

# Osteoporosis in Children

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Pediatric Endocrinology



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## Disclosures

- I will be discussing off label uses for medications

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## Objectives

- Discuss common factors associated with low bone density in children
- Discuss evaluation of child presenting to the endocrine clinic
- Discuss treatment options

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**Bone Health In Children**

- Osteoporosis in adults can often have pediatric origins
- Peak bone mass is achieved in adolescence, this can be a predictor of osteoporosis in adults

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**Evaluation of Fractures**

- Fragility vs Traumatic Fractures
  - Vertebral and femur fractures without significant trauma
- Infant fractures: abuse?
- Non weight bearing children

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**Peak fracture risk in children**

- Times of peak growth velocity

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**Bone Mass Acquisition by age**

- Infancy: Rapid
- Mid-Childhood: Slow
- Adolescence: Rapid
- Adults after age 30 years: None

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**Peak Bone Mass**

- Most by age of 20 years old
- First hip, then spine, then whole body
- Girls hit puberty earlier so they get to peak bone density earlier

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**Risks for low bone density**

- Genetics (majority)
- Physical activity (immobile patients)
- Nutritional
- Drug induced

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### Who is at risk for Fragility Fractures

- Elderly population
- Females
- Caucasian and Asians
- Family history of osteoporosis fractures
- Early menopause

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### Issues associated with fragility fractures

Drugs	Chronic Diseases	Nutritional Conditions	Endocrine Diseases or Metabolic Causes
Diuretics	Hypertension	Vitamin D deficiency	Hypoparathyroidism
Drugs for osteoporosis	Vitamin B12 deficiency	Malabsorption	Hyperparathyroidism
Anticoagulants	Chronic kidney disease	Celiac disease	Thyroid disease
Statins	Rheumatoid arthritis	Malnutrition	Diabetes mellitus
Antidepressants	Hypothyroidism	Chronic liver disease	Hyperthyroidism
Antipsychotics	Chronic kidney disease	Chronic liver disease	Adrenal insufficiency
Lithium	Chronic kidney disease	Chronic liver disease	Adrenal insufficiency
Antiepileptics	Chronic kidney disease	Chronic liver disease	Adrenal insufficiency
Antibiotics	Chronic kidney disease	Chronic liver disease	Adrenal insufficiency
Anticancer drugs	Chronic kidney disease	Chronic liver disease	Adrenal insufficiency

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### Update for AAP



FROM THE AMERICAN ACADEMY OF PEDIATRICS

Guidance for the Clinician on  
Rendering Pediatric Care

CLINICAL REPORT

Optimizing Bone Health in Children and Adolescents

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### Recommendations from AAP

- Adequate dietary intake of calcium and vitamin D
- No routine screening for healthy adolescents with no risk factors
- For those at higher risk, higher doses of Vitamin D may be needed, recommendations are lacking

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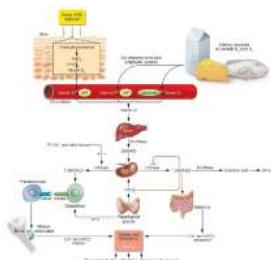
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### Vitamin D Metabolism



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### Risk Factors for Vitamin D Deficiency

- Poor exposure to sunlight
- Poor dietary intake of Vitamin D
- Breast fed infants, worse for non-Caucasians
- Females
- Low SES

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**Risk Factors for Vitamin D Deficiency**

- Low BMI
- Elderly
- African American, Hispanic, or middle eastern
- Chronic illness
- Living in the US north of Atlanta or during the winter

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**History and Physical**

- Breast fed
- Race
- Physical and radiographic findings

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**Clinical Presentation**

- Muscle weakness, pain
- Decreased bone density
- Rachitic growth plates
- Genu valgus/varum.

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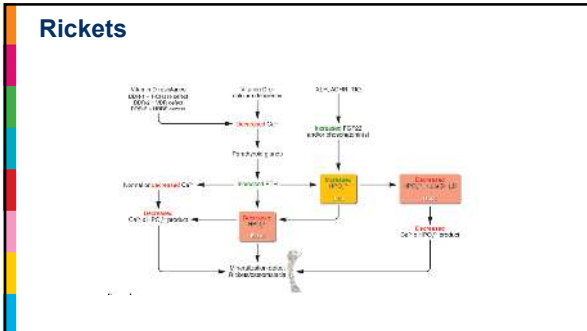
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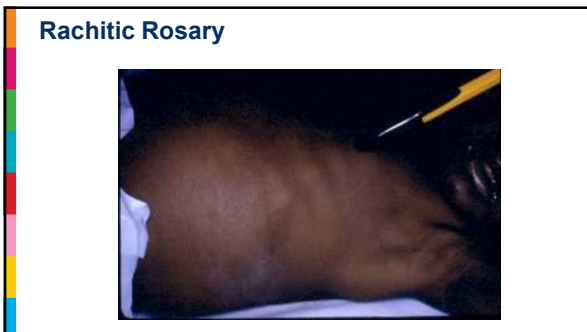
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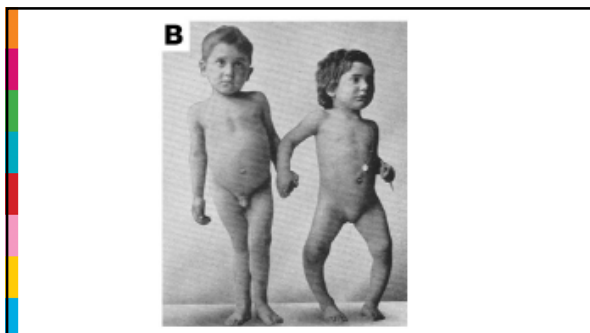
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**Treatment of Vitamin D Rickets**

- 1000-2000 IU daily or oral Cholecalciferol . May go up to 8000-16000 IU daily.
- Oral calcium 30-80 mg/kg/day or elemental calcium in 2-3 divided doses as calcium carbonate
- May use up to 600,000 in one to three doses over a 24 hour period if suspect non-compliance

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**Treatment of Vitamin D Rickets**

- As radiographic evidence of healing occurs reduce Vit d to 400-1000 IU daily
- Prevent primary phosphate deficiency with premature formula or breast milk fortifier
- If low phos start 20-25 mg/kg of elemental phosphate as Mg sulfate orally in three or 4 divided doses

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### Vitamin D Rickets

- Radiographic resolution usually in about 6 months
- May need corrective surgery for orthopedic findings in older children

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### Osteoporosis Evaluation

- Good history and physical
- If fractures present, get detailed history of the fracture to see if it was appropriate for the trauma

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### Screening Labs

- CBC, Diff, Platelets
- CMP (alkaline phosphatase)
- Sed rate
- PTH
- Ca, Mg, PO<sub>4</sub>
- Spot urine Ca/Cr ratio
- 25 OH vitamin D

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### Osteoporosis

- Disease characterized by low bone mass and microarchitectural deterioration of bone tissue which leads to bone fragility and consequent fractures.
- The remodeling process becomes imbalanced during aging, with removal exceeding bone replacement
- Postmenopausal women lose approximately 12% of their bone mass in 5 to 7 years surrounding menopause

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### Osteoporosis in children

- No clear definition in childhood

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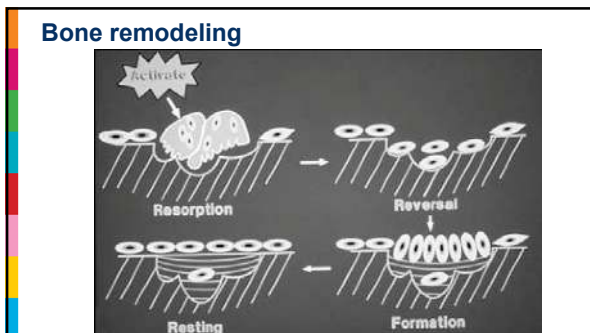
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**Adult Screening for Osteoporosis**

- The BMD testing with DXA should be used to screen all women aged  $\geq 65$  years and men  $\geq 70$  years for osteoporosis
- A BMD T-score  $\leq -2.50$  at the spine, femoral neck, or total hip is diagnostic of osteoporosis in the absence of fracture.<sup>5</sup> A T-score between  $-1.0$  and  $-2.5$  indicates low bone mass (osteopenia), and a T-score  $\geq -1.0$  is normal.

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**DEXA**

- T score
  - Value that compares BMD to the mean value in a young adult population (matched for sex and race)
- Z score
  - Value that compares BMD to the mean value for patients of the same age/sex
- Age appropriate software.
- TBS (trabecular bone score) as a complement to a DXA examination

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### DEXA issues in Children

- Takes a 2D picture and tries to estimate based on a 3D model
- May be affected by stature, pubertal status and body habitus
- Limited reference ranges
- Different machines report out different data

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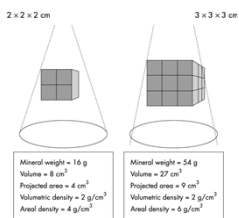
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### DEXA Method



Community child health, public health, and epidemiology  
 Bone densitometry in children assessed by dual x-ray absorptiometry: uses and pitfalls. [doi:10.1111/j.1365-2214.2012.03111.x](#)  
 © 2012 Blackwell Publishing Ltd, *Journal of Clinical Investigation*

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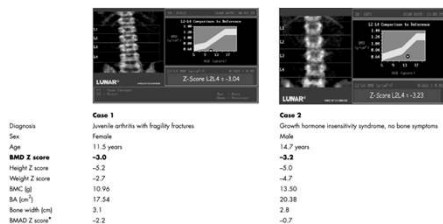
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### Pitfalls of DEXA



	Case 1	Case 2
Diagnosis	Juvenile arthritis with fragility fractures	Growth hormone insensitivity syndrome, no bone symptoms
Sex	Female	Male
Age	11.5 years	14.7 years
BMD Z score	-3.0	-3.3
Height Z score	-5.2	-5.0
Weight Z score	-2.7	-4.7
BMC (g)	10.96	13.30
BA (cm²)	17.54	20.38
Bone width (mm)	3.1	2.8
BMAD Z score*	-2.2	-0.7

Community child health, public health, and epidemiology  
 Bone densitometry in children assessed by dual x-ray absorptiometry: uses and pitfalls. [doi:10.1111/j.1365-2214.2012.03111.x](#)  
 © 2012 Blackwell Publishing Ltd, *Journal of Clinical Investigation*

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### Dexa in Children

- Age matched ranges down to age 5 exist
- May be used down to age 3 for longitudinal tracking
- Under the age of 3 normative data is not available

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### Z-Score Calculator for patient not of normal stature (Check their age ranges)

**Pediatric Z-Score Calculator**

**Instructions**  
All fields are required. Please enter a value for every field. The default units are cm and kg.

**Reference Values**

Age Group	BMD (g/cm²)	Z-score
5-9	0.080 - 0.100	-1.645 - 1.645
10-14	0.100 - 0.120	-1.645 - 1.645
15-19	0.120 - 0.140	-1.645 - 1.645
20-24	0.140 - 0.160	-1.645 - 1.645
25-29	0.160 - 0.180	-1.645 - 1.645
30-34	0.180 - 0.200	-1.645 - 1.645
35-39	0.200 - 0.220	-1.645 - 1.645
40-44	0.220 - 0.240	-1.645 - 1.645
45-49	0.240 - 0.260	-1.645 - 1.645
50-54	0.260 - 0.280	-1.645 - 1.645
55-59	0.280 - 0.300	-1.645 - 1.645
60-64	0.300 - 0.320	-1.645 - 1.645
65-69	0.320 - 0.340	-1.645 - 1.645
70-74	0.340 - 0.360	-1.645 - 1.645
75-79	0.360 - 0.380	-1.645 - 1.645
80-84	0.380 - 0.400	-1.645 - 1.645
85-89	0.400 - 0.420	-1.645 - 1.645
90-94	0.420 - 0.440	-1.645 - 1.645
95-99	0.440 - 0.460	-1.645 - 1.645

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### How do we diagnose Osteoporosis in Children

- Low bone mineralization for age
- Apparent bone fragility
  - > Vertebral fractures
  - > Two long bone fractures before age of 10 years
  - > Three long bone fractures by age of 19 years

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**Treatment of low bone density**

- Optimize Vitamin D status
- Judicious calcium replacement

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**Treatment of Osteoporosis  
(low bone density with fragility fractures)**

- Evaluate if underlying causes can be modified
- Optimize vitamin D status
- Calcium supplementation
  
- Consider bisphosphonates based on risk benefit

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**Bisphosphonate uses**

- Hypercalcemia
- Osteogenesis Imperfecta
- Immobilization osteoporosis (Juvenile osteoporosis vs. steroid induced)
- Hypophosphatasia
- Juvenile Arthritis
- Cerebral Palsy with fractures
- Fibrous Dysplasia

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**Bisphosphonate Side effects**

- Acute phase reaction with fever, musculoskeletal aches and emesis.
- Respiratory distress (1<sup>st</sup> dose)
- Hypocalcemia
- Hypophosphatemia
- Transient decline in renal function

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**Bisphosphonate side effects**

- Eye inflammation
- Osteonecrosis of Jaw
- Atypical femoral fractures
- (Oral route) Esophageal Erosion

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**Bisphosphonates: Concerns**

- Limited long term data
- Jaw osteonecrosis
- Osteopetrosis with zealous use
- Questions about
  - Growth
  - Pregnancy
  - Fracture healing

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**Bisphosphonates (Oral)**

- Alendronate (Fosamax)
- Risedronate (Actonel)
- Ibandronate Boniva

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**Oral Bisphosphonate**

- Risk of esophageal erosion
- Improved outcomes are not well documented

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**Bisphosphonates (IV)**

- Pamidronate (most experience in pediatrics OI)
- Ibandronate (Boniva)
- Zoledronic Acid (Reclast/Zometa) (increasing experience in last 10 years)

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### Pamidronate

- Dose: 0.4-1 mg/kg IV qd x3 days q3-6mo; Max: 90 mg/dose;
- Calcium and vitamin D supplementation recommended if inadequate dietary intake
- Monitor DEXA annually to prevent overtreatment

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### Zoledronic Acid

Zoledronic acid dosage for osteoporosis

<2 years old: 0.0125 mg/kg IV first dose, then 3 months later, 0.025 mg/kg IV every 3 months

>2 years old: 0.0125 mg/kg IV first dose, then 3 months later, give 2nd dose at 0.025 mg/kg\*

The 3rd (6 months from start) and subsequent doses: 0.05 mg/kg (max dose 4 mg) IV every 6 months

If lumbar spine BMD Z score >-2, reduce zoledronic acid dose to 0.025 mg/kg q 6 months

If lumbar spine BMD Z score >0, reduce zoledronic acid dose to 0.025 mg/kg q 12 months

Thrombocytopenia: 2017 Oct; 6(4): 288-296.  
doi: 10.1016/j.2017.08.010

Zoledronic acid in pediatric metabolic bone disorders  
Bogdan A. Rebecq and Eric D. Minkin

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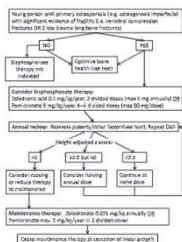
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### Consensus Statement on Use



**Consensus guidelines on the use of bisphosphonate therapy in children and adolescents**  
Bogdan A. Rebecq and Eric D. Minkin  
Pediatrics 2017; 140(4): e20170911

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Questions?

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