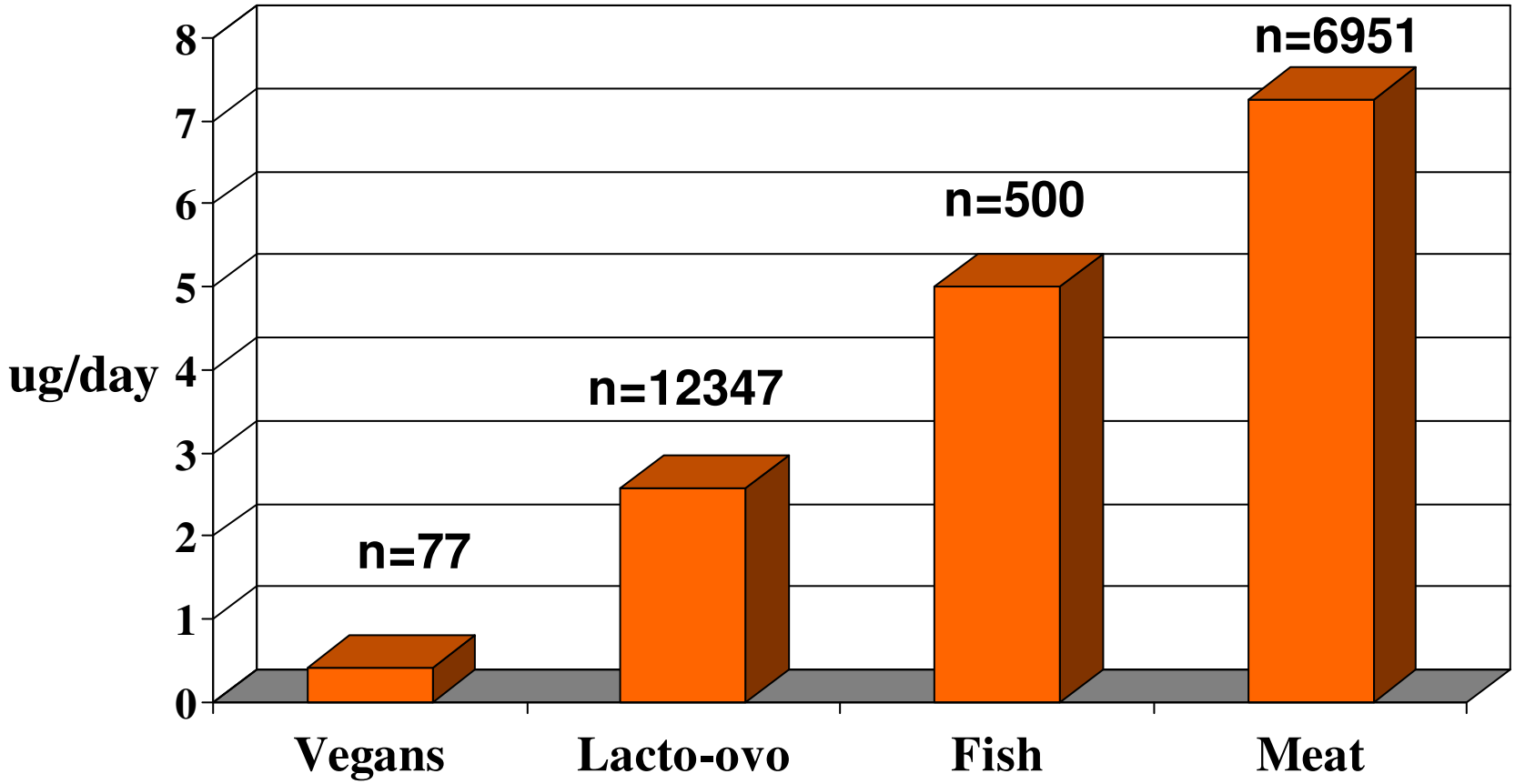
Vitamin B12 fortification of flour

Lindsay Allen, Irwin Rosenberg, Godfrey Oakley, Gil Omenn, Joshua Miller

Reasons to consider B12 fortification of flour

- Low intake of animal source foods (ASF) causes widespread deficiency and depletion; deficient + marginal plasma B12 in 40-80% people with low ASF intake, all ages.
- Even lacto-ovo vegetarians have greater risk of deficiency - does not require strict vegetarianism.
- ↑ depletion and deficiency with aging, even in wealthier countries (food cobalamin malabsorption; most can absorb crystalline B12).
- Many adverse effects of B12 deficiency. Especially critical in pregnancy and lactation?

Mean B12 intakes of men by diet groups in EPIC study (UK) (Davey, 2002)



Intakes assessed by Food Frequency Questionnaire

Evidence for serum B12 and function

	V. deficient <100 pmol/L	Deficient <150 pmol/L	Marginal <221 pmol/L
Anemia	++	+	No
Neuropathy	++	+	No
Hcy	++	++	++
Breast milk	++	++	+
Child devpt	++	+	+
Cognition	++	+/-	?
Depression	+	+	+
Bone	+	+	+
NTD	?	?	+

"+" = intervention trials

Who would benefit most from B12 fortification?

In developing countries:

- Low consumers of ASF – all ages, both genders.
- Pregnant & lactating women, infants (40% Guatemalan women and 12 mo postpartum have NO B12 in breast milk).
- Young children? Elderly.

In wealthier countries:

- Low consumers of ASF if no fortified cereals or supplements.
- Pregnant women? Elderly.

Uncertainties

- Will elderly with food cobalamin absorption absorb B12 from flour? Probably YES – can absorb crystalline B12 except if severe gastric atrophy.
- Will the recommended level of fortification be effective? 9 ug/d is effective added to bread of healthy elderly but no studies with less, or with gastric atrophy (these are ongoing).

Pros and cons of B12 fortification

PROS

- Only source is ASF.
- Low intakes common, EAR not met.
- Deficiency & marginal status prevalent.
- All ages, male + female, esp. elderly.
- Will ↓ tHcy.
- Serious effects of (severe) deficiency.
- No UL/safety concern.

CONS

- Uncertainty about effective dose,
- and prevalence/effect of FCM on absorption from fortified flour.
- No experience/data.
- Few relevant intervention trials so uncertain about functional benefits, especially for marginal deficiency.

Recommendations on level of B12 addition

- No Upper Level for vitamin B12.
- Uncertainty about prevalence of FCM and effect on absorption of crystalline B12.
- No intrinsic B12 in cereals, no interaction with phytate or inhibitors.
- No technological constraints – even at 1000 ug/100g flour.
- Cyanocobalamin is stable in baking.
- COST is first constraint – but can afford to add ≈EAR (2 ug/d).

Recommended B12 fortification levels – provide approx. 2 ug/100g flour.

	Refined wheat flour consumption (g/d)			
	Low	Medium	High	V. high
Adj./capita	<75	75-100	150-300	>300
Lowest	25	50	75	150
Median	50	100	200	400
Highest	150	300	600	1000
B12*	**0.04**	**0.02**	**0.01**	**0.008**

mg/kg, 0.1% water soluble. COST = 10% of total fortificants.

Summary

- B12 deficiency is prevalent because of low intake of ASF, affecting all ages.
- Consequences of severe, and possibly of marginal, deficiency are serious.
- No safety concerns.
- Recommend 2 ug/100 g flour.
- Efficacy & effectiveness need confirmation, including in elderly with gastric atrophy.