The relationship between declining marine diet in childbearing women and vitamin D deficiency and rickets in Alaska Native infants

Alaska Native Health Research Conference
Oct 17, 2017

Rosalyn Singleton MD MPH
ANTHC, Community Health Services
risingleton@anthc.org
Objectives

• Describe link between low prenatal vitamin D and risk of rickets in infants

• Identify relationship between decline in traditional food intake and lower vitamin D levels in childbearing women

• Discuss national recommendations for vitamin D supplementation in infants and prenatal women
What is Vitamin D?

- Vitamin D is an essential fat-soluble vitamin that is produced in the skin when ultraviolet sunlight contacts the skin and causes vitamin D synthesis.

- It is also naturally present in some foods, like oily fish (e.g., salmon, mackerel, and tuna).

- Vitamin D promotes bone health by maintaining adequate levels of calcium and phosphorus.

- Vitamin D deficiency is known to cause bone disorders, including rickets in children and osteomalacia in adults.
# Vitamin D content of Seafood

*Salmon has one of the highest vitamin D contents of any food.*

## Subsistence Foods

<table>
<thead>
<tr>
<th>Item</th>
<th>Vitamin D Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmon, fresh wild (3.5 oz)</td>
<td>600-1000 IU Vit D</td>
</tr>
<tr>
<td>Sockeye Salmon, canned (3 oz)</td>
<td>715 IU Vit D</td>
</tr>
<tr>
<td>King Salmon, with skin, kippered (3 oz)</td>
<td>44 IU Vit D</td>
</tr>
<tr>
<td>Beluga Whale Oil</td>
<td>51 IU Vit D</td>
</tr>
<tr>
<td>Seal Oil (100g)</td>
<td>30 IU Vit D</td>
</tr>
</tbody>
</table>

## Other SeaFood

<table>
<thead>
<tr>
<th>Item</th>
<th>Vitamin D Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Codliver oil (1 tsp)</td>
<td>400-1000 IU Vit D</td>
</tr>
<tr>
<td>Canned tuna (3.5 oz)</td>
<td>236 IU Vit D</td>
</tr>
<tr>
<td>Sardines canned (3.5 oz)</td>
<td>300 IU Vit D</td>
</tr>
</tbody>
</table>

Nutrient Values of Alaska Native Foods, Nobmann E, Alaska Area Native Health Service, December 11, 1992
## Vitamin D content of Fortified Food

<table>
<thead>
<tr>
<th>Fortified Milk</th>
<th>100 IU/8 oz, usually vitamin D₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fortified orange juice</td>
<td>100 IU/8 oz vitamin D₃</td>
</tr>
<tr>
<td>Infant formulas</td>
<td>100 IU/8 oz vitamin D₃</td>
</tr>
<tr>
<td>Fortified yogurts</td>
<td>100 IU/8 oz, usually vitamin D₃</td>
</tr>
<tr>
<td>Fortified butter</td>
<td>56 IU/3.5 oz, usually vitamin D₃</td>
</tr>
<tr>
<td>Fortified margarine</td>
<td>429 IU/3.5 oz, usually vitamin D₃</td>
</tr>
<tr>
<td>Fortified cheeses</td>
<td>100 IU/3 oz, usually vitamin D₃</td>
</tr>
<tr>
<td>Fortified breakfast cereals</td>
<td>~100 IU/serving, usually vitamin D₃</td>
</tr>
</tbody>
</table>
Vitamin D deficiency and Rickets

• Rickets – failure of bone mineralization
  – A state of extreme vitamin D deficiency in growing infants/children
  – Soft bones, bowed legs, seizures from low calcium

• Risk factors—low dietary intake and sun exposure
  – Darker skin color
  – Limited foods high in Vitamin D: salmon, whale, seal, dairy
  – Northern latitudes (sunlight is best source of Vitamin D)
  – Breastfeeding exclusively without Vitamin D supplement
Vitamin D: Non-Bone Effects?

• Recently, many single observational studies have shown associations between vitamin D deficiency and many non-bone health outcomes.
  – Like cancer, cardiovascular disease, depression, diabetes, prematurity, etc.

• A review of hundreds of studies don’t support most associations:
  – Observational studies: association only consistent for birth weight
  – Supplement studies: Failed to confirm associations. Probable association only for birth weight, child dental cavities, women’s vitamin D level at term

Theodoraou E. Vitamin D and multiple health outcomes...BMJ 2014:348:1-19.
What Vitamin D Levels are healthy?  
(25-hydroxyvitamin D (25[OH]D) concentrations)

<table>
<thead>
<tr>
<th>Serum Level</th>
<th>Health Impact in Healthy Persons</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;30 nmol/L</td>
<td>&lt;12 ng/mL</td>
</tr>
<tr>
<td>30-&lt;50 nmol/L</td>
<td>12-&lt;20 ng/mL</td>
</tr>
<tr>
<td>≥50 nmol/L</td>
<td>≥20 ng/mL</td>
</tr>
</tbody>
</table>

Institute of Medicine Report on Vitamin D, 2011
Vitamin D Supplementation – Infants

- American Academy of Pediatrics Guidelines:
  - Supplement with 400 IU Vitamin D/day
    - All breastfed or partially breastfed infants
    - Non-breastfed infants who take <24 ounces/day of vitamin D fortified milk/formula

Vitamin D intake for Pregnant Women

Pregnant women should receive 600 IU/d of Vitamin D.

– Prenatal vitamins contain 400 IU of Vitamin D
– Calcium supplements contain 200 IU of Vitamin D

Munns CF, Global Consensus on Rickets Prevention JCEM 2016

Routine screening not recommended

– Women who are Vitamin D deficient should receive 1000-2000 IU of Vitamin D supplements

American College of Obstetricians and Gynecologists, Committee Opinion, Number 495, 2011.
Study: Rickets and Vitamin D Deficiency in Alaska Native Children

Background:
- Increasing reports of vitamin D deficiency and rickets in Alaska Native children led ANTHC providers to conduct an epidemiologic study.

Methods:
- Analysis of rickets hospitalizations in Alaska Native children and US child population
- Case control study of Alaska Native children with rickets/vitamin D deficiency and matched controls

Institutions:
- Alaska Native Tribal Health Consortium
- Arctic Investigations Program – CDC

Investigators:
- Rachel Lescher MD
- Rosalyn Singleton MD et al
Results: Rickets in Alaska Native children

- Rickets visits/diagnosis **more common in Alaska Native children** than in other US or American Indian children

- Rickets diagnosis increased with:
  - Increasing latitude
  - Diagnosis of malnutrition

- Rickets/vitamin D deficiency occurred in both breastfed and formula fed infants

- Rickets/vitamin D deficiency more common in infants who didn’t take vitamin D supplements

**Confirms the importance of AAP recommended vitamin D supplementation of infants**
Serologic Survey of Biomarkers for Traditional Marine Diet and Vitamin D Levels in YK Delta Childbearing-aged Women

Investigators include
• Diane O’Brien PhD, Center for AK Native Health Research (CANHR)
• Rosalyn Singleton MD, ANTHC
• Joseph Klejka MD, YKHC

Objective: Explore how intake of traditional marine foods and serum Vitamin D levels have changed in YK women from 1960’s through the present

Method: Test Specimen Bank serum samples of YK Delta women 20-29 years old at points from 1960s to 1990s, for biomarkers of traditional marine diet ($\delta^{15}$N) and 25-OH vitamin D levels
A Biomarker of Traditional Marine Food Intake – $\delta^{15}\text{N}$

- Fish and marine mammals are naturally enriched in the heavy stable isotope of nitrogen

- As fish and marine mammal intake increases, so does the nitrogen isotope ratio ($\delta^{15}\text{N}$) in blood and hair

- A person with no marine diet intake would have a $\delta^{15}\text{N}$ of ~8‰

- An Alaska Native elder with high marine diet intake might have a $\delta^{15}\text{N}$ of ~12-15‰

Validated by Diane O’Brien’s group at UAF (CANHR)
Serum Vitamin D and traditional marine diet intake, YK Delta women, 20-29 yrs, 1960s-2010s

- Traditional diet decreased during 1960-1990s

- This was correlated with a decrease in Vitamin D levels

Fig 2
Summary

• Vitamin D is critical to bone health
• Sunlight is important source of Vitamin D
• In Alaska, salmon and oily fish are important Vitamin D sources
• Traditional marine diet has decreased in Alaska Native women – increasing risk of rickets in their infants
• Infants need Vitamin D supplementation to prevent rickets
• Pregnant women need prenatal vitamins to prevent infant rickets
Acknowledgements

Thank you!

Rickets study
• Rachel Lescher MD
• Robert Holman MS
• Bradford Gessner MD
• Timothy Thomas MD
• Thomas Hennessy MD
• Matthew Benson MD
• John Rosenfeld MD
• Dana Haberling
• Lisa Bulkow MS
• Anthony Kretz
• Gail Thompson RN
• James Tiesinga MD
• Michael Bruce MD

Marine Biomarker Study
• Diane O’Brien PhD, Center for AK Native Health Research (CANHR)
• Rosalyn Singleton MD, ANTHC
• Joseph Klejka MD, YKHC
• Bert Boyer (CANHR)
• Ken Thummel (U Washington)
• Lisa Bulkow (AIP-CDC)