–8.8	54	47–64	Yes
Malawi	575	13571	2004	N	15.00–49.99	7271	5201		5.8	5.1–6.6	33	29–38	Yes
Malaysia	553	26114		R					4.4	1.3–14.4	25	7–80	No
Maldives	7	300	2001	N	15.00–49.99	1313	2987		4.6	3.2–6.5	0	0–0	No
Mali	604	11968	2001	N	15.00–49.99	8291	3446		19.1	17.9–20.3	115	108–123	Yes
Malta	4	405		R					3.7	1.0–12.3	0	0–0	No
Marshall Islands	1	58		R					4.3	1.2–14.0	0	0–0	No
Mauritania	103	3044		R					9.7	2.9–27.5	10	3–28	Yes
Mauritius	19	1252		R					4.0	1.1–13.1	1	0–2	No
Mexico	2075	105342		R					3.8	1.1–12.6	79	22–261	No
Micronesia (Federated States of)	3	111		R					3.6	1.0–12.3	0	0–0	No
Monaco	0	33						GDP ≥ US$ 15000					No, assumed
Mongolia	49	2605		R					3.4	0.9–11.4	2	0–6	No
Montenegro	8	601		R					3.3	0.9–11.5	0	0–1	No
Morocco	646	30853	2004	N	15.00–49.99	4695	5191		2.2	1.7–2.9	14	11–19	No
Mozambique	852	20971	2004	N	15.00–49.99	7179	5195		5.3	4.6–6.1	45	39–52	Yes
Myanmar	892	48379	2005	N	15.00–49.99	1598	5685		1.1	0.6–2.1	10	5–19	No
Namibia	54	2047		R					6.2	1.8–18.9	3	1–10	Yes
Nauru	0	10		R					8.9	2.4–27.9	0	0–0	Yes
Nepal	800	27641	2001	N	15.00–49.99	4745	3321	Survey excluded six areas due to security	19.6	18.1–21.2	157	144–170	Yes
Netherlands	182	16379						GDP ≥ US$ 15000					No, assumed
New Zealand	57	4140						GDP ≥ US$ 15000					No, assumed
Nicaragua	140	5532	2001	N	15.00–49.99	4848	3460		5.1	4.3–6.0	7	6–8	Yes
Niger	711	13737	2000	N	15.00–49.99	1360	3392		17.1	14.5–20.1	122	103–143	Yes
Nigeria	5975	144720	2003	N	15.00–49.99	3911	4764		7.7	6.6–9.0	460	394–536	Yes
Niue	0	2		R					3.0	0.7–12.1	0	0–0	No
Norway	56	4669						GDP ≥ US$ 15000					No, assumed
Oman	58	2546		R					4.4	1.3–14.3	3	1–8	No
Pakistan	4515	160943	2001	N	15.00–49.99	10155	4640		7.8	7.1–8.6	352	320–387	Yes
Palau	0	20		R					3.7	1.0–12.4	0	0–0	No
Panama	70	3288		R					4.7	1.4–15.0	3	1–11	No
Papua New Guinea	189	6202		R					10.3	3.1–29.3	19	6–55	Yes
Paraguay	153	6016		R					4.5	1.3–14.7	7	2–22	No
Peru	586	27589	2004	N	15.00–49.99	1773	5357		6.5	5.1–8.3	38	30–49	Yes
Philippines	2292	86264	2003	N	15.00–49.99	4802	5192		7.9	6.9–9.0	181	158–207	Yes
Poland	362	38140		R					2.8	0.8–10.0	10	3–36	No
Portugal	112	10579						GDP ≥ US$ 15000					No, assumed
Qatar	14	821						GDP ≥ US$ 15000					No, assumed
Republic of Korea	449	48050						GDP ≥ US$ 15000					No, assumed
Republic of Moldova	43	3833	2005	N	15.00–49.99	1387	5489		5.1	3.7–7.0	2	2–3	Yes
Romania	210	21532		R					3.0	0.8–10.6	6	2–22	No
Russian Federation	1518	143221		R					2.8	0.7–10.0	43	11–152	No

Table A3.2 Country estimates of the prevalence of night blindness in pregnant women 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with night bindness		Population with VAD (number of individuals)(000)		Public health problem
	Pregnant women (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Rwanda	441	9464	2005	N	15.00–49.99	5245	5781		7.9	6.9–9.0	35	31–40	Yes
Saint Kitts and Nevis	1	50		R					2.9	0.8–10.1	0	0–0	No
Saint Lucia	3	163		R					3.7	1.0–12.3	0	0–0	No
Saint Vincent and the Grenadines	2	120		R					3.8	1.1–12.9	0	0–0	No
Samoa	5	185		R					3.3	0.9–11.2	0	0–1	No
San Marino	0	31						GDP ≥ US$ 15000					No, assumed
Sao Tome and Principe	5	155		R					5.0	1.5–15.8	0	0–1	Yes
Saudi Arabia	622	24175		R					5.1	1.4–16.3	32	9–101	Yes
Senegal	441	12072	2005	N	15.00–49.99	6927	5739		12.7	11.6–13.9	56	51–61	Yes
Serbia	127	9851		R					3.3	0.9–11.5	4	1–15	No
Seychelles	4	86		R					3.2	0.9–10.9	0	0–0	No
Sierra Leone	272	5743		R					9.7	2.9–27.6	26	8–75	Yes
Singapore	36	4382						GDP ≥ US$ 15000					No, assumed
Slovakia	54	5388		R					2.9	0.8–10.3	2	0–6	No
Slovenia	18	2001						GDP ≥ US$ 15000					No, assumed
Solomon Islands	15	484		R					6.6	2.0–20.0	1	0–3	Yes
Somalia	379	8445		R					12.8	3.8–35.2	49	14–134	Yes
South Africa	1086	48282		R					4.5	1.3–14.5	49	14–158	No
Spain	480	43887						GDP ≥ US$ 15000					No, assumed
Sri Lanka	291	19207		R					3.5	1.0–11.9	10	3–35	No
Sudan	1232	37707		R					9.6	2.9–27.4	118	36–337	Yes
Suriname	9	455		R					4.8	1.4–15.6	0	0–1	No
Swaziland	33	1134		R					4.1	1.2–13.6	1	0–4	No
Sweden	103	9078						GDP ≥ US$ 15000					No, assumed
Switzerland	69	7455						GDP ≥ US$ 15000					No, assumed
Syrian Arab Republic	539	19408		R					4.6	1.3–15.1	25	7–81	No
Tajikistan	186	6640		R					3.8	1.1–12.6	7	2–24	No
Thailand	932	63444		R					3.7	1.0–12.2	34	10–113	No
The former Yugoslav Republic of Macedonia	22	2036		R					3.3	0.9–11.3	1	0–3	No
Timor-Leste	49	1114	2003	N	15.00–49.99	3323	5050		13.4	11.8–15.1	7	6–7	Yes
Togo	246	6410		R					9.5	2.8–27.5	23	7–67	Yes
Tonga	3	100		R					3.0	0.8–10.5	0	0–0	No
Trinidad and Tobago	20	1328		R					3.7	1.0–12.3	1	0–2	No
Tunisia	174	10215		R					4.5	1.3–14.5	8	2–25	No
Turkey	1388	73922		R					5.4	1.6–16.7	74	22–232	Yes
Turkmenistan	109	4899		R					3.4	0.9–11.5	4	1–13	No
Tuvalu	0	10		R					3.6	1.0–12.1	0	0–0	No
Uganda	1467	29899	2001	N	15.00–49.99	4489	3207		8.3	7.2–9.5	122	106–140	Yes
Ukraine	423	46557		R					2.5	0.6–9.5	11	3–40	No
United Arab Emirates	72	4248						GDP ≥ US$ 15000					No, assumed
United Kingdom of Great Britain and Northern Ireland	728	60512						GDP ≥ US$ 15000					No, assumed
United Republic of Tanzania	1601	39459	2005	N	15.00–49.99	5772	5221		2.7	2.2–3.4	43	35–54	No
United States of America	4298	302841						GDP ≥ US$ 15000					No, assumed
Uruguay	51	3331		R					3.2	0.9–11.0	2	0–6	No
Uzbekistan	623	26981		R					3.4	0.9–11.6	21	6–72	No
Vanuatu	7	221		R					11.8	3.6–32.8	1	0–2	Yes

Table A3.2 Country estimates of the prevalence of night blindness in pregnant women 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with night bindness		Population with VAD (number of individuals)(000)		Public health problem
	Pregnant women (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Venezuela	598	27191		R					4.7	1.4–15.2	28	8–91	No
Viet Nam	1650	86206		R					4.1	1.2–13.2	67	19–218	No
Yemen	872	21732		R					9.8	3.0–27.8	85	26–242	Yes
Zambia	473	11696	2003	N	15.00–49.99	527	5098		5.7	1.7–17.5	27	8–83	Yes
Zimbabwe	374	13228	1999	N	15.00–49.99	2770	4680, 3331		4.6	3.4–6.1	17	13–23	No

[a] Population figures are based on the 2006 projection from the 2007 revision from the United Nations Population Division.
[b] Level of survey: N=nationally representative, F=surveys at the first administrative level boundary, S=survey at the second administrative level boundary, R=regression–based estimate.
[c] Corresponds to the numerical reference available in the WHO Global Database on Vitamin A Deficiency (http://www.who.int/vmnis/en/).
[d] NS = not specified

Table A3.3 ***Country estimates of the prevalence of serum retinol <0.70 µmol/l in preschool-age children 1995–2005***

Member State	Population 2006[a]		Survey Information						Proportion of the population with serum retinol <0.70 µmol/l		Population with VAD (number of individuals) (000)		Public health problem
	0–4.99 yrs (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Afghanistan	4823	26088		R					64.5	13.2–95.6	3109	639–4609	Severe
Albania	250	3172		R					18.6	2.0–72.1	47	5–180	Moderate
Algeria	3213	33351		R					15.7	1.7–66.3	505	56–2129	Moderate
Andorra	4	74						GDP ≥ US$ 15000					No public health problem assumed
Angola	3082	16557	1999	N	0.00–5.07	765	2839	Two provinces left out due to war	64.3	59.4–68.9	1982	1830–2125	Severe
Antigua and Barbuda	8	84	1997	N	1.00–4.99	92	3758	Predicted prevalence based on mean and prevalence <0.35 µmol/l	7.4	2.6–19.4	1	0–2	Mild
Argentina	3346	39134	2004–2005	N	2.00–5.99	7200	5837		14.3	13.2–15.5	478	441–518	Moderate
Armenia	164	3010	1998	N	0.00–4.99	2341	3329		0.6	0.27–1.2	1	0–2	No public health problem
Australia	1267	20530						GDP ≥ US$ 15000					No public health problem assumed
Austria	394	8327						GDP ≥ US$ 15000					No public health problem assumed
Azerbaijan	547	8406		R					32.1	4.3–83.7	176	23–458	Severe
Bahamas	28	327						GDP ≥ US$ 15000					No public health problem assumed
Bahrain	65	739						GDP ≥ US$ 15000					No public health problem assumed
Bangladesh	18951	155991	1998	N	0.50–4.99	1136	3900	National survey in rural areas	21.7	18.5–25.3	4112	3506–4790	Severe
Barbados	17	293		R					6.5	0.48–49.9	1	0–8	Mild
Belarus	455	9742		R					17.4	1.8–7.1	79	8–323	Moderate
Belgium	561	10430						GDP ≥ US$ 15000					No public health problem assumed
Belize	36	282		R					11.7	1.2–5.9	4	0–21	Moderate
Benin	1488	8760	1999	F	1.00–5.99	1491	5797	Weighted prevalence; survey covers 82.7% of population	70.7	67.3–73.9	1052	1002–1099	Severe
Bhutan	61	649	1999	F	1.00–4.99	910	2715	Survey covers 29% of population; prevalence predicted based on mean and prevalence <0.35 µmol/l	22.0	18.4–26.0	13	11–16	Severe
Bolivia (Plurinational State of)	1243	9354		R					21.8	2.6–74.7	271	32–929	Severe
Bosnia and Herzegovina	195	3926		R					13.2	1.4–62.0	26	3–121	Moderate
Botswana	216	1858		R					26.1	2.9–80.5	57	6–174	Severe
Brazil	18092	189323		R					13.3	1.4–62.0	2405	257–11222	Moderate
Brunei Darussalam	40	382						GDP ≥ US$ 15000					No public health problem assumed
Bulgaria	341	7693		R					18.3	1.9–72.6	62	6–248	Moderate
Burkina Faso	2605	14359		R					54.3	9.7–93.0	1415	253–2421	Severe
Burundi	1461	8173	2005	N	0.50–4.99	714	5748		27.9	23.5–32.8	408	343–479	Severe
Cambodia	1690	14197	2000	N	0.50–4.99	359	5761		22.3	16.8–29.0	377	284–490	Severe
Cameroon	2851	18175	2000	N	1.00–5.99	2375	3470		38.8	36.1–41.6	1106	1028–1186	Severe
Canada	1716	32577						GDP ≥ US$ 15000					No public health problem assumed
Cape Verde	73	519	1996	N	0.50–5.99	299	5630	Two agricultural areas excluded	2.0	0.65–6.0	1	0–4	Mild

Table A3.3 Country estimates of the prevalence of serum retinol <0.70 µmol/l in preschool-age children 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with serum retinol <0.70 µmol/l		Population with VAD (number of individuals) (000)		Public health problem
	0–4.99 yrs (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Central African Republic	668	4265	1999	N	0.50–3.07	882	1722		68.2	63.7–72.4	455	425–483	Severe
Chad	1943	10468		R					50.1	8.3–91.7	973	161–1782	Severe
Chile	1233	16465		R					7.9	0.74–49.3	97	9–608	Mild
China	84700	1328474	2002	N	3.00–12.99	13870	5770		9.3	8.6–10.0	7877	7317–8475	Mild
Colombia	4438	45558	2005	N	1.00–4.99	4409	5773		5.9	5.0–7.0	262	221–309	Mild
Comoros	129	818		R					21.5	2.5–74.9	28	3–96	Severe
Congo	587	3689		R					24.6	2.9–77.9	144	17–457	Severe
Cook Islands	2	14		R					10.4	0.75–64.1	0	0–1	Moderate
Costa Rica	393	4399	1999	N	1.00–6.99	567	4227		8.8	6.0–12.7	35	24–50	Mild
Côte d'Ivoire	2849	18914	1996	F	2.00–5.99	282	1986	Survey conducted in the 4 main food zones	57.3	49.0–65.2	1633	1396–1857	Severe
Croatia	205	4556		R					9.2	0.79–56.6	19	2–116	Mild
Cuba	652	11267	2000	N	0.50–2.07	2371	3224	National survey in urban areas	3.6	2.7–4.8	23	17–31	Mild
Cyprus	49	846						GDP ≥ US$ 15000					No public health problem assumed
Czech Republic	466	10189		R					5.8	0.39–48.9	27	2–228	Mild
Democratic People's Republic of Korea	1606	23708		R					27.5	3.3–80.7	441	53–1297	Severe
Democratic Republic of the Congo	11843	60644	1999	N	0.50–3.07	601	5800	Survey excluded three of 11 provinces due to war	61.1	55.5–66.4	7236	6570–7870	Severe
Denmark	321	5430						GDP ≥ US$ 15000					No public health problem assumed
Djibouti	107	819		R					35.2	4.9–85.2	38	5–91	Severe
Dominica	6	68	1997	N	1.00–4.99	160	3758	Prevalence predicted based on prevalence <0.87 µmol/l and SD of 0.35 µmol/l	4.2	1.4–11.6	0	0–1	Mild
Dominican Republic	1110	9615		R					13.7	1.5–62.8	152	16–697	Moderate
Ecuador	1414	13202		R					14.7	1.6–64.7	208	23–915	Moderate
Egypt	8634	74166	1995	N	0.50–5.99	1577	103		11.9	9.8–14.4	1027	848–1239	Moderate
El Salvador	775	6762		R					14.6	1.6–64.5	113	12–500	Moderate
Equatorial Guinea	81	496		R					13.9	0.83–75.6	11	1–61	Moderate
Eritrea	808	4692		R					21.4	2.3–75.6	173	19–611	Severe
Estonia	67	1340		R					8.7	0.64–58.4	6	0–39	Mild
Ethiopia	13439	81021	1996, 1997	F	0.50–5.99	1087	1910, 5639c	Pooled data from one regional and one state survey; weighted prevalence; surveys cover 86.4% of population	46.1	41.9–50.3	6195	5637–6760	Severe
Fiji	90	833		R					13.6	1.4–62.7	12	1–56	Moderate
Finland	286	5261						GDP ≥ US$ 15000					No public health problem assumed
France	3834	61330						GDP ≥ US$ 15000					No public health problem assumed
Gabon	158	1311		R					16.9	1.8–69.6	27	3–110	Moderate
Gambia	261	1663	1999	N	1.00–5.99	405	2806		64.0	57.2–70.3	167	149–183	Severe
Georgia	237	4433		R					30.9	3.4–85.2	73	8–202	Severe
Germany	3548	82641						GDP ≥ US$ 15000					No public health problem assumed
Ghana	3195	23008	1997	F	0.50–4.99	1050	3004	Survey covers 82.5% of population	75.8	72.0–79.3	2422	2299–2533	Severe

Table A3.3 Country estimates of the prevalence of serum retinol <0.70 µmol/l in preschool-age children 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with serum retinol <0.70 µmol/l		Population with VAD (number of individuals) (000)		Public health problem
	0–4.99 yrs (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Greece	513	11123						GDP ≥ US$ 15000					No public health problem assumed
Grenada	10	106		R					14.1	1.5–64.5	1	0–7	Moderate
Guatemala	2066	13029	1995	N	1.00–4.99	1576	3091	Survey excluded Peten	15.8	13.4–18.5	326	277–383	Moderate
Guinea	1544	9181		R					45.8	7.3–90.0	707	113–1390	Severe
Guinea-Bissau	322	1646		R					54.7	9.9–93.0	176	32–300	Severe
Guyana	73	739	1997	N	1.00–4.99	141	3758	Prevalence predicted based on prevalence <0.87 µmol/l and SD of 0.35 µmol/l	4.1	1.3–12.2	3	1–9	Mild
Haiti	1244	9446	2005	N	0.50–4.99	780	5353		32.0	27.6–36.8	398	343–458	Severe
Honduras	943	6969	1996	N	1.00–5.99	1618	3095	Survey excludes departments of Islas de la Bahia and Gracias a Dois	13.8	11.6–16.4	130	109–154	Moderate
Hungary	475	10058		R					7.0	0.51–52.5	33	2–249	Mild
Iceland	21	298						GDP ≥ US$ 15000					No public health problem assumed
India	126843	1151751	2001–2003	F	1.00–4.99	3934	5839, 5840	Survey covers 48.3% of population	62.0	59.8–64.1	78643	75895–81331	Severe
Indonesia	21720	228864		R					19.6	2.2–72.3	4261	485–15699	Moderate
Iran (Islamic Republic of)	6270	70270	2001	N	1.25–1.99	8493	5379		0.5	0.33–0.76	31	21–48	No public health problem
Iraq	4223	28506		R					29.8	3.8–81.9	1256	161–3456	Severe
Ireland	315	4221						GDP ≥ US$ 15000					No public health problem assumed
Israel	679	6810						GDP ≥ US$ 15000					No public health problem assumed
Italy	2729	58779						GDP ≥ US$ 15000					No public health problem assumed
Jamaica	277	2699	1998	N	1.00–4.99	284	3093	Prevalence predicated based on mean and SD	29.4	22.5–37.4	81	62–103	Severe
Japan	5622	127953						GDP ≥ US$ 15000					No public health problem assumed
Jordan	718	5729	2002	N	1.00–4.99	1036	4382		15.1	12.3–18.4	108	88–132	Moderate
Kazakhstan	1253	15314	2002	F	0.50–5.07	1019	5675	Weighted prevalence; survey covers 14.2% of population	27.1	23.4–31.1	340	293–390	Severe
Kenya	6161	36553	1999	N	0.17–5.07	945	3442		84.4	80.8–87.4	5200	4981–5385	Severe
Kiribati	10	94		R					21.8	2.6–74.8	2	0–8	Severe
Kuwait	236	2779						GDP ≥ US$ 15000					No public health problem assumed
Kyrgyzstan	504	5259		R					26.3	3.2–79.2	133	16–399	Severe
Lao People's Democratic Republic	715	5759	2000	N	0.00–4.99	419	770		44.7	38.1–51.5	320	273–368	Severe
Latvia	102	2289		R					13.0	1.2–65.4	13	1–67	Moderate
Lebanon	363	4055		R					11.0	1.1–57.9	40	4–210	Moderate
Lesotho	272	1995		R					32.7	4.3–84.1	89	12–229	Severe
Liberia	690	3579	1999	N	0.50–2.99	643	1242		52.9	47.4–58.3	365	327–402	Severe
Libyan Arab Jamahiriya	676	6039		R					8.0	0.77–49.4	54	5–334	Mild
Lithuania	151	3408		R					11.1	0.98–61.1	17	1–92	Moderate

Table A3.3 Country estimates of the prevalence of serum retinol <0.70 µmol/l in preschool-age children 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with serum retinol <0.70 µmol/l		Population with VAD (number of individuals) (000)		Public health problem
	0–4.99 yrs (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Luxembourg	27	461						GDP ≥ US$ 15000					No public health problem assumed
Madagascar	3142	19159	2000	N	0.50–4.99	584	5090		42.1	36.6–47.8	1323	1149–1503	Severe
Malawi	2425	13571	2001	N	0.50–3.07	476	5602		59.2	52.8–65.3	1436	1282–1583	Severe
Malaysia	2758	26114	1999	N	NS[d]–4.99	434	4394		3.5	1.7–7.0	97	48–192	Mild
Maldives	30	300	2001	N	2.00–2.99	640	2987		9.4	6.7–13.1	3	2–4	Mild
Mali	2247	11968		R					58.6	11.2–94.1	1317	252–2114	Severe
Malta	20	405		R					4.0	0.23–42.2	1	0–8	Mild
Marshall Islands	6	58	1995	N	1.00–5.99	919	3886		60.7	56.2–65.1	4	4–4	Severe
Mauritania	456	3044		R					47.7	7.8–90.8	217	35–414	Severe
Mauritius	94	1252	1995	N	3.00–6.99	285	395	Prevalence pooled from the Islands of Mauritius and Rodrigues	9.2	5.4–15.2	9	5–14	Mild
Mexico	10445	105342	1999	N	0.00–4.99	322	2997	Data disaggregated by age pooled	26.8	20.5–34.2	2799	2145–3568	Severe
Micronesia (Federated States of)	14	111	2000, 2002P	F	2.00–6.99	728	5672, 2548	Data pooled from two state surveys and weighted; surveys cover 68.2% of population	54.2	49.1–59.3	8	7–9	Severe
Monaco	2	33						GDP ≥ US$ 15000					No public health problem assumed
Mongolia	233	2605	1999	N	0.58–6.07	416	5767		19.8	14.9–25.8	46	35–60	Moderate
Montenegro	38	601		R					17.2	1.8–70.0	7	1–27	Moderate
Morocco	2978	30853	1996	N	0.50–5.99	1453	5496		40.4	36.9–44.0	1203	1098–1310	Severe
Mozambique	3670	20971	2002	N	0.50–4.99	705	589		68.8	63.8–73.4	2525	2341–2695	Severe
Myanmar	4146	48379		R					36.7	5.1–86.2	1523	213–3572	Severe
Namibia	248	2047		R					17.5	2.0–69.1	43	5–171	Moderate
Nauru	1	10		R					10.0	1.0–55.0	0	0–1	Moderate
Nepal	3626	27641	1998	N	0.50–4.99	843	1083		32.3	28.0–36.9	1171	1015–1338	Severe
Netherlands	987	16379						GDP ≥ US$ 15000					No public health problem assumed
New Zealand	284	4140						GDP ≥ US$ 15000					No public health problem assumed
Nicaragua	671	5532	2004	N	0.50–4.99	479	5730a		3.1	1.5–6.2	21	10–42	Mild
Niger	2713	13737		R					67.0	14.6–96.0	1819	396–2605	Severe
Nigeria	24503	144720	2001	N	0.00–4.99	3099	4581		29.5	27.3–31.8	7228	6685–7797	Severe
Niue	0	2		R					15.5	1.0–76.3	0	0–0	Moderate
Norway	284	4669						GDP ≥ US$ 15000					No public health problem assumed
Oman	269	2546	2004	N	0.50–4.99	152	5525	Children with CRP >10 µg/dl excluded	5.5	2.1–13.5	15	6–36	Mild
Pakistan	19012	160943	2001	N	0.50–4.99	5682	4640		12.5	11.3–13.8	2377	2155–2617	Moderate
Palau	2	20		R					8.9	0.84–53.1	0	0–1	Mild
Panama	344	3288	1999	N	1.00–4.99	924	3097		9.4	7.1–12.4	32	24–43	Mild
Papua New Guinea	898	6202	1998P	F	0.50–5.99	130	4140	Survey covers 22.4% of population	11.1	5.4–21.3	100	49–191	Moderate
Paraguay	731	6016		R					14.1	1.5–64.5	103	11–472	Moderate
Peru	2815	27589	2001	N	NS–4.99	734	5412a		14.9	11.6–18.9	419	327–533	Moderate
Philippines	11027	86264	2003	N	0.50–4.99	3544	5452		40.1	37.8–42.4	4422	4173–4675	Severe
Poland	1765	38140		R					9.3	0.83–55.6	164	15–982	Mild

Table A3.3 Country estimates of the prevalence of serum retinol <0.70 µmol/l in preschool-age children 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with serum retinol <0.70 µmol/l		Population with VAD (number of individuals) (000)		Public health problem
	0–4.99 yrs (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Portugal	557	10579						GDP ≥ US$ 15000					No public health problem assumed
Qatar	64	821						GDP ≥ US$ 15000					No public health problem assumed
Republic of Korea	2369	48050						GDP ≥ US$ 15000					No public health problem assumed
Republic of Moldova	213	3833		R					25.6	2.8–80.2	55	6–171	Severe
Romania	1058	21532		R					16.3	1.6–69.5	173	17–735	Moderate
Russian Federation	7195	143221		R					14.1	1.4–65.8	1017	100–4731	Moderate
Rwanda	1617	9464	1996	N	0.00–6.07	423	2558		6.4	3.8–10.6	103	61–171	Mild
Saint Kitts and Nevis	5	50		R					7.1	0.54–51.7	0	0–2	Mild
Saint Lucia	15	163		R					11.3	1.2–58.1	2	0–9	Moderate
Saint Vincent and the Grenadines	12	120	1997	N	1.00–4.99	174	3758	Prevalence predicted based on prevalence <0.87 µmol/l and SD of 0.35 µmol/l	2.1	0.49–8.5	0	0–1	Mild
Samoa	25	185		R					16.1	1.8–67.3	4	0–17	Moderate
San Marino	1	31						GDP ≥ US$ 15000					No public health problem assumed
Sao Tome and Principe	23	155	1999	S	1.00–5.99	252	5803	Survey covers 62.7% of population	95.6	90.3–98.1	22	21–23	Severe
Saudi Arabia	2879	24175		R					3.6	0.23–38.5	104	6–1108	Mild
Senegal	1913	12072		R					37.0	5.3–86.1	707	101–1647	Severe
Serbia	605	9851		R					17.2	1.8–70.0	104	11–423	Moderate
Seychelles	6	86		R					8.0	0.70–51.7	1	0–3	Mild
Sierra Leone	999	5743		R					74.8	19.2–97.4	747	192–973	Severe
Singapore	207	4382						GDP ≥ US$ 15000					No public health problem assumed
Slovakia	259	5388		R					8.3	0.71–53.4	21	2–138	Mild
Slovenia	89	2001						GDP ≥ US$ 15000					No public health problem assumed
Solomon Islands	70	484		R					13.1	1.3–63.6	9	1–44	Moderate
Somalia	1507	8445		R					61.7	12.5–94.8	930	188–1429	Severe
South Africa	5254	48282		R					16.9	1.8–69.0	890	96–3624	Moderate
Spain	2268	43887						GDP ≥ US$ 15000					No public health problem assumed
Sri Lanka	1483	19207	1996	N	0.50–5.99	1750	2716	Survey excluded northern & eastern provinces	35.3	32.3–38.5	524	478–571	Severe
Sudan	5483	37707		R					27.8	3.5–80.2	1523	193–4396	Severe
Suriname	45	455		R					18.0	2.0–70.1	8	1–31	Moderate
Swaziland	147	1134		R					44.6	6.6–90.3	66	10–133	Severe
Sweden	499	9078						GDP ≥ US$ 15000					No public health problem assumed
Switzerland	362	7455						GDP ≥ US$ 15000					No public health problem assumed
Syrian Arab Republic	2500	19408		R					12.1	1.2–60.8	302	30–1520	Moderate

Table A3.3 Country estimates of the prevalence of serum retinol <0.70 µmol/l in preschool-age children 1995-2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with serum retinol <0.70 µmol/l		Population with VAD (number of individuals) (000)		Public health problem
	0-4.99 yrs (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Tajikistan	858	6640	2002	F	0.50-5.07	500	5718	Survey covers 35.1% of population	26.8	21.7-32.6	230	186-280	Severe
Thailand	4514	63444		R					15.7	1.7-66.5	708	77-3002	Moderate
The former Yugoslav Republic of Macedonia	117	2036	1999	N	0.50-4.99	939	1609		29.7	25.7-34.0	35	30-40	Severe
Timor-Leste	190	1114		R					45.8	6.9-90.6	87	13-172	Severe
Togo	1045	6410		R					35.0	4.8-85.3	366	50-892	Severe
Tonga	12	100		R					17.0	1.8-69.1	2	0-8	Moderate
Trinidad and Tobago	93	1328		R					7.2	0.55-52.2	7	1-49	Mild
Tunisia	823	10215		R					14.6	1.6-64.5	120	13-531	Moderate
Turkey	6630	73922		R					12.4	1.3-60.5	824	86-4011	Moderate
Turkmenistan	491	4899		R					28.0	3.5-80.5	137	17-396	Severe
Tuvalu	1	10		R					21.8	2.5-75.0	0	0-1	Severe
Uganda	5840	29899	2001	N	0.50-4.99	859	3207	Not all districts covered due to security	27.9	23.9-32.3	1629	1394-1888	Severe
Ukraine	2001	46557		R					23.8	2.5-79.5	476	49-1591	Severe
United Arab Emirates	315	4248						GDP ≥ US$ 15000					No public health problem assumed
United Kingdom of Great Britain and Northern Ireland	3467	60512						GDP ≥ US$ 15000					No public health problem assumed
United Republic of Tanzania	6953	39459	1997	N	0.50-5.99	853	5738		24.2	20.4-28.5	1683	1416-1981	Severe
United States of America	20776	302841						GDP ≥ US$ 15000					No public health problem assumed
Uruguay	254	3331		R					11.9	1.2-59.5	30	3-151	Moderate
Uzbekistan	2861	26981	2002	F	0.50-4.99	633	4950	Survey covered 10.9% of population	53.1	47.6-58.5	1519	1361-1675	Severe
Vanuatu	31	221		R					16.1	1.7-67.3	5	1-21	Moderate
Venezuela	2880	27191		R					9.4	0.94-53.2	271	27-1533	Mild
Viet Nam	8101	86206	2001	F	0.00-5.07	1657	5813	Survey covers 65.3% of population	12.0	10.1-14.2	972	820-1149	Moderate
Yemen	3639	21732		R					27.0	3.3-80.1	984	120-2915	Severe
Zambia	2012	11696	2003	N	0.50-4.99	659	5098		54.1	48.8-59.4	1089	980-1195	Severe
Zimbabwe	1703	13228	1999	N	1.00-5.99	346	2641		35.8	29.0-43.2	610	494-736	Severe

[a] Population figures are based on the 2006 projection from the 2007 revision from the United Nations Population Division.
[b] Level of survey: N=nationally representative, F=surveys at the first administrative level boundary, S=survey at the second administrative level boundary, R=regression-based estimate.
[c] Corresponds to the numerical reference available in the WHO Global Database on Vitamin A Deficiency (http://www.who.int/vmnis/en/).
[d] NS = not specified

Table A3.4 ***Country estimates of the prevalence of serum retinol <0.70 µmol/l in pregnant women 1995–2005***

Member State	Population 2006[a]		Survey Information						Proportion of the population with serum retinol <0.70 µmol/l		Population with VAD (number of individuals) (000)		Public health problem
	Prergnant women (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Afghanistan	1337	26088		R					16.0	2.1–63.0	213	28–842	Moderate
Albania	52	3172		R					1.4	0.1–19.1	1	0–10	No public health problem
Algeria	710	33351		R					21.2	2.5–73.6	151	18–523	Severe
Andorra	1	74						GDP ≥ US$ 15000					No public health problem assumed
Angola	818	16557		R					15.0	2.1–59.1	122	17–484	Moderate
Antigua and Barbuda	2	84		R					2.3	0.3–18.0	0	0–0	Mild
Argentina	696	39134		R					2.0	0.2–16.6	14	2–115	Mild
Armenia	38	3010		R					23.3	2.9–75.5	9	1–28	Severe
Australia	257	20530						GDP ≥ US$ 15000					No public health problem assumed
Austria	77	8327						GDP ≥ US$ 15000					No public health problem assumed
Azerbaijan	138	8406		R					23.2	2.9–75.2	32	4–104	Severe
Bahamas	6	327						GDP ≥ US$ 15000					No public health problem assumed
Bahrain	13	739						GDP ≥ US$ 15000					No public health problem assumed
Bangladesh	3972	155991	1998	N	NS[d]	118	3900	National survey in rural areas	23.7	14.6–36.1	941	579–1435	Severe
Barbados	3	293		R					2.3	0.2–17.8	0	0–1	Mild
Belarus	91	9742		R					2.2	0.2–17.3	2	0–16	Mild
Belgium	109	10430						GDP ≥ US$ 15000					No public health problem assumed
Belize	7	282		R					1.8	0.2–16.5	0	0–1	No public health problem
Benin	369	8760		R					18.0	2.6–64.1	66	10–237	Moderate
Bhutan	12	649		R					17.0	2.4–63.1	2	0–8	Moderate
Bolivia (Plurinational State of)	263	9354		R					1.7	0.1–16.7	4	0–44	No public health problem
Bosnia and Herzegovina	35	3926		R					2.1	0.2–16.6	1	0–6	Mild
Botswana	47	1858		R					19.3	2.6–67.7	9	1–32	Moderate
Brazil	3698	189323		R					2.1	0.2–16.8	77	8–620	Mild
Brunei Darussalam	8	382						GDP ≥ US$ 15000					No public health problem assumed
Bulgaria	68	7693		R					2.2	0.2–17.3	1	0–12	Mild
Burkina Faso	661	14359		R					16.7	2.5–61.2	110	16–405	Moderate
Burundi	410	8173		R					12.2	1.2–61.0	50	5–250	Moderate
Cambodia	386	14197		R					16.5	2.2–63.0	64	9–243	Moderate
Cameroon	647	18175		R					17.9	2.6–63.9	116	17–413	Moderate
Canada	341	32577						GDP ≥ US$ 15000					No public health problem assumed
Cape Verde	16	519		R					21.2	2.5–73.8	3	0–11	Severe
Central African Republic	159	4265	1999	N	15.00–49.99	303	1722		16.8	11.7–23.6	27	19–37	Moderate

Table A3.4 Country estimates of the prevalence of serum retinol <0.70 µmol/l in pregnant women 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with serum retinol <0.70 µmol/l		Population with VAD (number of individuals) (000)		Public health problem
	Prergnant women (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Chad	497	10468		R					17.1	2.5–62.1	85	13–309	Moderate
Chile	251	16465		R					2.4	0.3–18.5	6	1–47	Mild
China	17459	1328474		R					22.8	2.9–74.2	3981	514–12957	Severe
Colombia	869	45558		R					2.0	0.2–16.5	17	2–143	Mild
Comoros	28	818		R					15.1	2.1–59.2	4	1–17	Moderate
Congo	134	3689		R					18.2	2.6–64.6	24	4–86	Moderate
Cook Islands	0	14		R					2.2	0.2–17.4	0	0–0	Mild
Costa Rica	80	4399		R					2.2	0.2–17.1	2	0–14	Mild
Côte d'Ivoire	688	18914		R					19.0	2.7–66.9	131	18–460	Moderate
Croatia	41	4556		R					2.4	0.3–18.7	1	0–8	Mild
Cuba	116	11267		R					2.3	0.2–17.9	3	0–21	Mild
Cyprus	10	846						GDP ≥ US$ 15000					No public health problem assumed
Czech Republic	93	10189		R					2.3	0.3–18.0	2	0–17	Mild
Democratic People's Republic of Korea	315	23708		R					17.8	2.6–63.8	56	8–201	Moderate
		3166	60644		R					16.1	2.4–60.3	510	75–1910
Moderate													
Denmark	61	5430						GDP ≥ US$ 15000					No public health problem assumed
Djibouti	24	819		R					18.2	2.6–64.6	4	1–16	Moderate
Dominica	1	68	1997	N	15.00–NS	151	3758	Prevlance predicted based on mean and SD	1.8	0.3–9.1	0	0–0	No public health problem
Dominican Republic	231	9615		R					2.2	0.2–17.6	5	1–41	Mild
Ecuador	282	13202		R					1.7	0.1–16.7	5	0–47	No public health problem
Egypt	1845	74166		R					21.5	2.5–74.5	397	46–1375	Severe
El Salvador	158	6762		R					1.7	0.2–16.5	3	0–26	No public health problem
Equatorial Guinea	20	496		R					16.5	2.4–60.9	3	0–12	Moderate
Eritrea	193	4692		R					15.7	2.3–59.8	30	4–116	Moderate
Estonia	14	1340		R					2.4	0.3–19.2	0	0–3	Mild
Ethiopia	3222	81021		R					13.2	1.5–59.6	424	50–1919	Moderate
Fiji	18	833		R					2.3	0.2–17.7	0	0–3	Mild
Finland	59	5261						GDP ≥ US$ 15000					No public health problem assumed
France	756	61330						GDP ≥ US$ 15000					No public health problem assumed
Gabon	35	1311		R					20.0	2.6–69.8	7	1–24	Severe
Gambia	60	1663	1999	N	NS	315	2806		34.0	27.0–41.7	21	16–25	Severe
Georgia	47	4433		R					23.6	2.9–76.3	11	1–36	Severe
Germany	675	82641						GDP ≥ US$ 15000					No public health problem assumed
Ghana	703	23008		R					18.1	2.6–64.4	127	18–453	Moderate
Greece	103	11123						GDP ≥ US$ 15000					No public health problem assumed
Grenada	2	106		R					2.3	0.3–18.0	0	0–0	Mild

Table A3.4 Country estimates of the prevalence of serum retinol <0.70 µmol/l in pregnant women 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with serum retinol <0.70 µmol/l		Population with VAD (number of individuals) (000)		Public health problem
	Prergnant women (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Guatemala	450	13029		R					1.1	0.0–24.8	5	0–112	No public health problem
Guinea	378	9181		R					18.8	2.7–66.2	71	10–250	Moderate
Guinea-Bissau	86	1646		R					18.0	2.6–64.2	15	2–55	Moderate
Guyana	13	739	1997	N	15.00–NS	282	3758	Prevalence predicted based on prevalence <0.87 µmol/l and SD of 0.35 µmol/l	1.0	0.2–5.0	0	0–1	No public health problem
Haiti	270	9446		R					2.0	0.2–16.5	5	1–44	Mild
Honduras	200	6969		R					1.5	0.1–18.1	3	0–36	No public health problem
Hungary	93	10058		R					2.2	0.2–17.6	2	0–16	Mild
Iceland	4	298						GDP ≥ US$ 15000					No public health problem assumed
India	27077	1151751		R					16.4	2.2–63.0	4438	599–17046	Moderate
Indonesia	4360	228864		R					17.1	2.4–63.3	748	106–2758	Moderate
Iran (Islamic Republic of)	1462	70270	2001	N	NS	4368	5379		15.2	13.8–16.8	222	201–245	Moderate
Iraq	931	28506		R					21.0	3.0–69.7	196	28–649	Severe
Ireland	67	4221						GDP ≥ US$ 15000					No public health problem assumed
Israel	137	6810						GDP ≥ US$ 15000					No public health problem assumed
Italy	539	58779						GDP ≥ US$ 15000					No public health problem assumed
Jamaica	54	2699	1998	N	15.00–NS	3251	3093	Prevalence predicted based on mean and SD	14.4	12.8–16.2	8	7–9	Moderate
Japan	1062	127953						GDP ≥ US$ 15000					No public health problem assumed
Jordan	155	5729		R					24.2	2.8–77.9	38	4–121	Severe
Kazakhstan	305	15314		R					23.6	2.9–76.3	72	9–233	Severe
Kenya	1496	36553		R					17.3	2.6–62.5	259	38–935	Moderate
Kiribati	2	94		R					1.5	0.1–18.1	0	0–0	No public health problem
Kuwait	52	2779						GDP ≥ US$ 15000					No public health problem assumed
Kyrgyzstan	117	5259		R					20.1	2.9–67.5	23	3–79	Severe
Lao People's Democratic Republic	159	5759		R					16.6	2.3–63.0	26	4–100	Moderate
Latvia	21	2289		R					2.4	0.3–19.2	1	0–4	Mild
Lebanon	75	4055		R					23.5	2.9–76.0	18	2–57	Severe
Lesotho	58	1995		R					14.7	2.0–59.0	9	1–34	Moderate
Liberia	192	3579	1999	N	14.00–49.99	188	1242		12.0	6.8–20.3	23	13–39	Moderate
Libyan Arab Jamahiriya	146	6039		R					21.7	2.5–75.1	32	4–109	Severe
Lithuania	31	3408		R					2.4	0.3–19.2	1	0–6	Mild
Luxembourg	5	461						GDP ≥ US$ 15000					No public health problem assumed
Madagascar	726	19159		R					13.8	1.7–59.1	100	13–429	Moderate

Table A3.4 Country estimates of the prevalence of serum retinol <0.70 µmol/l in pregnant women 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with serum retinol <0.70 µmol/l		Population with VAD (number of individuals) (000)		Public health problem
	Prergnant women (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Malawi	575	13571		R					13.7	1.7–59.2	79	10–341	Moderate
Malaysia	553	26114		R					22.2	3.0–72.6	123	16–401	Severe
Maldives	7	300		R					19.9	2.9–67.1	1	0–5	Moderate
Mali	604	11968		R					16.7	2.5–61.3	101	15–370	Moderate
Malta	4	405		R					2.4	0.3–19.2	0	0–1	Mild
Marshall Islands	1	58		R					2.2	0.2–17.4	0	0–0	Mild
Mauritania	103	3044		R					17.1	2.5–62.1	18	3–64	Moderate
Mauritius	19	1252		R					22.5	2.4–77.5	4	0–15	Severe
Mexico	2075	105342		R					1.9	0.2–16.3	40	4–339	No public health problem
Micronesia (Federated States of)	3	111		R					2.2	0.2–17.4	0	0–1	Mild
Monaco	0	33						GDP ≥ US$ 15000					No public health problem assumed
Mongolia	49	2605	2002	F	16.00–50.99	139	5768	Survey covers 49.3% of population	19.3	11.6–30.3	9	6–15	Moderate
Montenegro	8	601		R					2.2	0.2–17.3	0	0–1	Mild
Morocco	646	30853		R					20.9	2.6–72.6	135	17–469	Severe
Mozambique	852	20971	2002	N	NS	70	589		14.3	6.1–30.1	122	52–256	Moderate
Myanmar	892	48379		R					18.0	2.6–64.0	161	24–571	Moderate
Namibia	54	2047		R					19.2	2.7–67.5	10	1–36	Moderate
Nauru	0	10		R					2.2	0.2–17.4	0	0–0	Mild
Nepal	800	27641	1998	N	15.00–49.99	89	1083		31.5	19.6–46.4	252	157–371	Severe
Netherlands	182	16379						GDP ≥ US$ 15000					No public health problem assumed
New Zealand	57	4140						GDP ≥ US$ 15000					No public health problem assumed
Nicaragua	140	5532		R					1.7	0.2–16.6	2	0–23	No public health problem
Niger	711	13737		R					14.7	2.0–59.0	104	14–420	Moderate
Nigeria	5975	144720	2001	N	NS	684	4581		1.7	0.8–3.8	102	45–226	No public health problem
Niue	0	2		R					2.2	0.2–17.4	0	0–0	Mild
Norway	56	4669						GDP ≥ US$ 15000					No public health problem assumed
Oman	58	2546		R					23.5	2.9–76.0	14	2–44	Severe
Pakistan	4515	160943	2001	N	15.00–49.99	100	4640		10.0	4.2–21.9	451	191–987	Moderate
Palau	0	20		R					2.3	0.3–18.2	0	0–0	Mild
Panama	70	3288		R					1.8	0.2–16.4	1	0–11	No public health problem
Papua New Guinea	189	6202		R					1.2	0.0–22.7	2	0–43	No public health problem
Paraguay	153	6016		R					2.0	0.2–16.4	3	0–25	Mild
Peru	586	27589		R					1.7	0.2–16.6	10	1–97	No public health problem
Philippines	2292	86264	2003	N	NS	582	5452		17.5	13.6–22.3	401	311–511	Moderate
Poland	362	38140		R					2.2	0.2–17.3	8	1–63	Mild
Portugal	112	10579						GDP ≥ US$ 15000					No public health problem assumed

Table A3.4 Country estimates of the prevalence of serum retinol <0.70 µmol/l in pregnant women 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with serum retinol <0.70 µmol/l		Population with VAD (number of individuals) (000)		Public health problem
	Prergnant women (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
Qatar	14	821						GDP ≥ US$ 15000					No public health problem assumed
Republic of Korea	449	48050						GDP ≥ US$ 15000					No public health problem assumed
Republic of Moldova	43	3833		R					2.2	0.2–17.3	1	0–7	Mild
Romania	210	21532		R					2.0	0.2–16.6	4	0–35	Mild
Russian Federation	1518	143221		R					2.2	0.2–17.3	33	4–263	Mild
Rwanda	441	9464	1996	N	NS	161	2558		6.2	2.6–14.0	27	11–62	Mild
Saint Kitts and Nevis	1	50		R					2.3	0.3–18.0	0	0–0	Mild
Saint Lucia	3	163		R					2.2	0.2–17.4	0	0–1	Mild
Saint Vincent and the Grenadines	2	120	1997	N	15.00–NS	81	3758	Prevalence predicted based on prevalence <0.87 µmol/l and SD of 0.35 µmol/l	0.7	0.0–22.1	0	0–1	No public health problem
Samoa	5	185		R					2.2	0.2–17.1	0	0–1	Mild
San Marino	0	31						GDP ≥ US$ 15000					No public health problem assumed
Sao Tome and Principe	5	155		R					17.9	2.6–64.0	1	0–3	Moderate
Saudi Arabia	622	24175		R					22.5	3.0–73.4	140	18–456	Severe
Senegal	441	12072		R					19.4	2.6–67.9	85	12–300	Moderate
Serbia	127	9851		R					2.2	0.2–17.3	3	0–22	Mild
Seychelles	4	86		R					24.2	2.1–82.4	1	0–3	Severe
Sierra Leone	272	5743		R					17.6	2.6–63.1	48	7–171	Moderate
Singapore	36	4382						GDP ≥ US$ 15000					No public health problem assumed
Slovakia	54	5388		R					2.2	0.2–17.3	1	0–9	Mild
Slovenia	18	2001						GDP ≥ US$ 15000					No public health problem assumed
Solomon Islands	15	484		R					1.5	0.1–17.8	0	0–3	No public health problem
Somalia	379	8445		R					18.8	2.7–66.3	71	10–252	Moderate
South Africa	1086	48282		R					18.9	2.7–66.6	205	29–723	Moderate
Spain	480	43887						GDP ≥ US$ 15000					No public health problem assumed
Sri Lanka	291	19207		R					22.7	2.9–74.0	66	9–215	Severe
Sudan	1232	37707		R					16.1	2.4–60.3	198	29–743	Moderate
Suriname	9	455		R					2.1	0.2–16.7	0	0–1	Mild
Swaziland	33	1134		R					17.7	2.6–63.5	6	1–21	Moderate
Sweden	103	9078						GDP ≥ US$ 15000					No public health problem assumed
Switzerland	69	7455						GDP ≥ US$ 15000					No public health problem assumed
Syrian Arab Republic	539	19408		R					21.8	3.0–71.7	118	16–386	Severe
Tajikistan	186	6640		R					18.0	2.6–64.0	33	5–119	Moderate
Thailand	932	63444	2003	N	15.00–44.99	241	5848		1.7	0.4–6.4	16	4–60	No public health problem

Table A3.4 Country estimates of the prevalence of serum retinol <0.70 µmol/l in pregnant women 1995–2005

Member State	Population 2006[a]		Survey Information						Proportion of the population with serum retinol <0.70 µmol/l		Population with VAD (number of individuals) (000)		Public health problem
	Prergnant women (000)	General (000)	Date of survey (years)	Level of survey[b]	Age range (years)	Sample Size	Reference[c]	Notes	Estimate	95% CI	Estimate	95% CI	
The former Yugoslav Republic of Macedonia	22	2036		R					2.1	0.2–16.9	0	0–4	Mild
Timor-Leste	49	1114		R					15.4	1.9–63.2	8	1–31	Moderate
Togo	246	6410		R					19.9	2.6–69.5	49	6–171	Moderate
Tonga	3	100		R					2.3	0.3–18.4	0	0–0	Mild
Trinidad and Tobago	20	1328		R					2.3	0.3–18.1	0	0–4	Mild
Tunisia	174	10215		R					22.5	2.4–77.5	39	4–135	Severe
Turkey	1388	73922		R					22.8	2.9–74.2	317	41–1030	Severe
Turkmenistan	109	4899		R					20.7	3.0–68.9	23	3–75	Severe
Tuvalu	0	10		R					2.2	0.2–17.4	0	0–0	Mild
Uganda	1467	29899	2001	N	15.00–49.99	118	3207	Not all districts covered due to security	23.3	14.2–35.7	342	209–524	Severe
Ukraine	423	46557		R					2.3	0.2–17.7	10	1–75	Mild
United Arab Emirates	72	4248						GDP ≥ US$ 15000					No public health problem assumed
United Kingdom of Great Britain and Northern Ireland	728	60512						GDP ≥ US$ 15000					No public health problem assumed
United Republic of Tanzania	1601	39459		R					14.8	2.0–59.1	237	33–946	Moderate
United States of America	4298	302841						GDP ≥ US$ 15000					No public health problem assumed
Uruguay	51	3331		R					2.1	0.2–16.8	1	0–8	Mild
Uzbekistan	623	26981		R					21.0	3.0–69.6	131	19–434	Severe
Vanuatu	7	221		R					1.7	0.2–16.6	0	0–1	No public health problem
Venezuela	598	27191		R					2.0	0.2–16.5	12	1–99	Mild
Viet Nam	1650	86206		R					17.7	2.6–63.7	292	42–1051	Moderate
Yemen	872	21732		R					15.8	2.0–63.0	138	18–549	Moderate
Zambia	473	11696		R					14.0	1.8–59.0	66	9–279	Moderate
Zimbabwe	374	13228	1999	N	15.00–49.99	NS	2641	Sample size for all women = 804	20.0	11.1–33.3	75	42–125	Severe

[a] Population figures are based on the 2006 projection from the 2007 revision from the United Nations Population Division.
[b] Level of survey: N=nationally representative, F=surveys at the first administrative level boundary, S=survey at the second administrative level boundary, R=regression-based estimate.
[c] Corresponds to the numerical reference available in the WHO Global Database on Vitamin A Deficiency (http://www.who.int/vmnis/en/).
[d] NS = not specified

ANNEX 4

Country references

Afghanistan

Afghanistan MICS2 Steering Committee et al. *2000 Afghanistan Multiple Indicator Cluster Survey (MICS2), Vol. 1: Situation Analysis of Children and Women in the East of Afghanistan*. United Nations Children's Fund, 2001. *Ref 3302*.

Angola

Ministry of Health et al. *Assessing vitamin A and iron deficiency anaemia, nutritional anaemia among children aged 0–60 months in the Republic of Angola [technical report]*. Ministry of Health, 2000. *Ref 2839*.

Antigua and Barbuda

Micronutrient Working Group. Iron and vitamin A status in five Caribbean countries. *Cajanus*, 2002, 35 (1): 4–34. *Ref 3758*.

Argentina

Ministerio de Salud, Plan Federal de Salud. Encuesta Nacional de Nutrición y Salud (ENNyS) [Nacional Nutrition and Health Survey]. Ministerio de Salud, Argentina, 2007. *Ref 5837*.

Armenia

Branca F, Napoletano A, Coclite D, Rossi L. The health and nutritional status of children and women in Armenia. Rome, National Institute of Nutrition, 1988. *Ref 3329*.

National Statistical Service, et al. *Armenia Demographic and Health Survey 2005*. Calverton, MD, ORC Macro, 2006. *Ref 5804*.

Bangladesh

Institute of Public Health Nutrition. *Vitamin A status throughout the lifecycle in rural Bangladesh: National Vitamin A Survey 1997–98*. Dhaka, Helen Keller International, 1999. *Ref 3900*.

Institute of Public Health. *Bangladesh in Facts and Figures: 2005 Annual Report of the Nutritional Surveillance Project*. Dhaka, Helen Keller International, 2006. *Ref 5473*.

National Institute of Population Research and Training (NIPORT), et al. *Bangladesh Demographic and Health Survey 2004*. Calverton, MD, ORC Macro, 2005. *Ref 5206*.

Benin

Institut National de la Statistique et de l'Analyse Économique et al. *Enquête Démographique et de Santé au Bénin*, 2001. Calverton, MD, Institut National de la Statistique et de l'Analyse Économique et ORC Macro, 2002. *Ref 3461*.

République du Benin, Ministère de la Sante Publique, Direction de la Sante Familiale, UNICEF, USAID. *Enquête Nationale sur la Carence en Vitamine A et la Disponibilité en Sel Iode dans les Ménages. Rapport de l'Enquête Familiale. 2000. Ref 5797*.

Bhutan

Pem N, Gyeltshen K, Tenzin N. *Report of a survey for vitamin A deficiency in children under Five and pregnant women in Bhutan*. Bhutan Ministry of Health, 2000. *Ref 2715*.

Bolivia (Plurinational State of)

Gutiérrez Sardán M et al. *Bolivia Encuesta Nacional de Demografía y Salud 2003 [Bolivia National Demographic and Health Survey 2003]*. La Paz, Ministerio de Salud y Deportes, Instituto Nacional de Estadística, 2004. *Ref 5095*.

Burkina Faso

Institut National de la Statistique et de la Démographie [Burkina Faso] et al. *Burkina Faso Enquête Démographique et de Santé 2003 [Burkina Faso Demographic and Health Survey 2003]*. Calverton, MD, ORC Macro, 2004. *Ref 4948*.

Projet de Développement Santé et Nutrition. *Enquête Épidémiologique sur les Carences en Micronutriments dans 15 Provinces*. Centre National Pour la Nutrition, Ministère de la Santé, Burkina Faso, 1997. *Ref 5801*.

Burundi

Rapport de l'Enquête Nationale de Nutrition de la Population, 2005. Ministère de la Santé Publique, République du Burundi, 2006. *Ref 5748*.

Cambodia

Hix J, Rasca P, Morgan J, Denna S, Panagides D, Tam M, Shankar AH. Validation of a rapid enzyme immunoassay for the quantitation of retinol-binding protein to assess vitamin A status within populations. E*uropean Journal of Clinical Nutrition*, 2006, 60(1):1299–1303. *Ref 5761*.

Semba RD, de Pee S, Panagides D, Poly O, Bloem MW. Risk factors for xerophthalmia among mothers and their children and for mother–child pairs with xerophthalmia in Cambodia. *Archives of Ophthalmology*, 2004, 122(4):517–523. *Ref 5021*.

National Institute of Public Health, National Institute of Statistics, MEASURE DHS ORC Macro. Cambodia Demographic and Health Survey 2005. Calverton, MD, ORC Macro, 2006. *Ref 5646*.

Cameroon

Institut National de la Statistique et al. *Enquête Démographique et de Santé: Cameroon 2004. [Demographic Health Survey: Cameroon 2004]*. Calverton, MD, ORC Macro, 2005. *Ref 5214*.

Ministère de la Santé Publique, UNICEF-Cameroun. *Enquête Nationale sur la Carence en Vitamine A et l'Anémie au Cameroun, 2000*. 2001. *Ref 3470*.

Cape Verde

Ministério da Saúde e Promoção Social, Fundo das Nações Unidas para a Infância. *Caracterização Deficiência de Vitamina "A" e da Anemia em Crianças Pré-escolares de Cabo Verde*, 1997. *Ref 5630*.

Central African Republic

Ministere Delegue a l'Economie au Plan et a la Cooperation Internationale et al. *Enquête nationale sur l'avitaminose A, la carence en fer et la consommation du sel iode*. Republique Centrafricaine, 2000. *Ref 1722*.

Chad

Mildon A. *Vitamin A Add-On Program – Final Survey and Program Report, December 2005*. World Vision Canada, 2005. *Ref 5102*.

China

Jingxiong J, Toschke AM, von Kries R, Koletzko B, Liangming L. Vitamin A status among children in China. *Public Health Nutrition*, 2006, 9(8):955–960. *Ref 5788*.

Colombia

National Survey on the Nutritional Situation (ENSIN), Colombia 2005, Protocol – Executive Summary. Bogota, Instituto Colombia de Bienestar Familiar, 2005. Ref 5773.

Congo (The)

Samba C, Tchibindat F, Houze P, Gourmel B, Malvy D. Prevalence of infant Vitamin A deficiency and undernutrition in the Republic of Congo. *Acta Tropica*, 97(3):270–83, 2006. *Ref 5631*.

Centre National de la Statistique et des Études Économiques (CNSEE), et al. *Enquête Démographique et de Santé du Congo. [Demographic Health Survey of Congo, 2005]*. Calverton, MD, ORC Macro, 2006. *Ref 5733*.

Costa Rica

Carvajal Fernandez D, Alfaro Calvo T, Monge-Rojas R. Deficiencia de vitamina A en niños preescolares: un problema re-emergente en Costa Rica? [Vitamin A deficiency among preschool children: a re-emerging problem in Costa Rica?]. *Archivos Latinoamericanos de Nutrición*, 2003, 53(3):267–270. *Ref 4227*.

Côte d'Ivoire

Asobayire FS. *Development of a food fortification strategy to combat iron deficiency in the Ivory Coast* [dissertation]. Zurich, Swiss Federal Institute of Technology, 2000. *Ref 1986*.

Cuba

Matos CM, Rodríguez GP, Gutiérrez PM, Jiménez EA, Ramos Mesa MA. Estado nutricional de la vitamina A en niños Cubanos de 6 a 24 meses de edad. *Revista Cubana de Alimentación y Nutrición*, 2002, 16(2):95–104. *Ref 3224*.

Democratic Republic of the Congo

Ministère de la Santé Publique. *Importance de la carence en vitamine A en Republique Democratique du Congo*, 2000. *Ref 5800*.

Dominica

Micronutrient Working Group. Iron and vitamin A status in five Caribbean countries. *Cajanus*, 2002, 35 (1):4–34. *Ref 3758*.

Dominican Republic

Achécar MM, Ramírez N, Polanco JJ, Ochoa LH, Lerebours G, Garcia B. República Dominicana; Encuesta demográfica y de salud (ENDESA 2002). Calverton, MD, ORC Macro, 2002. *Ref 4739*.

Egypt

Nutrition Institute. *National Survey for Assessment of Vitamin "A" Status in Egypt*. United Nations Children's Fund, Cairo, Egypt, 1995. *Ref 103*.

Eritrea

National Statistics and Evaluation Office, et al. *Demographic and Health Survey, Eritrea 2002*. Calverton, MD, ORC Macro, 2003. *Ref 4639*.

Ethiopia

Haidar J, Demissie T. Malnutrition and xerophthalmia in rural communities of Ethiopia. *East African Medical Journal*, 1999, 76(10):590–593. *Ref 1910*.

MacDonald C. *World Vision Ethiopia MICAH Program – Final Evaluation Report*. World Vision Canada, 2006. *Ref 5639c*.

Central Statistical Agency, et al. *Ethiopia Demographic and Health Survey, 2005*. Calverton, MD, ORC Macro, 2006. *Ref 5694*.

Gabon

Ministère de la Planification de la Programmation du Développement et de l'Aménagement du Territoire, et al. Enquête Démographique de Santé Gabon 2000 [Demographic and Health Survey Gabon 2000]. Calverton, MD, ORC Macro, 2001. *Ref 5100*.

Gambia

Bah A et al. *Nationwide survey on the prevalence of vitamin A and iron deficiency in women and children in the Gambia*. Banjul, National Nutrition Agency, 2001. *Ref 2806*.

Ghana

Ghana Statistical Service (GSS) et al. *Ghana Demographic and Health Survey 2003*. Calverton, MD, ORC Macro, 2004. *Ref 4943*.

Quarshie K, Amoaful E. *Proceedings of the workshop on dissemination of findings of vitamin A and anaemia prevalence surveys*. Accra, Ghana, 1998. *Ref 3004*.

David P. *Evaluating the Vitamin A Supplementation Programme in Northern Ghana: Has it Contributed to Improved Child Survival?* The Micronutrient Initiative, 2003. *Ref 5099*.

MICAH Ghana Follow-Up Survey Report. World Vision Ghana, 2000. *Ref 5104b*.

Guatemala

Encuesta Nacional de Micronutrientes. Guatemala City, Ministerio de Salud Publica y Asistencia Social, 1996. *Ref 3091*.

Guinea

Direction Nationale de la Statistique (DNS) (Guinée). *Enquête Démographique et de Santé Guinée 2005* [Demographic and Health Survey Guinea 2005]. Calverton, MD, ORC Macro, 2006. *Ref 5726*.

Guyana

Micronutrient Working Group. Iron and vitamin A status in five Caribbean countries. *Cajanus*, 2002, 35 (1): 4–34. *Ref 3758*.

Haiti

République d'Haïti et al. *Enquête Mortalité, Morbidité et Utilisation des Services EMMUS-III Haïti 2000*. République d'Haïti, 2001. *Ref 3264*.

Ministère de la Sante Publique et de la Population et al. *Enquête sur la prévalence de la carence en vitamine A et de la déficience end iode end Haïti*. L'institut Haitien de l'Enfance, 2005. *Ref 5353*.

Honduras

Ministerio de Salud Pública et al. *Encuesta Nacional de Micronutrientes Honduras, 1996*. Tegucigalpa, Secretaria de Salud, Ministerio de Salud Pública, 1997. R*ef 3095*.

Secretaría de Salud [Honduras], Instituto Nacional de Estadística (INE), Macro International. Encuesta Nacional de Salud y Demografía 2005–2006. Calverton, MD, ORC Macro, 2006. *Ref 5799*.

India

Department of Women & Child Development, UNICEF. Multiple Indicator Survey – 2000 (MICS – 2000) India [summary report]. UNICEF, 2001. *Ref 4534*.

International Institute for Population Sciences et al. *National Family Health Survey (NFHS-2), 1998–1999: India*. Mumbai, International Institute for Population Sciences, 2000. *Ref 2972*.

International Institute for Population Sciences et al. *National Family Health Survey (NFHS-2), India, 1998–1999, Northeastern States: Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura*. Mumbai, International Institute for Population Sciences, 2002. *Ref 3780a*.

National Nutrition Monitoring Bureau. *NNMB Technical Report No. 22: Prevalence of Micronutrient Deficiencies*. Hyderabad, National Institute of Nutrition, Indian Council of Medical Research, 2003. *Ref 5839*.

National Institute of Nutrition et al. *Annual Report 2005–2006*. Hyderabad, Indian Council of Medical Research, 2006. *Ref 5840*.

Indonesia

Statistics [Indonesia], National Family Planning Coordinating Board, Ministry of Health, ORC Marco. Indonesia Demographic and Health Survey 2002–2003. Calverton, MD, ORC Macro, 2003. *Ref 4538*.

Iran (Islamic Republic of)

Medical University et al. *An Investigation of Under-nutrition in Iran Year 1380 (2001)*. Islamic Republic of Iran, Ministry of Health and Medical Education, 2006. *Ref 5379*.

Jamaica

WHO/PAHO et al. *Micronutrient study report: an assessment of the vitamin A, E, beta-carotene, and iron status in Jamaica*. Kingston, WHO, Pan American Health Organization, Caribbean Food and Nutrition Institute, 1998 (PAHO/CFNI/98.J1). *Ref 3093*.

Jordan

Ministry of Health Jordan et al. *National baseline survey on iron deficiency anemia and vitamin A deficiency*. Amman, Ministry of Health, 2002. *Ref 4382*.

Kazakhstan

Kazakh Academy of Nutrition, et al. *Estimation of vitamin A deficiency prevalence in Kazakhstan*. UNICEF [Central Asian Republics and Kazakhstan], 2002. *Ref 5675*.

Kenya

Mwaniki DL et al. *Anaemia and status of iron, vitamin A and zinc in Kenya. The 1999 National Survey*. Nairobi, Ministry of Health, 2002. *Ref 3442*.

Lao People's Democratic Republic

Ministry of Health, Lao People's Democratic Republic. *Report on national health survey: health status of the People of LAO PDR*. Vientiane, Ministry of Health, 2001. *Ref 770*.

Lesotho

Ministry of Health and Social Welfare et al. *Lesotho Demographic and Health Survey 2004*. Calverton, MD, ORC Macro, 2005. *Ref 5356*.

Liberia

Mulder-Sibanda M et al. *National Micronutrient Survey. A national prevalence study on vitamin A deficiency, iron deficiency anemia, iodine deficiency*. Monrovia, Ministry of Health and Social Welfare, Family Health Division, United Nations Children's Fund, 1999. *Ref 1242*.

Madagascar

Institut National de la Statistique et al. *Enquête Démographique et de Santé de Madagascar 2003–2004*. Calverton, MD, ORC Macro, 2005. *Ref 5190*.

Berthine R. *Enquête sur la Carence en Vitamine A Chez les Femmes et les Enfants et Enquête sur l'Anemie Chez les Ecoliers de 6 à 14 Ans, Madagascar 2000*. Most Project, USAID, 2001. *Ref 5090*.

Malawi

National Statistical Office et al. *Malawi Demographic and Health Survey 2004*. Calverton, MD, ORC Macro, 2005. *Ref 5201*.

Ministry of Health, UNICEF. *Malawi Micronutrient Survey 2001*. Ministry of Health, Lilongwe, Malawi, 2003. *Ref 5602*.

Malaysia

Ministry of Health. *A study of malnutrition in under five children in Malaysia*. Kuala Lumpur, Ministry of Health, 1999. *Ref 4394*.

Maldives

Minister of Health, Republic of Maldives. *Multiple Indicator Cluster Survey (MICS 2), Maldives*. Malé, Ministry of Health, 2001. *Ref 2987*.

Mali

Schemann J, Malvy D, Sacko D, Traore L. Trachoma and vitamin A deficiency. *Lancet*, 2001, 357(9269):1676. *Ref 4195*.

Cellule de Planification et de Statistique du Ministère de la Santé (CPS/MS), Direction Nationale de la Statistique et de l'Informatique (DNSI). *Enquête Démographique et de Santé au Mali 2001*. [Mali: Demographic and Health Survey 2001]. Calverton, MD, ORC Macro, 2002. *Ref 3446*.

Marshall Islands

Palafox NA, Gamble MV, Dancheck B, Ricks MO, Briand K, Semba RD. Vitamin A deficiency, iron deficiency, and anemia among preschool children in the Republic of the Marshall Islands. *Nutrition*, 2003, 19(5):405–408. *Ref 3886*.

Mauritius

Ministry of Health Mauritius. *A survey of nutrition in Mauritius and Rodrigues (1995)*. Port Louis, Ministry of Health, 1995. *Ref 395*.

Mexico

Encuesta Nacional de Nutrición 1999. Mexico City, Instituto Nacional de Salud Publica, 1999. *Ref 2997*.

Micronesia (Federated States of)

Kim D, Sowell A. *Vitamin A deficiency among children and caregivers in Chuuk State, Federated States of Micronesia*. Atlanta, Centers for Disease Control and Prevention, 2002. *Ref 5672*.

Socorro P, Gonzaga C. *Results of vitamin A, anemia and blood lead survey among 2–4 year old children and reproductive-aged women in Yap proper and Kosrae State, Federated States of Micronesia*. Atlanta, Centers for Disease Control and Prevention, 2000. *Ref 2548*.

Mongolia

Erdenechimeg E. *Physiologic and hygienic assessment of vitamin A deficiency in children, Mongolia. Mongolia*. Public Health Institute, 2000. *Ref 5767*.

Amardulam N, Erdenechimeg E, Burmaa B, Batdelger SH, Zina P. *Vitamin A deficiency in Mongolia and results of "A" vitaminization*. Moscow, First International Congress on School Hygine, May 12, 2004. *Ref 5768*.

Morocco

Nasri I, El Bouhali B, Aguenaou H, Mokhtar N. Vitamin A deficiency among Moroccan women and children. *African Health Sciences*, 2004, 4:3–8. *Ref 5496*.

Ministère de la Santé, ORC Macro, Projet PAPFAM. *Enquête sur la Population et la Santé Familiale 2003–04*. ORC Macro, 2005. *Ref 5191*.

Mozambique

Ministério da Saúde et al. *Inquérito nacional seovre a deficiência de vitamina A, prevalência de anemia e malária em crianças dos 6–59 meses e respectivas mães*. Maputo, Instituto Nacional de Saúde, 2003. *Ref 589*.

Instituto Nacional de Estatística, Ministério da Saúde. *Moçambique: Inquérito Demográphifico e de Saúde 2003* [Mozambique: Demographic and Health Survey 2003]. Calverton, MD, ORC Macro, 2005. *Ref 5195*.

Myanmar

Zin MM. Report on National Survey of Micronutrients, 2004–2005. Myanmar, Ministry of Health, 2005. *Ref 5685*.

Nepal

Ministry of Health Nepal et al. *Nepal Micronutrient Status Survey 1998*. Kathmandu, Ministry of Health, 1999. *Ref 1083*.

Ministry of Health, New ERA, ORC Macro. *Nepal Demographic and Health Survey 2001*. Calverton, MD, ORC Macro, 2001. *Ref 3321*.

Nicaragua

Gurdián M, Kontorovsky I, Alvarado E, Ramírez SA, Hernández R. *Sistema integrado de vigilancia de intervenciones nutricionales (SIVIN), 2004 [Integrated system of monitoring nutrition interventions (SIVIN), 2004]*. Managua, Ministerio de Salud, 2005. *Ref 5730a*.

Instituto Nacional de Estadísticas y Censos, Ministerio de Salud. *Encuesta Nicaragüense de Demografía y Salud 2001* [Demographic Health Survey Nicaragua 2001]. Calverton, MD, ORC Macro, 2002. *Ref 3460*.

Niger

République du Niger, et al. *Enquête à Indicateurs Multiples de la Fin de la Décennie (MICS)*. United Nations Children's Fund, 2000. *Ref 3392*.

Nigeria

International Institute of Tropical Agriculture (IITA), USAID, UNICEF, USDA. *Nigeria Food Consumption and Nutrition Survey 2001–2003* [summary]. International Institute of Tropical Agriculture, 2004. *Ref 4581*.

Ajose OA, Adelekan DA, Ajewole EO. Vitamin A status of pregnant Nigerian women: relationship to dietary habits and morbidity. *Nutrition and Health*, 2004, 17(4):325–333. *Ref 4764*.

Oman

Ministry of Health of the Sultanate of Oman, UNICEF Muscat, World Health Organization-Eastern Mediterranean Regional Office. *National Micronutrient Status and Fortified Food Coverage Survey, Oman, 2004*. Department of Nutrition, Ministry of Health the Sultanate of Oman, 2006. *Ref 5525*.

Pakistan

Pakistan Institute of Development Economics et al. *National Nutrition Survey 2001–2002*. Islamabad, Government of Pakistan, Planning Commission, 2003. *Ref 4640*.

Panama

Ministerio de Salud, et al. *Encuesta nacional de vitamina A y anemia por deficiencia de hierro [National survey of vitamin A and iron deficiency anemia]*. Panama City, Ministerio de Salud, 2000. *Ref 3097*.

Papua New Guinea

Friesen H, Verma N, Lagani W, Billson F, Saweri W, Earl J. Vitamin A status of children in different provinces in Papua New Guinea. In: *Abstracts of the 34th Annual Symposium of the Medical Society of Papua New Guinea; 1998 Sept 7–11*. Port Moresby, Papua New Guinea Medical Society, 1998. *Ref 4140*.

Peru

Instituto Nacional de Salud, Centro Nacional de Alimentación y Nutrición, Dirección Ejecutiva de Vigilancia Alimentaria y Nutricional. *Informe nacional de deficiencia de vitamina A en niños menores de 5 años y mujeres en edad fértil 1997–2001*. Lima, Ministerio de Salud, 2001. *Ref 5412a*.

Céspedes R, Dácila E, Fort A, Ulloa L, Castro Z. *Perú Encuesta Demográfica y de Salud Familiar ENDES Continua 2004; Informe principal*. Calverton, MD, ORC Macro, 2005. *Ref 5357*.

Philippines

Pedro MRA, Cerdena CM, Molano WL, Constantine A, Perlas LA, Palafox EF, Patalan L, Chavez M, Madriaga J, Castillo E, Barba CVC. *Sixth National Survey 2003*. Manila, Food and Nutrition Research Institute, Department of Science and Technology, 2006. *Ref 5452*.

National Statistics Office, ORC Macro. *Philippines: National Demographic and Health Survey 2003*. Calverton, MD, ORC Macro, 2004. *Ref 5192*.

Republic of Moldova

Moldova Ministry of Health and Social Protection, et al. *Moldova Demographic and Health Survey 2005: Preliminary Report*. Chisinau, Moldova Ministry of Health and Social Protection, 2005. *Ref 5489*.

Rwanda

Ministère de la Santé et al. *National Nutrition Survey of Women and Children in Rwanda in 1996 [final report]*. Kigali, Ministère de la Santé, 1997. *Ref 2558*.

Institut National de la Statistique du Rwanda (INSR), et al. *Rwanda Demographic and Health Survey 2005*. Calverton, MD, ORC Macro, 2006. *Ref 5781*.

St. Vincent and the Grenadines

Micronutrient Working Group. Iron and vitamin A status in five Caribbean countries. *Cajanus*, 2002, 35 (1): 4–34. *Ref 3758*.

Sao Tome and Príncipe

Carvalho A, Sousa L, Costa P, Neto O. *Relatório do Estudo Sobre a Carência de Micronutrientes*. Republica Democrática de São Tome e Príncipe, 2000. *Ref 5803*.

Senegal

Salif N, Ayad M. *Enquête Démographique et de Santé au Sénégal 2005*. Calverton, MD, ORC Macro, 2006. *Ref 5739*.

Sri Lanka

Ministry of Health and Indigenous Medicine, Medical Research Institute. *Vitamin A deficiency status of children in Sri Lanka 1995/1996 [survey report]*. Dehiwela, Ministry of Health and Indigenous Medicine, 1998. *Ref 2716*.

Sudan

Federal Ministry of Health et al. *Comprehensive Nutrition Survey*. Khartoum, Federal Ministry of Health, National Nutrition Department, 1997. *Ref 1443*.

Tajikistan

Avgonov ZT, Gaibov AG, Tazhibaev ShS, Khairov KhS. [Prevalence of vitamin deficiency in Tajik children] *Voprosy Pitaniia*, 2005, 74(4):14–16. *Ref 5718*.

The former Yugoslav Republic of Macedonia

Branca F et al. *Multiple indicator cluster survey in FYR Macedonia with micronutrient component*. Rome, National Institute of Nutrition, 2000. *Ref 1609*.

Thailand

Nutrition Division, Department of Health, Ministry of Public Health. *The 5th National Nutrition Survey of Thailand, 2003*. Thailand, 2003. *Ref 5848*.

Timor-Leste

Ministry of Health Timor-Leste et al. *Timor Leste 2003 Demographic and Health Survey*. Newcastle, Australia, Ministry of Health/University of Newcastle, 2003. *Ref 5050*.

Uganda

Uganda Bureau of Statistics (UBOS) et al. *Uganda Demographic and Health Survey 2000–2001*. Calverton, MD, ORC Macro, 2001. *Ref 3207*.

United Republic of Tanzania

National Bureau of Statistics (NBS) Tanzania et al. *Tanzania Demographic and Health Survey 2004–05*. Dar es Salaam, National Bureau of Statistics, ORC Macro, 2005. *Ref 5221*.

Ballart A, Mugyabyso JKL, Ruhiye DRM, Ndossi GD, Basheke MM. *The National Vitamin A Deficiency Control Programme. A Preliminary Report on the National Vitamin A Survey 1997*. Dar es Salaam, Tanzania Food and Nutrition Centre, 1998 (TFNC Report No: 1880). *Ref 5738*.

Uzbekistan

Analytical and Information Center et al. *Uzbekistan Health Examination Survey 2002*. Calverton, MD, Analytical and Information Center, State Department of Statistics, ORC Macro, 2004. *Ref 4950*.

Viet Nam

Khan NC, Ninh NX, Nhien NV, Khoi HH, West CE, Hautvast JGAJ. Sub clinical vitamin A deficiency and anemia among Vietnamese children less than five years of age. *Asia Pacific Journal of Clinical Nutrition*, 2007, 16(1): 152–157. *Ref 5813*.

National Institute of Nutrition General Statistical Office. *2000 Vietnam-Child and Mother Nutrition Situation*. Hanoi, Medical Publishing House, 2001. *Ref 2976*.

Zambia

Luo C, Mwela CM. *National survey on vitamin A deficiency in Zambia: a random cluster study for children (0–5 years) and mothers attending national immunization days in August 1997*. Lusaka, National Food and Nutrition Commission, 1997. *Ref 1325*.

Micronutrient Operational Strategies and Technologies (MOST) et al. *Report of the national survey to evaluate the impact of vitamin A interventions in Zambia, July and November 2003*. Zambia, Micronutrient Operational Strategies and Technologies, United States Agency for International Development (USAID) Micronutrient Program, 2003. *Ref 5098*.

Zimbabwe

Ministry of Health and Child Welfare, Nutrition Unit. *Zimbabwe National Micronutrient Survey: 1999*. Harare, Ministry of Health and Child Welfare, 2001. *Ref 2641*.

Central Statistical Office, Macro International Inc. *Zimbabwe Demographic and Health Survey 1999*. Calverton, MD, ORC Macro, 2000. *Ref 4680*.

Measure DHS+. *Micronutrient Update*. Calverton, MD, ORC Macro, 2002. *Ref 3331*.

WHO Global Database on Vitamin A Deficiency
www.who.int/vmnis

For further information about the WHO Global Database on Vitamin A Deficiency,
or if you would like to provide information, please contact:
micronutrients@who.int

ISBN 978 92 4 159801 9