How to Assess the Zinc Status of a Population

Janet C. King, Ph.D.

Senior Scientist, Children's Hospital Oakland Research Institute

Professor, University of California at Berkeley and Davis

The Challenge:

Zinc is one of the most prevalent nutrient deficiencies world-wide.

YET---

- **No specific biomarker of zinc status**
- **Hinders zinc public health interventions**

Why isn’t there a specific biomarker of zinc status?

Zinc is a Type 2 Nutrient

Golden, M.H. SCN News 1995; (12): 10-14.

Nutrient deficiencies and growth:

- **Type 1: Growth continues by consuming body reserves and then functional forms of the nutrient.**

  Examples: Most of micro-nutrients: iron, selenium, copper, vitamin C, vitamin A, folate

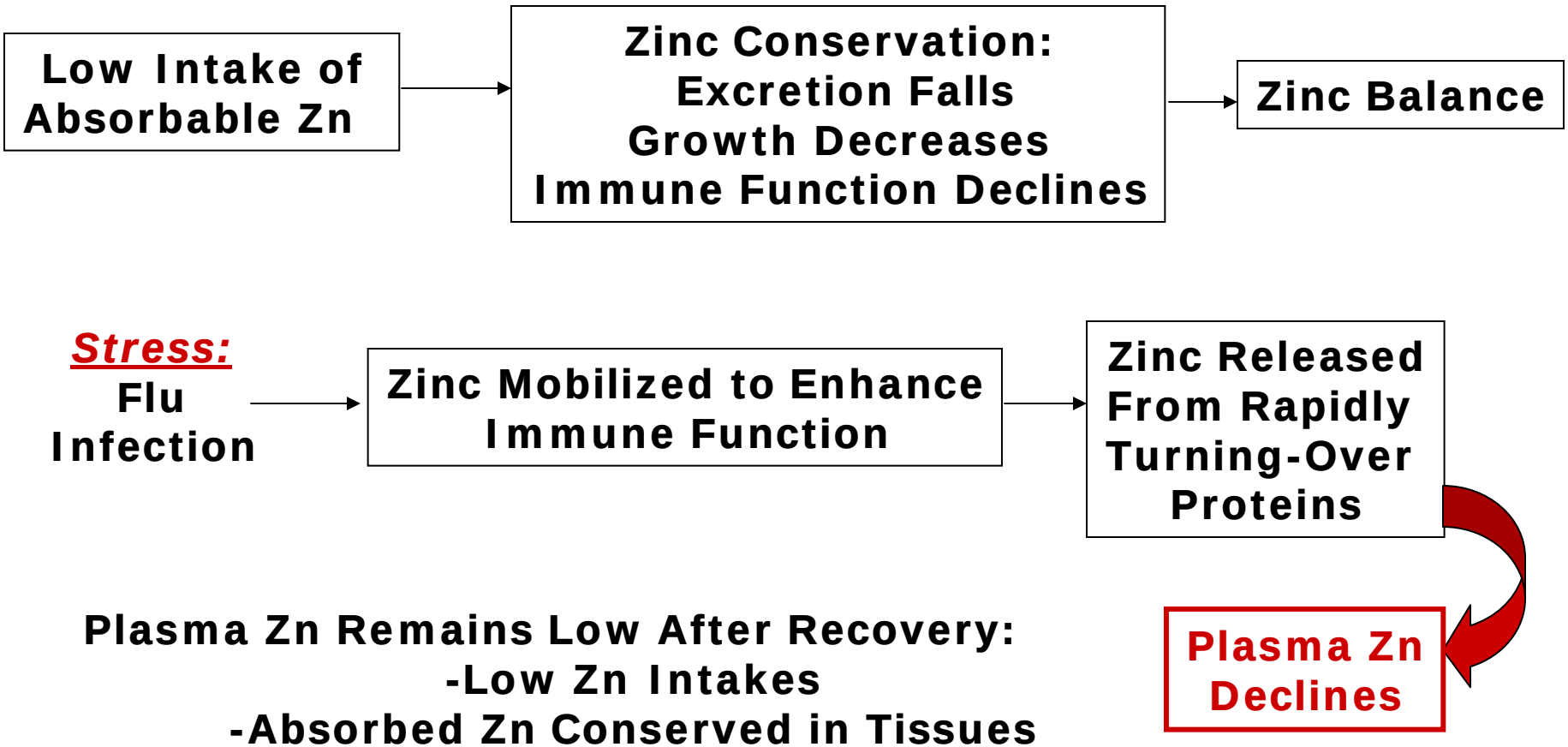
  Assessment of status: biochemical markers

- **Type 2: Growth stops to avidly conserve the nutrient to maintain tissue concentrations and functions**

  Examples: Protein, potassium,and zinc

  Assessment of status: anthropometric changes (stunting)

Development of Human Zinc Depletion



Symptoms of Zinc Depletion

Clinical signs—general, non-specific

- **Poor growth or stunting**
- **Decreased immune function or increased infection**

Low Endogenous Fecal Zinc

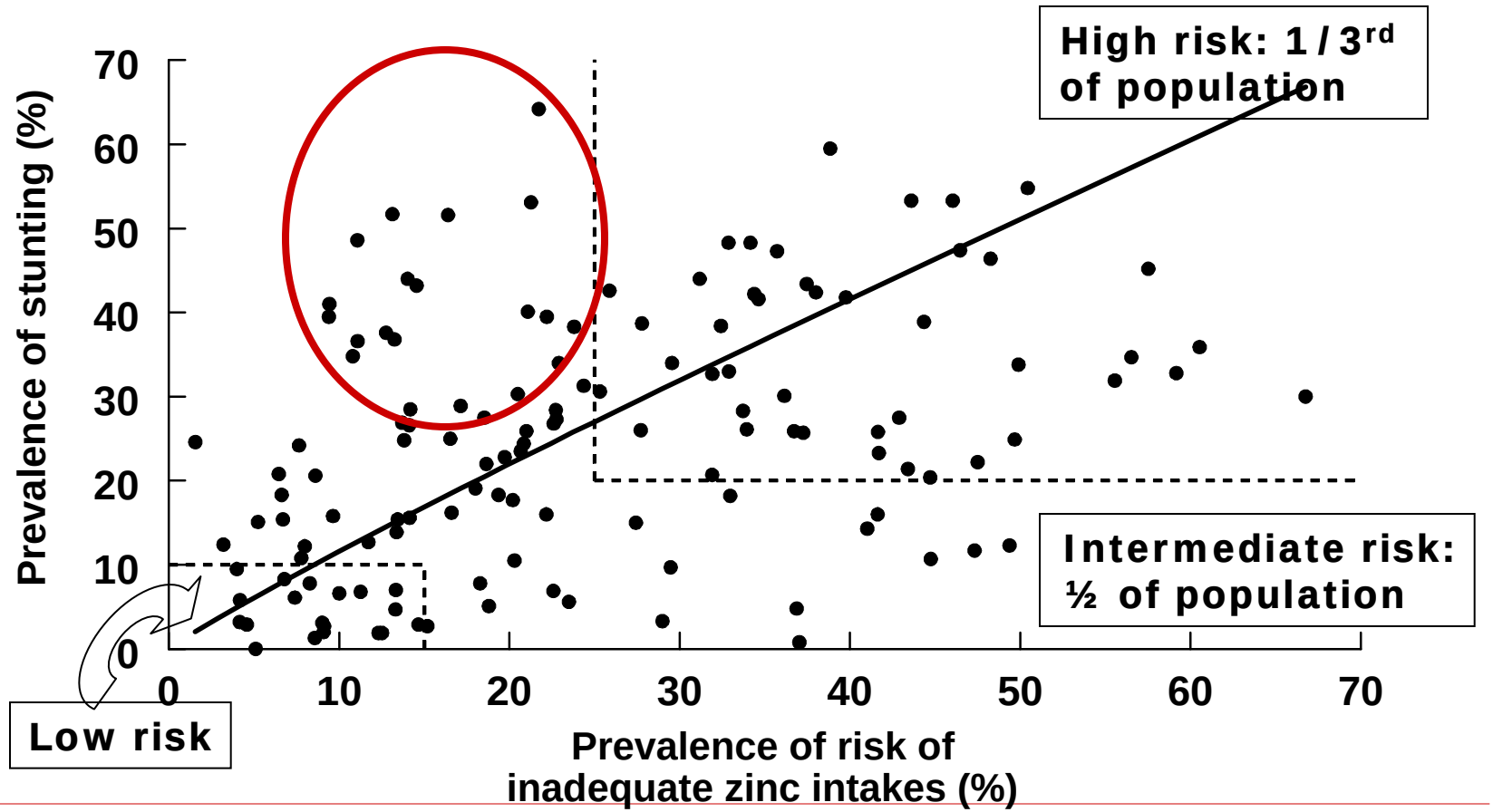
Low Serum Zinc Concentrations

- **Exchangeable zinc pool size also decreases, but more slowly than serum zinc**

Components of Zinc Assessment

- Intake of Absorbable Zinc
- Stunting
- Serum Zinc Concentration

Inadequate Zinc Intakes and Stunting are Related ($r^2 = 0.37$, $p<0.001$)



From: IZiNCG. Food and Nutrition Bulletin. 2004; 25:S94.

Low Serum Zinc *Confirms* the Presence of a Zinc Deficiency in a Population

If funds are limited, could focus on high risk groups:

- **Infants, children**
- **Pregnant women**

Few countries collect serum zinc data:

- **Those data are essential for explaining the cause(s) of stunting**

Criteria for Identifying Populations at Risk for Zinc Deficiency

- Based on data from USA NHANES Survey
- Cut-off: 2.5th percentile
- High risk: >20% of population below the cut-off

	Serum Zinc, μg/dl			
Age	<10 yr	≥ 10 yr		
	Children	Females		Males
		Non-Preg	Pregnant	
AM-Fasting	na	70	Tr 1: 56 Tr 2&3: 50	74
AM-Other	65	66		70
PM	57	59		61

Hotz, C et al., AJCN. 2003

Beware of Physiological States that Lower Serum Zinc

- **Infection**
  - Serum zinc is mobilized to the liver & bone marrow for immune function
  - Serum C-reactive protein—a biomarker for infection
- **Hypoalbuminemia**
  - Albumin transports ~ 65% of serum zinc
  - Conditions lowering albumin: severe malnutrition, cachexia, acute infection, sepsis, liver cirrhosis, cancer
- **Hemodilution (plasma volume expansion)**
  - Pregnancy
  - Steroids/oral contraceptives
  - Over hydration
- **Food Intake**

Avoid Falsely Increased Serum Zinc Values

- **Hemoconcentration**
  - Dehydration
  - Applying the tourniquet for >1 minute
- **Hemolysis**
  - Weaken blood cell membranes—Sickle cell disease
  - Blood cells lysis during blood draw
  - Serum separation delayed >1 hr; can reduce with refrigeration
- **Contamination**
  - Avoid rubber; use polyethylene tubes & stoppers
  - For plasma zinc, be sure anti-coagulant is zinc-free
  - Acid-wash all equipment
  - Cover/seal all tubes, materials, and equipment

Other Potential Zinc Biomarkers

- **Urinary Zinc**
  - Increases with supplemental zinc
  - No evidence of a decline with low zinc intakes
- **Hair Zinc**
  - Increases with supplemental zinc
  - May decline in children with chronic marginal zinc deficiency

Lowe, NM et al., AJCN. 2009

When should zinc interventions be considered?

1. **Low Absorbable Zinc Intake:**
   - **>25% of population below mean requirement**
2. **Stunting:**
   - **>20% of children under 5 years have Ht/Age Z-scores below -2**
3. **Serum zinc:**
   - **>20% of population below cut-off values**

IZiNCG Technical Document #1, Food & Nutrition Bulletin. 2004

Unanswered Questions

- **Zinc dose?**
  - **Consider amount provided by usual diet**
  - **Avoid nutrient-nutrient interactions**
  - **Potential range: 5-15 mg/d**
- **Zinc form and mode of administration?**
  - **With or without food**
  - **Supplement/fortificant/diet modification**
- **How to assess immune function in a field setting?**

References

IZiNCG Technical Bulletins

#1—Zinc assessment

#2—Serum zinc measurement

#3—Assessing zinc intake

Available from IZiNCG Website:

www.izincg.org