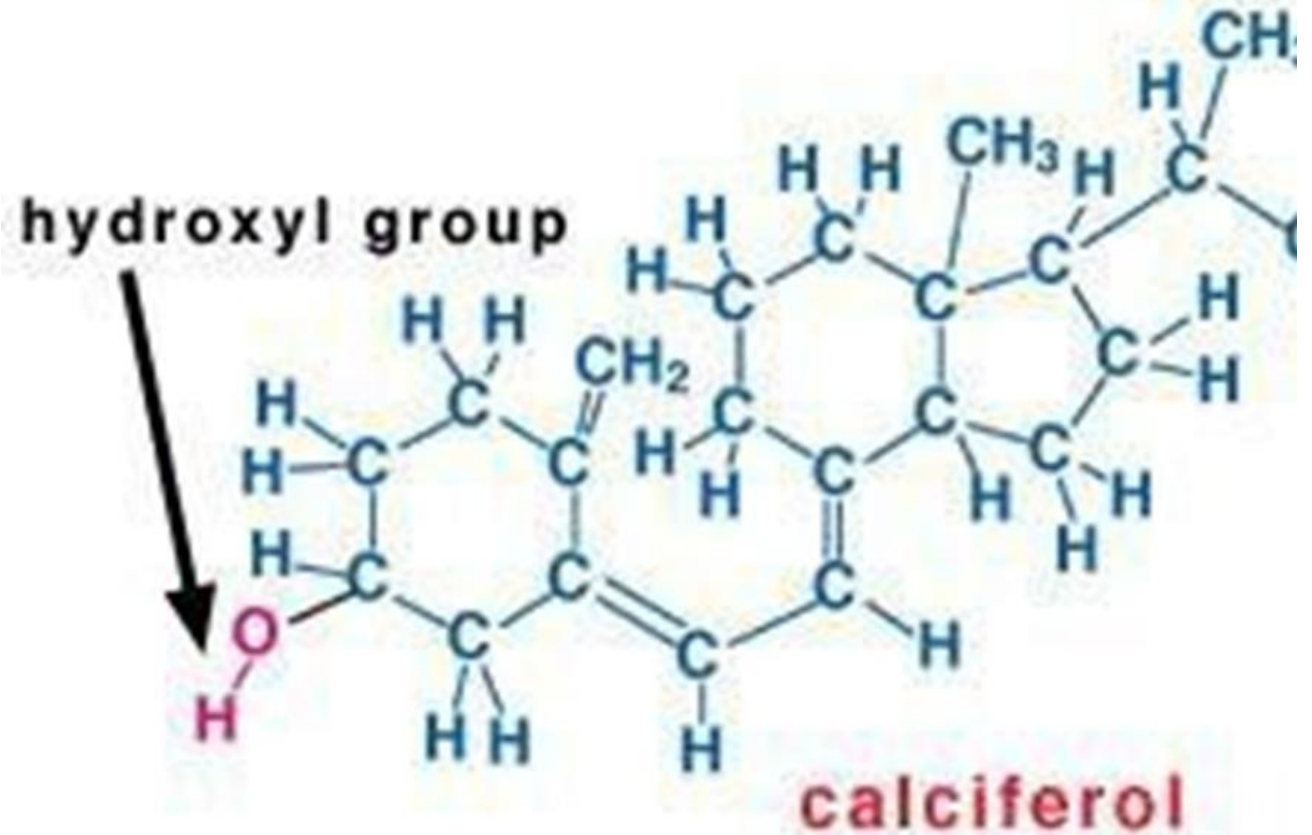


# Vitamin D deficiency in Children

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# Objectives

- Introduction.
- Vitamin D metabolism.
- Vitamin D resources.
- Vitamin D Benefits.
  - Both on skeletal & 'extra-skeletal' benefits of vitamin D.
- Vitamin D Deficiency
  - Definition.
  - Causes.
  - Symptoms & signs.
  - Laboratory findings.
  - Radiological findings.
- Prevention & Treatment.

# Introduction

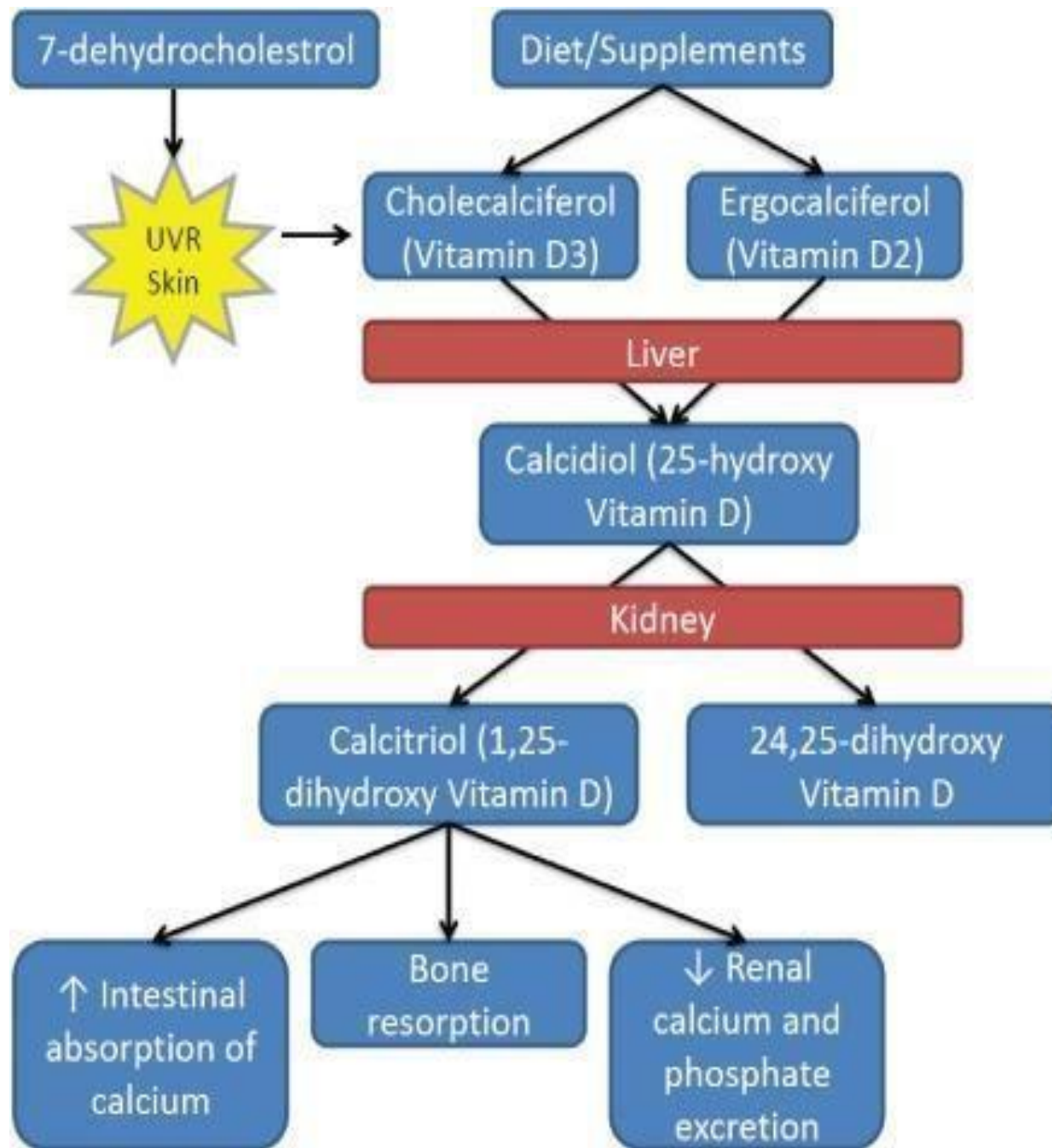
- Vitamin D is an extremely important vitamin that has powerful effects on several systems of the body.
- Unlike other vitamins, vitamin D functions like a hormone & every single cell in the body has a receptor for it.
- Vitamin D deficiency is very common medical condition in Saudi Arabia.
- It's estimated that about 1 billion people worldwide have low levels of the vitamin D.
  - All age groups are affected!
  - 41.6% of adults in the US are deficient.
  - 69.2% in Hispanics and 82.1% in African-Americans .
  - 90 -95 % prevalence in Saudi Arabia.

# Vitamin D resources

- Both ergocalciferol (D2) & cholecalciferol (D3) are equipotent, both increase vitamin D stores, however, recent evidence suggests that vitamin D3 increases vitamin D concentrations two - to threefold more than D2.
- The commonest dietary resources of vitamin D3 are fish (e.g., salmon and tuna), cod liver oil, milk and all fortified milk products, whereas vitamin D2 is found in plant sources like yeast and mushrooms.
- Vitamin D is available commercially as ergocalciferol, cholecalciferol, one alpha calcidiol & calcitriol.

# Vitamin D resources

- Nearly 90% of vitamin D requirement is met by adequate exposure of the skin to sunlight through the action of ultraviolet B radiations (UVB) and remaining 10% is said to meet through diet.
- The WHO expert consultation states that humans can get vitamin D from abundant sunshine, **by exposing 18% of body surface area** (without sunscreen) to mid-day sun (10 am-3 pm) for average of 15-30 min/day.
- Pollution hinders solar UVB rays reaching the ground.
- Lack of space, overcrowdings prevent the direct sunlight reaching inside most parts in urban regions with limited outdoor activities.
- High phytate (Chapati bread) and/ or low calcium diet causes vitamin D deficiency by impairing its absorption.



# Vitamin D Benefits

# Vitamin D benefits on the skeleton

- Vitamin D is extremely important for the human's skeleton & non skeleton tissues right from conception throughout lifespan.
- It has major implications on bone health, since approximately 40% - 60% of total skeletal mass at maturity is accumulated during childhood & adolescence.
- Has profound effect on growth & development during childhood.
- Regulates calcium & phosphorus balance for bone mineralization & bone remodelling.



Vitamin D is not only just for skeletons!!

# Extra - skeletal Benefits

- Vitamin D acts as potent antioxidant protecting against free radical damage & inducer of cellular differentiation, protecting against carcinogenesis.
- Has a role to fight against serious infections, by controlling T cell antigen receptor signaling and activation of human T cells.
- Since these diseases are multifactorial, optimum vitamin D levels may not prevent these diseases, but their risk is lowered.
- In pediatric age group, subclinical vitamin D deficiency & non-exclusive breastfeeding in the first 6 months of life were found to be significant increase risks for acute respiratory tract infections , tuberculosis as well other diseases.
- Significant inverse relationship between vitamin D levels & severity of Asthma, COPD were observed in some studies.

# Role of vitamin D in reducing risk of Autoimmune Disease

- Vitamin D supplementation is associated with lower risk of autoimmune diseases.
- In Finnish birth cohort study of 10,821 children, supplementation with vitamin D at 2000 IU/d reduced the risk of type 1 diabetes by approximately 78%, whereas children who were at risk for rickets had 3-fold higher risk for type 1 diabetes.
- In a case-control study of 7 million US military personnel, high circulating levels of vitamin D were associated with a lower risk of multiple sclerosis.
- Similar associations have also been described for vitamin D levels & rheumatoid arthritis.

# When to say vitamin D is deficient??

- Vitamin D deficiency is typically diagnosed by measuring the concentration of the serum level of 25- hydroxy vitamin D, which is the most accurate measure of stores of vitamin D in the body.
  - Deficiency: < 20 ng/ml.
  - Insufficiency: 20–29 ng/ml.
  - Normal: 30–100 ng/ml.
- Vitamin D levels falling within this normal range prevent clinical manifestations of vitamin D insufficiency / deficiency.
  - Multiply ng/ml by 2.5 to get nmol/l

# Rickets / Osteomalacia

- Rickets is disease of the growing bones in which defective mineralization occurs in both bone & cartilage of the epiphyseal growth plates.
- Is associated with growth retardation & skeletal deformities:
  - skeletal muscles have vitamin D receptor.
  - vitamin D deficiency causes muscle weakness.
- Osteomalacia is a disorder of the mature bone in which mineralization of new osteoid bone is inadequate or delayed.

# Types

- Hypocalcaemic Rickets (commonest type).
- Hypophosphatemic Rickets (not common).
- Combined Rickets (combination of hypocalcemia & hypophosphatemia).

# Hypocalcaemic rickets (with secondarily elevated parathyroid hormone levels)

- Lack of vitamin D due to:
  - Decreased sun exposure.
  - Dietary-deficient intake.
  - Malabsorption diseases that affects absorption of vitamin D (e.g. celiac disease, CF, chronic diarrhea...etc)
- Chronic liver diseases (affects conversion of cholecalciferol to calcidiol).
- Anticonvulsant drugs (phenytoin, phenobarbitone due to increased metabolism of vitamin D by inducing cytochrome P450 activity).

# Nutritional Rickets

- Commonest cause in Saudi Arabia & in developing countries.
- Lack of exposure to U/ V sun light.
  - Dark skin.
  - Covered body.
  - Kept in-door.
- Exclusive breast feeding.
  - Limited intake of vitamin D fortified milk & diary products.
- Peak prevalence during periods of rapid growth:
  - Infancy.
  - Puberty.



# other causes of vitamin D deficiency

- Celiac disease.
- Pancreatic insufficiency.
  - Cystic fibrosis.
- Hepato-biliary disease
  - Biliary Atresia.
  - Cirrhosis.
  - neonatal hepatitis.
- Anti-convulsant.
  - Phenobarbitone.
  - Phenytoin.
- Diet
  - Excess of phytate in diet with impaired calcium absorption (chapati flour).

# Renal Rickets

## **Chronic renal failure (Renal Osteodystrophy):**

- Occurs due to lack of synthesis of active form (1,25-dihydroxy vitamin D) as consequences of 1- $\alpha$ - hydroxylase enzyme deficiency.

## **Renal Tubular acidosis:**

- Metabolic acidosis from proximal or distal tubular disease.
- Fanconi syndrome (generalized form of RTA)
  - associated with cystinosis, tyrosinemia & Wilson's disease
- Accompanied with other urinary loss:
  - Calcium.
  - Phosphate.
  - Glucose.
  - Protein.
- Isolated or generalized forms.
  - Hereditary hypophosphatemic rickets.

# Hereditary Rickets

- Hypophosphatemic rickets (Vit D resistant).
- Vitamin D dependent rickets.

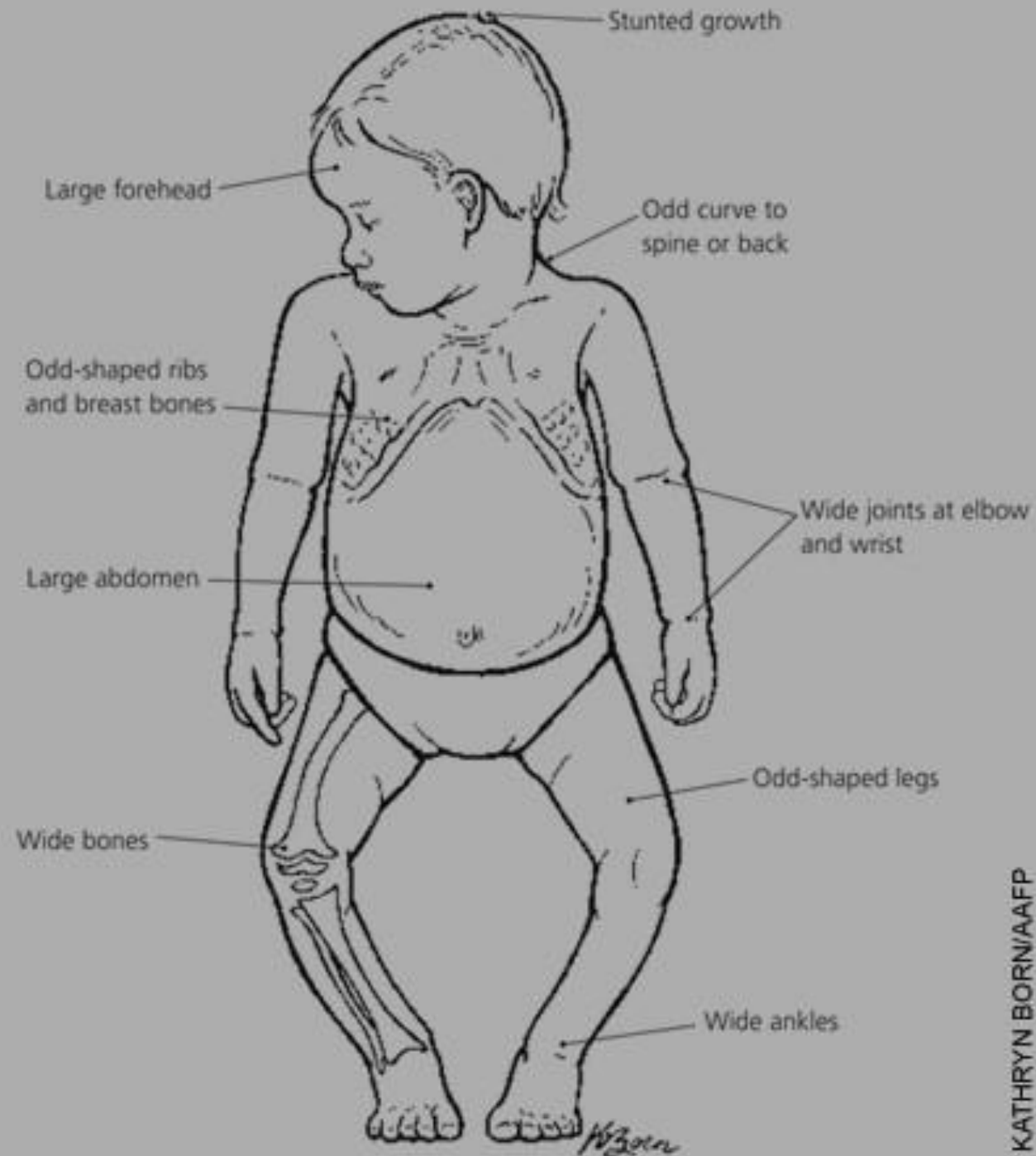
# Vitamin D dependent rickets

## Type 1

- Rare, autosomal recessive.
- Lack of 1  $\alpha$  hydroxylase enzyme.
- Clinically & biochemically like nutritional rickets except it appears early at 3-4 months.

## Type 2

- Rare autosomal recessive disorder.
- 1  $\alpha$  hydroxylase enzyme is present.
- Lack of Calcitriol receptors.
- Common in Arabs.
- Baldness.
- Severely affected individuals.
- Unresponsive to treatment.



















# Prevention of vitamin D deficiency

- In premature infants, 800 IU of vitamin D & 150-200 mg/kg of calcium are recommended daily.
- In neonates, 400 U of vitamin D & 200 mg of calcium are recommended daily.
- In infants (after neonatal period) up to 1 year of age, 400 U of vitamin D/day and 250-500 mg/day of calcium are recommended daily.
- Ages from 1-18 years, 600 U vitamin D/day and 600-800 mg/day of calcium are recommended daily.

# Treatment of Vitamin D deficiency

- For premature neonates & infants up to 1-year of age:
  - 1000- 2000 units & elemental calcium of 70-80 mg/kg/day.
- For children 1-18 years:
  - 3000-6000 unit of vitamin D daily & calcium 500-800 mg daily.
- It is recommended that larger doses of vitamin D up to 50,000 IU/week for 8 -12 weeks, then to measure serum vitamin D, if restored to normal to continue on prophylactic doses (especially in communities with low sun exposure).

# Conclusions

- Vitamin D deficiency is incredibly common & most people are unaware of it.
- Symptoms are often subtle & non-specific.
- Advisable, all age groups to screen for its deficiency.
- Fortunately, a vitamin D deficiency is usually easy to be treated.
- Highly advisable, increase people awareness for its deficiency and broadcast preventive measures such as, either increase sun exposure, consume more of vitamin D fortified food / formulas, fish & salmon or fortified dairy products.
- Encourage either sun-exposure (15 -30 minutes per day (longer with darker skin) or vitamin D supplementations.
- The recommended daily intake is usually 400–800 U, but many experts advise to have up to 1000 unit/day.

Thank you