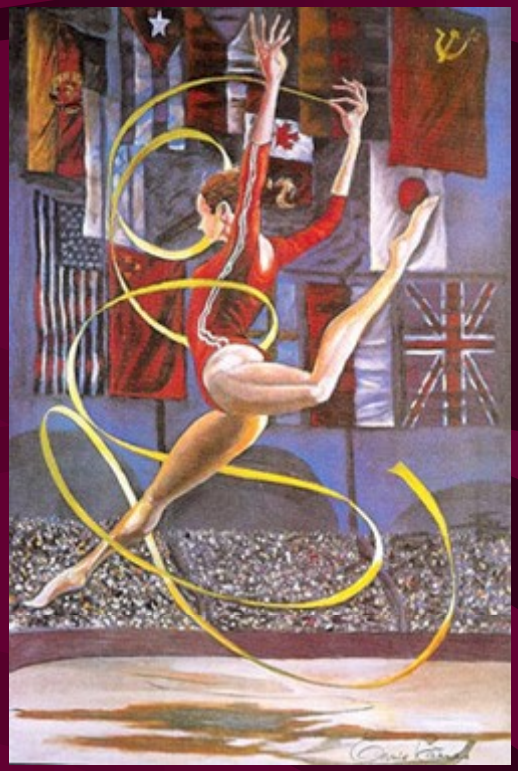
Female Athlete Triad…Info for Healthcare Providers



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Dewitt Army Community Hospital
Family Medicine Residency

Objectives

- American College of Sports Medicine Position Stand: Female Athlete Triad
- Updated Position Stand
- Diagnosis
- Treatment
- Education

Introduction

- Educational Amendment Act of 1972
  - Mandates that any institution accepting federal funding provide equal opportunities for men and women to participate in athletic programs
  - Title IX signed into law by President Nixon in 1972

History

- Not a new entity – various components have been noted for years
- Defined in 1992 by American College of Sports Medicine
- ACSM developed a Position Statement in 1997

1997 ACSM Position Statement

- Definition:
  - Syndrome that can develop in physically active girls and women with three interrelated components:
    - Disordered eating
    - Amenorrhea
    - Osteoporosis

Otis CL, Drinkwater B, Johnson M, et al. American College of Sports Medicine Position Stand: The female athlete triad. Med Sci Sports Exerc 1997; 29(5): i-ix.

Disordered Eating

- Includes a wide spectrum of unhealthy eating behaviors
  - Skipping meals or limiting calorie intake
  - Restricting certain foods such as those high in fat or protein
  - Binge eating or purging
  - Diet pills, laxatives, diuretics
  - Anorexia nervosa and bulimia nervosa

Disordered Eating

- May be intentional or unintentional
  - Lose a few pounds before an event
  - “Inadvertently failing to balance energy expenditures with adequate energy intake”

Amenorrhea

- Primary amenorrhea
  - Absence of menstruation by age 16 in a girl with secondary sex characteristics
- Secondary amenorrhea
  - Absence of 3 or more consecutive menstrual cycles in a girl who has begun menstruating
- Amenorrhea associated with exercise is hypothalamic in origin

Osteoporosis

- "Disease characterized by low bone mass and microarchitectural deterioration of bone tissue leading to enhanced skeletal fragility and increased risk of fracture"
- Principal cause of premenopausal osteoporosis in active women is decreased ovarian hormone production and hypoestrogenemia
- **Athletes may be at risk for fractures during their competitive years and premature osteoporotic fractures in the future**

Who is at Risk?

- "Potentially all physically active girls and women could be at risk for developing one or more components of the Triad"

- Sports that emphasize low body weight
  - Subjective scoring of performance (figure skating)
  - Endurance sports (distance running)
  - Body contour-revealing clothing (track, cheerleading)
  - Weight categories (wrestling, horse racing)
  - Emphasis on prepubertal body habitus (gymnastics)

- Male athletes are also at risk for disordered eating and anorexia nervosa

Position Stand

1. Alone or in combination, Female Athlete Triad disorders can decrease physical performance and cause morbidity and mortality

2. Internal and external pressures placed on girls to achieve unrealistically low body weight underlies development of these disorders

3. Sports medicine professionals need to be able to recognize, diagnose, and treat or refer women with any component

Position Stand

4. Women with one component should be screened for the others
   - Screening for the Triad can be done at the preparticipation exam or during clinical evaluation of any associated complaint
5. All sports medicine professionals including coaches and trainers should learn about preventing and recognizing the Triad
   - Should not pressure girls to lose weight and should know basic nutrition information
   - Have referral sources for nutritional counseling and medical and mental health evaluation
6. Parents should not pressure their daughters to be thin and should be educated about Triad warning signs

Position Stand

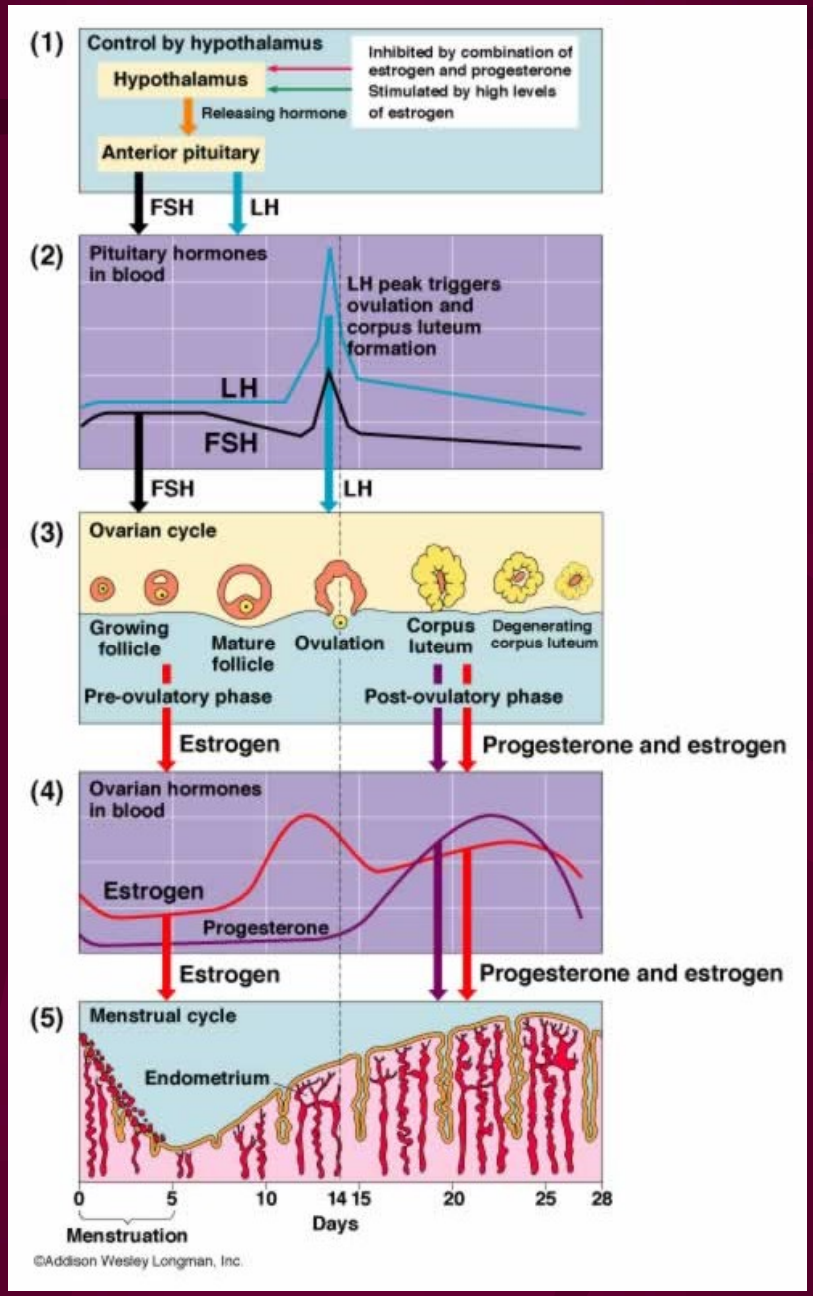
7. Sports medicine professionals, athletic administrators, officials of sport governing bodies share a responsibility to prevent, recognize and treat the Triad
   - Support development of educational programs

8. Physically active girls and women should be educated about proper nutrition, safe training practices, and warning signs of the Triad

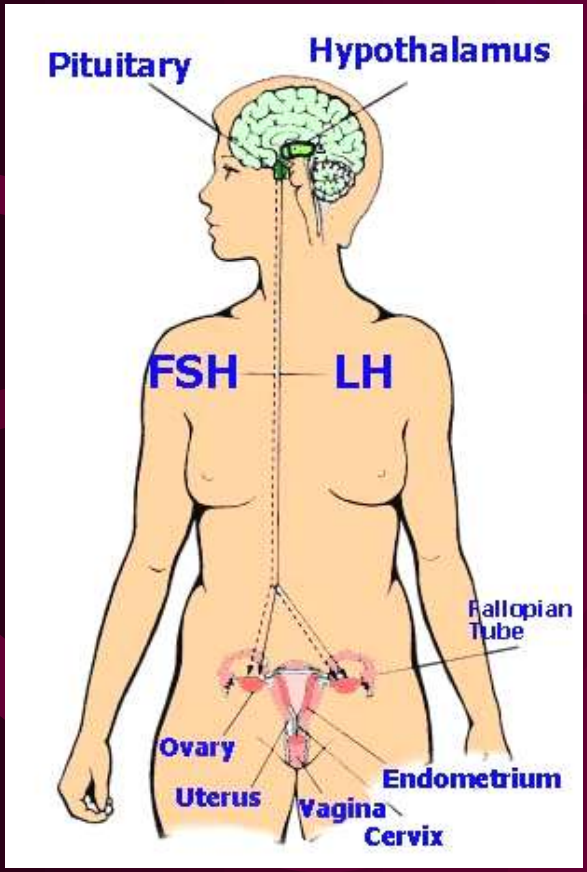
9. Further research is needed into the prevalence, causes, prevention, treatment, and sequelae of the Triad

Etiology

- In the 1970's low body weight or low body fat was thought to be the primary cause of amenorrhea
- Exercise-stress hypothesis
- Deficit in energy availability


(1)
Control by hypothalamus
Hypothalamus
Releasing hormone
Anterior pituitary
Inhibited by combination of estrogen and progesterone
Stimulated by high levels of estrogen
FSH
LH
(2)
Pituitary hormones in blood
LH peak triggers ovulation and corpus luteum formation
LH
FSH
FSH
LH
(3)
Ovarian cycle
Growing follicle
Mature follicle
Ovulation
Corpus luteum
Degenerating corpus luteum
Pre-ovulatory phase
Post-ovulatory phase
Estrogen
Progesterone and estrogen
(4)
Ovarian hormones in blood
Estrogen
Progesterone
Estrogen
Progesterone and estrogen
(5)
Menstrual cycle
Endometrium
0
5
10
14 15
20
25
28
Days
Menstruation
©Addison Wesley Longman, Inc.

Hypothalamic Dysfunction



- Disruption of hypothalamic-pituitary-ovarian axis
  - Decrease in pulsatile GnRH disrupts pituitary secretion of LH and FSH
  - Disruption of LH and FSH pulsatility shuts down stimulation to the ovary, ceasing production of estradiol

- What causes hypothalamic dysfunction?
- Deficit in energy availability

Energy Availability

- Definition
  - Dietary energy intake minus exercise energy expenditure OR
  - The amount of dietary energy remaining after exercise training to support physiological processes

- Energy balance
  - Occurs in young adults at an energy availability of 45 kcal per kilogram of fat-free mass per day (kcal/kg FFM daily)
  - In exercising women, LH pulsatility is disrupted below 30 kcal/kg FFM per day
  - Some amenorrheic athletes practice regimens that provide only 16 kcal/kg FFM per day

Loucks A & Nattiv A. The female athlete triad. Lancet 2005; 366:549-550.

Energy Availability

- Energy availability-hypothalamic dysfunction
  - Mechanism by which a deficit in energy availability disrupts GnRH is currently unknown but research suggests plasma glucose plays a role via glucose-sensing neurons in the brain
  - Glucoregulatory hormones do not maintain normal plasma glucose concentrations below energy availability of 30 kcal/kg FFM per day

Loucks A & Nattiv A. The female athlete triad. Lancet 2005; 366:549-550.

Energy Availability

- The bone connection
  - Estrogen suppresses osteoclast activity so bone loss in amenorrheic women was originally attributed to hypoestrogenism
  - However, estrogen replacement has not fully restored bone density in clinical trials
  - Low energy availability may have a direct effect on bone
    - Ihle and Loucks showed that markers of bone formation and resorption changed unfavorably in sedentary women exposed to low energy availability (below 30 kcal/kg FFM per day)

Beals K & Meyer N. Female Athlete Triad Update. Clin Sports Med 2007 26;69-89.

Energy Availability

- "Do athletes need to take special care to avoid low energy availability?"
  - Food deprivation increases hunger however the same deficit produced by exercise energy expenditure does not
  - Hunger appears to be mediated by oral and GI rather than metabolic mechanisms
  - Appetite is NOT a reliable indicator of energy requirements
  - Athletes must learn to eat by discipline not by appetite

Loucks, A. The female athlete triad: do female athletes need to take special care to avoid low energy availability? Medicine and Science in Sports and Exercise. 2006; 1694-1700.

Revised Position Stand

- Writing began in 2003
- Revised Position Stand will:
  - Rename components
    - Energy availability, menstrual dysfunction, bone health
  - Emphasize the spectrum that exists for each of the disorders ranging from health to disease as opposed to the original version which focused on the extreme end point of each category

Beals, K & Meyer, N. Female athlete triad update. Clin Sports Med, 2007;26:69-89.

Prevalence

- Prevalence of secondary amenorrhea in adult female athletes reported at 3-66% compared to 2-5% of the general population
- Only 3 studies have examined all 3 disorders using direct measures of BMD in female athletes (DEXA)
  - These studies indicate that the number of athletes with all 3 disorders simultaneously is relatively small however the number of athletes with disordered eating and menstrual dysfunction was large enough to warrant concern

Beals, K & Meyer, N. Female athlete triad update. Clin Sports Med, 2007;26:69-89.

Energy Availability

- Spectrum of energy availability
  - Clinical eating disorders
  - Subclinical eating disorders
  - Low energy availability
- Currently, no published studies have examined the prevalence of low energy availability among female athletes
- Effects of disordered eating on health and athletic performance depend on the severity and chronicity of the behaviors

Beals, K & Meyer, N. Female athlete triad update. Clin Sports Med, 2007;26:69-89.

Menstrual Dysfunction

- Spectrum of menstrual dysfunction
  - Luteal suppression
  - Anovulation
  - Oligomenorrhea
  - Amenorrhea
    - Primary – redefined by American Society of Reproductive Medicine as absence of menstruation by 15 years of age in girls with secondary sex characteristics
    - Secondary – absence of 3 consecutive cycles

Beals, K & Meyer, N. Female athlete triad update. Clin Sports Med, 2007;26:69-89.

Menstrual Dysfunction

- Prevalence studies
  - Wide range of prevalence estimates can be explained by methodologic differences among studies including differences in athletic populations studied, failure to control for OCP use, assessment and definition of menstrual dysfunction
  - Despite differences, menstrual dysfunction is more prevalent in sports that emphasize leanness
- Menstrual dysfunction is NOT a normal part of training!

Beals, K & Meyer, N. Female athlete triad update. Clin Sports Med, 2007;26:69-89.

Bone Health

- Spectrum of bone health
  - Low bone mass
  - Stress fractures
  - Osteoporosis
- Bone strength is characterized by bone mineral content and density as well as quality of bone
- Bone quality refers to the process of bone turnover

Beals, K & Meyer, N. Female athlete triad update. Clin Sports Med, 2007;26:69-89.

Diagnosis of low bone mass and osteoporosis in athletes

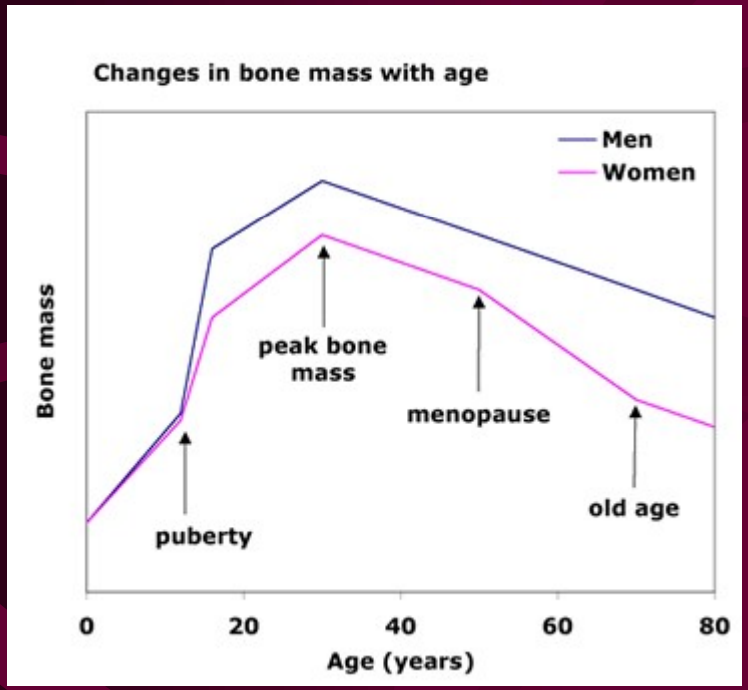
- Although imperfect, DEXA is currently the most accepted diagnostic tool
- International Society for Clinical Densitometry recommends using Z-scores in young patients
- Young woman with a low T or Z-score is no longer considered to be osteopenic or osteoporotic but is said to have BMD *low for chronologic age or below expected range for age*

Beals, K & Meyer, N. Female athlete triad update. Clin Sports Med, 2007;26:69-89

Bone Health

- Female athletes have higher BMD than nonathletic counterparts UNLESS they have menstrual dysfunction
- Bone density declines in proportion to the number of menstrual cycles missed
- Myburgh and colleagues showed a direct correlation between time spent amenorrheic and number of stress fractures in 1990
- Low bone mineral density may be irreversible resulting in a lifetime lower bone density
- Risk of stress fractures is two-four fold higher in athletes with menstrual disturbances compared to those without

Bone Health



- Females gain more than 50% of skeletal mass during adolescence and reach peak bone mass between 18 and 25 years of age
- Young women menstrual dysfunction during these years are at risk for losing 2% of bone mass annually instead of gaining 2-4%

Evaluation

- History and physical
  - Vital signs
  - Thyroid
  - Signs of virilism
  - Tanner staging
  - Visual fields and cranial nerves
  - Pelvic exam

Lo B, Hebert C, McClean A. The female athlete triad, no pain, no gain? Clinical Pediatrics 2003; 42(7) 573-580.

Laboratory Evaluation

- CBC, CMP, ESR, UA
- EKG and/or echocardiogram if abnormal cardiac exam
- TSH
- LH, FSH to rule out premature ovarian failure
- Prolactin to rule out pituitary tumor
  - Consider imaging
- If hirsutism, free testosterone, DHEA-S, 17-hydroxy-progesterone to screen for adrenal or ovarian tumors
- Progesterone Challenge
  - Medroxyprogesterone 5-10 mg for 5-10 days

Lo B, Hebert C, McClean A. The female athlete triad, no pain, no gain? Clinical Pediatrics 2003; 42(7) 573-580.

Bone Density

- Bone density
  - Consider DEXA for the following:
    - Amenorrheic > one year
    - BMI < 18
    - Documented history of stress fracture

Lo B, Hebert C, McClean A. The female athlete triad, no pain, no gain? Clinical Pediatrics 2003; 42(7) 573-580.

Treatment Goal

- Restore reproductive and metabolic hormones by increasing energy availability
  - Increase energy intake
  - Reduce energy expenditure
    - Weight gain of 1-2 kilograms (or 2-3%) or 10% decrease in exercise load in either duration or intensity is often sufficient to reverse reproductive dysfunction!

Loucks A & Nattiv A. The female athlete triad. Lancet 2005; 366:549-550

Treatment is Multidisciplinary

- Behavioral change
- Nutritional interventions: development of personalized nutrition plan
- Exercise interventions: exercise prescription or recommendations
  - Example: one day off each week
- Supplements recommended by AAP
  - Calcium 1500 mg daily, vitamin D 400-800 IU daily
- Psychological
  - Cognitive behavioral therapy has been shown to be most efficacious therapy for eating disorders
  - Treatment for depression if present

Waldrop, J. Early identification and interventions for female athlete triad. Journal of Pediatric Health Care. 2005; 19(4): 213-220.

Hormone Therapy

- In women who have not responded to non-pharmacological treatment, initiate therapy with low-dose oral contraceptive to raise estrogen concentrations and prevent further bone loss
- Minimal bone increases have been noted in women with hypothalamic amenorrhea on oral contraceptives but increases in BMD of 6-17% have been seen with spontaneous reversal of amenorrhea

Goodman, L & Warren, M. The female athlete and menstrual function. Adolescent and Pediatric Gynecology. 2005;17(5): 466-470.

PREVENTION!

- Educational programs targeting coaches, athletes, parents, athletic trainers, school administrators
  - Currently there is a lack of such programs
- Nutrition education
  - Emphasis should be placed on concept of food as energy for training and recovery rather than on body weight
  - ACSM and American Dietetic Association published a joint position statement entitled “Nutrition and Athletic Performance” in 2000

Educational Programs

- College
  - Survey of NCAA Division 1 programs for screening, education, and treatment of eating disorders and menstrual dysfunction
  - 79% of schools screen for menstrual dysfunction but only 24% used a comprehensive questionnaire
  - 60% screen for eating disorders but less than 6% used a structured interview or validated eating disorder questionnaire
  - Education was made available to athletes at 73% of schools and to coaches at 61% but was required at less than 41% of schools
  - **35% of respondents perceived their menstrual disorder screening programs to be successful compared with 26% for eating disorder screening programs**

Beals, K. Eating disorder and menstrual dysfunction screening, education, and treatment programs: Survey results from NCAA Division 1 schools. The Physician and Sportsmedicine. 2003;31(7): 33-38.

Educational Programs

- High school
  - Survey of high schools in a large California school district to determine the effectiveness of preparticipation history and physical forms in screening for the triad and to determine the prevalence of educational programs related to the triad
  - 67% of high schools screen female athletes for menstrual dysfunction and screening was often limited to 1-2 questions such as “is your period regular?”
  - 33% of schools reported having educational programs for athletes but less than 9% required participation and only 15% required education for coaches

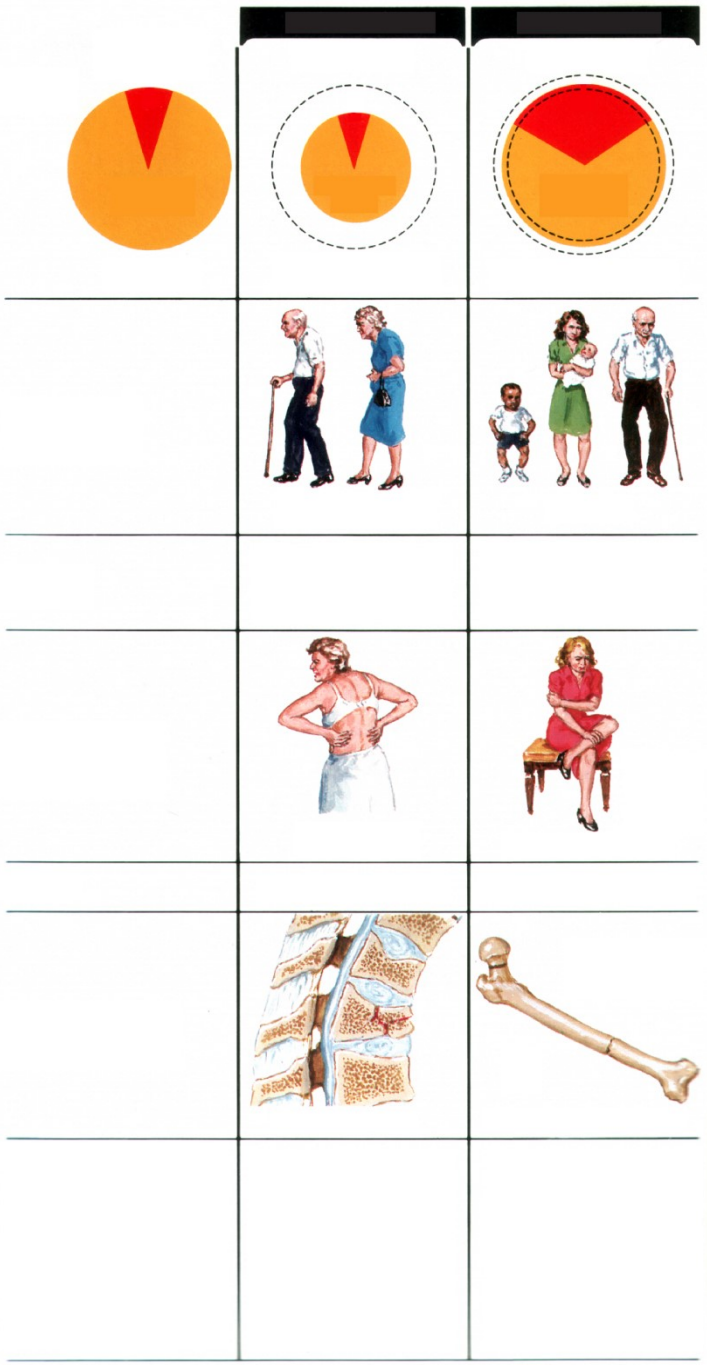
De La Torre D, Snell B. Use of the preparticipation physical exam in screening for the female athlete triad among high school athletes. Journal of School Nursing. 2005;21(5): 340-345.

Physician Knowledge

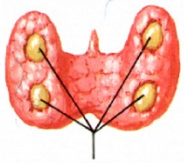
- 240 health care professionals (physicians, medical students, physical therapists, athletic trainers and coaches) were surveyed to determine their knowledge and comfort in treating the condition
- Results
  - 48% of physicians, 43% of therapists, 38% of trainers, 32% of medical students and 8% of coaches could identify all 3 components
  - When divided into specialties, 69% of PM&R physicians, 63% of orthopedic surgeons, 53% of family physicians, 36% of pediatricians, 17% of gynecologists identified all 3 components
  - Only 9% of physicians felt comfortable treating the disorder
- Conclusion: While recognition of the Triad has increased significantly, knowledge of treatment is still lacking among physicians and medical personnel

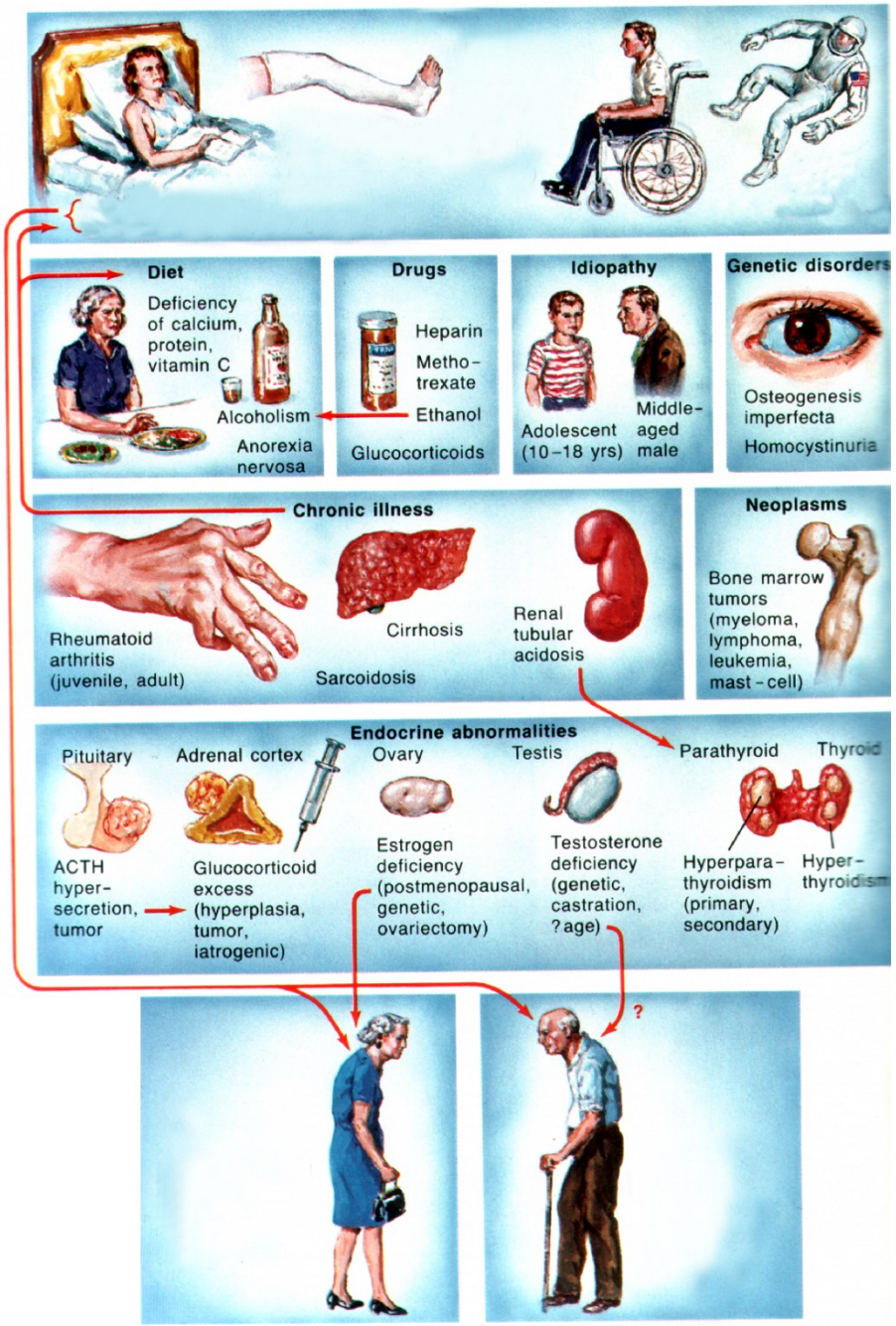
Troy K, Hoch A, Stavrakos, J. Awareness and comfort in treating the female athlete triad: are we failing our athletes? Wisconsin Medical Journal. 2006;105(7): 21-24.

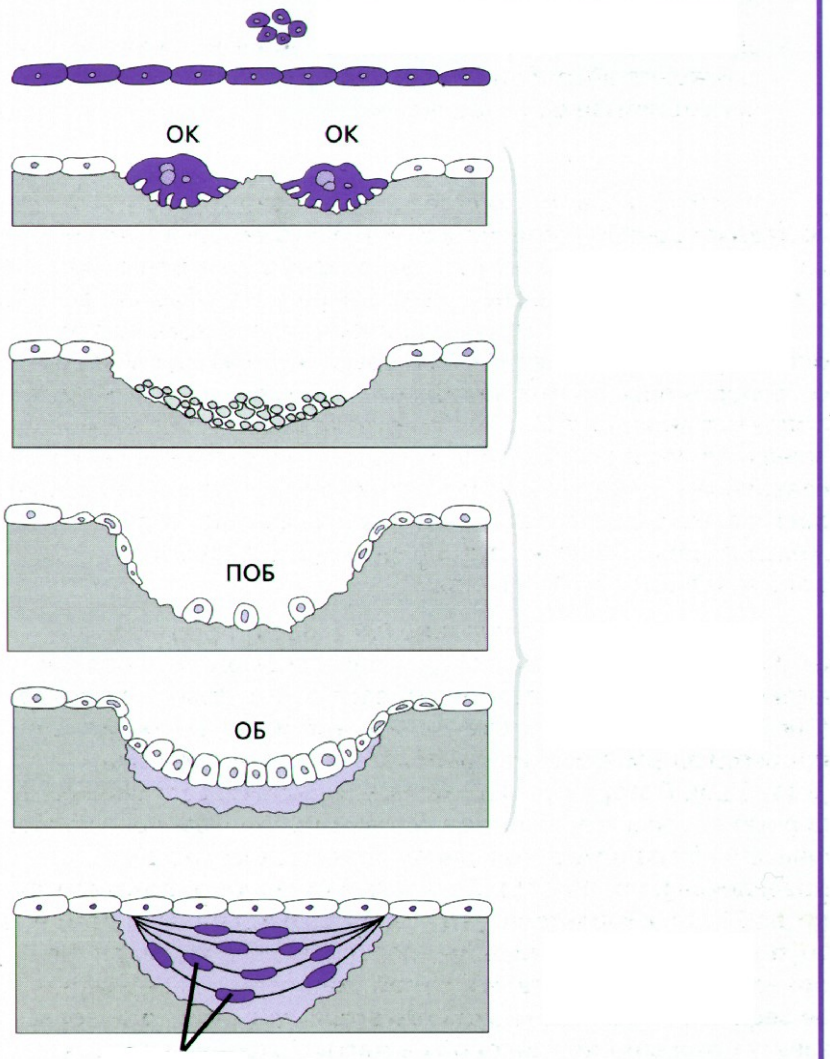
Osteoporosis and osteomalaica



Regulation of Calcium and Phosphate Metabolism

	Parathyroid hormone (PTH) (peptide)	$1,25(OH)_2D$ (steroid)	Calcitonin (peptide)
Hormone	 From chief cells of parathyroid glands	 From proximal tubule of kidney	 From parafollicular cells of thyroid gland
Factors stimulating production	Decreased serum Ca^{++}	Elevated PTH Decreased serum Ca^{++} Decreased serum P_i	Elevated serum Ca^{++}
Factors inhibiting production	Elevated serum Ca^{++} Elevated $1,25(OH)_2D$	Decreased PTH Elevated serum Ca^{++} Elevated serum P_i	Decreased serum Ca^{++}
End organs for hormone action — **Intestine** 	No direct effect Acts indirectly on bowel by stimulating production of $1,25(OH)_2D$ in kidney	Strongly stimulates intestinal absorption of Ca^{++} and P_i	?
Kidney 	Stimulates $25(OH)D\text{-}1\alpha\text{-}OH_{ase}$ in mitochondria of proximal tubular cells to convert $25(OH)D$ to $1,25(OH)_2D$ Increases fractional reabsorption of filtered Ca^{++} Promotes urinary excretion of P_i	?	?
Bone 	Stimulates osteoclastic resorption of bone Stimulates recruitment of preosteoclasts	Strongly stimulates osteoclastic resorption of bone	Inhibits osteoclastic resorption of bone ? Role in normal human physiology
Net effect on calcium and phosphate concentrations in extracellular fluid and serum	**Increased serum calcium** **Decreased serum phosphate**	**Increased serum calcium** **Increased serum phosphate**	**Decreased serum calcium (transient)**

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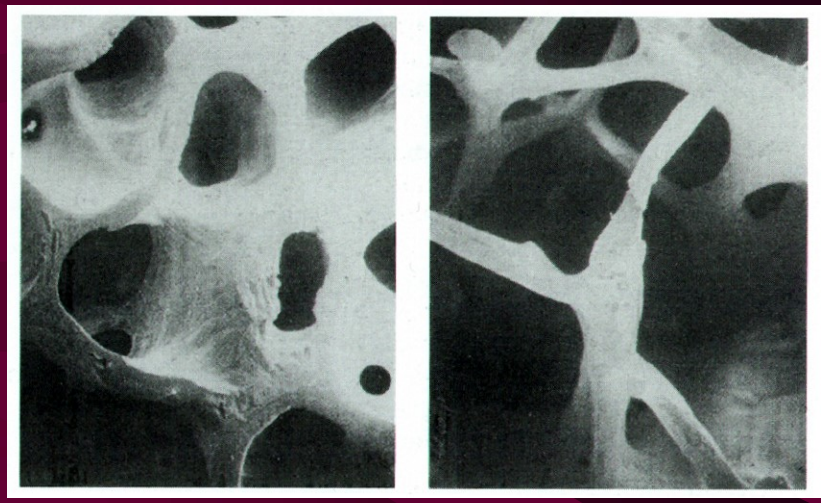
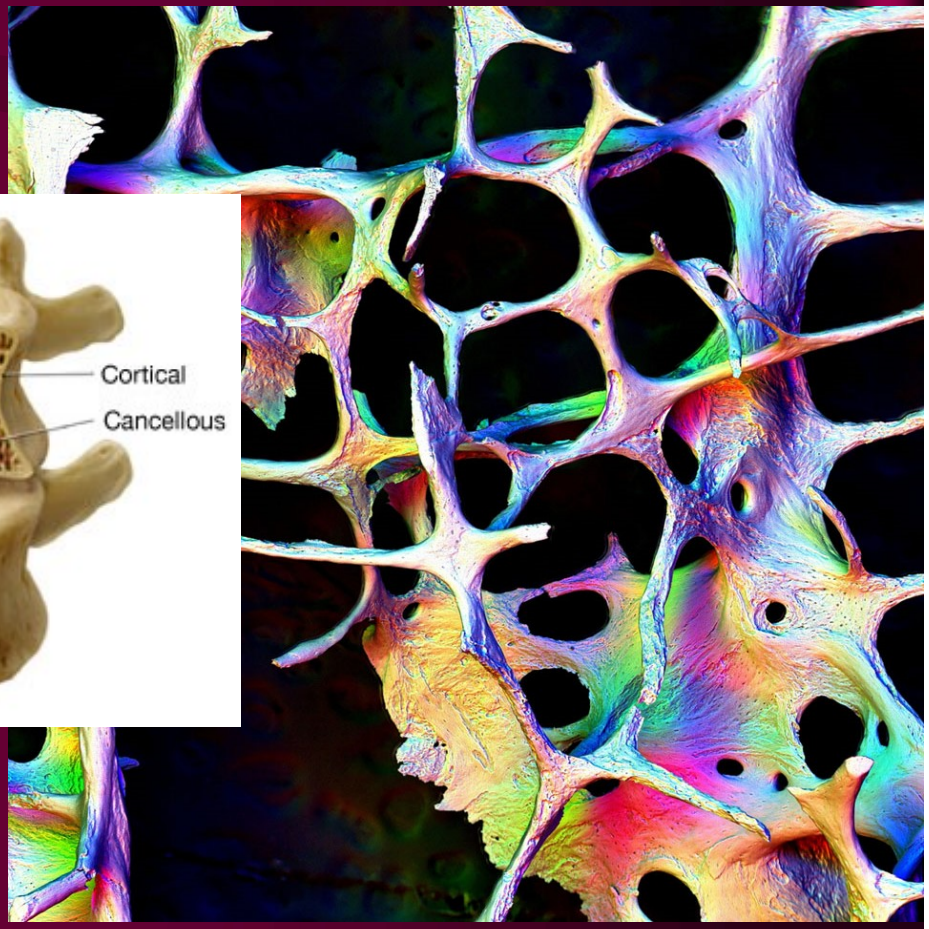
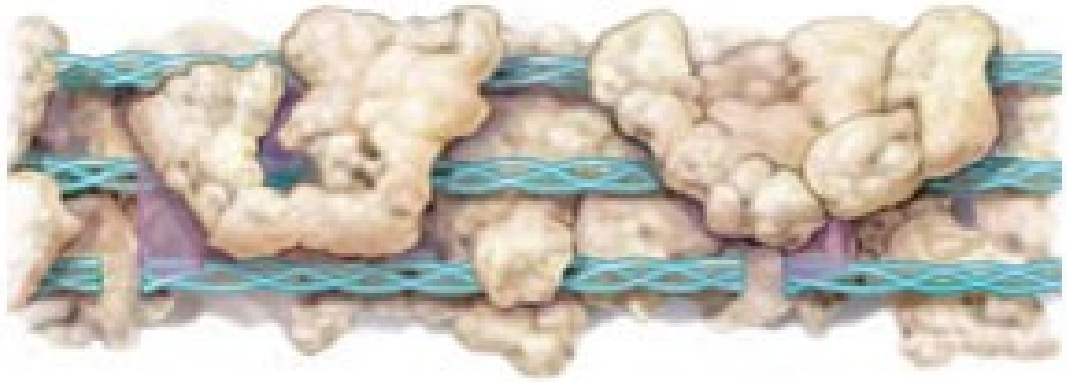


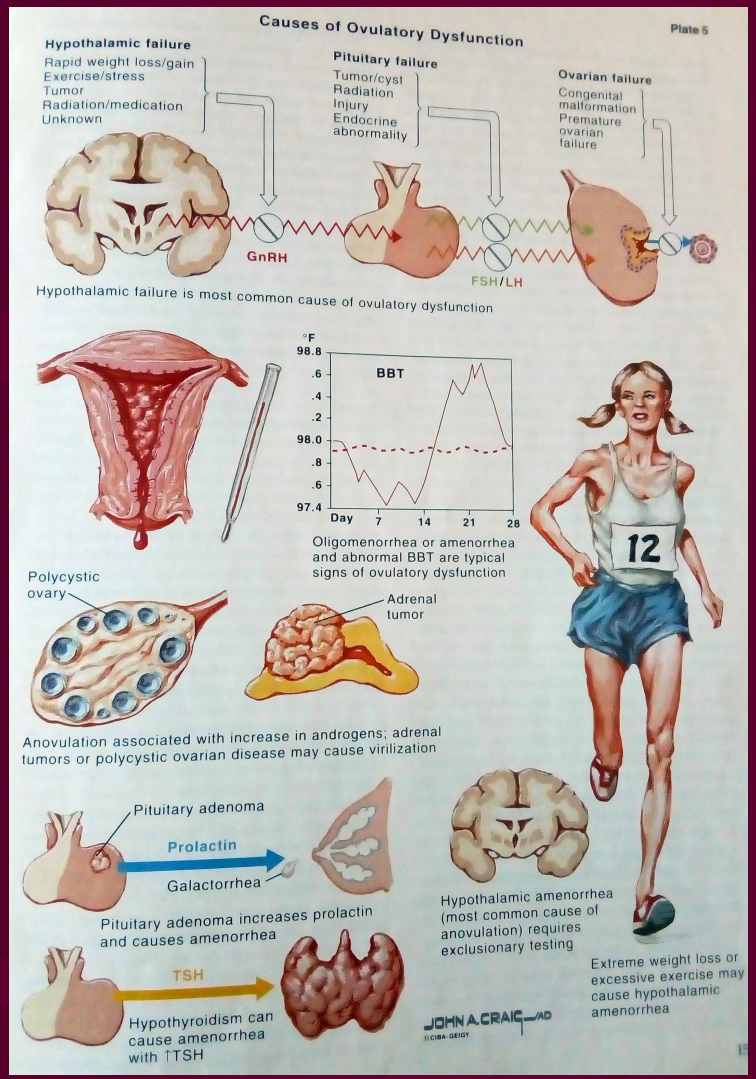
TRABECULAR BONE



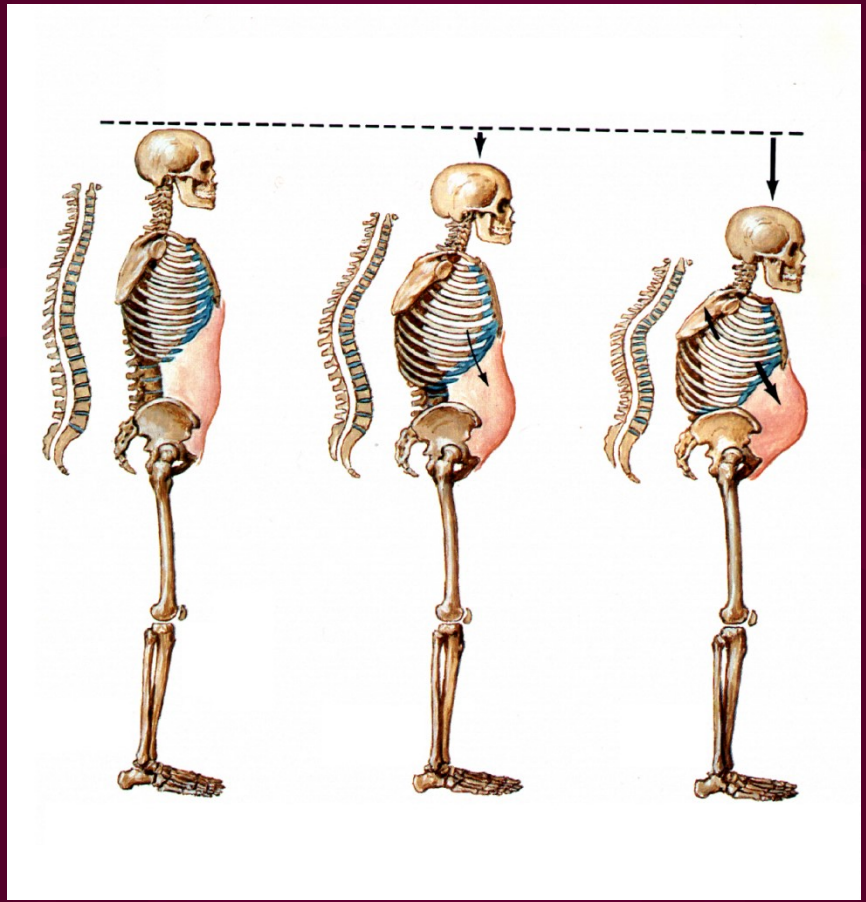
Hydroxyapatite crystals



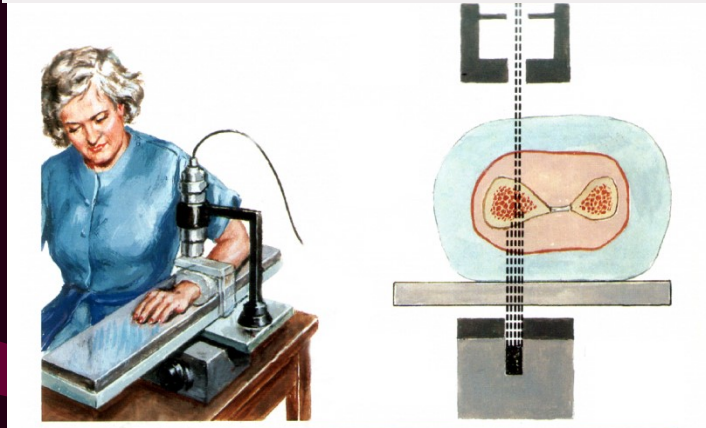
Amenorrhea as a cause of osteoporosis in young athletes

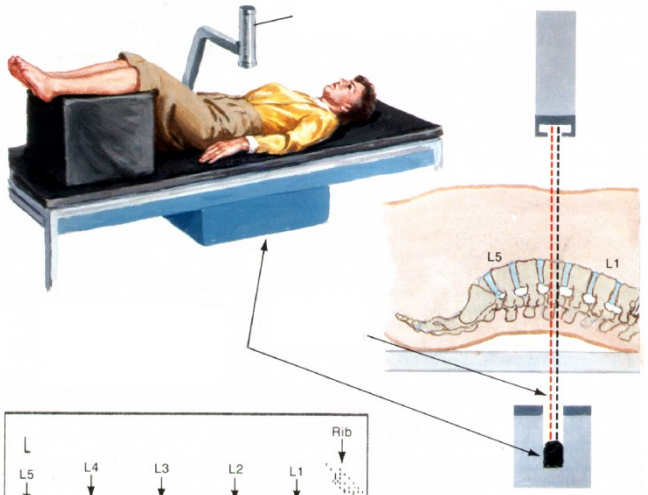


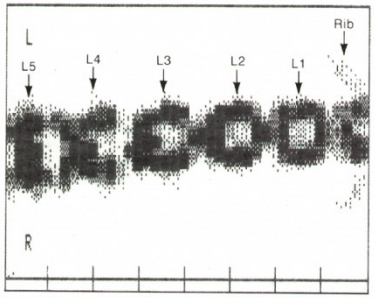
VERTEBRAL CHANGES



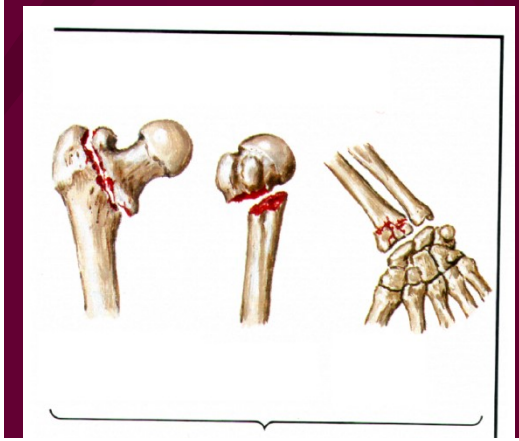
Bone density scan (DEXA scan)

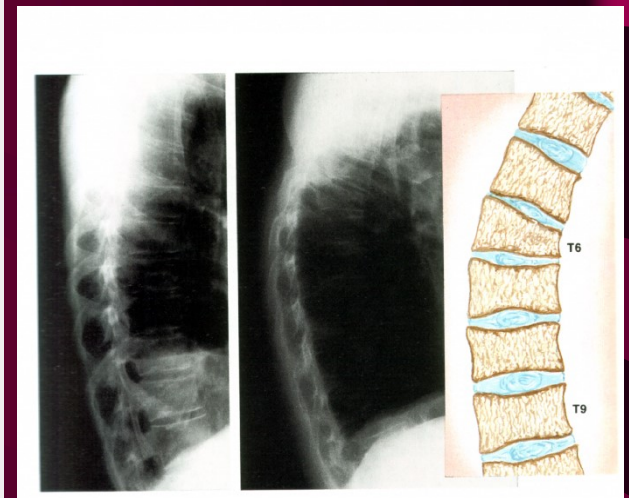


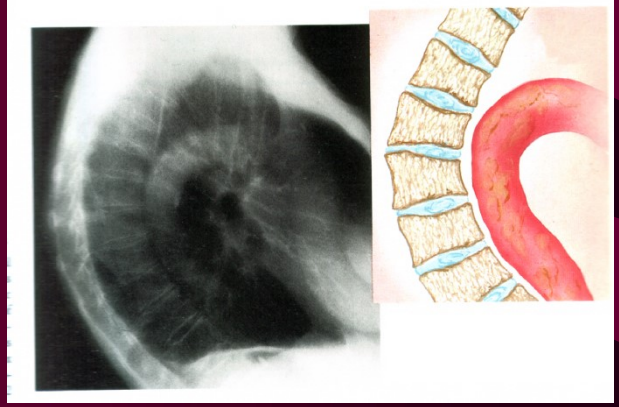




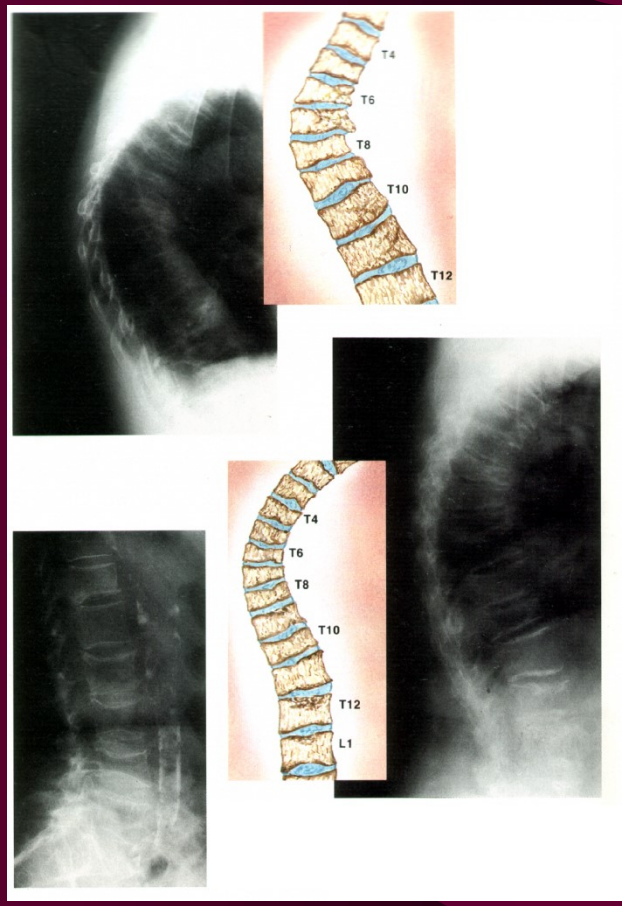
A bone density scan uses low dose X-rays to see how dense (or strong) your bones are. You may also hear it called a DEXA scan.







Bone densitometry is the gold standard for diagnosing osteoporosis, and dual-energy x-ray absorptiometry (DXA) is the preferred technology for measurement. **Because of its ease of use, low radiation exposure, and ability to measure BMD at both the hip and spine**, DXA is the most commonly used technique to measure BMD.



Prevention is more important!