# Understanding Nutrient Variability: Impact on Public Health

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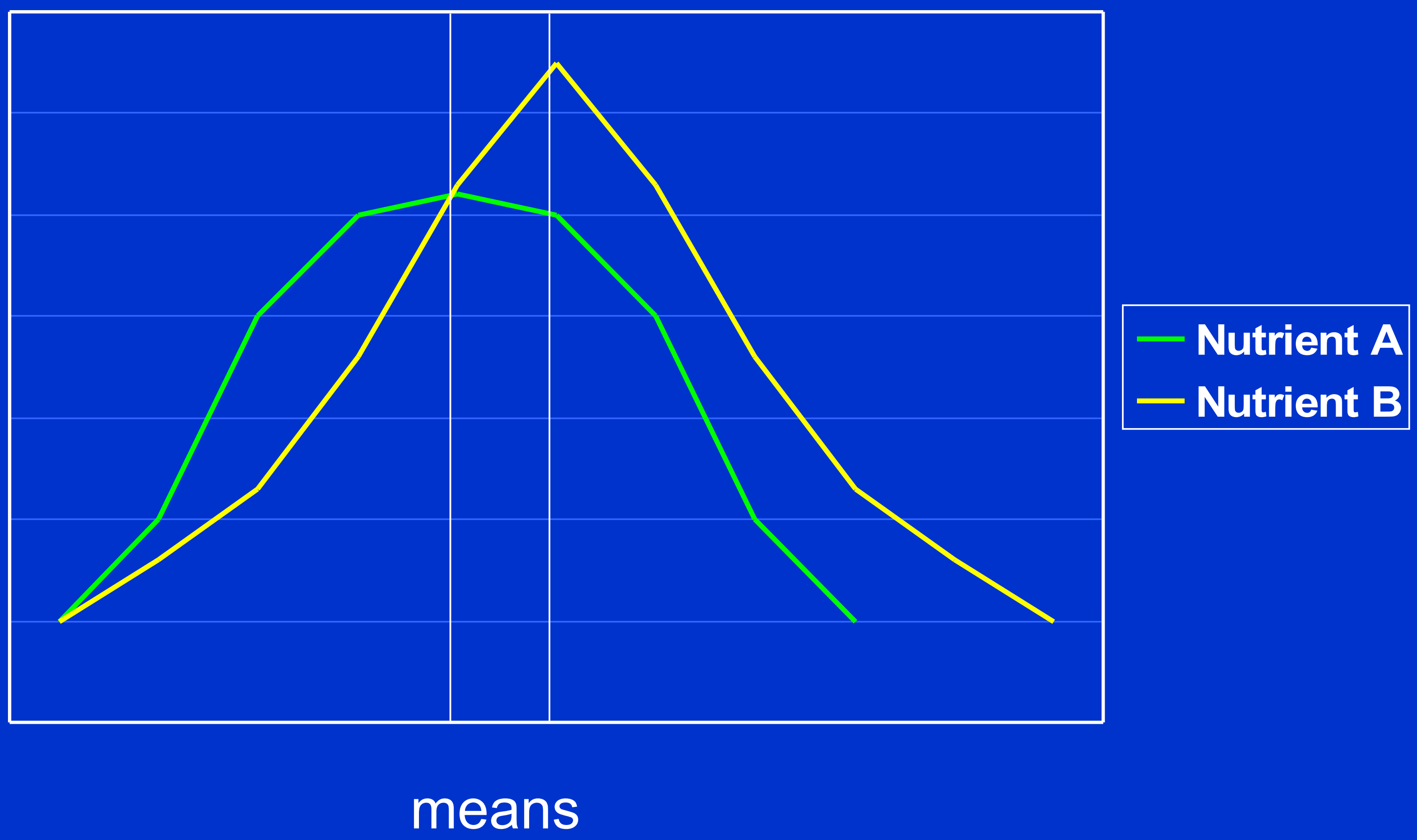
# Potential Sources of Nutrient Variation

- Genetic makeup, cultivar, breed
- Growing conditions (climate, soil, fertilizer)
- Butchering process/feed
- Transport and storage conditions
- Cooking and heating
- Location to location, purchase, preparation
- Brand to brand, reformulations within brand
- Fortification
- Nutrient stability and shelf-life
- Differences among analytical methods
- Intra-lab and inter-lab differences

# Why are Variability Estimates Important?

- Nutrients
  - Critical to assessment of intake (DRI, UL)
  - Nutrient intolerances
  - Data needs
    - New foods or versions of foods
    - New nutrients
- Determination of sample size for nutrient monitoring

# Nutrient Variability and Intakes: Bias and Distribution

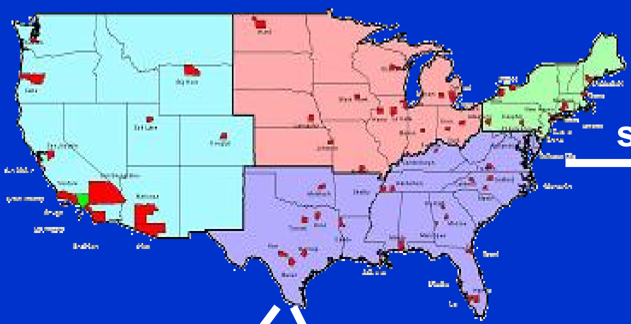


# Severity of Impact: Public Health

- Number of foods containing the nutrient
- Nutrient level in foods
- Variability of nutrient
- Dietary patterns

# Sampling: Fluoride Study

**72 Counties** Municipal Water



select ½ counties

**32 Counties**

Retail beverages:

Juices: 10% and 100%

Carbonated beverages

Tea (for brewing)

Beer

**Location A** **Location B**

**144 homes**

**Time 1** **Time 2** **Time 1** **Time 2**

**288 pickups/samples**

select ½ counties

**18 Counties**

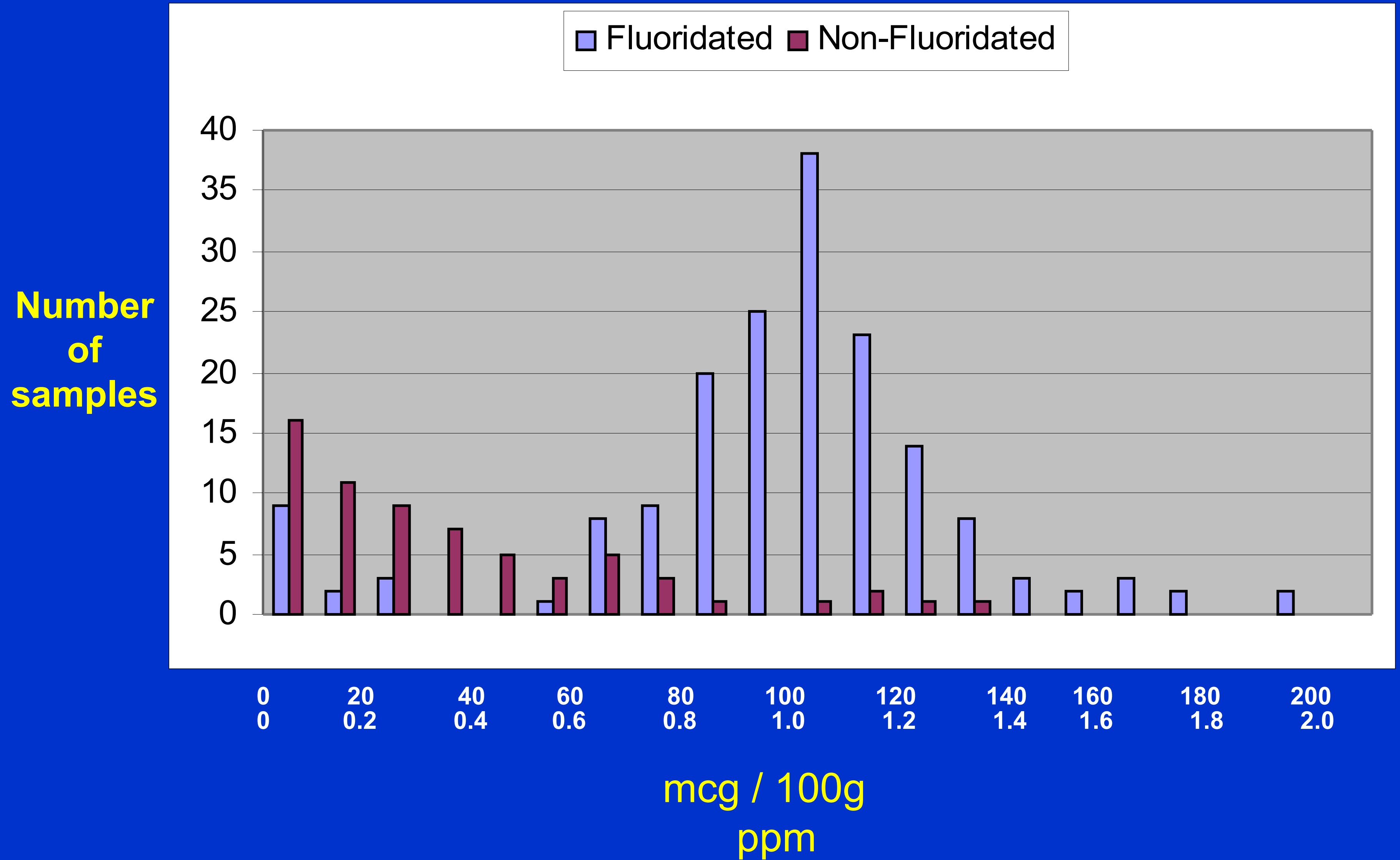
**Wine**

variable number

**NFNAP samples**

**Archived/new foods**

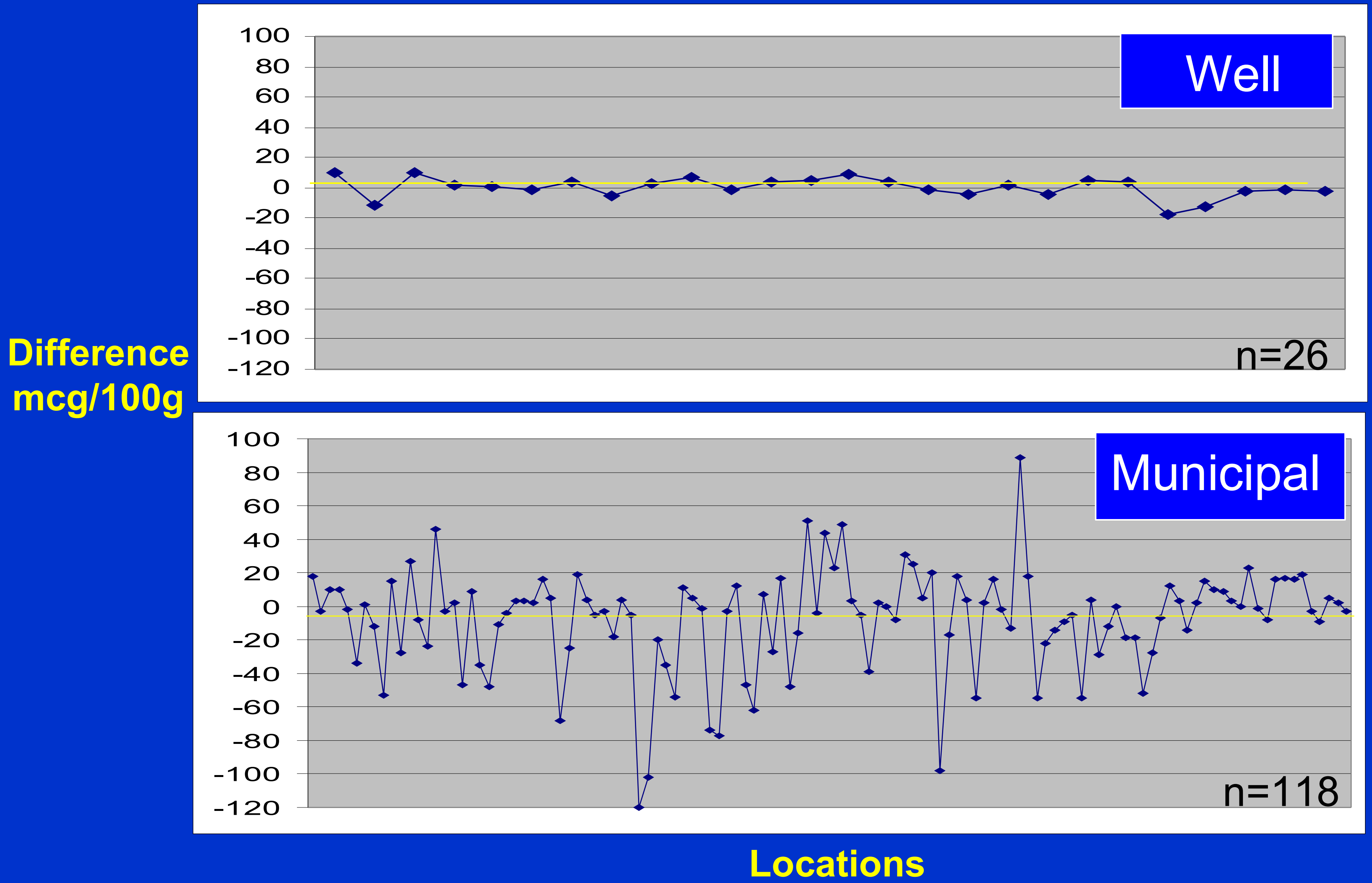
# Fluoride in Municipal Water



# Fluoride: Bottled Water v. Tap Water

- Bottled waters
  - 11 brands from 12 locations across U.S.
  - 15.9 ± 21 µg/100 g water
  - Range: 2 – 78 µg/100 g water
- Municipal water[1]
  - 118 U.S. homes
  - 2 seasons each (n=238)
  - Municipal 82 ± 45 µg/100 g water
  - Range: 2-193 µg/100 g water

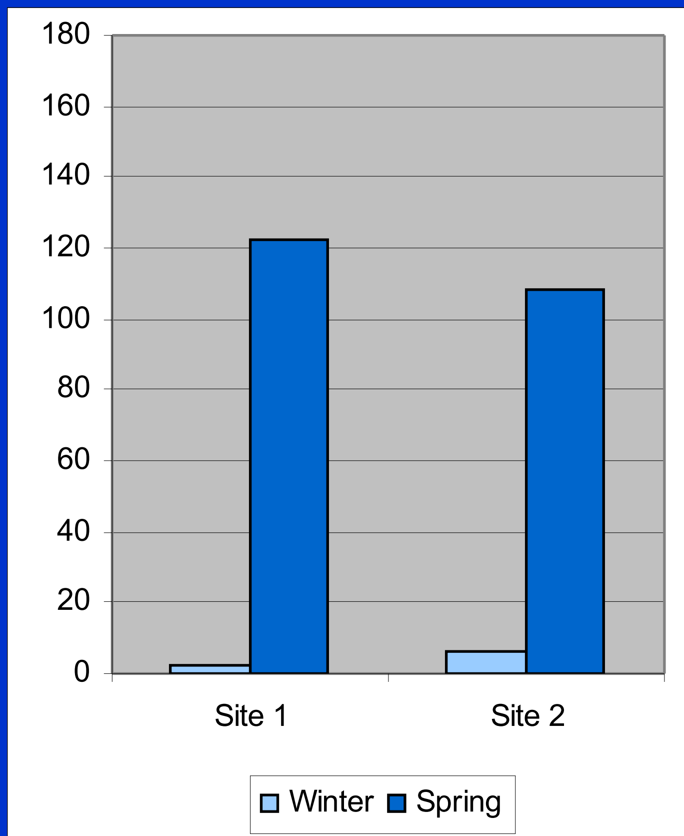
# Fluoride Differences over Time by Site



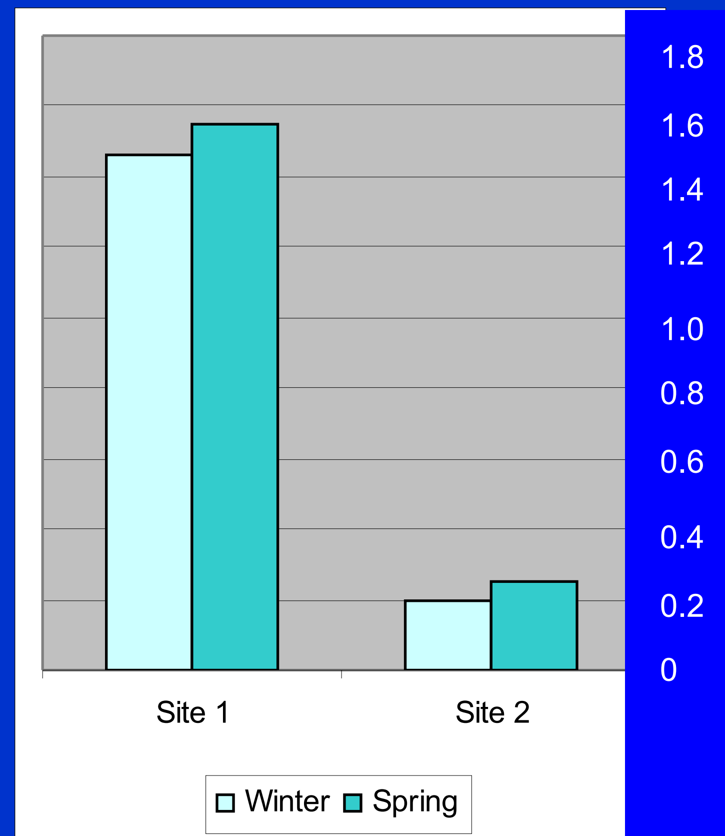
# Variation of Fluoridation in Tap Water

*PWS fluoridation* *Household*

**mcg /100g**



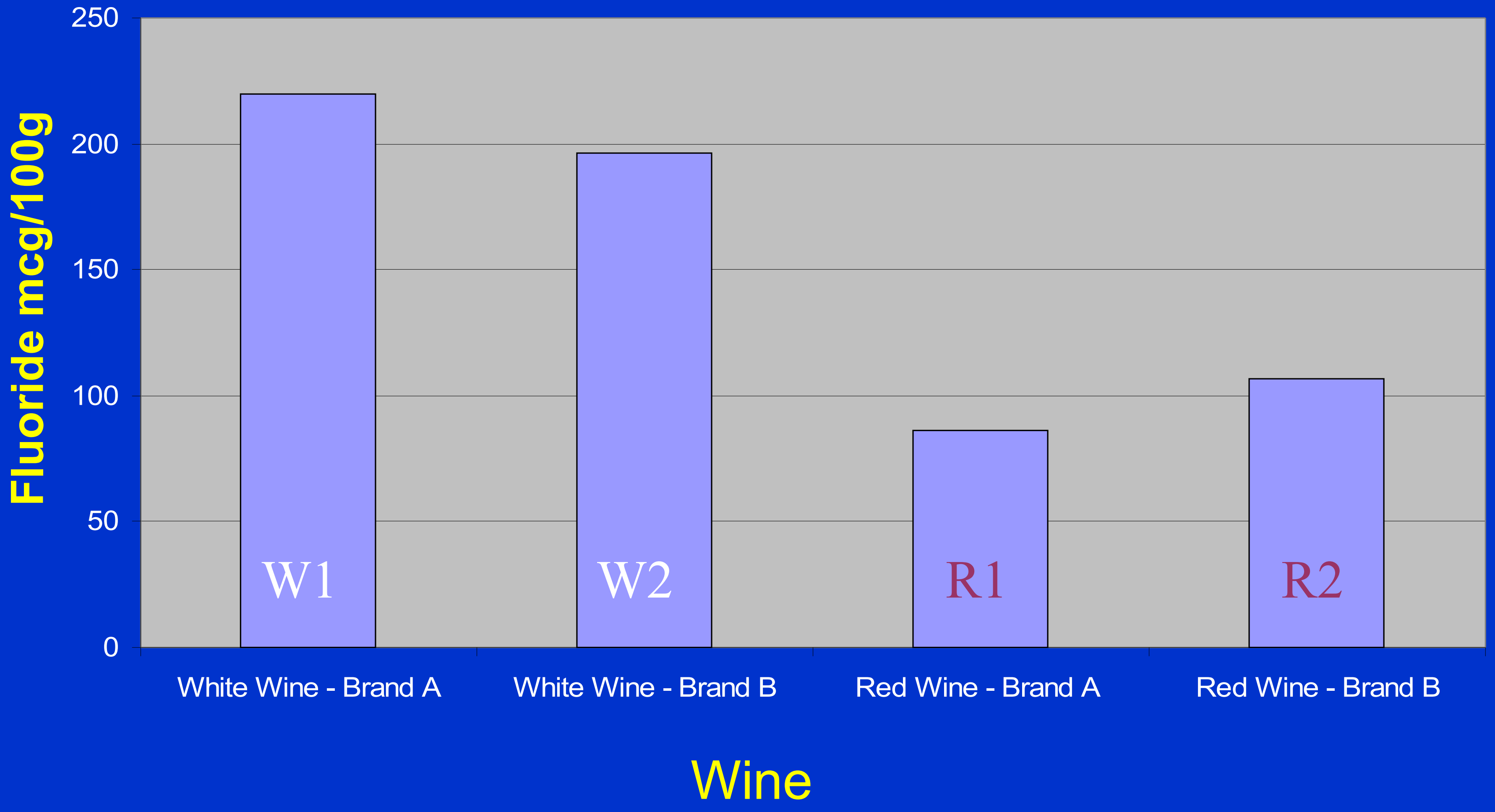

Bronx, NY




**ppm**

Kerrville, TX

# Fluoride in Red and White Domestic Wine



# NFNAP Variability Estimates

- Across composites: most samples
- Serving to serving: select foods and nutrients
  - High consumption foods (white bread, milk, eggs, flour, pizza)
  - Little or no variability information (phytonutrients, fluoride)

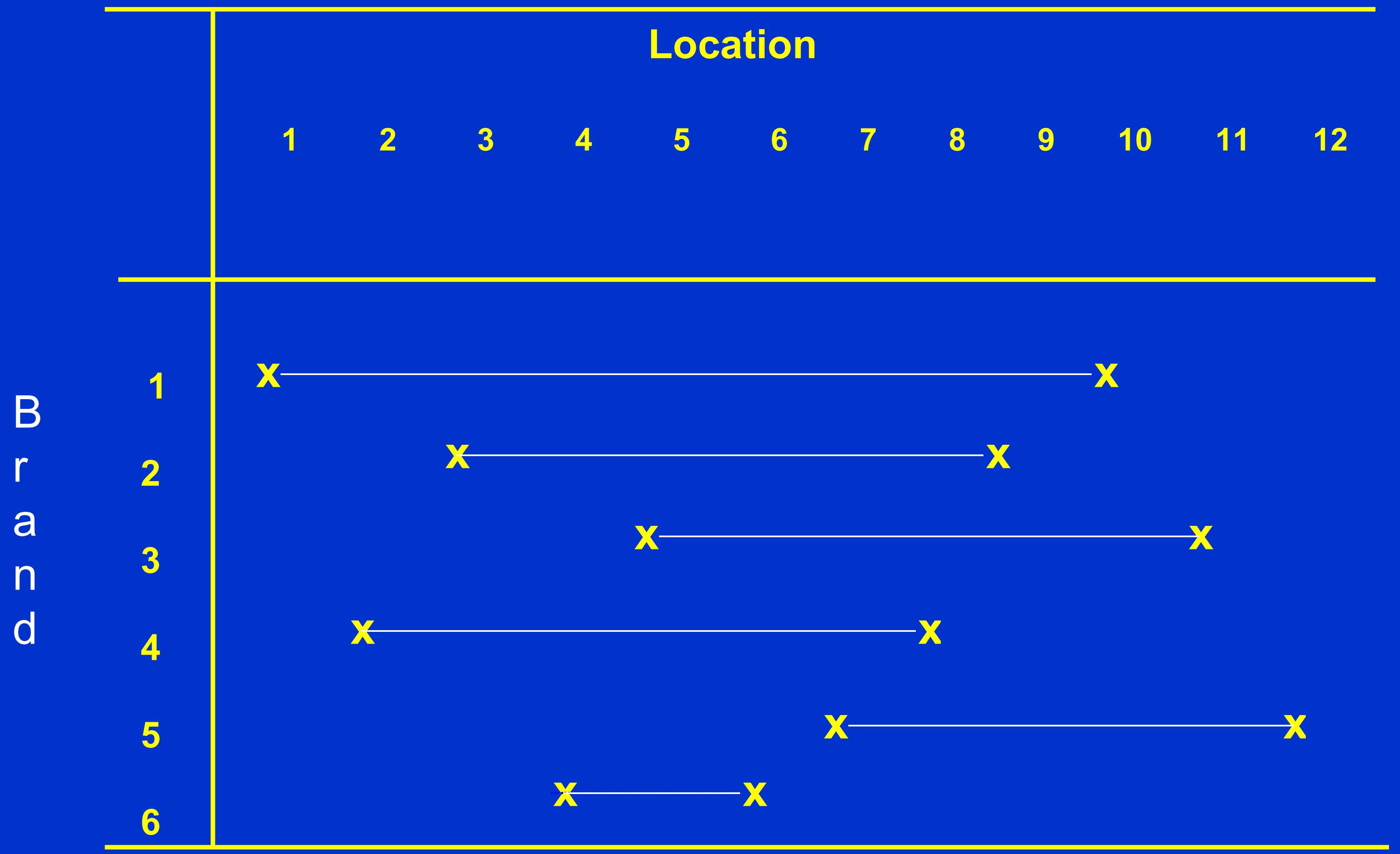
# NFNAP Compositing Scheme[1]

| Primary Sample | Outlets: location 1 | location 2 >>>>>>>>>>>> location 11 | location 12 |
|---|---|---|---|
| 1 | → | → | → |
| 2 | → | → | → |
| 3 | → | → | → |
| 4 | → | → | → |
| 5 | → | → | → |
| 6 | → | → | → |

**1 Theoretical sample size of 6 x 12 = 72.**

SE = variability across composites

# Serving-to-serving Variability in Select Foods and Nutrients*:




*Variability from geographic pairing, across brands or within brands

# White Bread: Composites vs SVs

| Nutrient | Mean ± se Composites (n=8) [1] | Mean ± sd SVs (n=16) | SSB/SSTOT [2] (%) |
|---|---|---|---|
| Protein (g) | 7.64 ± 0.03 | 7.48 ± 0.22 | 50.4 |
| Fat (g) | 3.29 ± 0.04 | 3.49 ± 0.33 | 28.5 |
| CHO, by difference (g) | 50.61 | 50.52 | 51.7 |
| Water (g) | 36.44 ± 0.13 | 36.57 ± 1.26 | 61.2 |
| Fe [3] (mg) | 3.74 ± 0.12 | 3.78 ± .58 | 52.5 |
| Thiamin [3] (mg) | .46 ± 0.02 | .41 ± .07 | 16.5 |

[1] One composite includes 12 sites; theoretical sample size of 96.

[2] SSB = sum of squares between locations; SSTOT = total variance.

[3] Fortification nutrients.

# Whole Eggs: Location-to-location and Lab-to-lab Variability [1]

| Nutrient | p < | Mean ± se (per 100 g) |
|---|---|---|
| Fat (g) | .21 | 9.93 ± .14 |
| Cholesterol (mg) | .313 | 423 ± 23 |
| Na (mg) | .631 | 140 ± 1 |
| Fe (mg) | .0002 | 1.83 ± .04 |
| Zn (mg) | .0001 | 1.11 ± .05 |
| Folate (ug) | .0001 | 47 ± 4.0 |

[1] Store brand eggs in carton, composited samples from 12 locations, 2 qualified NFNAP labs conducted analysis.

# Fast Foods, SV Sampling

- Hamburgers, chicken tenders/nuggets, French fries from 3 national chains in 12 locations
- 27 nutrients
- ANOVA
- Across fast food chains
- Serving-to-serving variability

# Fast Foods: Geographic Differences[1]

- French fries - 11 nutrients
  - Protein, several minerals (excludes Na), 2 FA
- Hamburgers - 5 nutrients
  - Fe, Mg, K, Na, Mn (minerals only)
- Chicken nuggets - 10 nutrients
  - 4 minerals (e.g., Na, Fe) and 6 FA

[1] ($p<.05$)

# Food and Nutrient Changes: Folate

- New DRIs
- Legislation to fortify grain products
- Specific forms of folate (natural and folic acid)
- Forms of total folate

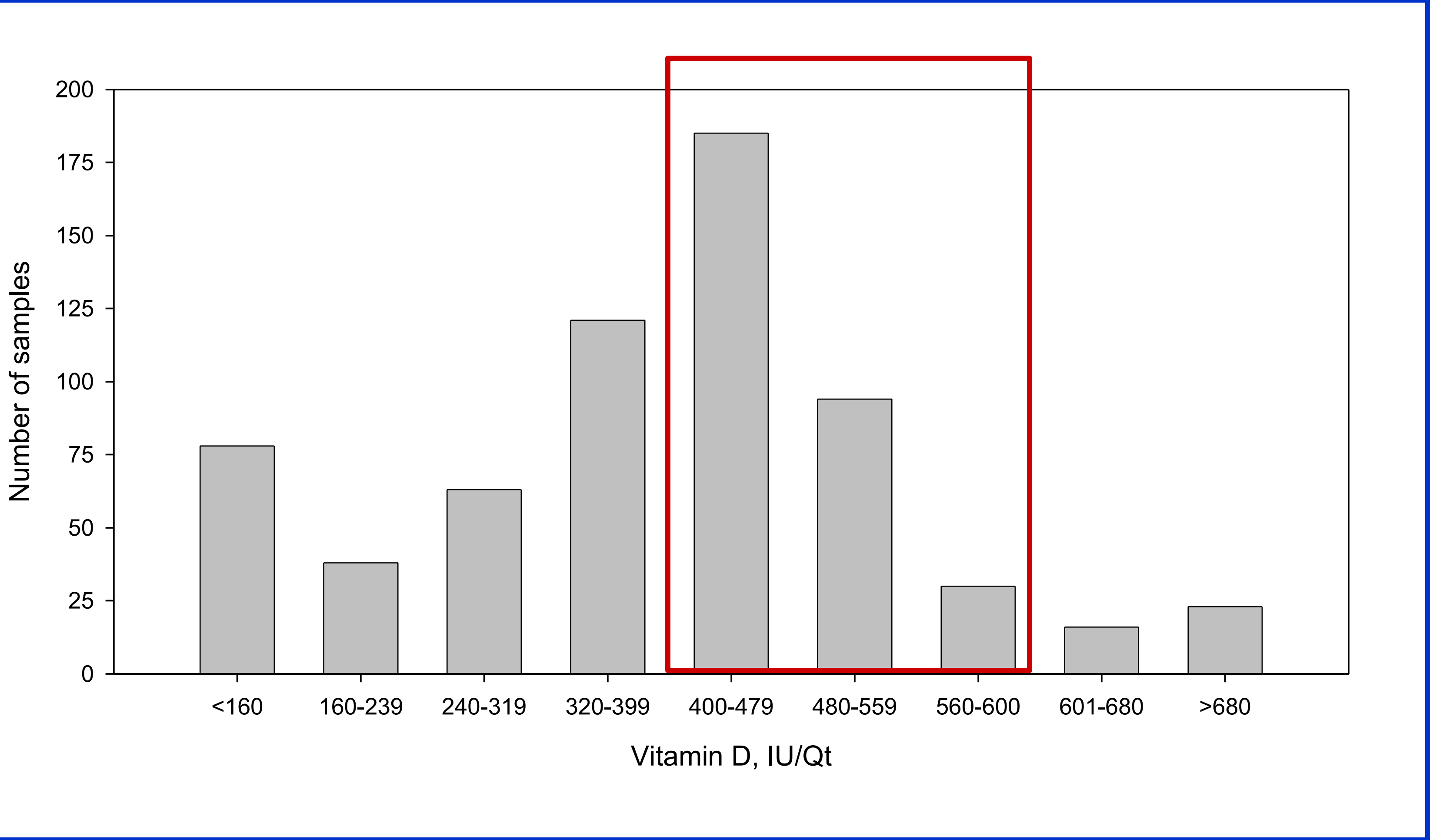
# Total Folate in Enriched Flour, Cornmeal and Spaghetti (:   g /100g)

| Food | Total folate mean ± sd | n | Min | Max | Food folate[1] mean | DFE |
|---|---|---|---|---|---|---|
| Retail flour | 183 ± 6 | 9 | 160 | 203 | 29 | 291 |
| Industrial flour[2] | 170 ± 6 | 27 | 77 | 248 | 31 | 268 |
| Cornmeal | 215 ± 22 | 34 | 72 | 387 | 30 | 345 |
| Spaghetti, unckd | 237 ± 72 | 16 | 143 | 492 | 18 | 391 |

[1] Food folate value reflects level before enrichment.

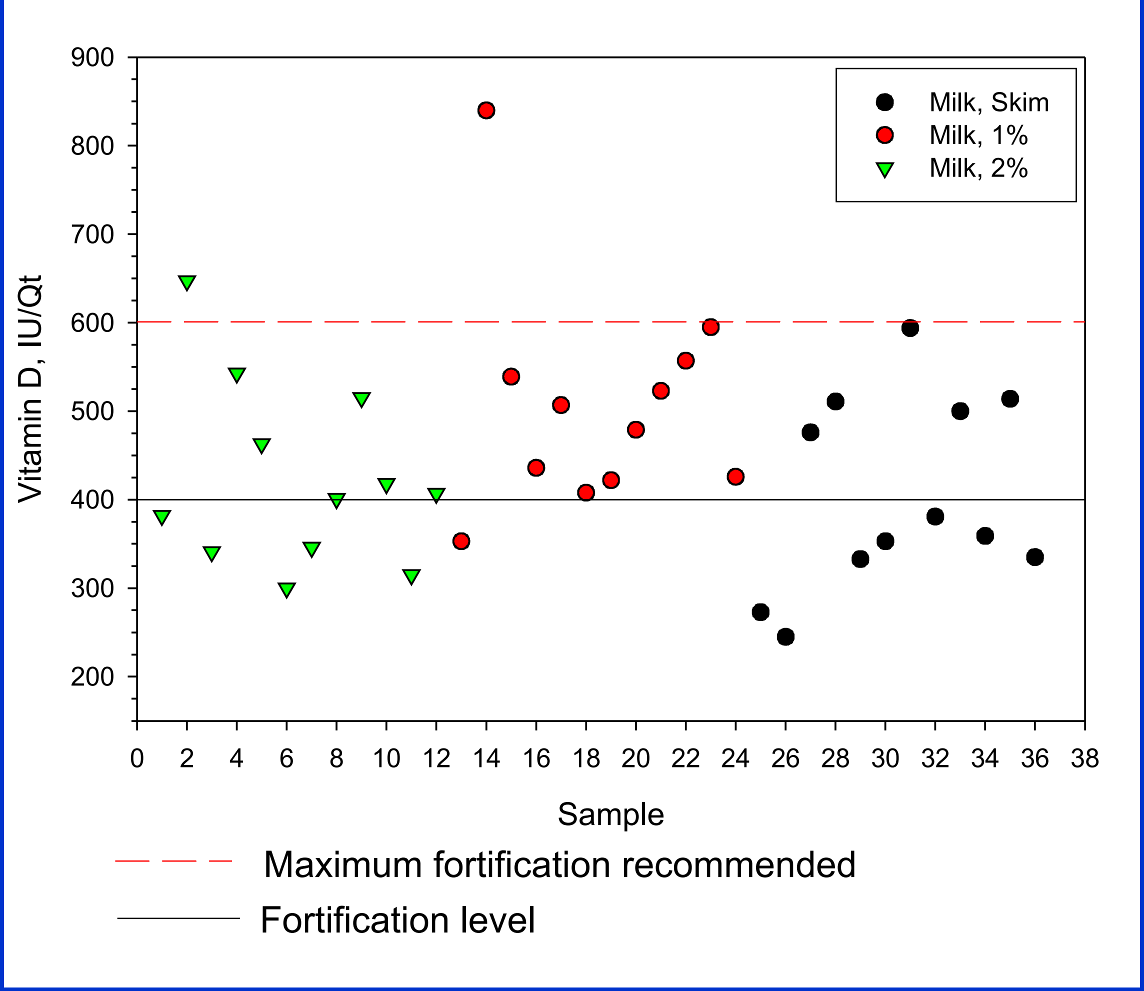
[2] Sampled from flour mills.

# Vitamin D in New York Milk Samples[1] 1997 - 2000




[1]Murphy, Whited, Rosenberry, Hammond, Bandler and Boor (2001) J. Dairy Sci. 84:2813-2820.

# Vitamin D in Milk, 12 Locations Nationwide, 2001

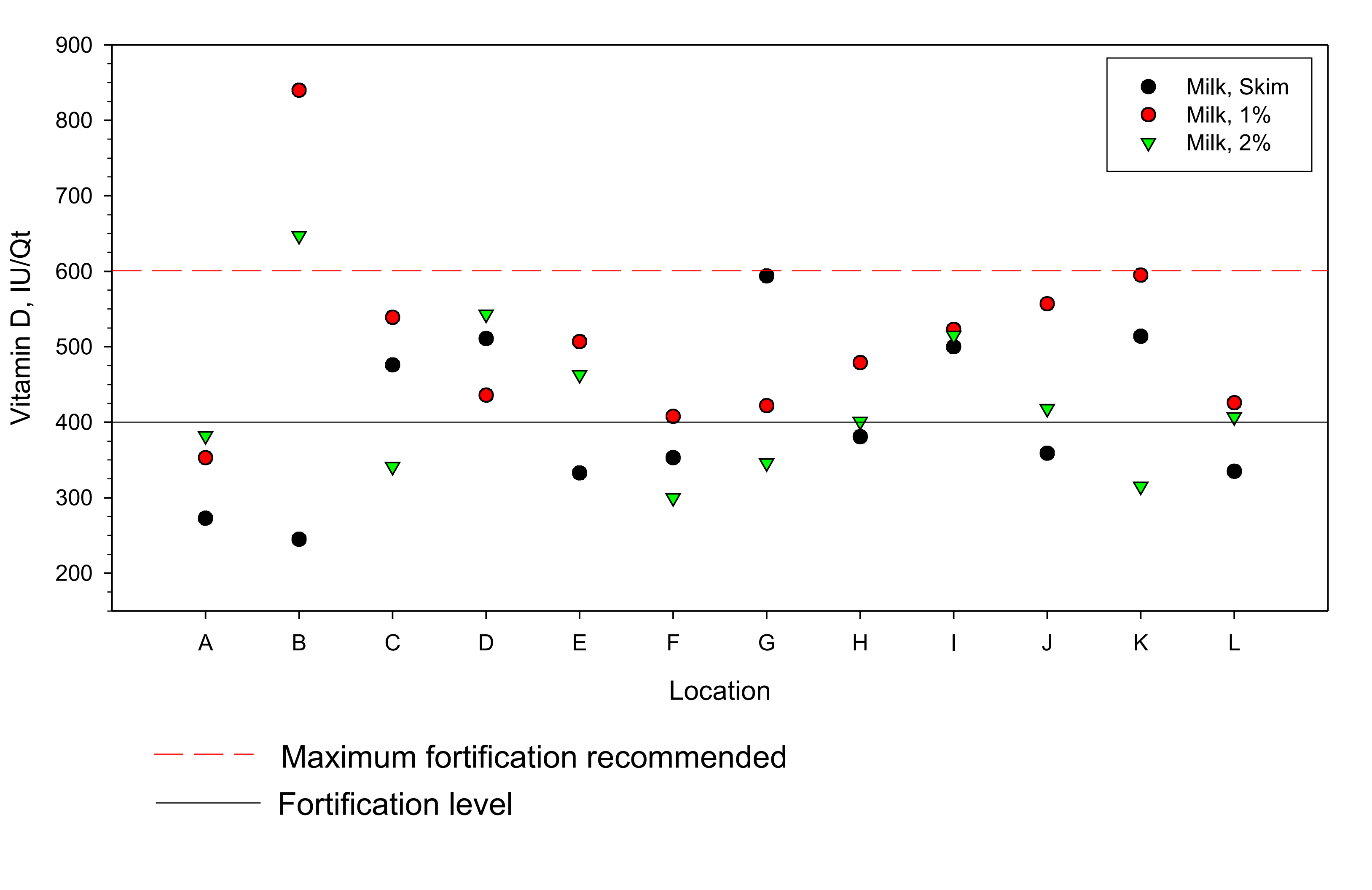


# In-house Controls for Vitamin D in Milk [1]

| Sample | Control material | Mean | Target | Min | Max |
|---|---|---|---|---|---|
| | | | -----------IU/100 g----------- | | |
| 1%, 2%, skim milk | cheese | 324 | 329 | 291 | 491 |
| | | | -----------ug/100 g----------- | | |
| Whole milk | Infant formula (powder) Lot#RC-3 | 9.13 | 8.725 | 8.05 | 9.4 |

[1] Analysis by HPLC

# Vitamin D in Milk by Location, 2001



# Impact on Public Health

- Chronic bias and long term health – vit D, Na (enhanced meats), fat (pizza variations)
- Accuracy in dietary assessment
  - Tracking of food patterns
  - Tracking of forms of foods
  - Accurate food composition/nutrient distributions data
- Variability in portion size and food patterns