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Recommendations for Indicators: Night Blindness during Pregnancy—A Simple Tool to Assess Vitamin A Deficiency in a Population[1,2]

Parul Christian[3]

Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD 21205

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ABSTRACT Night blindness during pregnancy caused by vitamin A deficiency is associated with an increased risk of morbidity and mortality among women. Because a history of maternal night blindness is simple and reliable to use, it is recommended as a population-based indicator of vitamin A deficiency. Furthermore, a maternal night blindness prevalence of ≥5% is recommended as a cut-off at which vitamin A deficiency may be considered to be a problem of public health significance within the community. This paper provides the justification for these recommendations. Night blindness during pregnancy is strongly associated with low serum and breast milk vitamin A concentration, abnormal conjunctival impression cytology and impaired dark adaptation, which suggests that it is a valid indicator of vitamin A deficiency. The prevalence of night blindness during pregnancy tends to be high in countries where the prevalence of xerophthalmia in children is high and in countries where interventions are in place to reduce childhood vitamin A deficiency. Existing data suggest that misclassification of self-reported maternal night blindness may account for a prevalence of up to 3%. The suggested cut-off, 5%, is set higher than this potential level of false-positive prevalence (3%). Illustrative data from India and Cambodia on childhood xerophthalmia and maternal night blindness rates are used to demonstrate the validity of using a 5% prevalence of maternal night blindness as indicative of a community vitamin A deficiency problem. Finally, it is recommended that night blindness history be elicited for a previous pregnancy that ended in a live birth in the past 3 y, using the local term for night blindness whenever possible. J. Nutr. 132: 2884S–2888S, 2002.

KEY WORDS: • *night blindness* • *vitamin A deficiency* • *pregnancy* • *indicator*

Pregnant women in many regions of the developing world frequently report having night blindness. Studies from Nepal have demonstrated that maternal night blindness is strongly associated with other biochemical and functional indicators of vitamin A deficiency (1). Women with night blindness also face a greater risk of morbidity during pregnancy (2) and mortality, especially from infectious causes (3), than women who do not develop night blindness during pregnancy. Because eliciting a history of night blindness is simple and the response is reliable (4,5), the question that arises is whether it can be used as a criterion for determining the existence of vitamin A deficiency as a problem of public health significance in a population. This paper provides the rationale and justification for using a history of maternal night blindness, when observed at a prevalence of ≥5%, to constitute a public health problem of vitamin A deficiency in the community. It also provides guidelines for obtaining estimates of the prevalence of night blindness.

Night blindness during pregnancy as an indicator of community vitamin A deficiency

Risk of maternal night blindness covaries with other indicators of vitamin A deficiency. A case-control study in Nepal found that night-blind pregnant women had four times the odds [95% confidence interval (CI)[4] = 2.2–7.4] of having low concentrations of serum retinol (<0.7 μmol/L), three times

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[3] To whom correspondence should be addressed.
E-mail: pchristi@jhsph.edu.

[4] Abbreviations used: CI, confidence interval; HKI, Helen Keller International; WHO, World Health Organization.

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TABLE 1

Association of night blindness with other indicators of vitamin A deficiency in women in Nepal[1]

Vitamin A status indicators	Night blind *N/n* (%)	Not night blind *N/n* (%)	OR	95% CI
Serum retinol <0.7 μmol/L	85/44 (51.0)	90/19 (21.1)	4.0	2.2–7.4
Serum retinol <1.05 μmol/L	85/65 (76.5)	90/50 (55.5)	2.5	1.4–4.6
CIC abnormal	85/24 (28.2)	90/11 (12.2)	2.8	1.3–6.1
Dark adaptation abnormal[2]	94/67 (71.2)	98/42 (43.8)	3.3	1.8–6.0
Breast milk vitamin A <1.05 μmol/L	94/56 (59.6)	97/41 (42.3)	2.0	1.1–3.6

[1] Data are from Ref. 1 and P. Christian et al., unpublished data. CIC, Conjunctival impression cytology; OR, odds ratio.
[2] Abnormal is defined as > −1.24 log cd/m[2].
N, denominator; n, numerator.

the odds of having abnormal conjunctival impression cytology (95% CI = 1.3–6.1) and twice the odds (95% CI = 1.1–3.6) of having low vitamin A concentrations in their breast milk after delivery (1) (**Table 1**). Furthermore, compared with normal pregnant women, the odds of abnormal dark adaptation scores among night-blind women were 3.3 (95% CI = 1.8–6.0) (P. Christian et al., unpublished data). Findings from a clinical trial in the same Nepalese population showed that the incidence of maternal night blindness was markedly reduced (relative risk = 0.33, 95% CI = 0.18–0.59) with weekly vitamin A supplementation at normal dietary levels (seven recommended daily allowances given in one weekly combined dose), providing causal evidence that night blindness during pregnancy is a consequence of vitamin A deficiency (6). Compliance with vitamin A supplementation was associated with reduction in night blindness during pregnancy in a dose-response manner (**Fig. 1**), with the greatest reduction in night blindness being observed among women who took 96–100% of all eligible weekly doses during pregnancy. Compliance of <40% provided no apparent protection against night blindness, which suggests that a minimum prophylactic dose of vitamin A was required to prevent the condition.

Night blindness during pregnancy is also commonly reported in poor rural regions where xerophthalmia in children constitutes a public health problem. In surveys from Nepal (7–10), India (11), Bangladesh (12), the Philippines (7,13), Laos (7,14) Cambodia (15), Thailand (Ref. 16 and E. Wasantwisuit, personal communications, Jan. 13, 2001) and Zambia (17), ~10% (range, 5–16%) of women reported night blindness during pregnancy (**Table 2**). In Nepal and northeastern Thailand, the prevalence of xerophthalmia is now low as a result of successful vitamin A distribution programs. For those two countries, childhood prevalence rates that previously existed and were the major impetus for initiating vitamin A supplementation programs have been used. Xerophthalmia rates reported for children in Bangladesh and Cambodia are from among those children who failed to receive vitamin A despite a national program. The data in Table 2 reveal that the prevalence of night blindness during pregnancy is high in those populations in which childhood xerophthalmia remains high or, because of childhood vitamin A supplementation, is now reduced.

Data are available that correlate rates of maternal night blindness and xerophthalmia in children from India, where vitamin A coverage is very low, and from Cambodia among those who failed to receive vitamin A despite a national program. Data from a recent National Family Health Survey in India, which included questions about night blindness during a previous pregnancy, found the national prevalence of this condition to be 12.1% (11). A small countrywide survey of xerophthalmia (which excluded night blindness) in children in India allowed comparison of the survey with rates of maternal night blindness in 21 states in the country. This re-

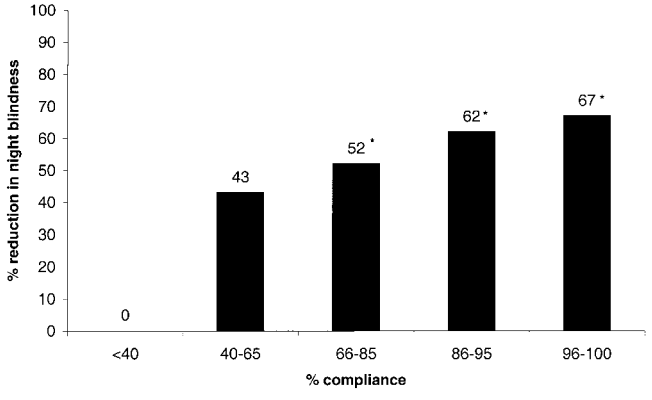

FIGURE 1 Percentage of reduction in occurrence of night blindness by percentage of compliance to vitamin A supplementation during pregnancy. * $P < 0.05$.

TABLE 2

Prevalence estimates of xerophthalmia in preschool children and maternal night blindness during pregnancy by country[1]

Country	Percentage of prevalence of xerophthalmia in children	Percentage of prevalence of night blindness during pregnancy
Nepal[2]	3 (7)	16.2 (5)
	3.3 (8)	11.7 (6)
	0.6 (9)	18 (10)
India	1.1 (11)	12.1 (11)
Bangladesh[3]	1.05 (12)	6.8 (12)
Philippines	0.4–0.7 (7)	8.6 (13)
Laos	0.7 (7)	11.5 (14)
Cambodia[3]	1.14 (15)	4.8 (15)
Thailand[2]	1.7 (16)	7.5[4]
Zambia	6.2 (17)	11.6 (17)

[1] References appear in parentheses.
[2] Pre-national vitamin A program rate.
[3] Rates seen in populations not covered by vitamin A supplementation.
[4] E. Wasantwisuit, personal communications (Jan. 13, 2001).

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vealed a high ecological correlation between the two criteria ($r = 0.63$, $p < 0.005$) after exclusion of three states with high rates (≥3%) of xerophthalmia in children (**Fig. 2**). These data provide evidence that prevalence rates of maternal and childhood xerophthalmia correlate in populations where vitamin A deficiency is endemic. In Nepal, the odds of night blindness during pregnancy in a recent study were four times higher (odds ratio = 3.7, 95% CI = 1.5–9.0) among women in households with xerophthalmic children during baseline assessment, almost 6 y earlier, than among women in households with nonxerophthalmic children (K. West et al., unpublished data). The data suggest that household clustering of vitamin A deficiency may be stable over time as well as intergenerational.

Maternal night blindness prevalence cut-off of ≥5% to constitute a vitamin A deficiency problem of public health significance

For any self-reported symptom, unreliable reporting creates background noise of false-positive prevalence. The question is how large this false-positive rate might be in populations where vitamin A deficiency does not occur. In a number of developing countries, maternal night blindness commonly occurs during pregnancy, particularly in the last trimester, a time when stress on maternal vitamin A stores is high as the fetus and placenta grow rapidly and draw on maternal vitamin A reserves. Maternal night blindness tends to disappear spontaneously within a few days or weeks after birth, although rates of 3–6% during lactation have been reported from Nepal (5), Bangladesh (12) and Laos (14). Thus, night blindness tends to be less common during the nonpregnant periods of a woman's life, especially beyond ~6 mo postpartum. To estimate the false-positive background prevalence, one needs to estimate the rates of night blindness in urban, well-nourished populations of nonpregnant, nonlactating women who live in homes with electricity where the need for dark adaptation is minimal. Although such estimates are difficult to obtain, in Bangladesh the Helen Keller International (HKI) Nutrition Surveillance Project data revealed night blindness prevalence among nonpregnant, nonlactating women, whose serum retinol concentrations were relatively normal (only 4.8% were <0.7 μmol/L), to be ~2% (12). One of the components of false-positive noise is related to the degree of nonspecificity of a history of night blindness. In Nepal, ~2% of women who reported being night-blind during pregnancy also reported abnormal daytime vision (6). Those women tended to be older, to have higher concentrations of serum retinol and pupillary threshold scores and to have higher rates of myopia than night-blind women who did not have daytime visual impairment (18). Another component of noise, estimated to account for a false-positive background prevalence of ~1%, may be factors other than vitamin A deficiency, such as zinc or other nutritional deficiencies or non-nutritional ophthalmologic conditions that may cause night blindness in a population (6,18).

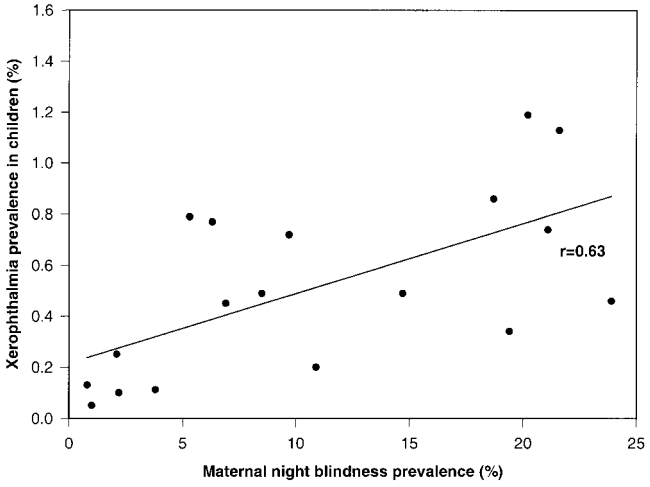

FIGURE 2 Statewise prevalence rates of xerophthalmia among children and night blindness during pregnancy in India (each data point represents a state). Three outliers with high rates of Bitot's spots were excluded.

TABLE 3

Concordance between childhood xerophthalmia and night blindness rates during pregnancy

Prevalence of maternal night blindness	Xerophthalmia among children[1]	
	No. of states above WHO cut-off for children	No. of states below WHO cut-off for children
India (11)		
≥5%	14	1
<5%	2	3
Mean prevalence	12.1%	4.4%
Cambodia (15)		
≥5%	3	0
<5%	1	6
Mean prevalence	11.4%	4.8%

[1] Xerophthalmia in India refers to Bitot's spots (cut-off, ≥0.5%) or corneal xerosis and/or corneal ulceration (cut-off, ≥0.01%). Xerophthalmia in Cambodia refers to symptoms of night blindness.

Thus, it seems reasonable that a prevalence of reported maternal night blindness of up to 3% represents misclassification and does not reflect vitamin A deficiency. A cut-off criterion for the prevalence of maternal night blindness constituting a problem of public health significance needs to be set at a higher rate, one that is unlikely to be encountered in a vitamin A-replete population. Thus, a conservative cut-off of ≥5% is suggested, although available data suggest that a figure of ≥4% would probably be nearly as reliable. As more data on the prevalence of night blindness during pregnancy and at other periods of life are collected through, e.g., ongoing Demographic Health Surveys[5] or representative surveys in other regions of the world, this cut-off may be further refined.

With ≥5% maternal night blindness used as the cut-off, the data from India indicate that 14 of the 16 states of the country identified as having vitamin A deficiency as a public health problem based on xerophthalmia rates in children were similarly identified by maternal night blindness rates of ≥5% (11) (**Table 3**). In addition, one of the four states not meeting

[5] Recently, Demographic Health Surveys data from six countries in Africa found that 4–17% of women who gave birth in the previous 5 y reported having night blindness during their last pregnancy. However, after exclusion of women who also reported day vision problems (as currently recommended), the prevalence rate of maternal night blindness dropped to 1–4.8%, all below the recommended cutoff of 5%. Further work is being undertaken to refine methods of collecting information on maternal night blindness in Africa and on the adjustment factor for daytime vision problems. Until then, maternal night blindness rates in these countries should be reported unadjusted as well as adjusted for "daytime blindness."

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childhood criteria did accede criteria for maternal night blindness. The difference in maternal night blindness prevalence between states with and without significant rates in children was quite large: 12.1% maternal night blindness in states that met childhood xerophthalmia criteria compared with 4.4% maternal night blindness in states where childhood xerophthalmia rates were below World Health Organization (WHO) cut-offs. In Cambodia, the prevalence of maternal night blindness was 11.4% in provinces where night blindness among children was ≥1%, compared with only 4.8% in provinces where childhood night blindness was <1% (15). Furthermore, three of four provinces where childhood vitamin A deficiency was considered a public health problem were identified by using a maternal night blindness prevalence of ≥5%. Prevalence rates of maternal night blindness from different regions of the world where vitamin A deficiency exists in children are found to be 5% or more (Table 2), again indicating that a cut-off of ≥5% to signify a public health problem of vitamin A deficiency is, if anything, conservative.

Although maternal night blindness can serve as a good indicator of underlying dietary deficiency in vitamin A, it cannot be used, for obvious reasons, as an indicator for evaluating the success of vitamin A intervention programs targeted at children. Supplementing or otherwise improving vitamin A intake in children may have no effect on the status of their mothers. For this purpose, xerophthalmia, pupillary thresholds and serum vitamin A concentrations in children should be used, all of which directly assess vitamin A status among the children targeted by the intervention programs.

Assessing population prevalence of night blindness during pregnancy

A history of night blindness is easy to elicit, especially when a local term exists for the condition, but the question must be asked in a standardized manner (19). In most settings where vitamin A deficiency is common, a valid local term describing night blindness can be identified. In places where a local term does not exist, descriptions of the symptoms of night blindness, such as poor vision at dusk or nighttime, can be used. Questions about daytime vision rule out other forms of visual impairment. Women with night blindness who also report daytime vision problems should be excluded. Because women are at highest risk of night blindness during pregnancy, asking about night blindness that occurs at any time during pregnancy will provide the longest duration of risk exposure and the lowest recall bias. Because the risk is highest toward the latter half of pregnancy, eliciting a night blindness history once during a current pregnancy, when a woman could be at any gestational age, usually underestimates the true incidence. For example, in Bangladesh the rate of night blindness of a current pregnancy was 2.7%, compared with a rate of 6.7% obtained for a previous, completed pregnancy (12). In Nepal, the rates were 6.1 and 16.7%, respectively (5). Furthermore, the incidence of night blindness among Nepalese women whose pregnancies ended in a stillbirth or a miscarriage was lower than that observed among women who had a live birth as an outcome (4% versus 9%; $p < 0.05$) (P. Christian et al., unpublished data), presumably because they did not experience the full, highest-risk, third trimester. It is proposed, therefore, that among women of reproductive age the history of night blindness be elicited only for the most recent pregnancy that ended in a live birth. To obtain a reasonably current and reliable estimate of the problem, the question probably should be restricted to women of reproductive age who have had a live birth in the past 3 y. Those without a live birth within the past 3 y should be excluded from both the numerator and the denominator, because the criterion relates to the initial incidence of night blindness among women who completed a pregnancy yielding a live birth within the past 3 y. For a more specific history of night blindness, reducing the risk of false-positive cases due to other causes, cases of night blindness also reporting daytime vision problems should be excluded from the numerator and the denominator.

Finally, the sample size required for detecting a prevalence of maternal night blindness of ≥5% with 95% confidence is much lower than the sample needed for finding a prevalence of ≥1% night blindness or ≥0.5% Bitot's spots in children, which makes it a more practical indicator for assessing vitamin A deficiency in the population (20).

In conclusion, a maternal history of night blindness during a recent pregnancy ending in a live birth is a practical, reliable, and valid indicator of vitamin A deficiency in a population. A criterion of ≥5% reliably identifies vitamin A deficiency to be a problem of public health significance in the community.

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