# Early Development and Growth, Physical Performance and Fitness: Role of Micronutrients

Dr Tarun Gera

Fortis Hospital

Shalimar Bagh

- Mental And Motor Development
- Anthropometric Parameters
- Physical Capacity

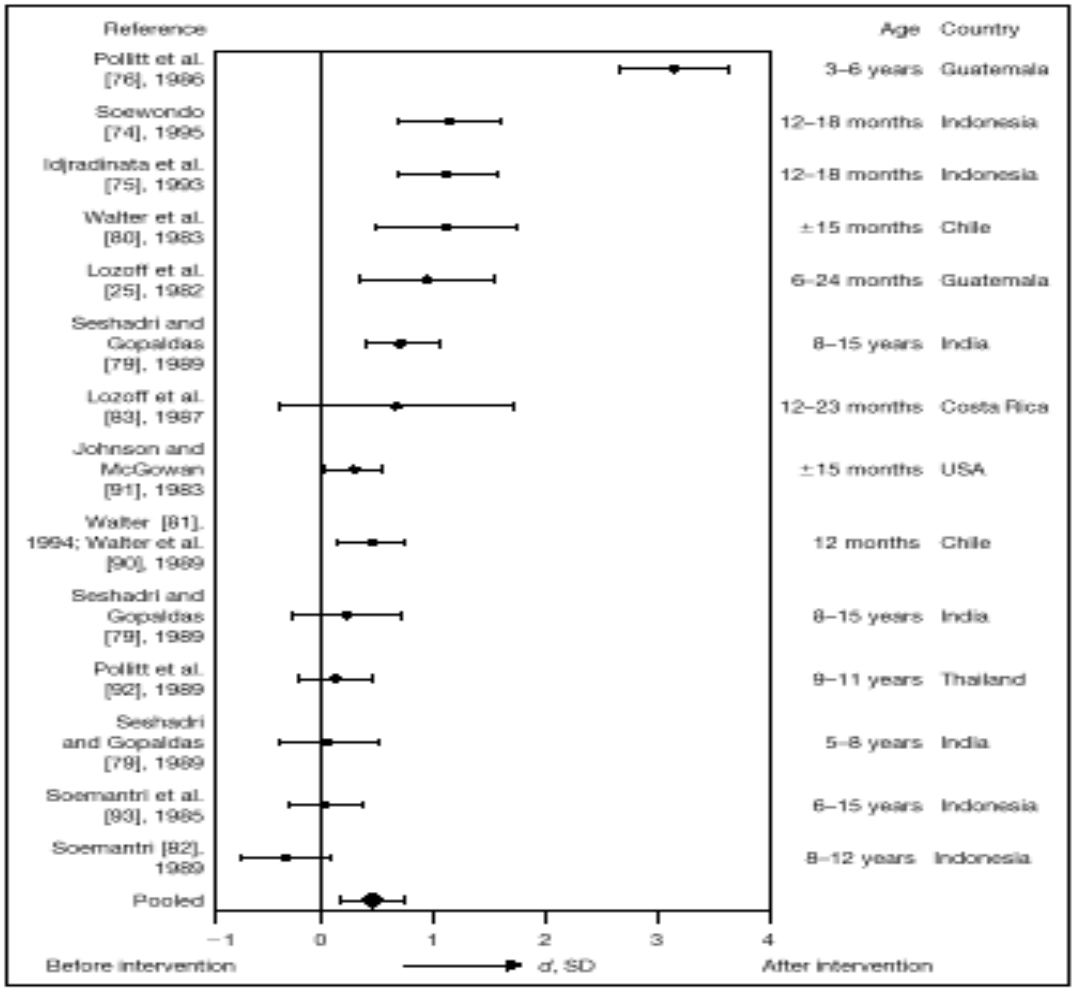
➢ Evidence

➢ Results

➢ Conclusions and Recommendations

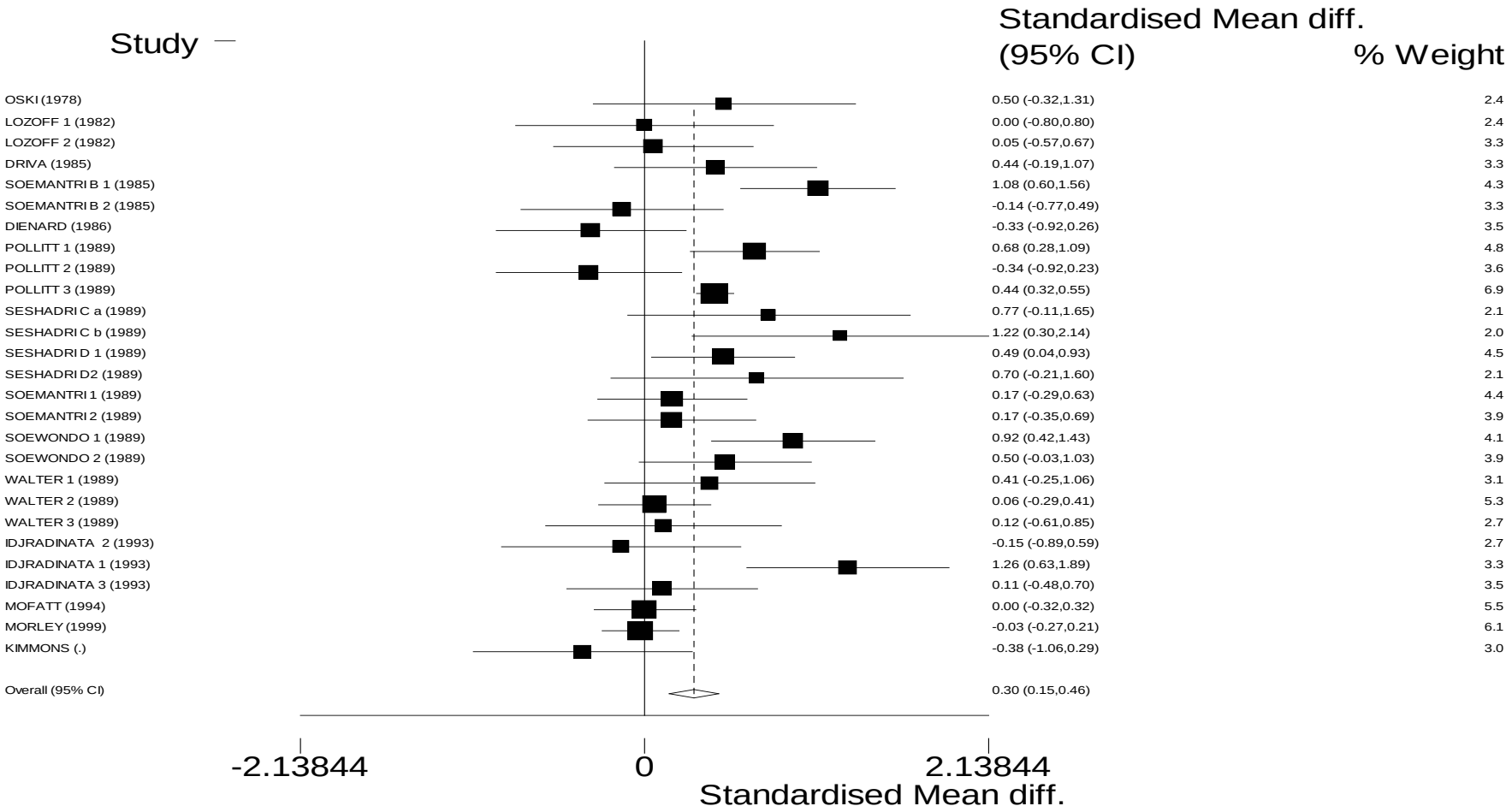
# Mental and Motor Development

# Iron and Cognition: Observational Data




**12-15 Point Benefit**

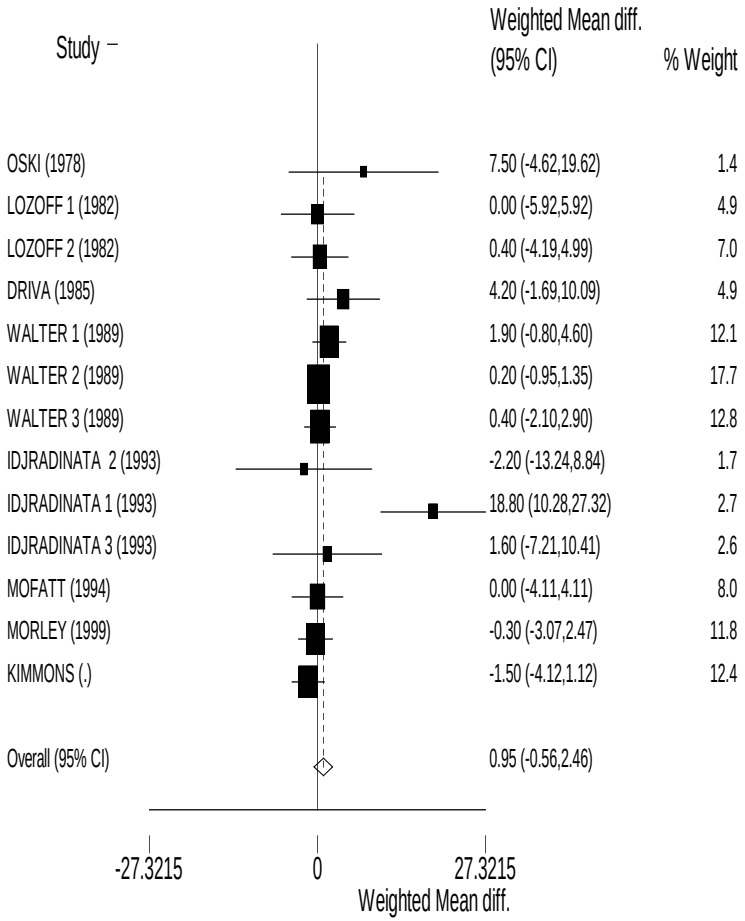
# Pooled Mental Development Score



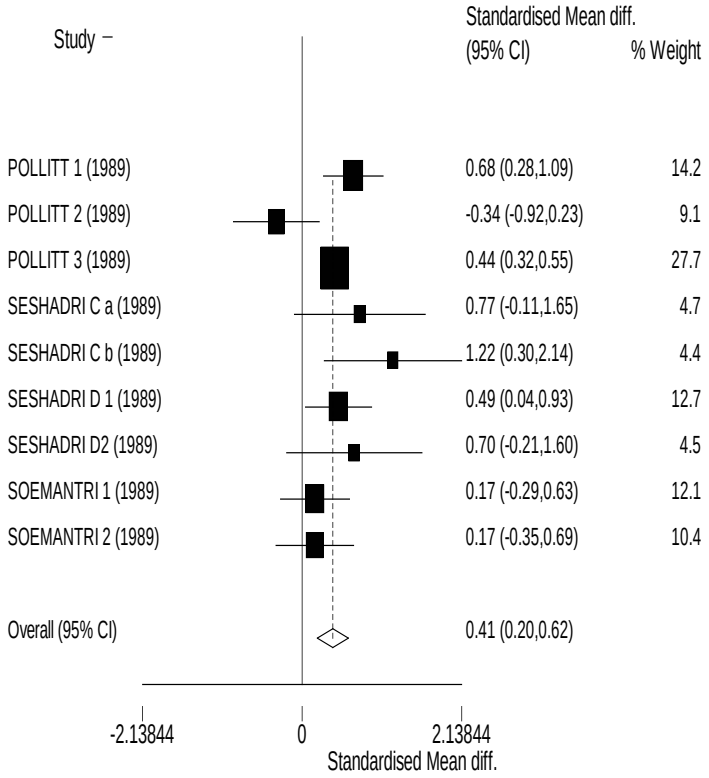

**SMD= 0.30 (95% CI = 0.15, 0.46), p<0.001**

**1.5 to 2 Point Benefit**

# Bayley MDI




# IQ Scores



# Summary: Iron & Brain Development

- Improves overall mental development score modestly (1.5-2 points)
- Evident for intelligence tests beyond 7 years and initially anemic or iron deficient anemic
- No effect on mental development below 27 months or motor development

# Review: Zinc Supplement Trials

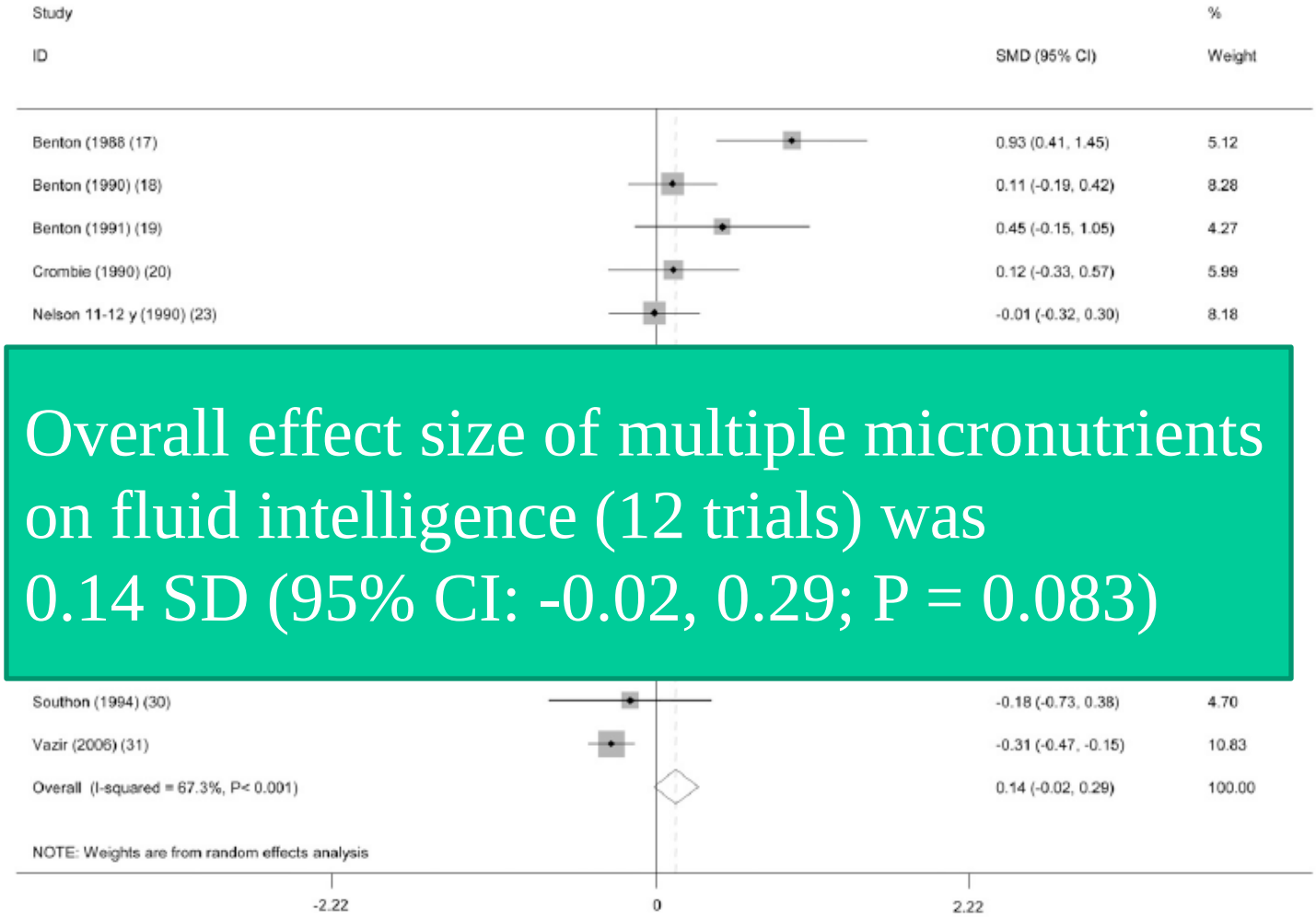
## Fetus – 1; Infants/toddlers – 8; School – 3

- **Activity –** 3/3 studies more activity
- **Motor development infants/toddlers: n=7**
  - ❑ 4 - NO impact
  - ❑ 2- Improved quality; 1 - Improves in VLBW
- **Mental development infants/toddlers: n=4**
  - ❑ 3 - NO impact; 1 – *Lower* scores
- **School-age:** 1/3 - NO impact; 2/3 – benefit neuropsychological process, *esp*. reasoning

# Evidence: Folate, Vitamins $B_{12}$ & $B_6$

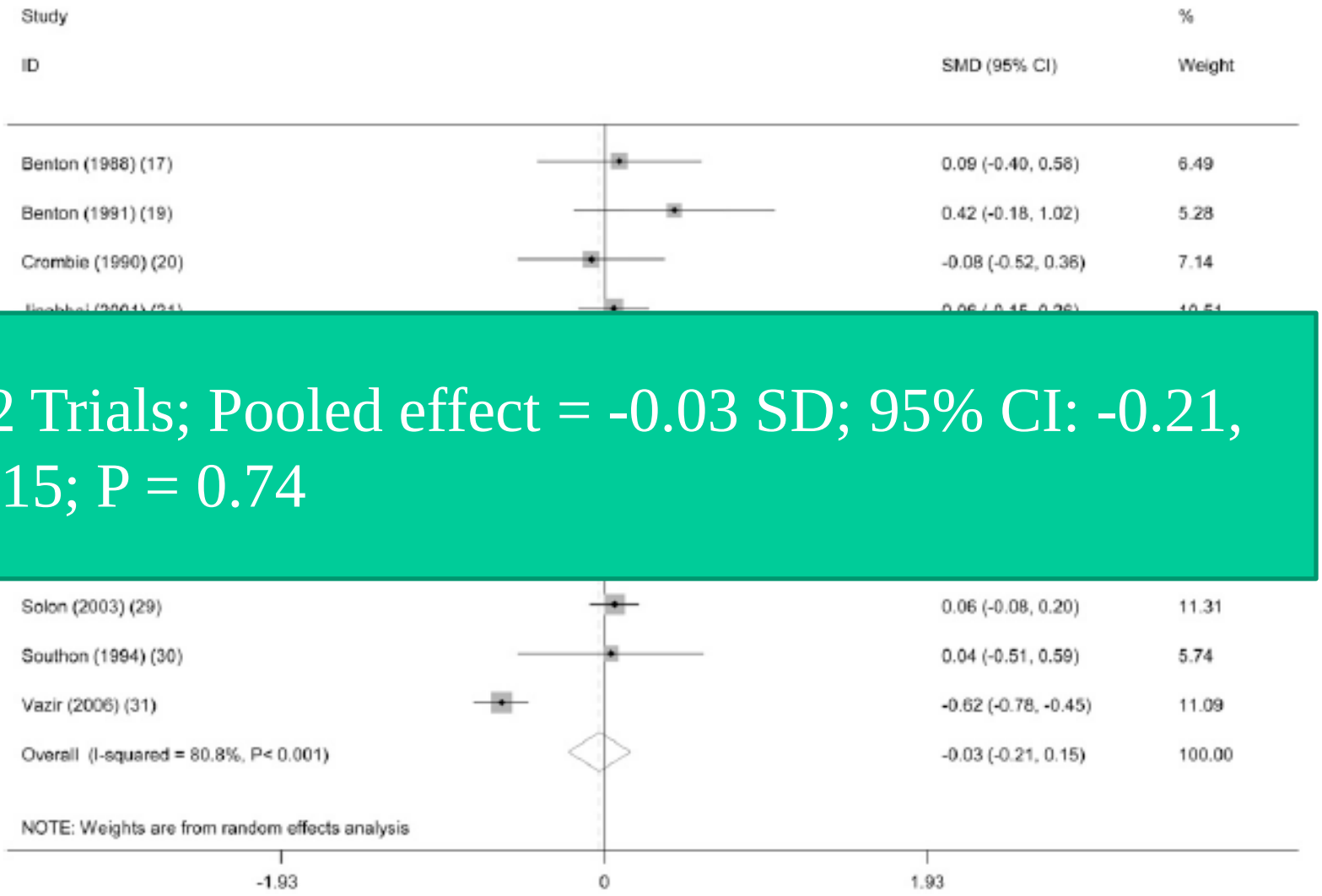
- Observational data: Prior intake of B Vitamins predicts cognition later in life
  - ❑ Macrobiotic & vegetarian diets
- Intervention data: Few trials in adults; short term supplements of these three small, positive effect on memory performance
- Need for RCT data in children

# Multiple Mn: Fluid Intelligence




Overall effect size of multiple micronutrients on fluid intelligence (12 trials) was 0.14 SD (95% CI: -0.02, 0.29; P = 0.083)

FIGURE 3. Forest plot for fluid intelligence, SMD, standardized mean difference; mn, micronutrients.




12 Trials; Pooled effect = -0.03 SD; 95% CI: -0.21, 0.15; P = 0.74

**FIGURE 5.** Forest plot for crystallized intelligence. SMD, standardized mean difference; Aus, Australia; Indo, Indonesia.

# Other Cognitive Domains

Overall effect size estimates per cognitive domain

| | | Overall effect size[1] | |
|---|---|---|---|
| Cognitive domain | No. of trials | Overall effect size (95% CI) | *P* value |
| Short-term memory | 6 | 0.05 (−0.11, 0.21) | 0.55 |
| Visual perception | 4 | 0.14 (−0.28, 0.56) | 0.51 |
| Long-term memory | 4 | 0.01 (−0.15, 0.17) | 0.89 |
| Cognitive processing speed | 7 | −0.20 (−0.61, 0.22) | 0.35 |
| Sustained attention | 3 | 0.13 (−0.11, 0.36) | 0.30 |
| Academic performance[2] | 4 | 0.30 (0.01, 0.58) | 0.04 |

# Concluding Comments

- Nutrition modifiable factor for brain
- Beneficial effects vulnerable or deficient: Iron (>7yr) and Iodine
- Suggestive requiring more evidence: Zinc, Folate, Vitamins $B_{12}$ and $B_6$
- No role of “routine tonics”

# Physical Growth

# Background

- Considerable variability in terms of type of intervention, control groups, age group and other explanatory variables
- Several meta-analysis conducted
- Zinc (Brown)
- Iron (Gera, Sachdev et al)
- Iron, Vit A, and MMN ( U Ramakrishnan)
- IRIS trial

Effects of micronutrients on growth of children under 5 y of age: meta-analyses of single and multiple nutrient interventions[1–3]

*Usha Ramakrishnan, Phuong Nguyen, and Reynaldo Martorell*

- Included studies

a) In children < 5 years old

b) RCTs

c) Vit A, Iron, Zinc and Multiple Mn

d) Studies effect on wt, ht and WHZ scores

**FIGURE 1 Effect sizes for height gain in vitamin A intervention trials among children aged <5 y old**

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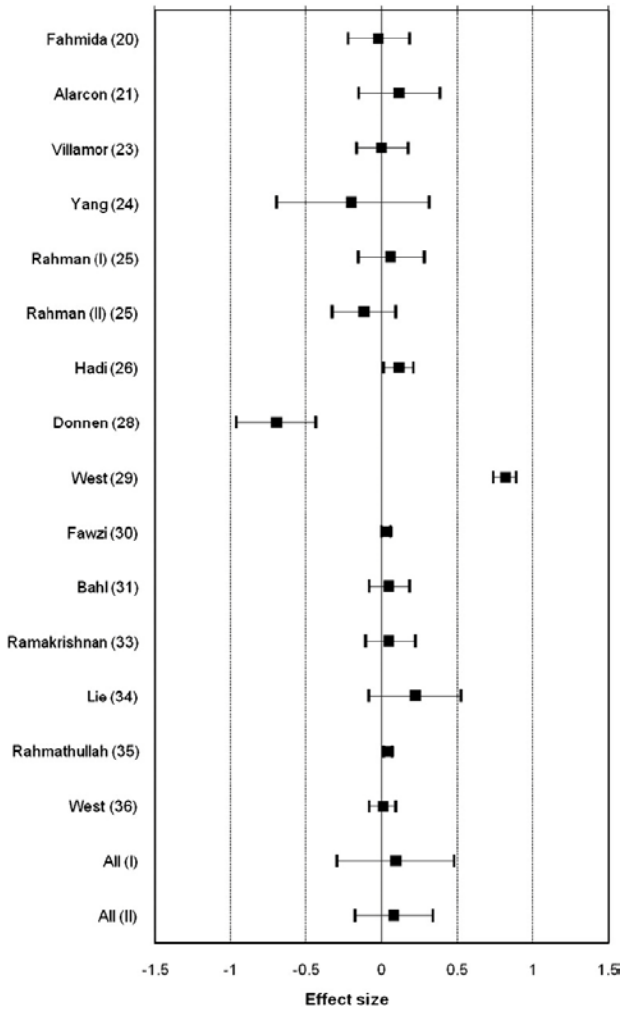


**Ramakrishnan, U. et al. Am J Clin Nutr 2009;89:191-203**

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**FIGURE 2 Effect sizes for height gain in iron intervention trials among children aged <5 y old**

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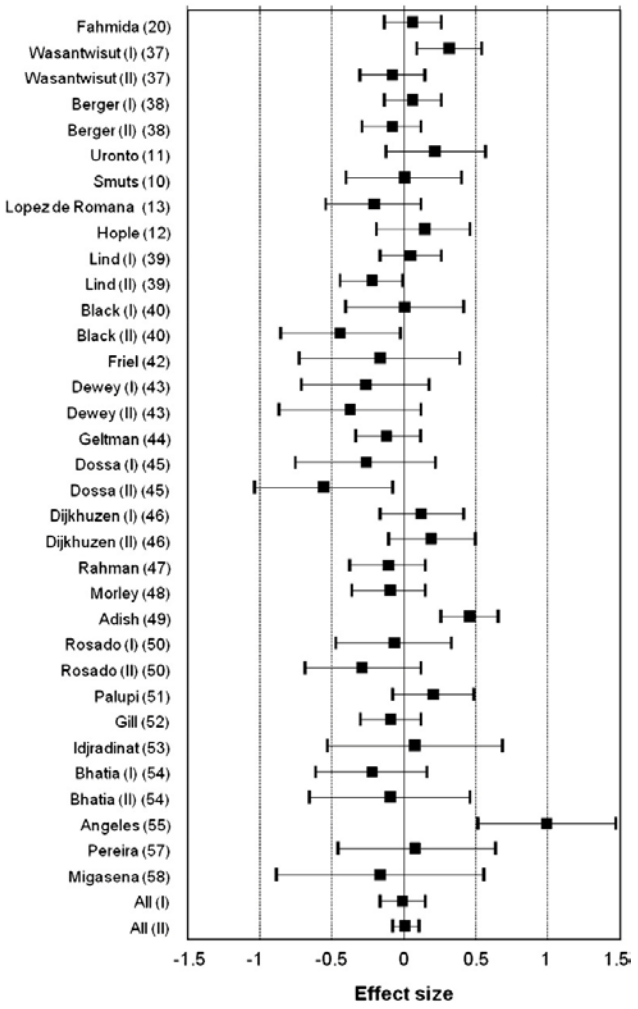


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**FIGURE 3 Effect sizes for height gain in zinc intervention trials among children aged <5 y old**

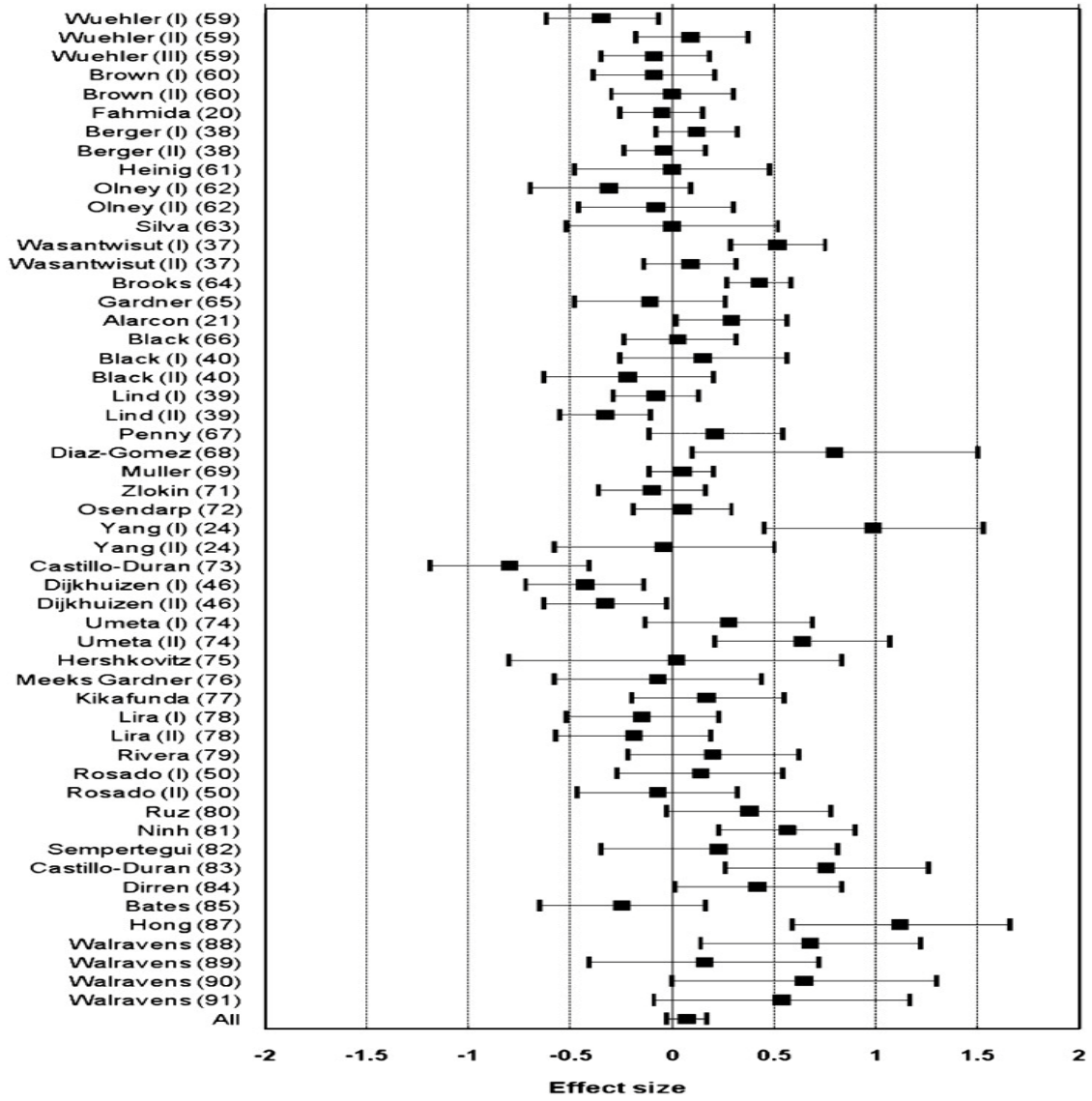


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**FIGURE 4 Effect sizes for height gain in intervention trials with 2-way micronutrient combinations among children aged <5 y old**

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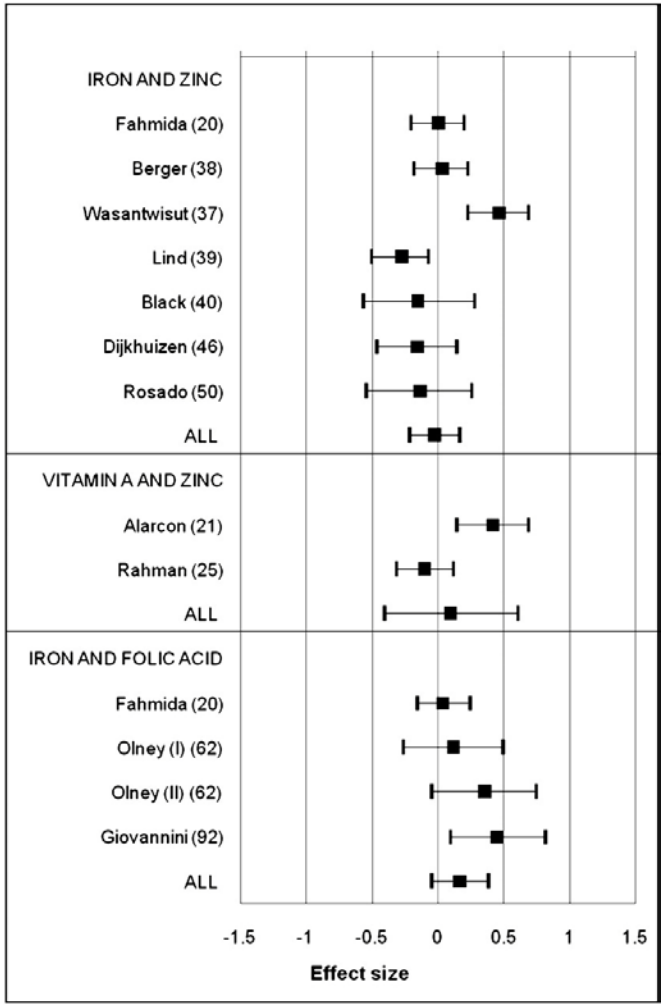


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# Multiple Micronutrients

- 27 datasets from 20 studies
- Conducted primarily in developing countries
- Age : 3-50 mo
- 80% of studies provided Fe, Vit A or Zn
- Supplemented as medicinal or fortificants
- Freq > 5/week

# Results

- Height: 0.09 (0.008, 0.17)
- Weight: 0.04 (-0.05, 0.12)
- WHZ: -0.001 (-0.07, 0.07)
- No evidence of heterogeneity or publication bias

**FIGURE 5 Effect sizes for height gain in multiple micronutrient intervention trials among children aged <5 y old**

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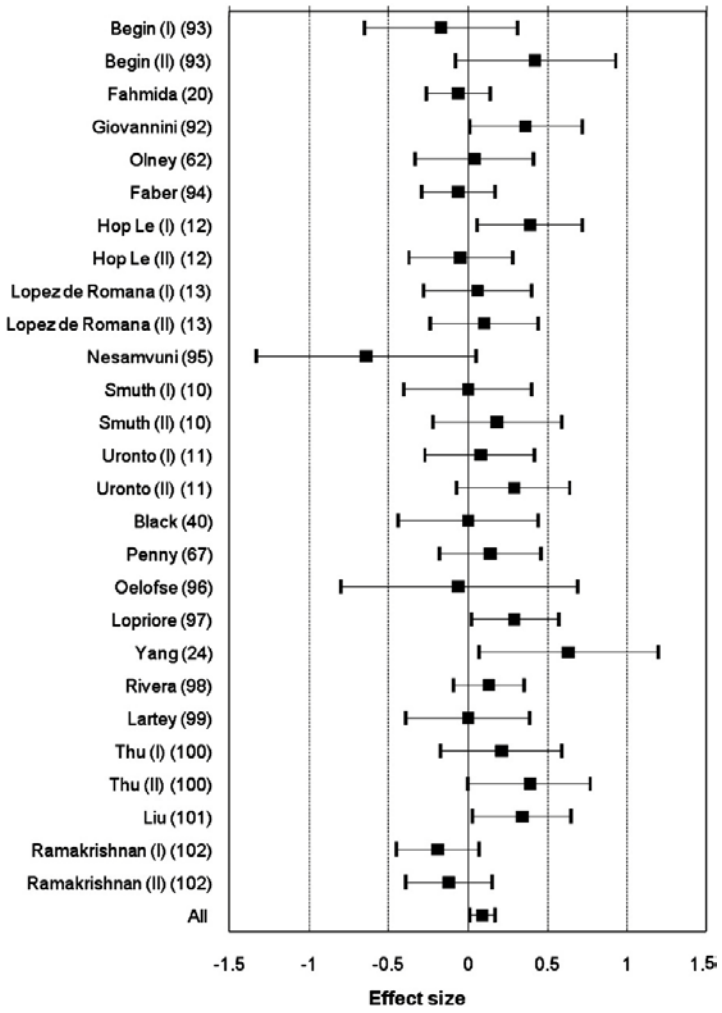


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# To Summarize

- Interventions containing iron only, vitamin A only, and combinations of iron and zinc, iron and vitamin A, and zinc and vitamin A do not improve growth
- Zinc only have a small positive effect (0.06; 95% CI: 0.006, 0.11) on change in WHZ !!!
- Finally,MM interventions have a small effect only on growth in height (0.09; 95% CI: 0.008, 0.17).

# Conclusions

- Little evidence to suggest the role of micronutrients, single or multiple in combating stunting
- More comprehensive approach that improves the diets of small children needed
- Improved complementary feeding
- Food security an important concern

# Physical Activity

# Vitamins

| Name of Vitamin | Possible Role in Physical Performance |
|---|---|
| A | Antioxidant |
| Thiamin | Carbohydrate metabolism |
| Riboflavin | Mitochondrial electron transport |
| Niacin | NAD, NADP |
| Pyridoxine (B6) | Amino acid synthesis |
| Folate | RBC synthesis |
| Biotin | Biosynthetic Reactions |
| B12 | RBC synthesis |
| C | Antioxidant, tissue repair |
| D | Calcium hemostasis |
| E | Antioxidant |

# Minerals

| Name | Possible Role in Physical Performance |
|---|---|
| Iron | Hemoglobin, Myoglobin synthesis |
| Magnesium | Cofactor, Calcium homeostasis, conductance across nerves and muscle |
| Zinc | Cofactor |
| Copper | Hb, catecholamine synthesis |
| Selenium | Antioxidant |
| Cobalt<br>Chromium<br>Molbdenum<br>Manganese<br>Phosphorus | Important metabolic roles ?? |

# Iron


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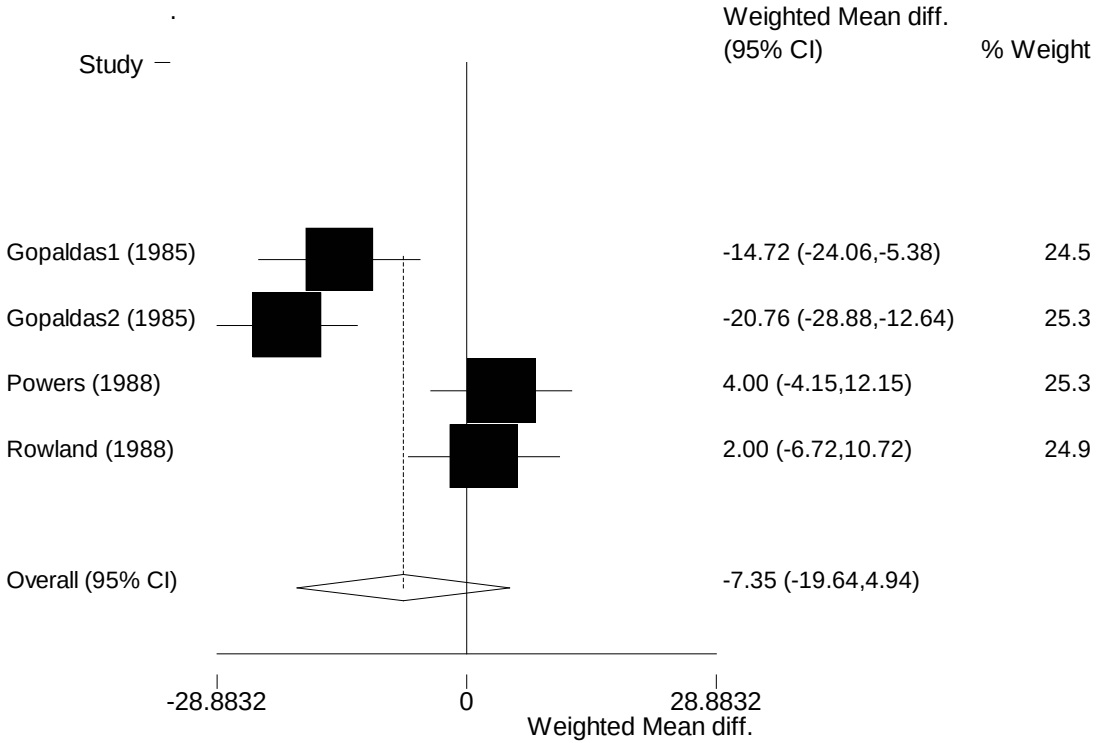
# Selected Studies

| Study | Parameter Studied | Variable Used |
|---|---|---|
| Gopaldas et al. | Submaximal work capacity using Harvard Step Test | HR, Blood lactate levels after exercise |
| Powers et al | Running performance on treadmill at 3 different speeds | HR, Oxygen consumption |
| Rowland et al | Running performance | HR, submax and maximal oxygen consumption |

# Heart Rate (-6 to -8/min) (106 subjects)



# Blood Lactate level (1 RCT)

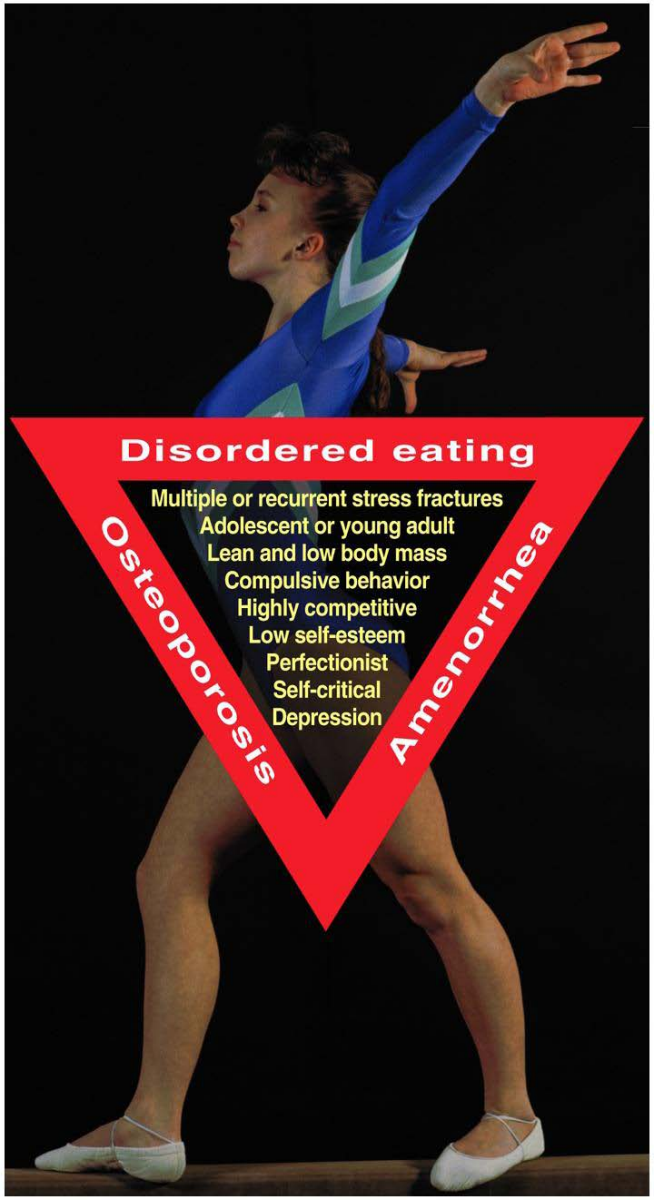
- Lower lactate levels in group receiving iron supplementation
- Levels lower in non-anemic subjects
- Benefit of iron @ 30mg/day on blood lactate levels not seen in non-anemic subjects

# Oxygen consumption and Treadmill Endurance Time

- Oxygen consumption: no effect of iron supplementation
- Treadmill endurance time were significantly higher in iron supplemented group; correlated with serum ferritin
- Conclusion: iron supplementation may have a positive effect on the physical performance of children, as evaluated through the post exercise heart rate, blood lactate levels and treadmill endurance time. In view of the limited data availability, this finding cannot be considered conclusive.

# Calcium

- Lack of calcium contributes to osteoporosis
- Female athlete triad
  - Disordered eating
  - Osteoporosis
  - Amenorrhea



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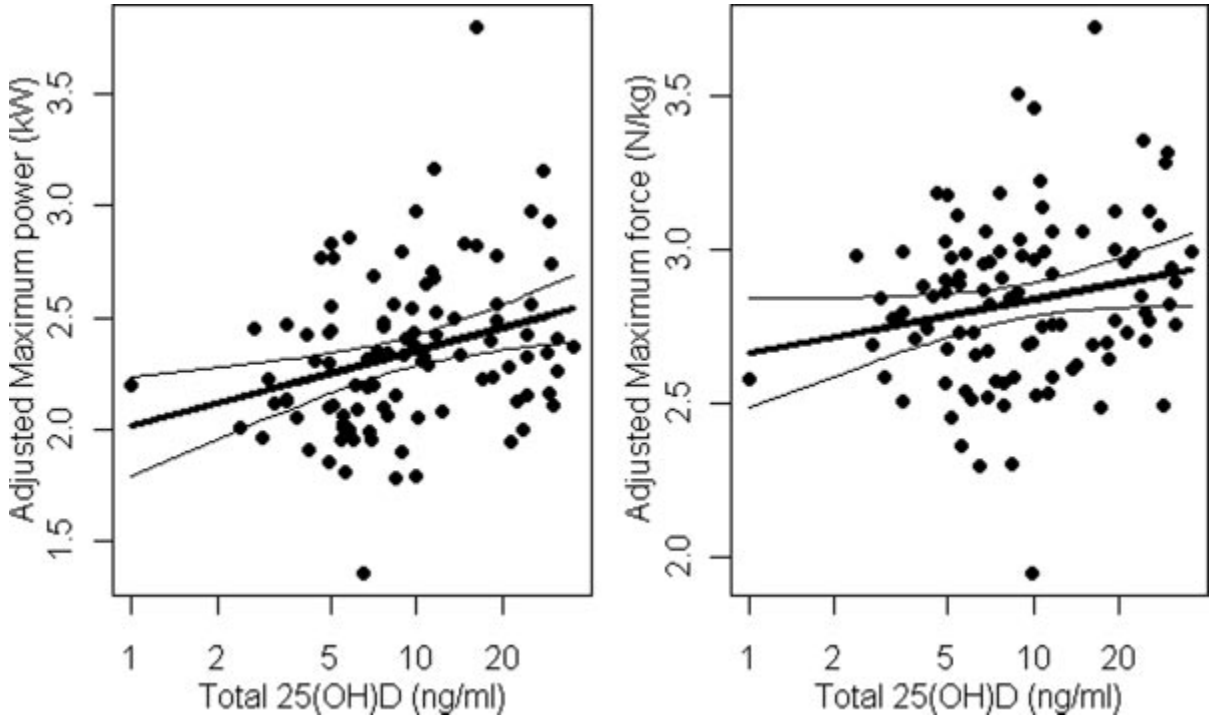
# Vitamin D and Muscle Power



# Multiple Micronutrients

- School children in Yugoslavia – given vit C, B6, riboflavin or placeba --- increased VO2
- Studies in Keneba, Gambia – iron, riboflavin, thiamin and Vit C improved treadmill work performance; neither iron alone or riboflavin plus Vit C alone had this effect
- Effect on Vit deficiencies or on iron economy??

# Policy Statements
## (ADA, Dieticians of Canada, American College of Sports Medicine)

- Physical activity, athletic performance, and recovery from exercise are enhanced by optimal nutrition
- Vitamin and mineral supplements are not needed if adequate energy to maintain body weight is consumed from a variety of foods
- Indicated in individuals who

a) restrict energy intake
b) use severe weight-loss practices
c) eliminate one or more food groups from their diet
d) consume unbalanced diets with low micronutrient density

# Conclusions

- No good evidence to suggest that specific supplementation with any of these dietary components is necessary or that it will improve physical performance
- Where the presence of a specific deficiency is established, this should be treated wherever possible by directing the individual towards a more appropriate choice of foods
- In the presence of clinical signs of an established deficiency vitamin or mineral supplementation be considered
- The only exceptions to the generalisation about the value of dietary supplements in meeting micronutrient needs may be iron and, in the case of very active girls, calcium.


ThankYou