

# Global burden of Vitamin A Deficiency in the year 2000

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This draft was prepared in 2002. It is to be superseded by work in progress and will be updated in due course.

## 1. Introduction

Vitamin A deficiency (VAD) was estimated to be the 56<sup>th</sup> leading cause of disease burden in the world in 1990, accounting for 0.3% of total DALYs (Murray & Lopez, 1996). Vitamin A deficiency occurs when body stores of vitamin A are low enough to have adverse health consequences even though clinical eye signs are not evident.

Clinical indicators for VAD include:

1. Xerophthalmia – ocular manifestations of VAD including nightblindness (XN) and bitots spots (XIB). These labels are a part of the standard classification system for ocular indicators of VAD that also provides the minimum prevalence criteria for interpretation to identify public health problems (WHO/NUT/95.3, 1995).
2. Corneal Scars (XS) – permanent corneal scar resulting from corneal ulceration due to VAD and potentially leading to blindness.

These are indicators for clinical VAD and reflect a burden of disease definition that is pertinent to the development of disease estimates and does not necessarily reflect an absolute nutritional definition. The 1995 WHO Nutrition document "Global Prevalence of Vitamin A Deficiency" states that while VAD occurs at all ages, it is a public health concern among pre-school age children (0-4 years) because of their susceptibility to infections and due to increased demand for the Vitamin A during a period of rapid growth (WHO/NUT/95.3, 1995). Therefore, the estimates presented here for both

xerophthalmia and corneal scars are specific to children in the 0-4 age group. In all other age groups the prevalence was assumed to be zero.

## 2. Case and sequelae definitions

The case definition and sequelae used for VAD are given below.

**Table 1. Case and sequelae definitions for Vitamin A deficiency**

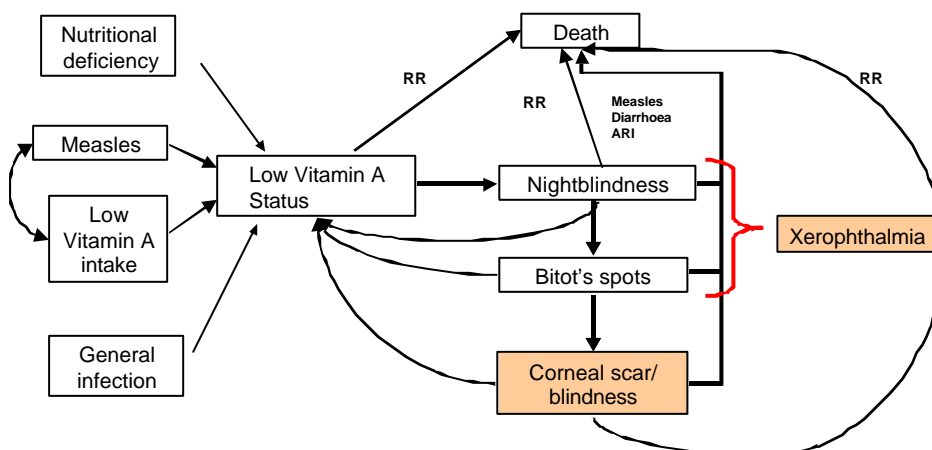
Cause category	GBD 2000 Code	ICD 9 codes	ICD 10 codes
Vitamin A deficiency	U056	264	E50

Case/ Sequelae	Definition
Vitamin A deficiency:	
Xerophthalmia	All ocular manifestations of vitamin A deficiency: night blindness, Bitot's spots, corneal xerosis, corneal ulceration and corneal scarring.
Corneal scar	Permanent corneal scar resulting from corneal ulceration due to Vitamin A deficiency and potentially leading to blindness

## 3. Disease model

### VITAMIN A DEFICIENCY



*YLD calculated for boxes with bold outline and orange shading.*

## 4. Methods

Country-specific estimates were obtained and used to calculate regional estimates for both xerophthalmia and corneal scars. The primary data source was the WHO Nutrition and Health for Development Program which is in the process of developing and refining a comprehensive database of country-specific estimates of both clinical and sub-clinical VAD from national level and sub-national nutrition surveys (MDIS VAD database, 2002).

Xerophthalmia is defined as ocular manifestations of Vitamin A deficiency and includes night blindness (XN) and Bitot's spots (XIB). Data on the prevalence of xerophthalmia were provided from the MDIS VAD database. Priority was given to the most recent national level estimates (majority are obtained from studies conducted in last 10 years). A correction factor of 0.75 was applied to all national level estimates in order to adjust for studies that were likely to over-sample undernourished populations as suggested by the Nutrition program and done in prior publications (WHO/NUT/95.3). Sub-national estimates were adjusted according to correction factors suggested in the MDIS Working Paper 2 (WHO/NUT/95.3,1995). These correction factors were less than 0.75 as they were used to adjust for subnational studies that were less representative than estimates from national-level studies. The paper also states that no consistent sex difference in vulnerability is demonstrated based on physiologic parameters, therefore a male to female ratio of 1:1 was assumed.

When country-specific data were missing, other nutritional and health status variables were examined and evaluated including the prevalence of stunting and/or under-five mortality (U5M) so that they could be used to derive sound estimates for VAD. These indicators were selected as national-level estimates were available for almost all countries and importantly, the factors that may influence or lead to vitamin A deficiency may also lead to increased risk of stunting and under-five mortality. The correlation between stunting and xerophthalmia was 0.637 and in simple linear regression analysis stunting was found to be significantly predictive of xerophthalmia. This analysis included

149 observations. Similar results were found with U5M, where a correlation of 0.639 was observed. As well, U5M was found to be significantly predictive of xerophthalmia in linear regression analysis with 149 observations. These regression models were used to predict the prevalence of xerophthalmia in countries where disease estimates were not available. Estimates were primarily derived using the regression model with stunting data. In a few instances, after comparing estimates derived using the different models, estimates derived with the U5M model was deemed more appropriate based on expert consult. This was the case with India and China where current national level estimates were not available. While these variables were predictive of VAD, it is not suggested that they are *indicators* of VAD in public health terms. Countries where regression estimates were used were compared with other countries with similar prevalence estimates across other health status variables such as adult and infant mortality levels, and per capita income levels. If the countries were deemed similar than the regression estimate for xerophthalmia was used.

Vitamin A supplementation has been an effective public health measure to reduce the burden of VAD globally (WHO/NUT/96.1). The impact of supplementation on xerophthalmia prevalence rates was assessed by examining data from countries where pre- and post-supplementation data existed because some of the survey data applied pre-date supplementation efforts. Data from Indonesia, Bangladesh, Vietnam and Nepal were examined. On average, a 70% reduction in the prevalence of xerophthalmia was observed from pre- to post-supplementation periods (range, 48%-85%). Based on this finding, disease estimates that were obtained from pre-supplementation periods were reduced by 70% in countries where supplementation has been in effect for 4 or more years. After consultation with experts, it was assumed that a period of 4 years of supplementation would be necessary for adequate coverage of the population so that population-level prevalence of VAD could be impacted. Also, it is assumed that vitamin A supplementation was the primary factor influencing the reduction of xerophthalmia in these countries.

The WHO Expanded Program on Immunization (EPI) provided country-specific data on the status of national vitamin A supplementation programs. This comprehensive

database provided information on programs that were both EPI linked and non-EPI linked supplementation activities. Approximately 55% of countries with vitamin A deficiency had some supplementation program in effect. There were 27 countries with supplementation in effect for 4 or more years.

Corneal scar is defined as permanent corneal scar resulting from corneal ulceration due to vitamin A deficiency that potentially could lead to blindness. The availability of current prevalence estimates for corneal scars either at the national or sub-national level is limited, if not non-existent. Therefore, with guidance from the WHO Nutrition program, prevalence estimates for corneal scars were derived after applying basic assumptions. First, as it is not considered a public health problem in developed countries, the prevalence in all 'A' regions was set to 0. Next, if the prevalence was 0 in the GBD 1990, then it was assumed that the current prevalence would also be 0 given that the prevalence of xerophthalmia had declined or remained constant (corneal scars is a more severe form of VAD than xerophthalmia). The prevalence of corneal scars in EME (established market economies), FSE (former socialist economies) in GBD 1990 was 0 and also xerophthalmia had declined or remained constant since then, thus the prevalence was set to 0 in all GBD 2000 A regions (AMRO A, EURO A, WPRO A) and then also EURO B1 and EURO C. (Note, the epidemiologic subregions for GBD 1990 and GBD 2000 differ.)

The prevalence of corneal scars was assumed to be 0, when vitamin A supplementation programs were in effect for a period of 4 or more years. This was based on data from Vietnam, Sri Lanka and Indonesia (see Table 2) where corneal scars prevalence data existed from both pre- and post-supplementation periods and was supported by expert views obtained from the WHO Blindness and Deafness program. As shown, the prevalence of corneal scars was reduced after supplementation programs were implemented. In Sri Lanka, the 1987 post-supplementation prevalence of 0.06% represents a combined estimate of corneal ulceration/keratomalacia (X3) and corneal scars (XS), with the actual prevalence of corneal scars being a fraction of this value.

**Table 2. Pre- & post-supplementation prevalence estimates for corneal scars**

Country	Year	Corneal Scar (XS) Prevalence	Supplementation Program
<b>Vietnam</b>	1985-89	0.12% (34,214 preschoolers)	Beginning in late 1980s
	1994	0.048% (37,920 preschoolers)	1994: 94% coverage of children
<b>Sri Lanka</b>	1979	0.05% (13,450 preschoolers)	Began in late 1970s (until early 1980s)
	1987	<u>X3 &amp; XS</u> : 0.06% (32,643 preschoolers)	
<b>Indonesia</b>	1977-8	0.20%	Began in 1977-8
	1992	0.03%	

Next, the prevalence was set to 0 in countries that were labeled 'not deficient' in WHO Nutrition program documents, including the MDIS documents from 1995 and 1996 (WHO/NUT/95.3 & 96.1) as well as unpublished data (Consultation with WHO Nutrition Regional Advisors, 2001).

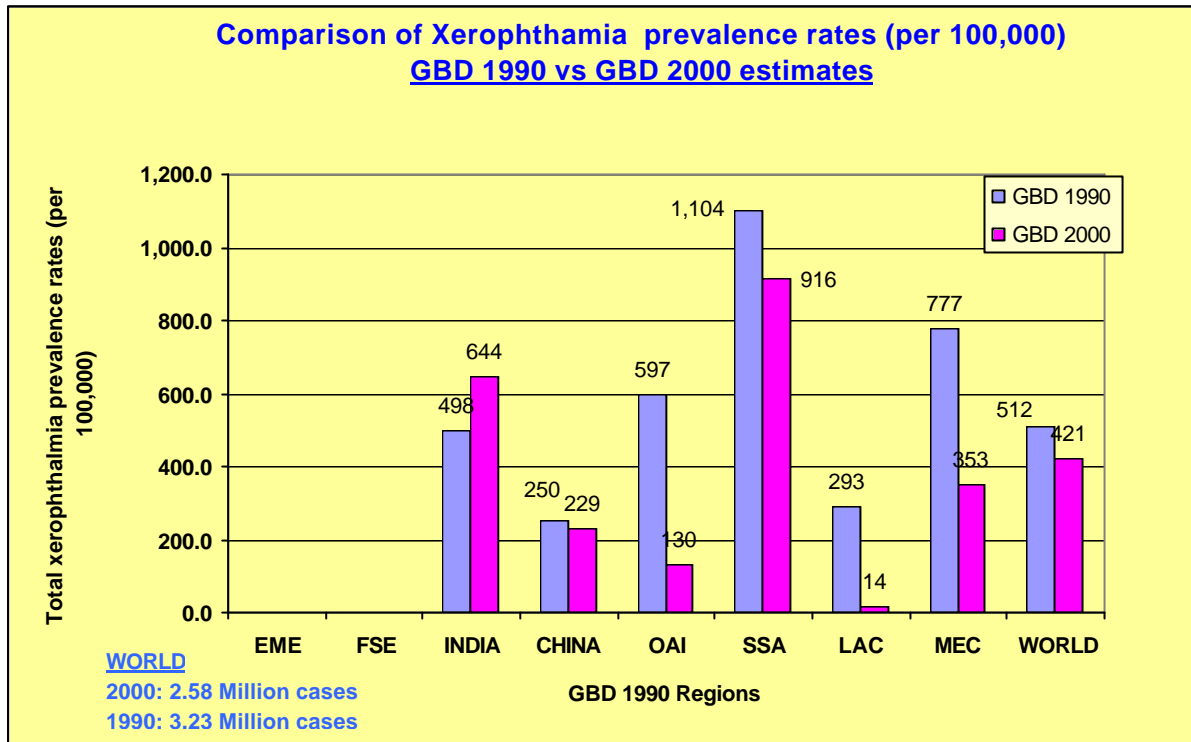
In order to estimate the prevalence of corneal scars in the remaining countries where severe VAD is a public health problem (n=39), the association between xerophthalmia (night blindness, bitot's spots) and corneal scars was examined. However, given limited data on corneal scars, it was difficult to discern an association, if any, from available data. Disease estimates from GBD 1990 were then evaluated for association between xerophthalmia and corneal scars (Table3).

**Table 3. Ratio of xerophthalmia to corneal scars in GBD 1990 by region**

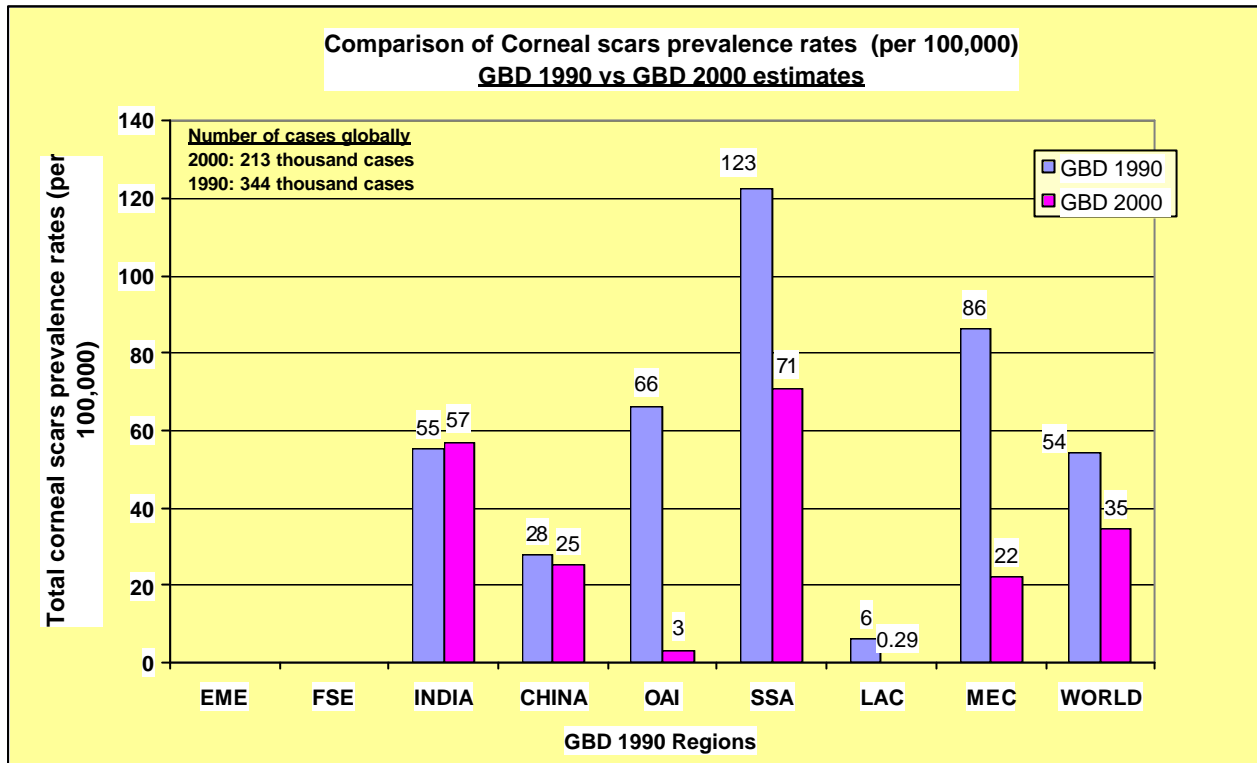
<b>GBD 1990 Region</b>	<b>Xerophthalmia</b>	<b>Corneal Scars</b>	<b>Corneal scars: Xerophthalmia ratio</b>
EME	0	0	0.00
FSE	0	0	0.00
INDIA	498	55.3	0.11
CHINA	250	27.8	0.11
OAI	597	66.4	0.11
SSA	1104	122.6	0.11
LAC	293	6.4	0.02
MEC	777	86.4	0.11
WORLD	512	54.3	0.11

As shown, most corneal scar estimates were 11% of the xerophthalmia estimates. These region specific ratios were applied to current estimates of xerophthalmia to obtain final estimates for corneal scars.

Figure 1 and 2 present the total prevalence rates (per 100,000) of xerophthalmia and corneal scars, respectively, by regions with a comparison of GBD 1990 and GBD 2000 estimates.

**Figure 1.**

**Figure 2.**



## 5. Health state descriptions and disability weights

**Table 5. Disability weights for Vitamin A deficiency**

Stage/sequela	GBD 1990	Netherlands Study	Australian BOD Study
Xerophthalmia	0 (treated) 0 (untreated)		
Corneal scars	0.274-0.282 (treated) 0.274-0.282 (untreated)		

## 6. Global burden of Vitamin A deficiency in 2000

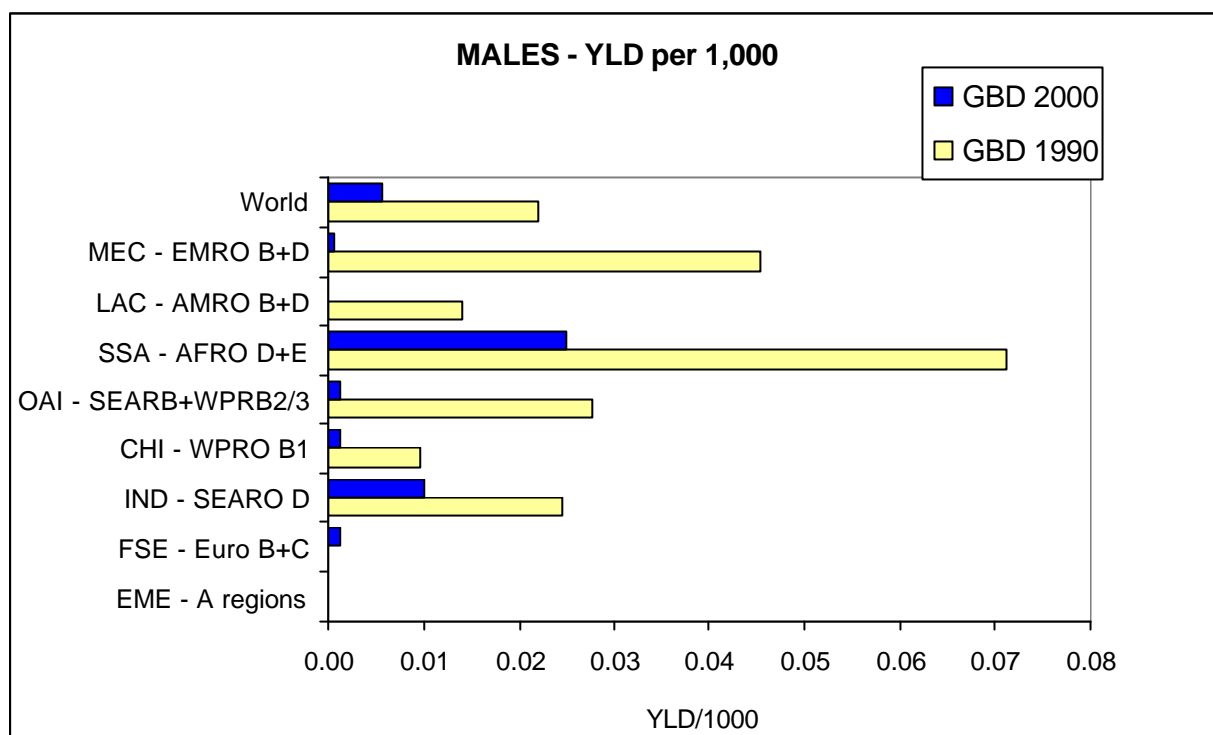
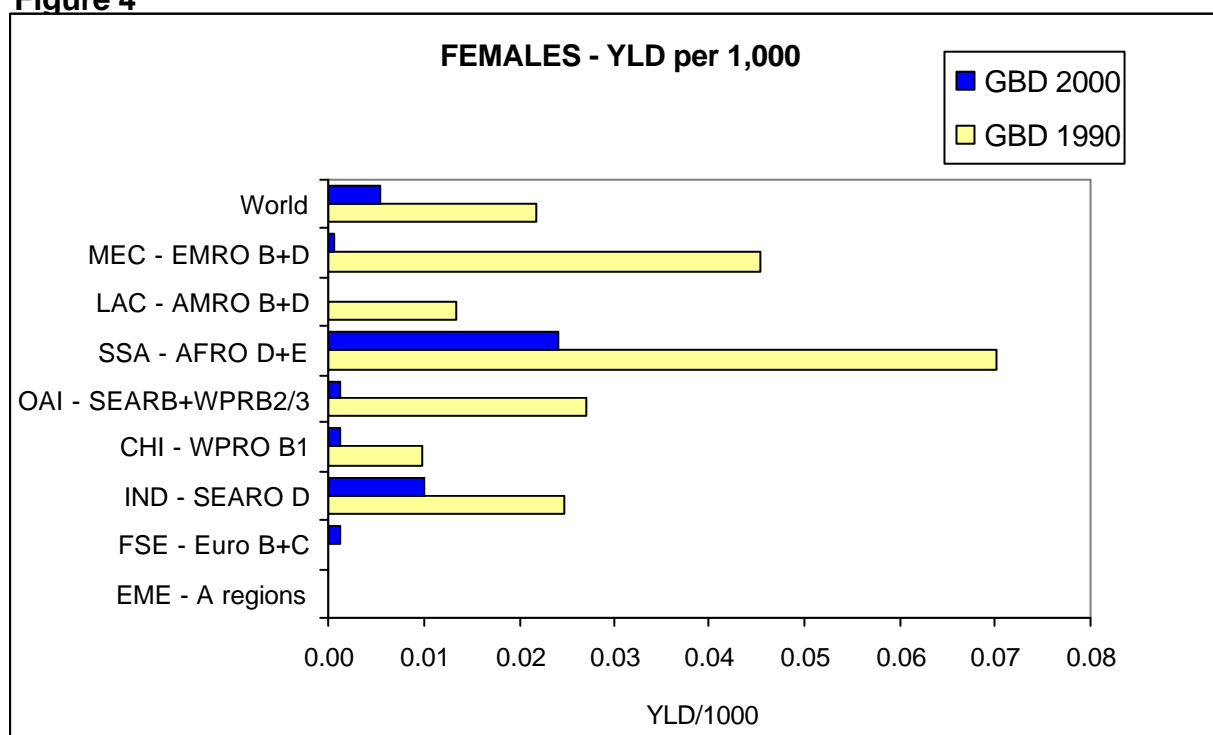
General methods used for the estimation of the global burden of disease are given elsewhere. The tables and graphs below summarise the global burden of Vitamin A deficiency estimates for the GBD 2000 and compare them with the Vitamin A deficiency estimates from the GBD 1990.

**Table 6. Global total of YLD, YLL and DALY**

	Males	Females	Total
YLL ('000)			
GBD 1990	1,882.19	1,840.08	3,722.27
GBD 2000	554.70	774.20	1,328.90
YLD ('000)			
GBD 1990	58.57	57.00	115.57
GBD 2000	16.90	16.20	33.10
DALY ('000)			
GBD 1990	1,940.76	1,897.08	3,837.84
GBD 2000	571.60	790.40	1,362.00

**Table 7. YLD, YLL & DALY estimates for WHO epid. subregions, 2000.**

	YLD/100,000		YLL/100,000		Total YLD	Total YLL	Total DALYs
	Males	Females	Males	Females	('000)	('000)	('000)
AFRO D	2.03	1.93	89.09	147.01	6.61	394.61	401.23
AFRO E	2.95	2.89	98.84	154.19	9.85	427.63	437.48
AMRO A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AMRO B	0.00	0.00	0.05	0.05	0.00	0.22	0.22
AMRO D	0.02	0.02	0.70	0.20	0.02	0.32	0.34
EMRO B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMRO D	0.11	0.11	0.00	0.00	0.15	0.00	0.15
EURO A	0.00	0.00	0.00	0.00	0.00	0.01	0.01
EURO B1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EURO B2	1.16	1.10	0.00	0.00	0.58	0.00	0.58
EURO B3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SEARO B	0.12	0.12	0.97	0.65	0.47	3.20	3.67
SEARO D	1.00	1.00	32.21	38.19	13.52	473.41	486.93
WPRO A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WPRO B1	0.13	0.12	0.00	0.00	1.70	0.01	1.70
WPRO B2	0.13	0.12	20.90	20.64	0.18	29.50	29.68
WPRO B3	0.35	0.35	0.00	0.00	0.02	0.00	0.02
<i>World</i>	0.56	0.54	18.22	25.80	33.10	1328.90	1362.00

**Figure 3****Figure 4**

## 7. Uncertainty analysis

General methods for uncertainty analysis of estimates for the Global Burden of Disease 2000 are outlined elsewhere. Uncertainty analysis for Vitamin A deficiency has not yet been completed.

## 8. Conclusions

Given very minimal country or regional data on the prevalence of corneal scars, future efforts should examine ways to better estimate this condition. Additionally, aside from under-five mortality and stunting, other potential indicators of Vitamin A status should be examined so that the prevalence of VAD can be more accurately predicted when data points are missing.

We welcome comments and criticisms of these draft estimates, and information on additional sources of data and evidence. Please contact Colin Mathers or Claudia Stein (EBD/GPE), emails: [mathersc@who.int](mailto:mathersc@who.int), [steinc@who.int](mailto:steinc@who.int).

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