Calcium and Vitamin D Status Across Life Stages - Elderly - Perspective

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The Trigger ……

- Vitamin D status in primary hyperparathyroidism in India (Clinical Endocrinology, 1995)
  - 20 consecutive patients with 1^0 HPTH; 14 normal age and sex matched controls
  - 25(OH)D levels:
  - patients – 8.39 ng/ml; normal controls – 8.29 ng/ml (Normal 9 – 37 ng/ml) – Tritium assay – β Counting

Kashmir	34.3 ^{0} N	77.9 ^{0} E
New Delhi	28.4 ^{0} N	77.1 ^{0} E
Tirupati	13.4 ^{0} N	77.2 ^{0} E

25(OH)D normal range

- **Population Based values**
  - Life style variations
  - Environmental characteristics (Latitude, altitude, dress code, Sun exposure, Skin color, pigmentation, Nature of food rich in vitamin D)
  - Normal data varies between labs
  - Geological variations in calcium homeostasis

- **Health Based reference values**

25(OH)D and calcium absorption

- Normal 25(OH)D levels important for fully normal calcium absorption efficiency in the gut
- Calcium absorption in the gut plateaus at 25(OH)D levels of 30 ng/ml
- 25(OH)D insufficiency – 2^0 HPT – accelerated bone remodeling – negative skeletal consequences

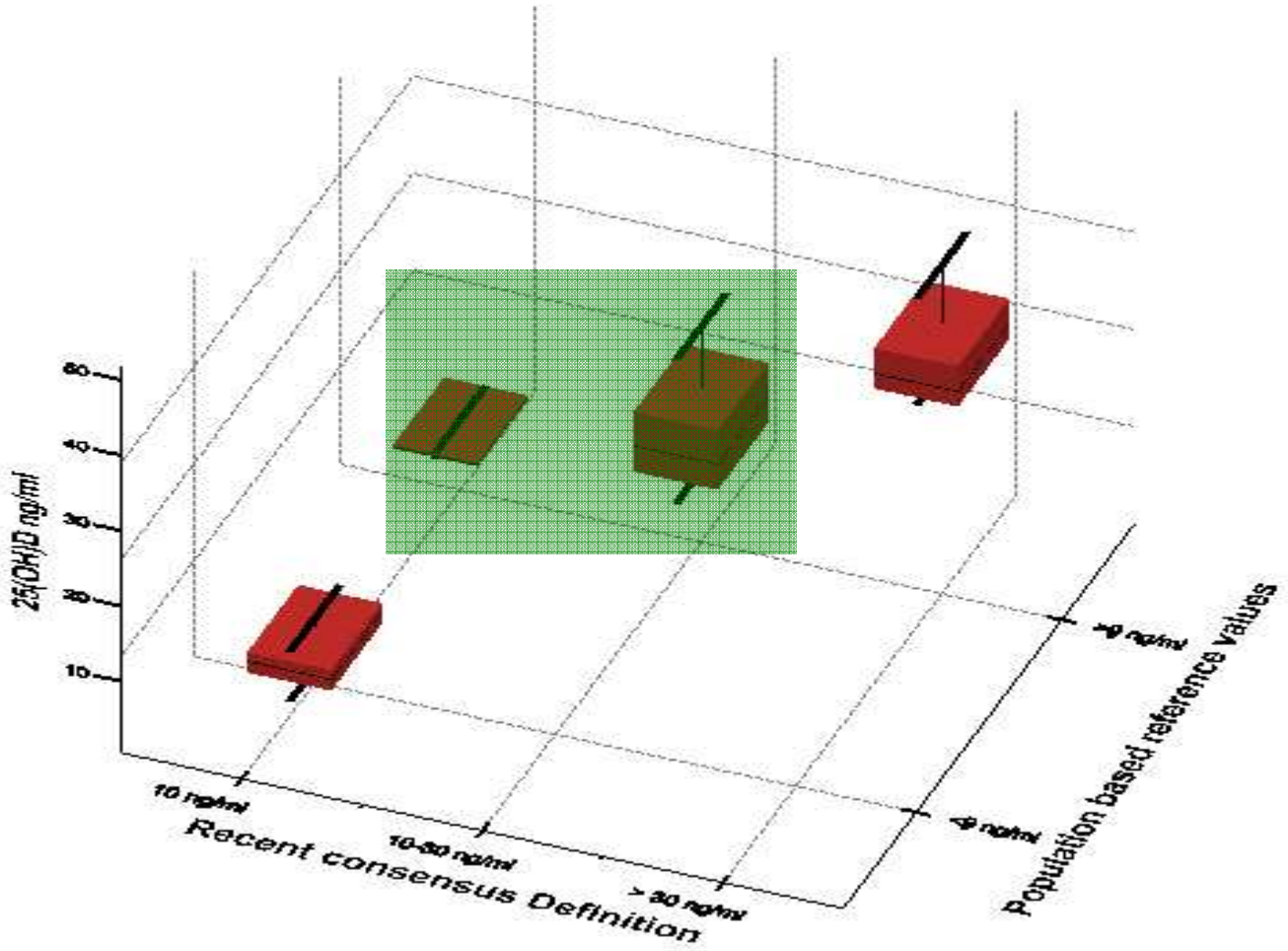
DEFINITIONS

RECENT CLASSIFICATION

25(OH)D

- deficiency < 20 ng/ml
- insufficiency 20-30 ng/ml
- sufficiency > 30 ng/ml

For conversion from ng/ml to nmol/l – multiply by 2.5


25(OH)D ng/ml
60
40
30
20
10
10 ng/ml
10-30 ng/ml
> 30 ng/ml
Recent consensus Definition
30 ng/ml
4 ng/ml
Population based reference values

- Population based reference value
  - Under diagnosed *(failed to detect)* vitamin D insufficiency
  - Over diagnose normal vitamin D status
- Health Based reference values
  - 2^0 HPT
  - Calcium absorption from the gut

VITAMIN D STATUS OF SOUTH INDIAN RURAL AND URBAN POPULATION

1. *Asia Pac J Clin Nut 2004;13(4)359-365*
2. *Am J Clin Nutr 2007;85:1062–7.*
3. *Indian J Med Res 127, March 2008, pp 211-218*

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AIM

To study the dietary calcium intake and vitamin D status of south Indian adult rural and urban population

1. *Asia Pac J Clin Nut 2004;13(4)359-365*
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METHODS

- Diet history – One week recall method
- Table “Nutritive value of Indian Foods” ICMR, NIN,1998

- Serum calcium, phosphorous, alkaline phosphatase, albumin
- 25(OH)D (DiaSorin, Stillwater, MN, USA, catalogue No. 68100E)
- N-tact PTH® (IRMA) (DiaSorin, Stillwater, MN, USA, catalogue No. 26100)

- Statistical analysis - SPSS (version 11.5)

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RESULTS

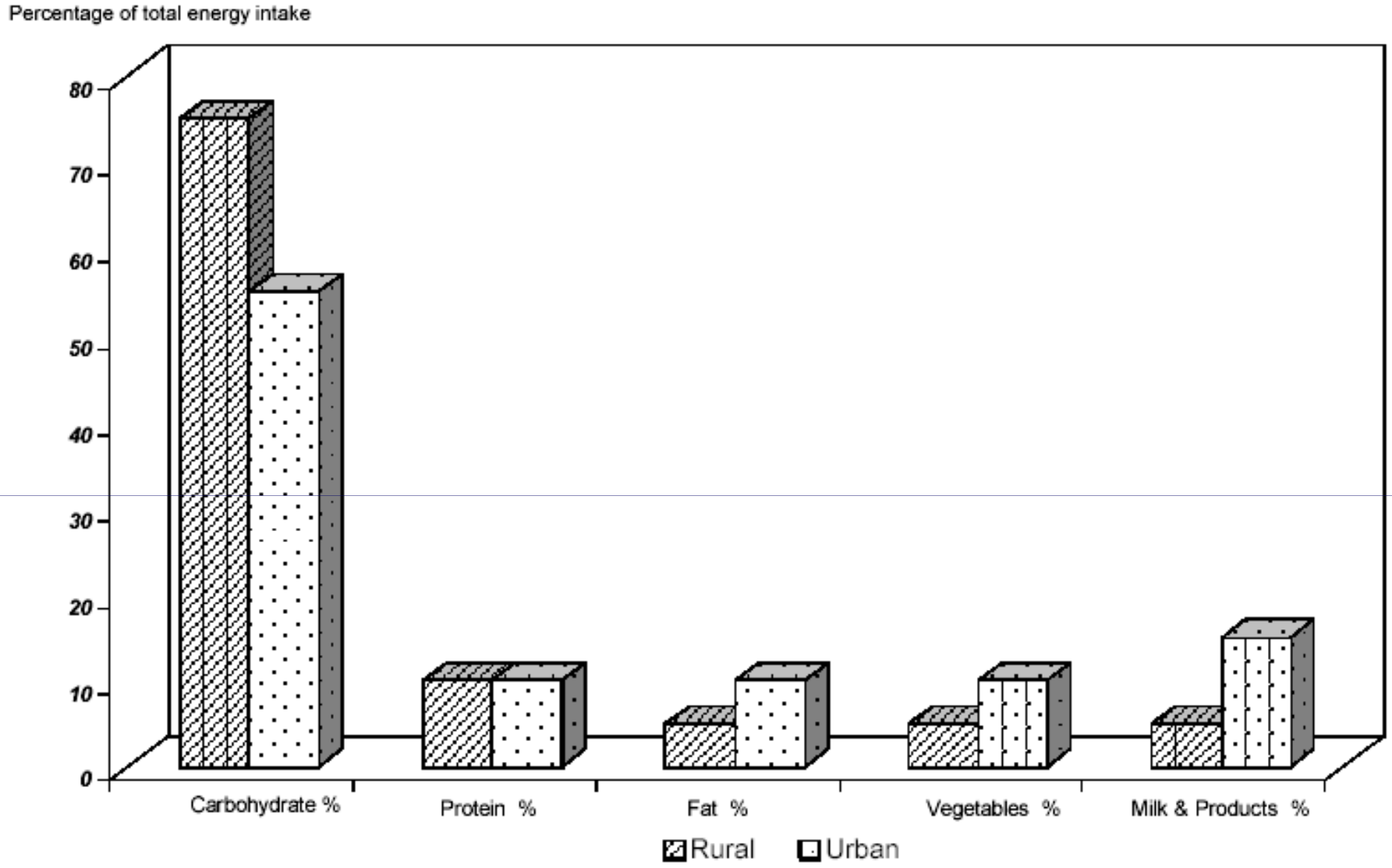
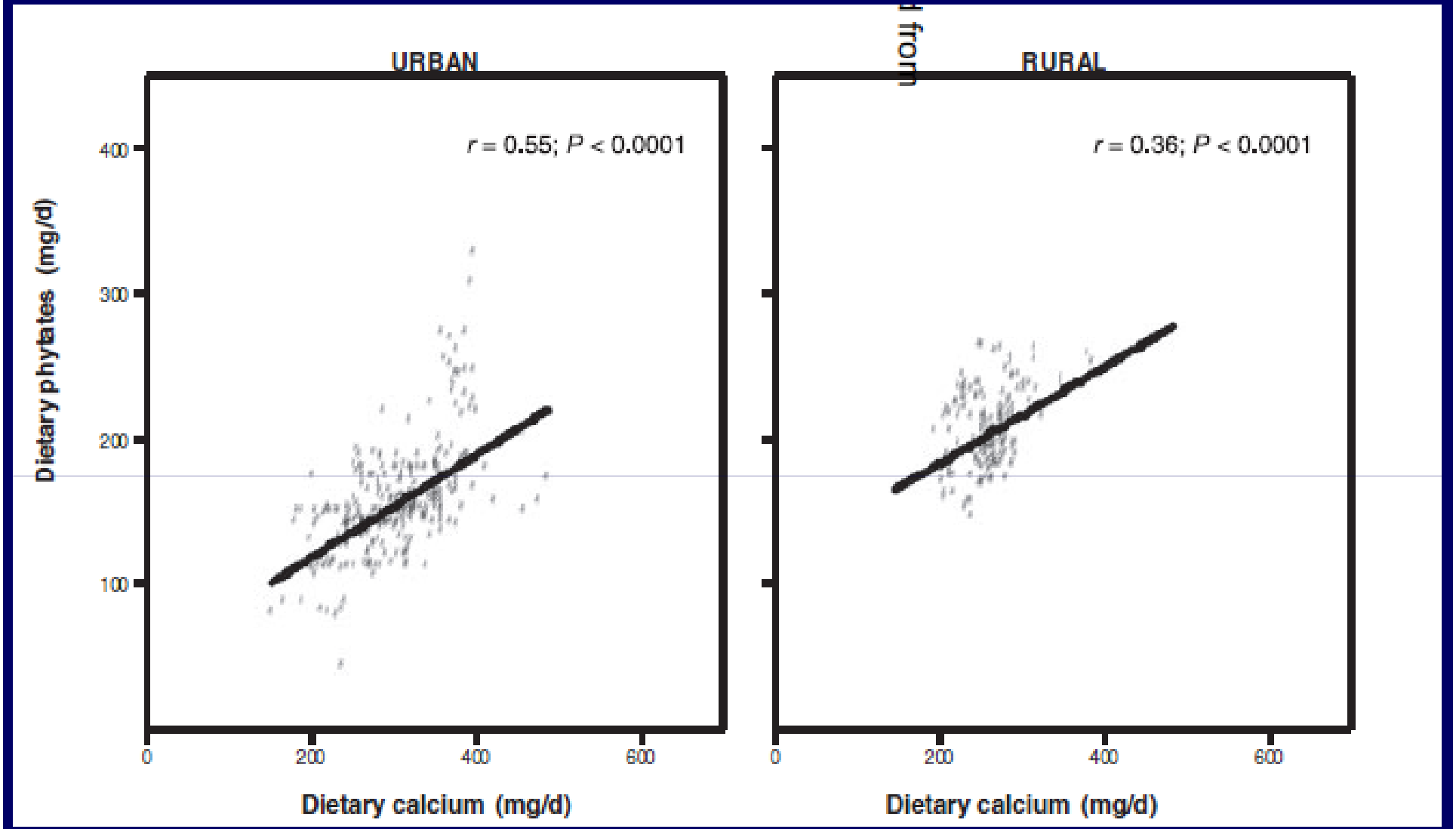


Figure 1. Dietary pattern (percentage of total energy intake) of rural and urban subjects

COMPARISION OF DIETARY INTAKE OF URBAN & RURAL - ADULTS & CHILDREN

Parameter	Adults males		Adults females	
	Urban (n=32)	Rural (n=109)	Urban (n=476)	Rural (n=96)
Dietary calcium (mg/day)	323 ± 8* (307 - 340)	271 ± 3 (263 - 280)	306 ± 2* (302 - 310)	262 ± 3 (253 - 271)
Dietary phosphorus (mg/day)	674 ± 17* (640 - 707)	493 ± 9 (475 - 511)	651 ± 9* (643 - 660)	481 ± 10 (462 - 501)
Phytate/calcium ratio	0.5 ± 0.02* (0.47 - 0.54)	0.76 ± 0.01 (0.74 - 0.78)	0.51 ± 0.01* (0.50 - 0.52)	0.76 ± 0.01 (0.74 - 0.78)

Parameter	Children males		Children females	
	Urban (n=28)	Rural (n=34)	Urban (n=43)	Rural (n=36)
Dietary calcium (mg/day)	293 ± 6 (280 - 305)	277 ± 6 (265 - 289)	317 ± 9* (298 - 336)	270 ± 7 (254 - 285)
Dietary phosphorus (mg/day)	632 ± 18* (595 - 670)	483 ± 15 (451 - 514)	667 ± 15* (637 - 698)	489 ± 16 (458 - 521)
Phytate/calcium ratio	0.49 ± 0.02* (0.45 - 0.53)	0.75 ± 0.02 (0.70 - 0.80)	0.52 ± 0.01* (0.49 - 0.55)	0.72 ± 0.03 (0.66 - 0.77)



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RDA OF INDIA

Category	INDIA	USA
Units	*mg/day*	*mg/day*
Infants		
Infants 0 – 6 months	500	500
Infants 6 – 12 months	500	750
Children Boys and Girls		
1 – 9 yrs	400	800
10 – 15 yrs	500	1200 – 1300
16 – 18 yrs	500	1200 – 1300
Men	400	800 – 1000
Women	400	800 – 1000
Pregnant and Lactating mothers	1000	1200 – 1300

Summary of the study….

- Diet insufficient in calcium - in the background of high phytate
- Calculated values Vs analytical values

- Is the diet far more depleted in calcium than what is presumed to be !!!!

COMPARISION OF BIOCHEMICAL AND HORMONAL PROFILE OF RURAL & URBAN GROUPS - ADULTS

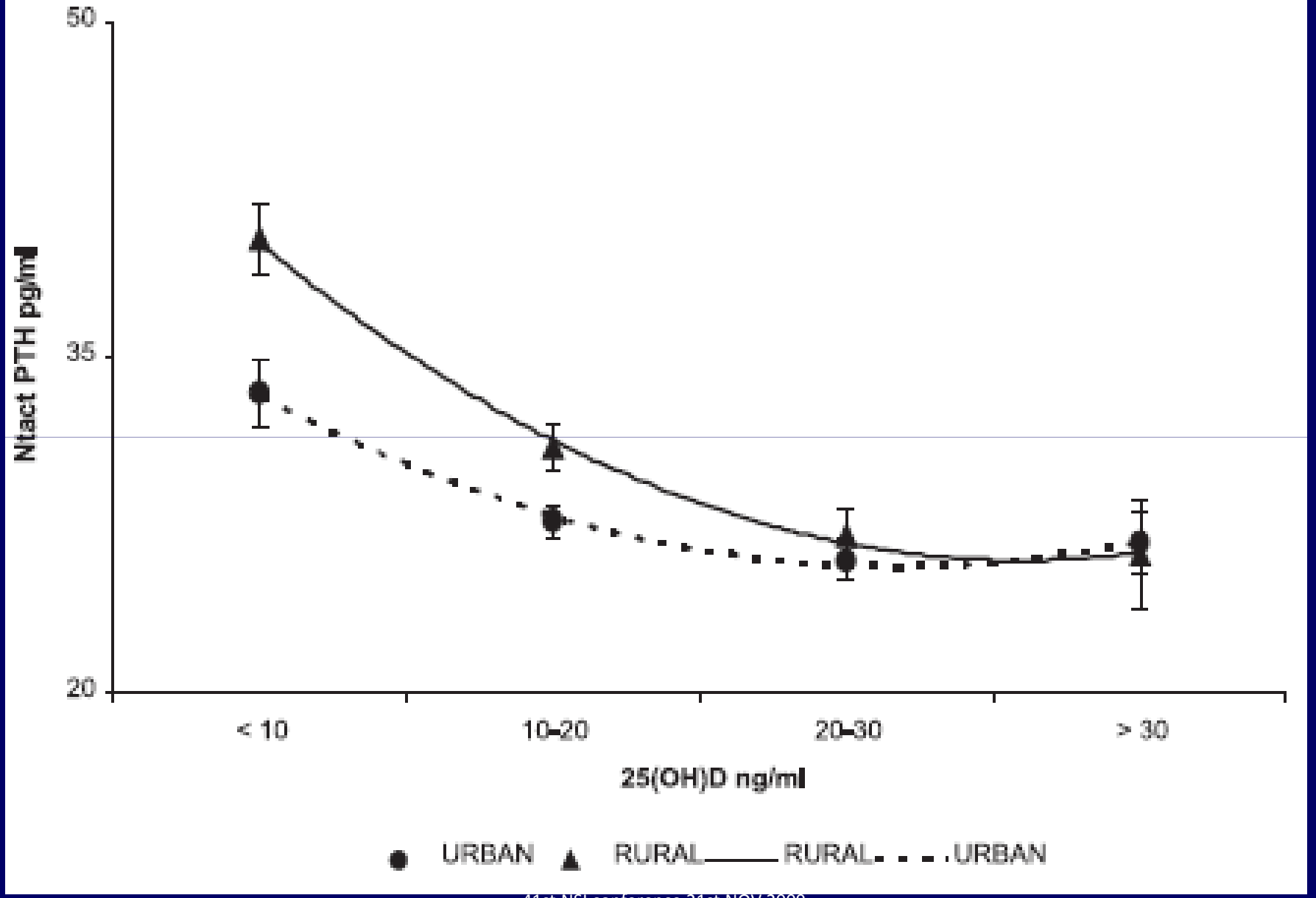
Parameter	Adult males		Adult females	
	Urban	Rural	Urban	Rural
Serum calcium (mg/dl)	9.74 ± 0.06 (9.63 to 9.85) (n=100)	10.06 ± 0.06* (9.95 to 10.2) (n=109)	9.68 ± 0.02 (9.64 to 9.73) (n=678)	9.98 ± 0.06* (9.87 to 10.15) (n=96)
Serum phosphorous (mg/dl)	3.50 ± 0.07 (3.37 to 3.64) (n=99)	2.84 ± 0.07* (2.27 to 2.97) (n=109)	3.64 ± 0.03 (3.59 to 3.69) (n=679)	2.74 ± 0.07* (2.79 to 3.09) (n=96)
SAP (IU/l)	84.87 ± 3.87 (78.85 to 90.9) (n=98)	55.67 ± 2.07* (49 to 61) (n=109)	80.4 ± 3.07 (78 to 90.17) (n=683)	62.7 ± 3.41* (56 to 69.4) (n=96)
25-(OH)D (ng/ml)	18.54 ± 0.8 (17 to 20) (n=134)	23.73 ± 0.8* (22 to 25) (n=109)	15.5 ± 0.3 (14.9 to 16) (n=807)	19 ± 0.89* (17.54-21) (n=96)
N-tact PTH (pg/ml)	27 ± 1.6 (23.9 to 30) (n=135)	29.24 ± 1.6 (26 to 32.35) (n=109)	28.35 ± 0.6 (27 to 29.5) (n=803)	29.21 ± 1.7 (25.75 to 32.7) (n=96)

Values are mean + SEM (95% CI) * P < 0.0001; ** P < 0.05

COMPARISION OF BIOCHEMICAL AND HORMONAL PROFILE OF RURAL & URBAN GROUPS - CHILDREN

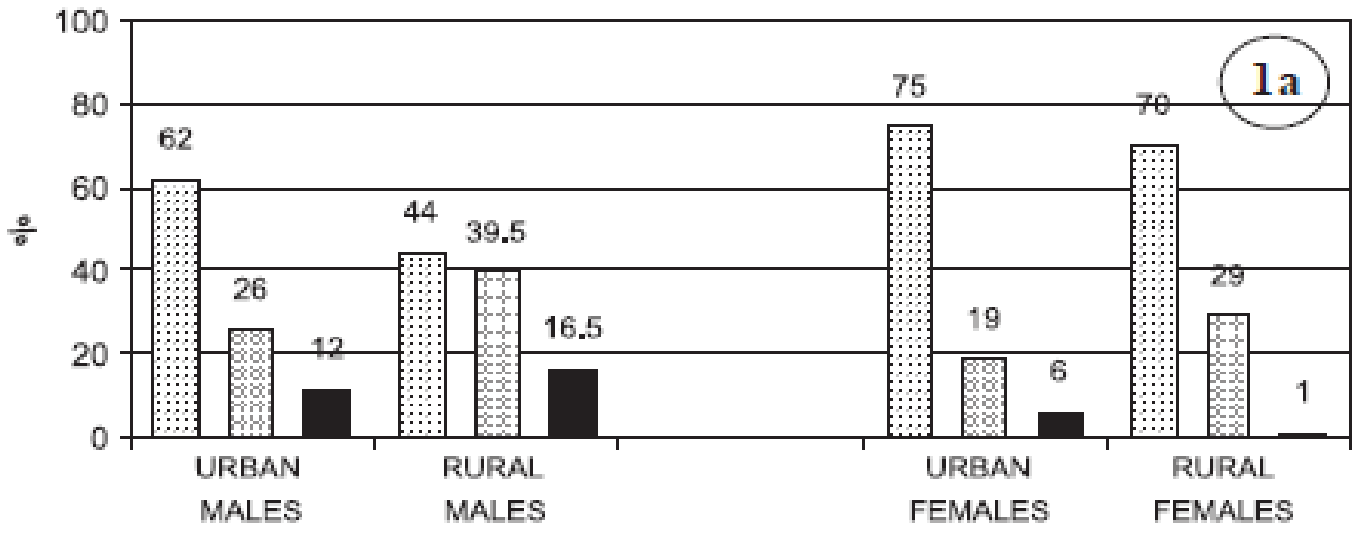
Parameter	Children males		Children females	
	Urban	Rural	Urban	Rural
Serum calcium (mg/dl)	9.67 ± 0.17 (9.33 to 10) (n=28)	10.28 ± 0.09* (10.09 to 10.48) (n=34)	9.78 ± 0.09 (9.59 to 9.97) (n=36)	10.03 ± 0.11 (9.80 to 10.27) (n=36)
Serum phosphorous (mg/dl)	4.0 ± 0.22 (3.55 to 4.45) (n=27)	3.15 ± 0.12* (2.92 to 3.39) (n=33)	4.08 ± 0.16 (3.76 to 4.41) (n=36)	3.31 ± 0.13* (3.05 to 3.56) (n=35)
SAP (IU/l)	161.55 ± 17.5 (125.7 to 197) (n=28)	90.7 ± 11.9* (66.5 to 115) (n=34)	132 ± 16 (99 to 165) (n=36)	87.6 ± 11.75** (63.8 to 111.5) (n=36)
25-(OH)D (ng/ml)	15.57 ± 1.21 (13 to 18) (n=30)	17 ± 1.3 (14 to 20) (n=34)	18.5 ± 1.66 (15 to 22) (n=39)	19 ± 1.59 (16 to 22) (n=36)
N-tact PTH (pg/ml)	36.7 ± 10 (16 to 58) (n=28)	26.51 ± 1.6 (23 to 30) (n=34)	21 ± 1.5 (18 to 24) (n=41)	25.28 ± 1.8 (22 to 29) (n=36)

Values are mean + SEM (95% CI) * P < 0.0001; ** P < 0.05

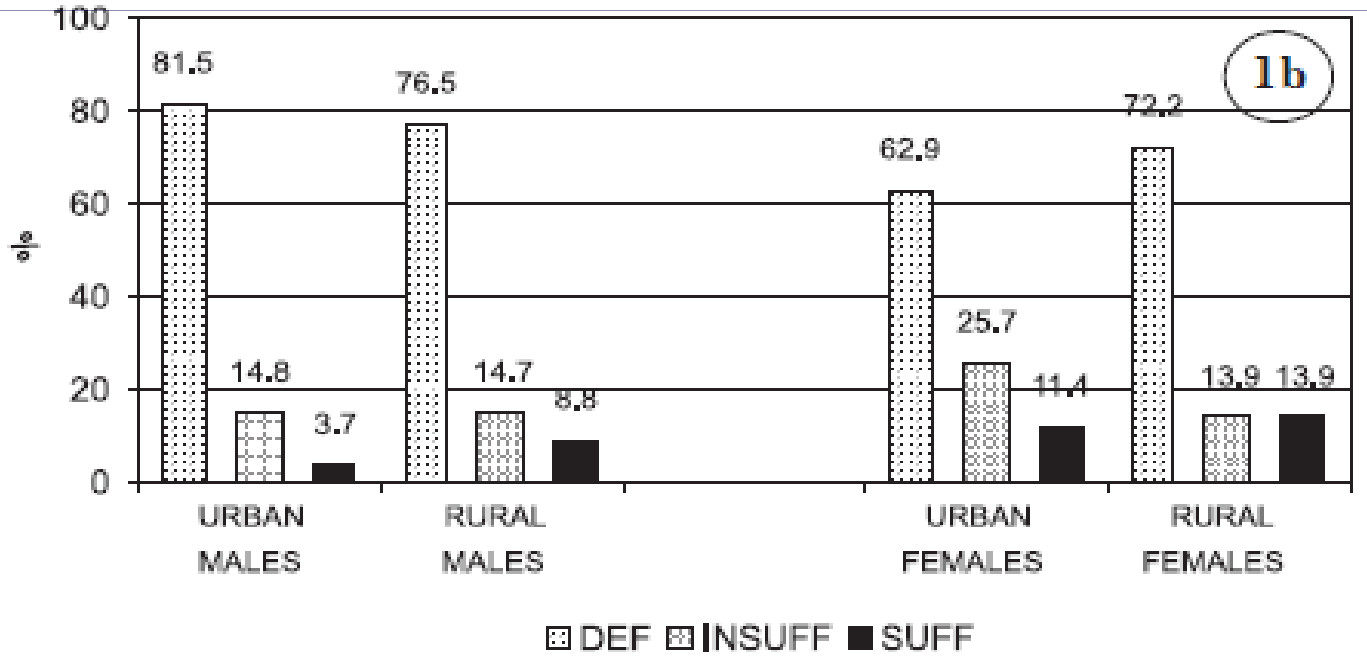

50
35
20
Ntact PTH pg/ml
< 10
10-20
20-30
> 30
25(OH)D ng/ml
URBAN
RURAL
RURAL
URBAN

DISTRIBUTION OF 25(OH)D LEVELS IN RURAL & URBAN

ADULTS



CHILDREN



SUMMARY

- High prevalence of low dietary calcium – both urban and rural populations
- High dietary phytate content retards absorption of calcium from gut
- High prevalence of **vitamin D insufficiency** in rural and urban populations
- **Vitamin D Deficiency**
  - Rural male – Dress code and occupation
  - Less in rural females compared to urban - Occupation

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LIMITATIONS OF THE STUDY

- Cross sectional study
- Methodological limitations
  - Urban sampling
  - Age groups
- Multicentric studies with a large sample size - nationally relevant guidelines
- Prospective longitudinal studies are required to assess the effect on bone mineral density, a surrogate marker for fracture risk or fracture rates.

- Dietary Calcium intake far less than RDA of ICMR -
  - Less than RDA of USA
- Analytical Values far less than Estimated values
- Role of Phytates in Calcium absorption
- Role of Fluoride – Environmental toxin

VITAMIN D AND DIETARY Ca RELATIONSHIP

- Low Dietary calcium or high phytate diet -> increased catabolism of 25(OH)D levels and formation of inactive metabolites -> reductions of 25(OH)D levels.

- Rickets in Asian community in UK - Low calcium, high cereal diet -> mild 2^0 HPT - Resultant reductions of 25(OH)D levels.

Clements MR, JHN,1989;2:105-16

SUMMARY OF INDIAN STUDIES

1. All studies
   a. uniformly point to low 25(OH)D levels in the populations studies despite abundant sunshine in our country.
   b. documented low dietary calcium intake compared to RDA by ICMR.
2. Residents of northern tip of India in Kashmir valley had low 25(OH)D levels.
3. Indian paramilitary forces who had dietary calcium well above the RDA and daily exercises in sunlight in the morning hours had better 25(OH)D levels compared to the civilian counterparts.

SUMMARY OF INDIAN STUDIES (contd)

4. Dietary calcium supplementation had positive effect on 25(OH)D levels.
5. The effect of short course of loading doses of vitamin D (60,000 IU) doesn't have a lasting effect and a maintenance dose is needed.
6. Low 25(OH)D levels has its implications of lower peak bone mass and lower BMD compared to west.

IMPLICATIONS

IMPLICATIONS OF LOW VITAMIN D STATUS AND LOW DIETARY CALCIUM INTAKE:

1. The prevalence of hypovitaminosis D may be over looked.
2. The Bone Mineral Density (BMD) - Early osteomalacia could co-exist with osteoporosis.
3. Validity to extrapolate the normogram of BMD of the west to the Indian population.
4. The clinical presentation of various diseases is modified.
    a. Early osteomalacia can coexist with osteoporosis,
    b. Presentation of primary hyperparathyroidism is altered.
    c. “Hungry bone syndrome” in the post operative period.

IMPLICATIONS OF LOW VITAMIN D STATUS AND LOW DIETARY CALCIUM INTAKE:

5. Vitamin D insufficiency associated SHPT, which is further amplified by inadequate calcium intake.
6. The effect of an environmental toxin like fluoride on bone mineral metabolism is severe and more complex in children with poor dietary calcium intake.
7. Vitamin D supplementation for osteoporosis
8. Urgent need to revise the RDA of calcium and propose new guidelines for 25(OH)D for Indian population.
9. Consider food fortification and monitoring programs

LIMITATIONS:

1. The major limitation of the available data is to translate it to the whole country with more than a billion populations.
2. We have limited data of populations residing at higher latitudes and altitude (soldier in Himalayas, northeastern part of India), in deserts of Rajasthan, fisherman in the sea coasts, and the rural population who are below the poverty line.
3. Multicentre studies with a large sample size are required to generate normal standards and evolve those guidelines.

THANK YOU

FREE DOWNLOAD FROM PubMed

1. Vitamin D status in India – ……. – A Review–

   JAPI 2009;40-48.

2. Vitamin D status in Andhra Pradesh: a population based study.

   Indian J Med Res. 2008;127(3):211-8.

3. High preval. of low dietary calcium, …….healthy south Indians.

   Am J Clin Nutr 2007;85:1062-67.