

Vitamin D status in Indians

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Introduction

- **Vitamin D is an important hormone necessary not only for maintaining calcium balance and safeguarding skeletal integrity but also essential for overall health and well being.**
- **Profound effect on growth and development of children and implication for adult bone health.**
- **Optimal bone mineral health during childhood and adolescence leads to adequate peak bone mass which acts as a safeguard against osteoporosis and susceptibility to fractures at a later age.**

Cont..

- **Primarily acquired by exposure to sunlight.**
- **Food articles commonly consumed by Indians do not provide adequate vitamin D.**
- **No food articles are fortified in India.**
- **Nutritional rickets and vitamin D deficiency continues to exist as a major health problem in India.**

Cont..

- The most sensitive index in assessing vitamin D status is 25(OH)D

(Hollis BW Calcif Tissue Int; 1996; 58; 4-5)

- Age, sex, pubertal status, latitude, season, race, pollution, sunscreen creams and ethnicity influence 25(OH)D levels.

- Approximately 40-50% of total skeletal mass at maturity is accumulated during childhood and adolescence.

(Mora et al, 1999; Cadogan et al, 1998)

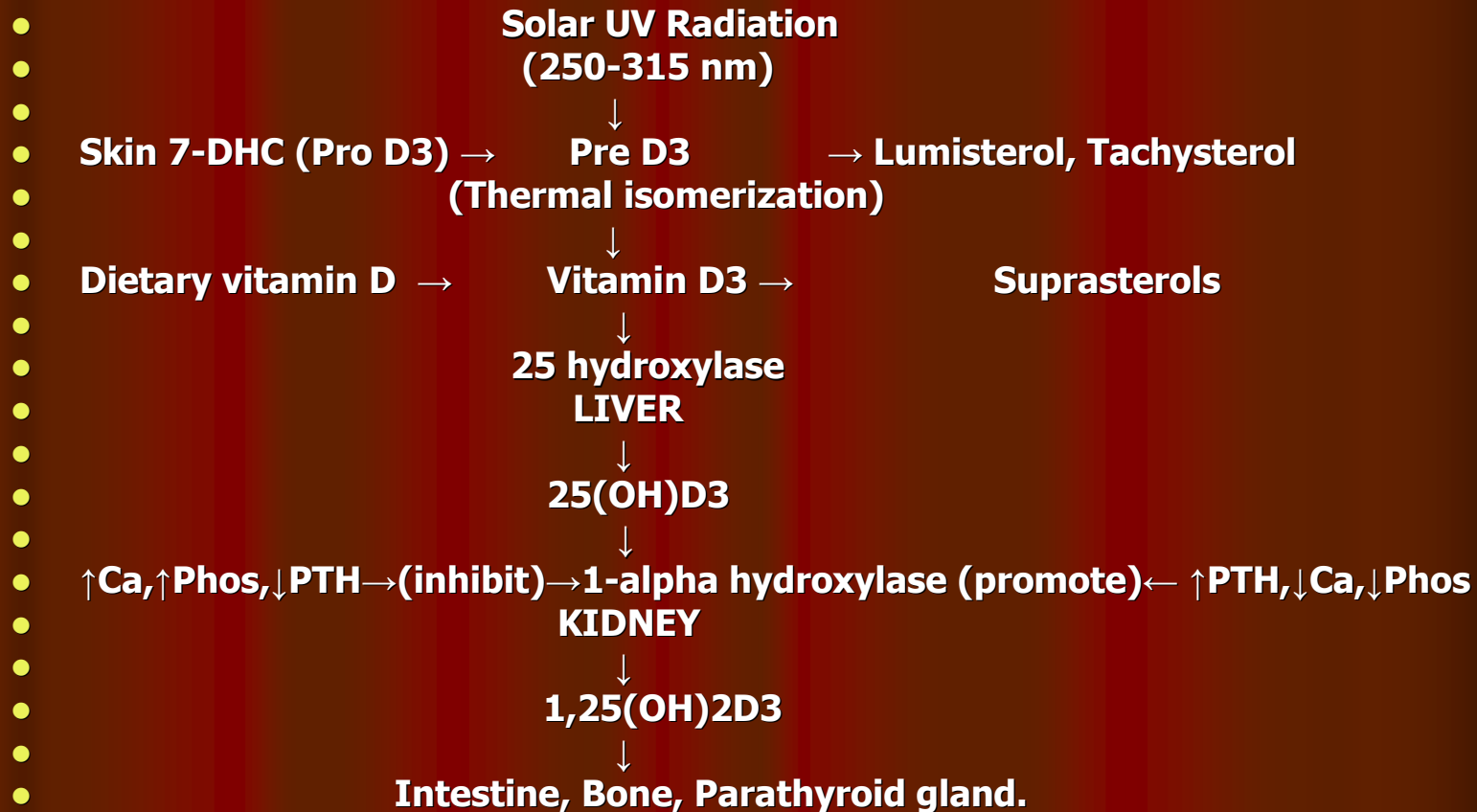
- Life style determinants - exercise, body composition, nutrition, calcium and Vitamin D intake affect bone development.

Role of Vitamin D in our Health

- **It maintains blood calcium level in normal range which is vital for normal functioning of nervous system, bone growth and achieving peak bone density.**
- **It is a potent immune system modulator and prevents development of the autoimmune disorders.**
- **It inhibits uncontrolled proliferation and stimulates differentiation of cells thereby preventing common cancers.**
- **Plays a role in insulin secretion under conditions of increased insulin demand.**

Whiting J S and Calvo S M American Society of Nutritional Sciences, 2005

Pathway of Vitamin D Synthesis



Normal levels of circulating 25(OH)D ?

- **Exact cut-offs for “deficiency” and “insufficiency” remain controversial**
- **Previous assessments based on Gaussian distribution of concentrations was grossly inadequate**
- **Threshold at which 25(OH)D induces an ↑ in iPTH concentration in adults range from 10-32ng/ml**
- **Several classifications exist e.g. Lips P:**
 - <5 ng/mL - severe hypovitaminosis D
 - 5-10ng/mL - moderate hypovitaminosis D
 - 10-20 ng/mL - mild hypovitaminosis D

Normal levels of circulating 25(OH)D

- **Functional indicators for defining 25(OH)D adequacy (80 nmol/L, 32ng/ml) as the "cut-off"**
- **Parathyroid hormone (PTH)**
(Vieth R et al JCEM 2003)
- **Calcium absorption**
(Heaney R et al J.Am, Coll. Nutr, 2003)
- **Bone Mineral Density**
(Bischoff- Ferrai H et al Am.J. Med. 2004)

Cont..

- Growing body of evidence suggest that serum 25(OH)D of <50 nmol/L or 20 ng/ml may be associated with greater risk of non skeletal chronic diseases.

(Zittermann A et al;2003,Holick MF et al 2004)

SIGNIFICANCE OF VITAMIN D STATUS TO CHRONIC DISEASE

Deficiency

Insufficiency

Optimal



**SHORT LATENCY
DISEASE :**

- Rickets
- Osteomalacia



LONG LATENCY DISEASES :

Loss of Calcitropic Effects

- Osteoporosis
- Muscle pain and fatigue
- Hypertension/ Cardiovascular Disease
- Loss of Antiproliferative effects
- Cancer (breast, colon, prostate)
- Loss of Immunomodulatory Effects
- Diabetes, Lupus etc.

Whiting J S and Calvo S M American Society of Nutritional Sciences, 2005

PREVALENCE OF VITAMIN D INSUFFICIENCY

- **Community-based studies** - the prevalence of clinical rickets in preschool children in India

- -1.5% to 11.4% - 1970's

(Srivastava et al Indian pediatrics. 1970. Gupta et al Indian. J. Ped. 1973.)

- -2% to 9.4% - 1990's

(Chainani et al indian J mat child health 1994. Dwivedi indian I mat child health 1994)

- However hypovitaminosis D was not documented in apparently normal children.

(Raghuramulu et al Arch. Dis. Child. 1980)

- **Hospital based studies** - a prevalence of 0.2% to 5.3%.

(Ghosh, et al J Indian Ped society. 1962., Agrawal et al, Indian Pediatrics. 1969)

PREVALENCE OF VITAMIN D INSUFFICIENCY

Vitamin D status in Asian immigrants

- In Asian migrants in the United Kingdom - prevalence of rickets in children and adolescents - 5% to 30%
(Goel KM et al Lancet, 1976; Dunnigan et al Scott Med. J, 1962; Holmes AM et al QJM, 1973)
- Immigrant studies using biochemical and radiological parameters - 12.5% to 66%
(Ford JA, Arch Dis Child 1976; Dunnigan MG Br Med J, 1981; Ford JA Br Med J 1972)
- In children of Indian origin residing in South Africa, the prevalence of knock knees and bow legs: 6.1 - 19.4%
(Richardson BD Postgrad Med. J 1975)
- Incidence of rickets had come down in the immigrant population
(Goel et al. Lancet 1981)

Vitamin D status in Indians

- Ever since the publication of Hodgkin et al on uncommon prevalence of vitamin D deficient Osteomalacia among Punjabis in India as compared to those residing in UK, no systemic studies appeared assessing the vitamin D status of subjects living in tropical and subtropical latitudes of India till 1995.
- Systemic evaluation of 25(OH)D in apparently healthy Indian population was first carried out by Goswami R et al in the year 2000 following a preliminary report of low 25(OH)D levels in patients with primary hyperparathyroidism and 14 healthy controls.

(Harinarian CV et al. Clin Endocrinol (oxf) 1995.)

Studies on vitamin D status in Indians

- High prevalence of hypovitaminosis D is being increasingly recognized globally.
- Similarly widespread vitamin D deficiency (74-96%) among apparently healthy Indians of all age groups and both sexes have been reported from India.

Vitamin D status in pregnancy

- Recent limited data on vitamin D status in pregnant women in all 3 trimesters from Delhi and Lucknow, reveal unexpectedly high prevalence (74-98%) of hypovitaminosis D ($25(\text{OH})\text{D} < 20 \text{ ng/dl}$)
- The mean $25(\text{OH})\text{D}$ values varied from 8.7 ± 4.3 to $14 \pm 9.3 \text{ ng/ml}$.

Sachan A et al;AJCN 2005, Sahu M et al;Clin Endocrinol 2009 (Lucknow), Goswami R et al;AJCN 2000 and Marwaha RK et al BJJN.

Vitamin D status in lactating mothers

Vitamin D nutritional status of exclusively breast fed infants and their mothers

Seth A and Marwaha RK et al;JPEM 2009

Mother-infant pairs studied : 180

- Mean serum 25(OH)D: 10.9 ± 5.8 ng/ml
(27.2 ± 14.6 nmol/L)
- Prevalence of vitamin D deficiency (<20 ng/ml) :
93.8%

Vitamin D status of Neonates and Infants

- **Clinical features of vitamin D deficiency : 3.9% (7/180)**

- **High prevalence of low serum 25(OH)D levels in 80-91% infants 2 -24 weeks old.**

(Seth A & Marwaha RK et al; JPEM 2009, Bhalala et al; Indian Pediatrics 2007)

- **Mean 25 (OH)D=11.55±8.3 ng/ml.**

- **Similar observation was made when cord blood was used.**

(Goswami R et al; AJCN 2000, Sachan A et al; AJCN 2005)

- **Significant correlation of 25(OH)D between mother infant pairs has also been reported by several Indian studies.**

(Marwaha RK et al; JPEM 2009, Bhalala et al; Indian Pediatrics 2007 ,Goswami R et al; AJCN 2000, Sachan A et al; AJCN 2005)

Table: Comparison of studies on prevalence of Hypovitaminosis D in neonates & infants in various countries.

Country	Author & yr. of study	Study group	Mean 25(OH)D	% of hypovitaminosis D
Leeds	Heckmatt JZ et al 1979	New born & young infants		36% (< 10 ng/ml)
U.A.E.	Dawodu A et al 2003	Infants		82% (<10 ng/ml)
New Delhi, India	Goswami R et al 2000	Newborns	6.686±4.2ng/ml	
Lucknow, Delhi	Bhatia VL et al 2005	Newborn Cord blood	8.4±5.7ng/ml	42.5% (<10ng/ml)
Netherlands	Hoogenboezem et al 1989	Newborn Cord blood	22±1.8ng/ml	
Pakistan (Study on hypocalcemic babies and their mothers)	Atiq M et al 1998	Infants	7.5±3.3ng/ml	
New Delhi, India	Marwaha et al 2009	Infants	11.55±8.3ng/ml	43.9% (<10ng/ml)

Vitamin D and bone mineral density status of Healthy School Children in northern India

Marwaha RK & Tandon N et al Am J Clin Nutr 2005

- Clinical vitamin D deficiency (G Varum & G Valgum) was noted in 556/5137 (10.82%) subjects [LSES – 11.6%, USES – 9.7% ($P = 0.07$)]
- Mean 25(OH)D value was 11.8 ± 7.2 ng/ml
- Low 25(OH)D levels according to Lips criteria seen in 92% of LSES and 84% of USES
- 25(OH)D higher in boys than girls in both the groups ($P = 0.030$ in LSES; $P = 0.015$ in USES).
- Secondary hyperparathyroidism was noted in only 11% subjects.

Vitamin D status of apparently healthy school girls from two different socio-economic strata in Delhi: Relation to nutrition & life style

Puri S & Marwaha RK et al BJN 2007

Objective:

- To examine the role of lifestyle & diet on vitamin D status in healthy school girls (6-18 yrs) from Delhi

Study Design:

- Clinical and anthropometric assessment was done in 3127 girls, 6-17yrs of age (LSES-1477 & USES-1650)
- Dietary, physical activity profile and biochemical assessment was randomly done in 193 LSES & 211 USES girls

RESULTS

- Clinical evidence of vitamin D deficiency was noted at 11.5% subjects.
- Mean serum 25(OH)D was 12.74 ± 6.17 ng/ml.
- Prevalence of biochemical hypovitaminosis D (< 20 ng/ml) was 90.8%.
- Significant correlation was found between 25(OH)D concentration and estimated sun exposure ($r=0.185$, $p<0.001$) and between 25(OH)D and percentage of body surface area exposed ($r=0.146$, $p=0.004$)
- No significant association was found between Vitamin D intake and serum 25(OH)D levels ($r=0.001$, $p=0.137$)

CONCLUSION

- Life style related factors contribute significantly to the vitamin D status of apparently healthy school girls.
- In the absence of vitamin D fortification of food, diet alone appears to have an insignificant role.

Vitamin D status in Indian Adults

- **Title:**
Prevalence and significance of low 25(OH)D conc. in healthy subjects in Delhi
Goswami R et al Am J Clin Nutr 2000; 72:472-5
- **Objective:**
To assess 25(OH)D status & it's functional significance in apparently healthy subjects
- **Design:**
- 123 healthy subjects in 5 different groups – soldiers, physicians & nurses, depigmented people, pregnant women & newborns from Delhi (Latitude 28.4° N, Longitude 77.1° E) were evaluated
- Subjects differed with respect to sunlight exposure, season of measurement, skin pigmentation and dietary Ca and phytate contents
- Serum Ca, PO₄, SAP, 25(OH)D, iPTH and 1,25(OH)₂D were measured

Cont..

- **Results:** All groups except soldiers with maximum direct sunlight exposure had subnormal conc. of 25(OH)D
- The 25(OH)D deficient groups tended to an imbalance in bone mineral homeostasis when exposed to winter weather and ↓ dietary Ca with significantly low serum Ca and elevated iPTH concentrations, chemical osteomalacia or both.

Cont..

- Significant negative correlation between 25(OH)D and iPTH
- Significant inverse relation between iPTH and calcium

Clinical characteristics, sun exposure and serum concentration of Vitamin D and related variables in the study groups

Variables	Soldiers (winter) (n= 31 M)	Physicians and nurses (winter) (n=11M, 8F)	Physicians and nurses (summer) (n=11M, 8F)	Pregnant women (summer) (n=29 F)	Newborns (summer) (n=16M, 13F)
Calcium Intake (mg/d)	1104 ± 666	879 ± 165	879 ± 165	345 ± 78	-
Sun exposure (min/d)	370 ± 30	25 ± 5	25 ± 5	25 ± 5	-
25(OH)D (nmol/L)	47.17 ± 11.73	7.98 ± 3.49	17.97 ± 7.98	21.9 ± 10.73	16.72 ± 4.99
1,25(OH)D (pmol/L)	ND	ND	93.6 ± 29.0	16.8 ± 5.9	114.5 ± 55.4
iPTH (ng/L)	17.6 ± 4.8	38.8 ± 18.2	ND	ND	ND
Total Calcium (nmol/L)	2.35 ± 0.17	2.17 ± 0.10	2.25 ± 0.3	1.16 ± 0.32	1.32 ± 0.32
ALK (KAU)	7.9 ± 3.0	6.4 ± 1.8	6.4 ± 2.3	14.0 ± 10.0	19.9 ± 15.3

Conclusions

- Healthy subjects in Delhi are vitamin D deficient because of inadequate sunlight exposure and skin pigmentation.

Osteoporos Int (2004) 15: 56–61
DOI 10.1007/s00198-003-1491-3

ORIGINAL ARTICLE

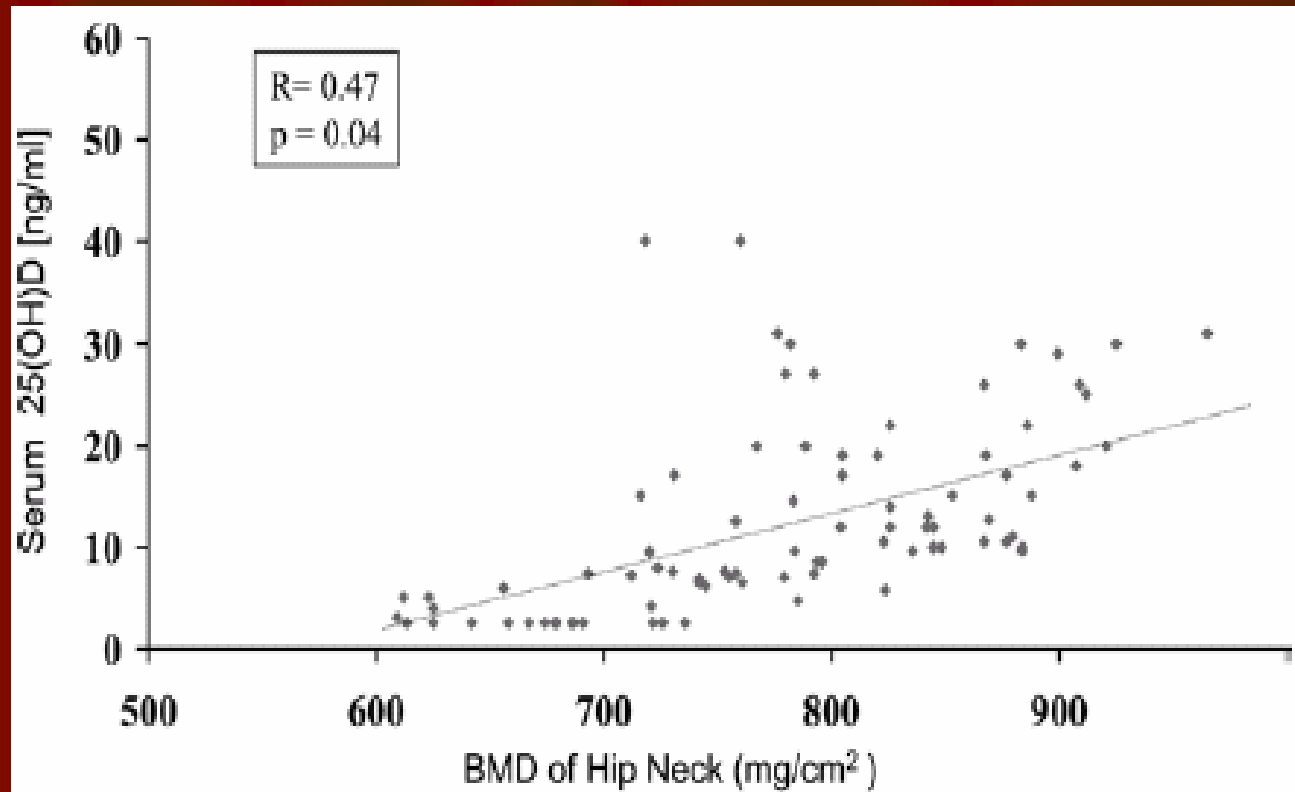
Vitamin D status and its relationship with bone mineral density in healthy Asian Indians

**Vivek Arya · Rajiv Bhambri · Madan M. Godbole
Ambrish Mithal**

BMD in Healthy Indians, Lucknow

- 92 (67F, 25M) young healthy volunteers
- Systemic disease/drugs – excluded
- Vitamin D and serum iPTH (15) measured
- 74% had daily calcium intake <500 mg
- 67% had serum 25(OH)D levels < 15 ng/ml
- BMD – spine and hip

Vitamin D and BMD in Healthy Indians



Correlation with 25(OH)D

Wards' triangle $r=0.50$, $p=0.020$

Femoral neck $r=0.46$, $p=0.037$

Other sites not significant

High prevalence of low dietary calcium and low vitamin D status in healthy south Indians

Harinarayan CV et al: Asia Pac J Clin Nutr 2004; 13 (4): 359-365

Objective: To document the dietary habits, serum calcium, 25(OH)D & PTH in Indian Urban and rural population

Methods:

- 125 healthy urban & 191 rural subjects were evaluated from Tirupati, South Andhra Pradesh.
- Location (Latitude 13.4°N, longitude 77.2°E)
- Cloud free sunlight for 8 – 10 Hours per day with little seasonal variation

RESULTS

- Daily intake of calcium in both rural (264 ± 1.9 mg/day) & urban (354 ± 4 mg/day) subjects was low compared to RDA (400mg/day) by ICMR
- Serum 25(OH)D (ng/ml) levels:
 - > 20 in 31% cases
 - 10-20 in 54%
 - < 10 in 15%
- 25(OH)D concentration in rural subjects were significantly higher than those of urban subjects (21 ± 0.46 vs 13.52 ± 0.59 ng/ml; $p < 0.001$) in both men and women.

25(OH)D Levels

		<20ng/ml	20-30ng/ml	>30ng/ml
Rural	M	44%	39.5%	16.5%
	F	70%	29%	1%
Urban	M	62%	26%	12%
	F	75%	19%	6%

CONCLUSION

- Low Ca & 25(OH)D concentration were associated with deleterious effects on bone mineral homeostasis
- Prospective longitudinal studies required to assess the effect on BMD, a surrogate marker for #risk and # rates

Vitamin D status in apparently healthy adults in Kashmir Valley of Indian subcontinent

Zargar et al Postgraduate Medical Journal 2007

- Total subjects studied – 92 (M-64, F-28)
- Location: Latitude(34.3°N) Longitude (73.9°E).
- Vitamin D deficiency (25 (OH)D<20ng/dl) reported in 83%.
- Mild hypovitaminosis D – 25%
- Moderate hypovitaminosis D – 33%
- Severe hypovitaminosis D – 25%
- Exposure to sunlight was inadequate in vitamin deficiency patients.

Presence of 25(OH)D deficiency in a rural north Indian village despite abundant sunshine

Goswami R et al JAPI 2008.

- **Design & Methods:**

A total of 57 subjects (32 males, 25 females) from 50/200 families from Agota village 90 Km east of Delhi were evaluated for serum 25(OH)D.

- **Location:** Latitude 28.5°N and longitude 77.8°E.

- **Sun exposure:** Approx. 5 Hrs/day.

Results

- The mean 25(OH)D values was 36.4 ± 22.5 nmol/L.
- The serum 25(OH)D values of males (44.2 ± 24.4 nmol/L) and females (26.9 ± 15.9 nmol/L) in rural area were six and four fold higher than that of the urban subjects (13.5 ± 3.0 nmol/L).
- Only 18/57 subjects (31.5%, 15 males and 3 females) had serum 25(OH)D levels ≥ 50 nmol/L.

Conclusion

- Longer sunshine exposure results in better 25(OH)D status among subject residing in rural areas as compared to urban counterparts, yet 2/3 rd of the rural subjects would remain 25(OH)D deficient with values <49.9 nmol/L.

Prevalence of vitamin D deficiency and its relationship with thyroid autoimmunity in Asian Indians : a community based survey

Goswami R, Marwaha RK et al BJN 2009

- Introduction:
 - 25(OH)D deficiency has been linked with predisposition to autoimmune disorders like Type I DM, Multiple Sclerosis, Rheumatoid Arthritis etc. (Arnson Y et al. *Ann Rheum Dis* 2007,66:1137-1142. Holick MF. *NEJM* 2007,357:266-281)
- **Objective:**
 - To assess prevalence of vitamin D deficiency
 - To assess relationship between serum 25(OH)D levels and thyroid autoimmunity.
- **Methodology:**
 - A total of 642 subjects (244 m, 398 F), 16-60 years old included students, teachers and staff were evaluated for thyroid function (T3, T4 and TSH), Thyroid autoimmunity by TPO Ab, 25(OH)D and PTH.

Results

- The mean serum 25(OH)D of the study subjects was 17.5 ± 10.2 nmol/L.
- >96% had values <50 nmol/L.
- 87% of subjects had values ≤ 25 nmol/L.
- Biochemical hyperparathyroidism was present in only 28.5% subjects.
- Relationship between 25(OH)D and TPO Ab was assessed with and without controlling for age.
- Significant inverse correlation ($r = -0.08$, $p = 0.04$) was noted when adjusted for age.

Results

- Secondary hyperparathyroidism was significantly higher (31%) in those with 25(OH)D levels ≤ 25 nmol/L as compared to those (10.8%) with levels >25 nmol/L.
- Serum 25(OH)D values show only weak inverse correlation with TPO Ab titres.

Conclusion

- Presence of weak association and narrow range of serum 25(OH)D did not allow us to interpret the results in terms of quantitative cut-off values of serum 25(OH)D.
- Further studies in vitamin D sufficient population with wider range of serum 25(OH)D levels are required to substantiate the findings of the current study.

Impact of nutrition and physical activity on BMD in young healthy Indian female

Marwaha RK et al

Background:

Peak bone mass is influenced by genetic, nutrition lifestyle and hormonal factors. This study was designed to evaluate the impact of physical activity and nutrition on bone mineral metabolic parameters in young sports persons.

Material & Methods

- 186 healthy female subjects (sports women – 90, control – 90) in the age group of 18-20 yrs were selected from Delhi colleges. Controls were age, weight and BMI matched.
- Detailed evaluation of anthropometry, biochemistry, 25(OH)D, PTH, diet and lifestyle was carried out.
- BMD at hip, forearm and lumbar regions were studied using central DEXA.

Results

	Sports Girls	Controls
Physical activity (per day)	2-3 hrs	Sedentary
Sunlight exposure (hrs/day)	2	1/2
Mean serum 25(OH)D (ng/ml)	21.3±7.6*	5.2±3.1*
iPTH (pg/ml)	35.3±17.6*	51.7±44.9*
ALP (IU/L)	194±51*	222.1±51.4*
Total calorie intake	2044 ± 629* (769 – 3690)	1429.5±274 (729.4-2070.2)

*** P <0.001**

Results

Vitamin D deficiency	Sports girls	Controls
Normal (>20 ng/ml)	51.6%	0%
Mild (10-20 ng/ml)	45.1%	17.3%
Moderate (5-10 ng/ml)	3.3%	38.5%
Severe (<5 ng/ml)	0%	54.2%

Anthropometric Parameters

Variable	Control girls (n=96)	Sports girls (n=90)	Overall (n=186)
Age (years)	18.5±1.3 (17-21)	18.7±1.2 (16-22)	18.6 ± 1.3 (16-22)
Height (cm)	158.1±5.7 (143-171)	158.5 ± 5.7 (146 – 178)	157.4 ± 5.7 (143-178.5)
Weight (kg)	52.4±8.4 (37-79.3)	54.0 ± 9.1 (41.5 – 100.4)	53.2 ± 8.8 (37 – 100.4)
Body Mass Index (kg/m ²)	21±3.5 (13.8-31.6)	21.6 ± 3.1 (16.1 – 34.7)	21.2 ± 3.3 (13.8 – 34.7)

Values are given as Mean ± SD (range)

Significant differences against controls (Student's t-test, independent data): ***P≤0.001.

ALP, Alkaline phosphatase; PTH, Parathyroid hormone

BMD Parameters

Parameter	Control girls (n=96)	Sports girls (n=90)
Total BMD (g/cm ²)	1.07±0.087	1.13±0.1***
Total femur (g/cm ²)	0.96±0.12	1.08±0.14***
Femur neck (g/cm ²)	1.07±0.87	1.04±0.13
33% Radius (g/cm ²)	0.60±0.09	0.65±0.55***
Lumber (L1-L4) (g/cm ²)	1.07±0.13	1.18±0.14***

Values are given as Mean ± SD

Significant differences against controls (Student's t-test, independent data): ***P≤0.001

Conclusion

- Physical activity, optimal nutrition and adequate sun exposure are vital for attaining peak bone mass.
- Despite 2 hours of sun exposure and 30% body surface area exposed, only 52% could achieve serum 25(OH)D levels beyond 20 ng/ml.

Peak Bone Mineral Density of physically active healthy Indian men with adequate nutrition and no known current constraints to bone mineralization

Marwaha RK & Tandon N et al Journal of Clinical Densitometry 2009

Objective:

To characterize peak bone density and evaluate its determinants in a healthy cohort of young military personnel.

Material & Methods:

- Total no. of Jawans (21-40 yrs) enrolled: 473
- Study was conducted between November and December 2007.
- The subjects underwent biochemical analysis for fasting glucose, thyroid profile, total and ionized Ca, PO₄, ALP, 25(OH)D and iPTH.
- Dietary assessment of total energy, protein, carbohydrate, calcium, phytate and fibre intake was made through 24 hrs recall of food intake.
- The entire cohort underwent regular outdoor weight bearing physical activities and adequate sun exposure.
- BMD of AP lumbar spine (L1-L4), femur (neck, wards triangle and trochanter) and forearm (total, ultradistal and 33% radius) were measured using the prodigy oracle according to std. protocol.

Results

- Intake of Calcium and protein exceeded recommended daily allowance.
- Mean serum 25(OH)D levels was 34.09 ± 15.8 nmol/L.
- Prevalence of vitamin D deficiency (<50 nmol/L) was noted in 85% subjects.
- Peak BMD in femoral and lumbar regions were achieved by 30 yrs of age- consistent with other studies.
- Body weight was the strongest predictor of BMD at all measured sites which reinforces the data from literature.
- No correlation of BMD at different sites with serum 25(OH)D levels as also reported earlier by various workers.
- Peak BMD in this population was comparable to that reported in US white males.

Prevalence of vitamin D Deficiency

Vitamin D levels (ng/ml)	Percentage
<5	4.2%
5-10	25.2%
10-20	55.4%
>20	15.1%

Conclusion

- The present study shows that 85% of the healthy Indian adult men could not achieve normal serum 25(OH)D levels despite adequate outdoor activities and sun exposure.

Vitamin D status of Senior Citizens of Delhi

Marwaha RK et al

Total no. of subjects studied is 1400

Female: 739

Male : 661.

- Mean 25(OH)D levels: Males- 9.7 ± 6.8 , Females- 9.6 ± 7.51
- Mean PTH levels: Males- 57.7 ± 36.9 , Females- 57.5 ± 37
- Secondary hyperparathyroidism : 431 (30.7%)

Overall vitamin D deficiency [25(OH)D <20 ng/dl] : 91.5%.

Mild hypovitaminosis D : 399(28.5%)

Moderate hypovitaminosis D : 474(33.8%)

Severe hypovitaminosis D : 396(28.3%)

No significant differences of vitamin D deficiency prevalence was noted in different sexes.

Conclusion

- **Studies on bone mineral health from different parts of India indicate wide prevalence of vitamin D deficiency (VDD) in all age groups including neonates, infants, school children, pregnant / lactating women and adult males and females residing in rural and urban India.**
- **These have resulted due to poor sun exposure, dark skin complexion, vegetarian food habits, sedentary life style and lack of vitamin D food fortification programme.**
- **Supranormal serum parathyroid hormone values and low peak bone mass in apparently healthy children and adults reported in various studies could be linked to hypovitaminosis D in Indians.**
- **In such a scenario active intervention may be required in the form of a national policy for vitamin D fortification/supplementation programme in our country.**



THANKS

Impact of vitamin D
deficiency on muscle
energy metabolism using
 ^{31}P NMR Spectroscopy

Objective

- To analyze muscle phosphate metabolism in vitamin D deficient subjects using ^{31}P Magnetic Resonance Spectroscopy and look upon the effect of vitamin D supplementation on muscle metabolism.

Methodology

- Seventeen vitamin D deficient otherwise healthy subjects performed plantar flexion exercise before and after three months of vitamin D supplementation while lying supine in 1.5 T magnetic resonance scanner using custom built exercise device.
- MR Spectroscopy measurements of inorganic phosphate (Pi), phosphocreatine (PCr), Phosphodiester (PDE) and ATP of calf muscle were taken during rest, at the end of exercise and in the recovery phase.

Results

- Baseline mean 25(OH)D level- 3.38 ng/ml
- Post supplementation mean 25(OH)D level- 32.2 ng/ml
- Baseline mean iPTH level- 68.18 IU/ml
- Post supplementation mean iPTH level- 56.6 IU/ml

Results

- Normal PCR/Pi ratio in normal people is (8.5 ± 2.1)
- PCR/Pi ratio in vitamin deficient subjects is (5.7 ± 0.81)
- PCR/Pi ratio in subjects supplemented with 60000 IU of vitamin D₃ for three months showed significant increase to $(6.66 \pm 0.89, p < 0.001)$

Conclusion

- The present study concludes that vitamin D deficiency has marked effect on muscle metabolism and vitamin D supplementation improves muscle metabolism as shown by increased PCR/Pi post supplementation.