How to Assess the Zinc Status of a Population

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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

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

Low Intake of Absorbable Zn → Zinc Conservation: Excretion Falls Growth Decreases Immune Function Declines → Zinc Balance

Stress: Flu Infection → Zinc Mobilized to Enhance Immune Function → Zinc Released From Rapidly Turning-Over Proteins

Plasma Zn Remains Low After Recovery: -Low Zn Intakes -Absorbed Zn Conserved in Tissues
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
$(r^2 = 0.37, \ p<0.001)$

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

<table>
<thead>
<tr>
<th>Age</th>
<th>Serum Zinc, μg/dl</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>&lt;10 yr</td>
<td>≥ 10 yr</td>
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<tr>
<td></td>
<td></td>
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<td>Females</td>
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<td>Pregnant</td>
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<tr>
<td>PM</td>
<td>57</td>
<td>59</td>
<td>61</td>
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</tbody>
</table>

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?
IZiNCG Technical Bulletins

#1—Zinc assessment
#2—Serum zinc measurement
#3—Assessing zinc intake

Available from IZiNCG Website:
www.izincg.org