

# Xerophthalmia and night blindness for the assessment of clinical vitamin A deficiency in individuals and populations

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## Background

The term “xerophthalmia” refers to the spectrum of ocular manifestations due to vitamin A deficiency. Such signs include those involving impaired sensitivity of the retina to light (night blindness), and (in order of their appearance and severity) epithelial disruptions of the cornea and conjunctiva, such as conjunctival xerosis, Bitot spots, corneal xerosis and keratomalacia (1, 2). These ocular symptoms are related to vitamin A deficiency and vary according to the severity of the deficiency, and age.

Night blindness, a condition in which a person cannot see in dim light, is generally the earliest clinical manifestation of vitamin A deficiency and is both a sensitive and a specific indicator for low serum retinol levels (3, 4). Within the eye, vitamin A, in the form of retinal, combines with opsin to produce rhodopsin, the photosensitive visual pigment of rods (5). Vitamin A deficiency leads to a decline in rhodopsin levels and impaired rod function, manifested as night blindness. In mild cases, night blindness is often only first noticeable following photopic stress from sudden exposure to bright light, and results in an increased turnover of rhodopsin (6).

Historically, the most characteristic sign of ocular problems related to vitamin A deficiency has been Bitot spots – opaque whitish deposits on the scleral conjunctiva (7). At this point, conjunctival xerosis is already present, with the conjunctiva appearing dry and dull. Spots of keratinized epithelial cells with the appearance of foam are also present (2, 7). If vitamin A deficiency continues, corneal xerosis may set in, with the appearance of a hazy cornea, followed by keratomalacia where there is liquefaction of part or all of the cornea (2). Corneal scars are not considered to be part of active vitamin A deficiency, but are considered a result of a previous bout of the deficiency (2). With prolonged vitamin A deficiency, there is an increase in morbidity and mortality from common infections, and blindness can occur (8).

Xerophthalmia can occur in any age group and especially in preschool-age children, adolescents and pregnant women. However, children are at higher risk of vitamin A deficiency and xerophthalmia, owing to their greater vitamin A requirements for growth. Children are also at higher risk of intestinal infestations and infections, which may impair the absorption of vitamin A and increase its loss. A peak in the incidence of night blindness is generally observed between 3 and 6 years of age. However, as it is difficult to assess night blindness in infants and young children who have not yet begun to crawl or walk, its presence may not always be recognized, and therefore it may be erroneously perceived that night blindness is not a problem. Affected children often exhibit limited

activity after dusk and are frequently unable to find their food or toys (9). Pregnant and lactating women are also at risk for night blindness. Neonates of vitamin A-deficient mothers are born with decreased vitamin A reserves (10, 11).

The first symptoms of vitamin A deficiency are characterized by impaired adaptation to the dark, which can begin when serum retinol concentrations fall below 1.0 µmol/L, but occurs more often when they fall below 0.7 µmol/L. Strict xerophthalmia is more frequent and severe at serum retinol concentrations below 0.35 µmol/L (12, 13). Night blindness generally responds rapidly to vitamin A therapy, within 1–2 days (7, 9, 14), and prompt treatment of xerophthalmia generally results in the full preservation of eyesight up to the stage of corneal xerosis (2).

## Scope and purpose

This document aims to provide users of the Vitamin and Mineral Nutrition Information System (VMNIS) with information about the use of xerophthalmia and night blindness for assessing the prevalence of vitamin A deficiency in populations. It is a compilation of the current World Health Organization (WHO) recommendations on the topic and summarizes, from the documents described below, the assessment of night blindness, criteria for defining the degree of a public health problem of xerophthalmia and vitamin A deficiency, and the chronology of their establishment.

The methods and criteria included in this summary are useful for identifying populations most at risk for vitamin A deficiency and in need of intervention. Assessment of the prevalence of xerophthalmia and night blindness permits monitoring of trends in vitamin A deficiency, as well as evaluation of the impact of interventions.

## Description of technical consultations

This document compiles the current WHO recommendations, previously published in the following documents:

[Vitamin A deficiency and xerophthalmia: report of a joint WHO/USAID meeting](#) (1). This document was published in 1976 following a meeting on vitamin A deficiency and xerophthalmia that was convened jointly by WHO and USAID in Jakarta, Indonesia, 25–29 November 1974. Vitamin A status was evaluated using clinical, biochemical and dietary methods and integrated with the known causes of vitamin A deficiency, to determine the priorities for research and vitamin A programmes. Meeting attendees discussed the feasibility of measures to prevent vitamin A deficiency and developed a protocol for the treatment of emergency cases of xerophthalmia. The outcomes of this meeting led to publication of the first edition

of a *Field guide to the detection and control of xerophthalmia* (15), published in 1978. This field guide is the first of three editions and was developed to meet the need for a practical guide for use by clinicians, nurses and public health officials concerned with preventing xerophthalmia.

[Control of vitamin A deficiency and xerophthalmia. Report of a joint WHO/UNICEF/USAID/Helen Keller International/IVACG](#) (16). This document was published in 1982 following a meeting that was also held in Jakarta, Indonesia, 13–17 October 1980. Meeting participants reviewed progress made in the establishment of measures to control vitamin A deficiency and xerophthalmia, which led to revisions of the clinical classification of the disease, prevalence criteria for when it constituted a public health problem, and treatment recommendations. The outcomes of this meeting led to publication of the second of three editions of a *Field guide to the detection and control of xerophthalmia* (3).

[Vitamin A deficiency and its consequences. A field guide to detection and control](#), 3rd edition (9). This document is in its third edition and was published in 1995. The first edition was published in 1978, followed by a second edition in 1982. The scope of this document was expanded to include new information on the importance of vitamin A in the broader realm of child health and survival.

[Indicators for assessing vitamin A deficiency and their application in monitoring and evaluating intervention programmes](#) (8). This document was published in 1996 following a technical consultation held in Geneva, Switzerland, 9–11 November 1992. The consultation was attended by academic and governmental experts in vitamin A deficiency. The objectives of the consultation were: (i) to identify indicators and establish cut-off points for assessing subclinical vitamin A deficiency in populations; (ii) to determine which indicator, or combination of indicators, may be useful in populations with vitamin A deficiency at levels that pose an important public health problem; (iii) to discuss, according to age and/or sex, which groups are most appropriate for assessment using different indicators; and (iv) to consider the characteristics of the indicators and their usefulness, given different surveillance objectives.

## Discussions and recommendations

The classification of xerophthalmia was first agreed in the 1974 consultation (1), in which night blindness was classified as a secondary sign of xerophthalmia and was not included as a criterion for assessing the vitamin A status of populations (1). Techniques available at that time for the assessment of impaired dark adaptation included rod scotometry, dark adaptometry and electroretinography, which detect changes in rod cells of the retina before presentation of any clinical manifestation (1). Unfortunately, these techniques were not easily applicable to

children of preschool age, particularly in resource-poor settings. Previous attempts to detect night blindness in children, through assessment of reflex irritability of the eye to light, had also failed to prove this was a reliable technique to assess damage to the rods (17). Members of the 1974 consultation concluded that development of a sensitive objective biophysical test of rod function would be beneficial if it was applicable to all population groups (1).

In 1980, the first national survey of vitamin A deficiency was conducted in Indonesian children (18). In this study, night blindness, elicited through careful history-taking from either a guardian or relative, was found to be an effective screening tool for xerophthalmia because it was closely correlated with other indicators of vitamin A deficiency. Furthermore, night blindness was twice as effective as an independent screening criterion for low serum levels of vitamin A as compared to assessment of conjunctival lesions (18). These and additional findings from surveys conducted in other countries were presented at the 1980 WHO consultation (16) and ultimately led to modifications of the classification of xerophthalmia to that shown in Box 1. The previous division into primary and secondary signs was found to be unnecessary and was removed. Additionally, the division of corneal ulceration/keratomalacia (X3) was modified to better describe the degree of damage and prognosis for vision. Both

field guides, published in 1978 (15) and 1982 (3), contain informative colour plates of the various forms of xerophthalmia. Members of the 1980 consultation (16) also updated criteria for assessing the public health significance of xerophthalmia and vitamin A deficiency, based on the prevalence among children aged 6 months to 6 years (see Table 1). Night blindness (among preschool-age children, with or without other signs of xerophthalmia) was added to the prevalence criteria and a cut-off value was fixed at greater than 1%, or twice that for Bitot spots. This criterion reinforced the utility of night blindness as a screening method, although it is highly dependent upon the quality of the history-taking, and was shown to exhibit increased specificity in communities with local terms for the condition, or knowledge of night blindness (16). One specific term used to describe night blindness is “chicken eyes”, as chickens lack rods and are therefore night blind (9).

Over the next decade, the criteria shown in Box 1 and Table 1 were widely used. However, during the 1992 consultation it was reaffirmed that a prevalence of night blindness greater than 1% indicates a public health problem. However, the population group that this applies to was narrowed to children aged from 2 years to less than 6 years (8). Additional criteria to define the level of importance of a public health problem, based on the assessment of night blindness in these children, were also agreed (see Table 2).

#### Box 1.

#### Classification of xerophthalmia by ocular signs<sup>a</sup>

- Night blindness (XN)
- Conjunctival xerosis (X1A)
- Bitot spots (X1B)
- Corneal xerosis (X2)
- Corneal ulceration/keratomalacia <½ corneal surface (X3A)
- Corneal ulceration/keratomalacia ≥½ corneal surface (X3B)
- Corneal scar (XS)
- Xerophthalmic fundus (XF)

<sup>a</sup> Source: reference (16).

Table 1

#### Prevalence criteria for determining the public health significance of xerophthalmia and vitamin A deficiency in children aged 6 months to 6 years<sup>a</sup>

Indicator	Minimum prevalence, %
Night blindness (XN)	>1
Bitot spots (X1B)	>0.5
Corneal xerosis/corneal ulceration/keratomalacia (X2/X3A/X3B)	>0.01
Corneal scar (XS)	>0.05

<sup>a</sup> Source: adapted from reference (16).

Table 2

**Prevalence of night blindness to define a public health problem and its level of importance among children aged 24–71 months<sup>a</sup>**

	Degree of public health problem, %		
	Mild	Moderate	Severe
Prevalence of night blindness	0.01–0.99	1.0–4.9	5.0 or more

<sup>a</sup> Source: adapted from reference (8).

Members of the 1992 consultation suggested that use of the following algorithm during interviews may increase the specificity and reduce error in the classification of night blindness as compared to classification based solely on interviewees' familiarity with the local term for night blindness (8):

1. Does your child have any problem seeing in the daytime?
2. Does your child have any problem seeing at nighttime?
3. If the answer to question 2 is yes, is this problem different from other children in your community? (Note: this question is particularly appropriate where vitamin A deficiency is not very prevalent.)
4. Does your child have night blindness (use local term that describes the symptom)?

Reaffirming that night blindness is one of many biological indicators for vitamin A deficiency, the 1992 consultation designated vitamin A deficiency as a public health problem requiring intervention when at least one of the following specifications is met:

- the population prevalence of at least two of the biological indicators of vitamin A status (night blindness, serum retinol, breast milk retinol, relative dose response, modified dose response, or conjunctival impression cytology) reach the threshold to define a public health problem;
- one biological indicator is supported by at least four demographic and ecological risk factors, including:
  - infant mortality rate higher than 75/1000 live births and under-5-year mortality rate higher than 100/1000 live births;
  - full immunization coverage in less than 50% of children at 12–23 months of age;
  - less than 50% prevalence of breastfeeding in 6-month-old infants;

- median dietary intake lower than 50% of recommended safe level of intake among 75% of children aged 1–6 years;
- two-week period prevalence of diarrhoea of 20% or higher;
- measles case-fatality rate of 1% or higher;
- no formal schooling or illiteracy in 50% or more of women aged 15–44 years;
- less than 50% of households with a safe water source.

Biological indicators are essential in assessing the vitamin A status of a population and are more specific than demographic and ecological indicators. The 1992 consultation ranked night blindness as the most useful biological indicator for assessing a population's risk of vitamin A deficiency, developing targeted programmes and evaluating the effectiveness of programmes using this indicator, compared to other markers such as serum retinol, relative dose response/modified relative dose response, and breast milk retinol (8).

Night blindness is most effectively assessed by taking a history, although no objective field-applicable tools have been developed to measure delayed dark adaptation in children aged less than 4 years (8). Progress is being made to measure pupillary and visual thresholds (19) and visual restoration time (20) in target populations of children aged over 4 years. However, children under 24 months of age continue to present a challenge for recognition of cases of night blindness (8). Despite the indicator's subjective nature, the 1992 consultation reinforced the value of night blindness in assessing a community's vitamin A status. A reliable assessment of night blindness by interview requires that there is a local word or term that describes the characteristic symptoms of night blindness that are specifically related to vitamin A deficiency. Since there is a tendency to receive a high number of positive responses if the respondent believes that such a response may result in beneficial treatment or therapy, a series of questions should be

asked to focus attention on visual acuity under different lighting conditions (e.g. during the day, evening and night), which are related to vitamin A deficiency. It is important to field-test the reliability of local words prior to undertaking a large population-based survey. It is also important to standardize procedures for data collection (e.g. training interviewers and standardizing their approach to asking questions), to make this a more reliable indicator. A high prevalence of night blindness can serve as a mapping tool in developing targeted programmes, and as a method for the community to monitor its population's vitamin A status, particularly in response to an intervention (8).

## Summary of statement development

This summary primarily used information from WHO publications released between 1976 and 1996 (1, 8, 15, 16). The first, [Vitamin A deficiency and xerophthalmia: report of a joint WHO/USAID meeting](#) (1), was published in 1976 and did not include night blindness as a criterion for evaluating the vitamin A status of a population. The first edition of *Field guide to the detection and control of xerophthalmia* (15) was published in 1978, in order to meet the need for a practical guide for use by clinicians, nurses and public health officials concerned with preventing xerophthalmia. The 1982 publications, [Control of vitamin A deficiency and xerophthalmia: report of a joint WHO/UNICEF/USAID Helen Keller International/IVACG meeting](#) (16) and the second edition of the *Field guide to the detection and control of xerophthalmia* (3) redefined xerophthalmia to include night blindness and designated night blindness as an effective screening tool for xerophthalmia. A prevalence of night blindness in preschool-age children (24–71 months) of >1% was defined as being of public health significance. [Vitamin A deficiency and its consequences](#).

[A field guide to detection and control](#), 3rd edition (9) and [Indicators for assessing vitamin A deficiency and their application in monitoring and evaluation intervention programmes](#) (8), were published in 1995 and 1996, respectively, and defined the severity of vitamin A deficiency as a public health problem, based on the prevalence of night blindness.

## Plans for update

The WHO Evidence and Programme Guidance Unit, Department of Nutrition for Health and Development, is responsible for reviewing this document and, if needed, will update it by 2017, following the procedures of the [WHO handbook for guideline development](#) (21).

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## References

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