Vitamin A Deficiency

Navigate this Resource

Vitamin A deficiency occurs when there is an insufficient intake of vitamin A—primarily found in milk and breastmilk, eggs, and liver—as well as yellow, orange, and dark green vegetables and fruits—and in fortified foods or supplements. Vitamin A deficiency can also be caused by poor absorption or excessive loss of the vitamin. The role of vitamin A deficiency in causing anemia has not been established with certainty, but it may involve a direct inhibition of red blood cell production. It may also cause anemia through indirect effects, such as increasing risk of **iron deficiency** (/publications/series/understanding-anemia/causes-anemia/micronutrient-deficiencies/iron) by decreasing iron absorption, or increased risk and severity of **infections** (/publications/series/understanding-anemia/causes-anemia/micronutrient-deficiencies/iron) (Balarajan et al. 2011; West, Gernand, and Sommer 2007). Vitamin A deficiency is most prevalent in Africa and South Asia, particularly in young children and pregnant women (Stevens et al. 2015). Vitamin A deficiency can also cause night blindness in pregnant women and children, is the leading cause of preventable blindness in children, and is associated with an increased risk of mortality in children (WHO 2016; Imdad et al. 2011).

How is vitamin A deficiency measured?

The gold standard for assessing vitamin A deficiency is to use isotope dilution testing to measure vitamin A stores in the liver, but because this method requires a liver biopsy, it is not viable for a population-based assessment. Alternatively, the modified relative dose response is an indirect measure of vitamin A stores in the liver. While some countries have used this biomarker to determine population-level vitamin A deficiency, it is not widely used, partly due to commercial availability (WHO 2012).

Circulating retinol is the most commonly used indicator for vitamin A status. It has been associated with functional outcomes of vitamin A deficiency, and generally reflects liver stores when they are depleted. Serum/plasma retinol levels can be determined using a venous blood sample and it requires maintaining a cold chain. Laboratory assessments include high-pressure liquid chromatography (the first choice, with high sensitivity and specificity), fluorescence, and ultraviolet spectrophotometry.

Recently, retinol-binding protein has also been used to measure vitamin A status and has, in some settings, produced similar results to serum retinol (Engle-Stone et al. 2011). Retinol-binding protein is easier to measure than serum retinol from a logistics standpoint, but it has not been validated to the same extent. Either capillary or venous samples can be used; it can be assessed using enzyme-linked immunosorbent assay, which is technically much easier than high-pressure liquid chromatography. Retinol-binding protein is also more stable and requires a lower sample volume that circulating retinol, but commercial assay kits have not been well standardized among manufacturers (WHO 2011).

Other less commonly measured biomarkers include night blindness, dark adoptometry, and breastmilk retinol concentrations. More information on these biomarkers can be found in the Biomarkers of Nutrition for Development-Vitamin A Review in the Journal of Nutrition (Tanumihardjo et al. 2016).

How is vitamin A deficiency categorized?

Vitamin A deficiency is considered to be a severe public health concern when the prevalence of low serum retinol concentrations is greater than 20 percent in a population. Table 6 shows the cut-offs to define a public health problem, which apply to most age groups, excluding infants under 6 months of age. Cut-offs for defining vitamin A deficiency using serum/plasma retinol are defined in Table 6.

Table 6: Severity of Vitamin A Deficiency As a Public Health Problem by Prevalence

	Mild	Moderate	Severe
Prevalence of low serum retinol (≤0.70 micromol/l or below)	2–9%	10–19%	20% or more

Source: WHO 2011

Where can we get these data?

Vitamin A deficiency is measured in population-based surveys and research studies, among women of reproductive age and children. Of the commonly administered population-based surveys, the National Micronutrient Survey is usually the only one that collects and analyzes information on the prevalence of vitamin A deficiency.

Methodological issues

- Consider the season(s) that data were collected, as this may affect the availability of vitamin A–rich foods and result in small shifts in serum retinol concentrations (Balarajan et al. 2011).
- Using dried blood spots to assess serum retinol is not reliable, despite this method still being used in some situations.
- Zinc plays a central role in the synthesis of vitamin A; a **zinc deficiency** (/publications/series/understanding-anemia/causes-anemia/micronutrient-deficiencies/zinc) may cause low levels of retinol in the blood, even if there are adequate stores in the liver.
- Depending on the prevalence of vitamin A deficiency in your country, one or multiple regular mass distribution campaigns for vitamin A supplementation may take place for children under 5 years of age. Collecting data immediately after a mass supplementation campaign might show a lower than normal rate of vitamin A deficiency. If you compare data across years, note the timing of data collection each year, and compare it to the vitamin A distribution campaigns. This will help you avoid identifying changes that are caused more by the vitamin A supplementation campaign than by any long-term change in vitamin A deficiency.
- Serum/plasma retinol is a common, but imperfect, indicator of vitamin A status. At marginal to sufficient vitamin A status, it is considered a poor indicator of the status of individuals because it is homeostatically controlled and does not reflect liver stores until vitamin A reserves drop to dangerously low levels or approach toxic levels. Circulating retinol can be affected by liver function, infection, and other nutritional deficiencies. Retinol declines during episodes of infection, as well as during protein and zinc deficiencies. Thus, assessing the vitamin A status of populations where infections or inflammation are common may overestimate the amount of “actual” vitamin A deficiency—as some low retinol may be ascribed to these other conditions.
- Approaches have been developed to adjust serum/plasma retinol and retinol-binding protein concentrations. A consensus has not been reached on the specific adjustment approach. The three types of approaches currently proposed are—
    1. Exclude individuals with elevated inflammation from calculations of vitamin A deficiency (Bresnahan and Tanumihardjo 2014),

2. Use a categorical correction factor (Thurnham et al. 2003),
3. Use a regression correction (Namaste et al. forthcoming).

Verify if any adjustment approach was used to determine vitamin A deficiency when using serum/plasma retinol and retinol-binding protein concentrations. If it was not used, note this in your limitations and recognize that vitamin A deficiency is likely a smaller problem than your data indicates. If you have the raw data available, you must apply these adjustments. Present both adjusted and unadjusted prevalence levels.

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