

BONE DENSITY

Seneca College

CHM 080

Poneet Rahul

Date: August 1, 2018

density = mass/volume [g/mL] [g/cc] [g/cm³]

- 1) Bone Density
- 2) Chemistry Link
Macro/Major minerals relevant to bone health
- 3) What is bone made of?
- 4) Calcium & Vitamin D intake
- 5) Exercise

Bone Density

High density = healthy, strong
Low density can mean osteoporosis

Osteoporosis

[Greek osteon "bone"] + [Greek pór(os) "passage"]

“Osteoporosis, or porous bone, is a disease characterized by low bone mass and structural deterioration of bone tissue.” (“Osteoporosis | John T. Milliken Department Of Medicine Division Of Bone & Mineral Diseases”)

Diagnosis

Measurement of Bone Mineral Density (BMD) via Dual-Energy X-Ray Absorptiometry (DXA/DEXA) commonly at the hip and/or vertebrae.



(“Early Epigenetic Switches Associated With Childhood Bone Health”)

Your Bone Mineral Density (BMD) is compared to a peak BMD (20–30 year old), and a score (“T-score”) is your measurement relative to the peak, in Standard Deviations (SD).

“Normal

Bone density is within 1 SD (+1 or -1) of the young adult mean.

Low bone mass

Bone density is between 1 and 2.5 SD below the young adult mean (-1 to -2.5 SD).

Osteoporosis

Bone density is 2.5 SD or more below the young adult mean (-2.5 SD or lower).

Severe (established) osteoporosis

Bone density is more than 2.5 SD below the young adult mean, and there have been one or more osteoporotic fractures.” (“Bone Mass Measurement: What The Numbers Mean | NIH Osteoporosis And Related Bone Diseases National Resource Center”)

The Normal Distribution Curve



$$\bar{x} = \frac{\text{sum of values}}{\text{\# of values}}$$

$$\sigma = \text{sqrt}[(x - \bar{x})^2]$$

(“Introduction To Statistical Distributions”)

Tulane University Health Science Ctr.
 1440 Canal Blvd.
 New Orleans, La. 70112

Telephone: 504-988-1016

Name: Sex: Male Height: 165.1 cm
 Patient ID: Ethnicity: Weight: 59.0 kg
 DOB: Age: 26

Referring Physician:

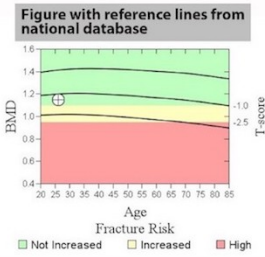
Scan Date: -

Region	BMD (g/cm ³)	T - score	Z - score
Total	1.148	-0.5	-0.5

The gold standard for diagnosing osteoporosis



Image not for diagnostic use
327 x 150



T-score vs. White Male. Source:2008 NHANES/Hologic
 White Male. Z-score vs. White Male. Source:2008

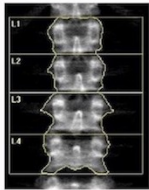
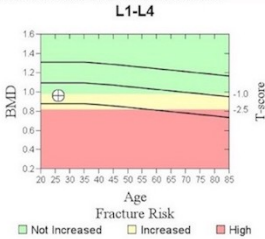


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116 x 136



T-score vs. White Male. Source:BMDCS/Hologic
 White Male. Z-score vs. White Male. Source:BMDCS/Hologic

Scan Date:

Region	BMD (g/cm ³)	T - score	Z - score
L1-L4	0.959	-1.2	-1.2

WHO Classification: Osteopenia
 Fracture Risk: Increased

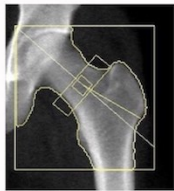
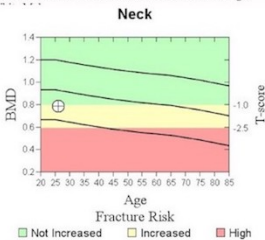


Image not for diagnostic use
104 x 107
NECK: 49 x 15



T-score vs. White Male. Source:BMDCS/NHANES
 White Male. Z-score vs. White Male. Source:BMDCS/NHANES
 White Male.

Scan Date:

Region	BMD (g/cm ³)	T - score	Z - score
Neck	0.787	-1.1	-1.0
Total	0.976	-0.4	-0.4

WHO Classification: Osteopenia
 Fracture Risk: Increased

WHO classification and fracture risk evaluation

HOLOGIC®
 ("Louisiana Osteoporosis Study")

Tulane University Health Science Ctr.
1440 Canal Blvd.
New Orleans, La. 70112

Telephone: 504-988-1016

Shows your bone, muscle, and fat | X-ray image | ex: Female | Ethnicity: | Fat percentage of your whole body compared to the group who have same age, race, gender with you

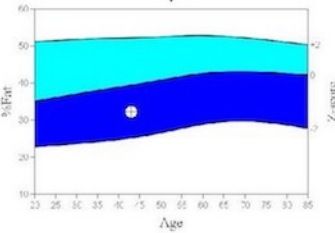


Images not for diagnostic use

Fat | Lean

Compared with young group

Total Body % Fat



Source: 2008 NHANES White Female

World Health Organization Body Mass Index Classification
BMI = 23.8 WHO Classification Normal



Fat mass index gives the best measure of excess fat

Estimate of visceral fat around the organs which is associated with diabetes

Body Composition Results

Region	Fat Mass (g)	Lean + BMC (g)	Total Mass (g)	% Fat	Percentile YN	Percentile AM
L. Arm	1284	1707	2991	42.9	61	44
R. Arm	1360	1923	3283	41.4	37	19
Trunk	8880	21049	29928	29.7	19	11
L. Leg	3279	6104	9383	34.9	16	11
R. Leg	3403	6248	9651	35.3	16	11
Subtotal	18206	37030	55236	33.0	30	16
Head	1069	3549	4618	23.1	30	15
Total	19274	40579	59854	32.2	30	15
Android (A)	1111	2937	4047	27.4	30	15
Gynoid (G)	3345	5779	9124	36.7	30	15

Fat percentage % of whole body

Compared with the group of same age

Adipose Indices

Measure	Result	Percentile YN	Percentile AM
Total Body % Fat	32.2	29	15
Fat Mass/Height ² (kg/m ²)	7.76	38	22
Android/Gynoid Ratio	0.75		
% Fat Trunk/% Fat Legs	0.85	64	47
Trunk/Limb Fat Mass Ratio	0.95	76	57
Est. VAT Mass (g)	204		
Est. VAT Volume (cm ³)	318		
Est. VAT Area (cm ²)	61.0		

Lean Indices

Measure	Result	Percentile YN	Percentile AM
Lean Mass/Height ² (kg/m ²)	15.5	58	50
Lean/Height ² (kg/m ²)	6.06	35	33

Est. VAT = Estimated Visceral Adipose Tissue
YN = Young Normal
AM = Age Matched

TBAR1904 - NHANES BCA calibration

HOLOGIC®

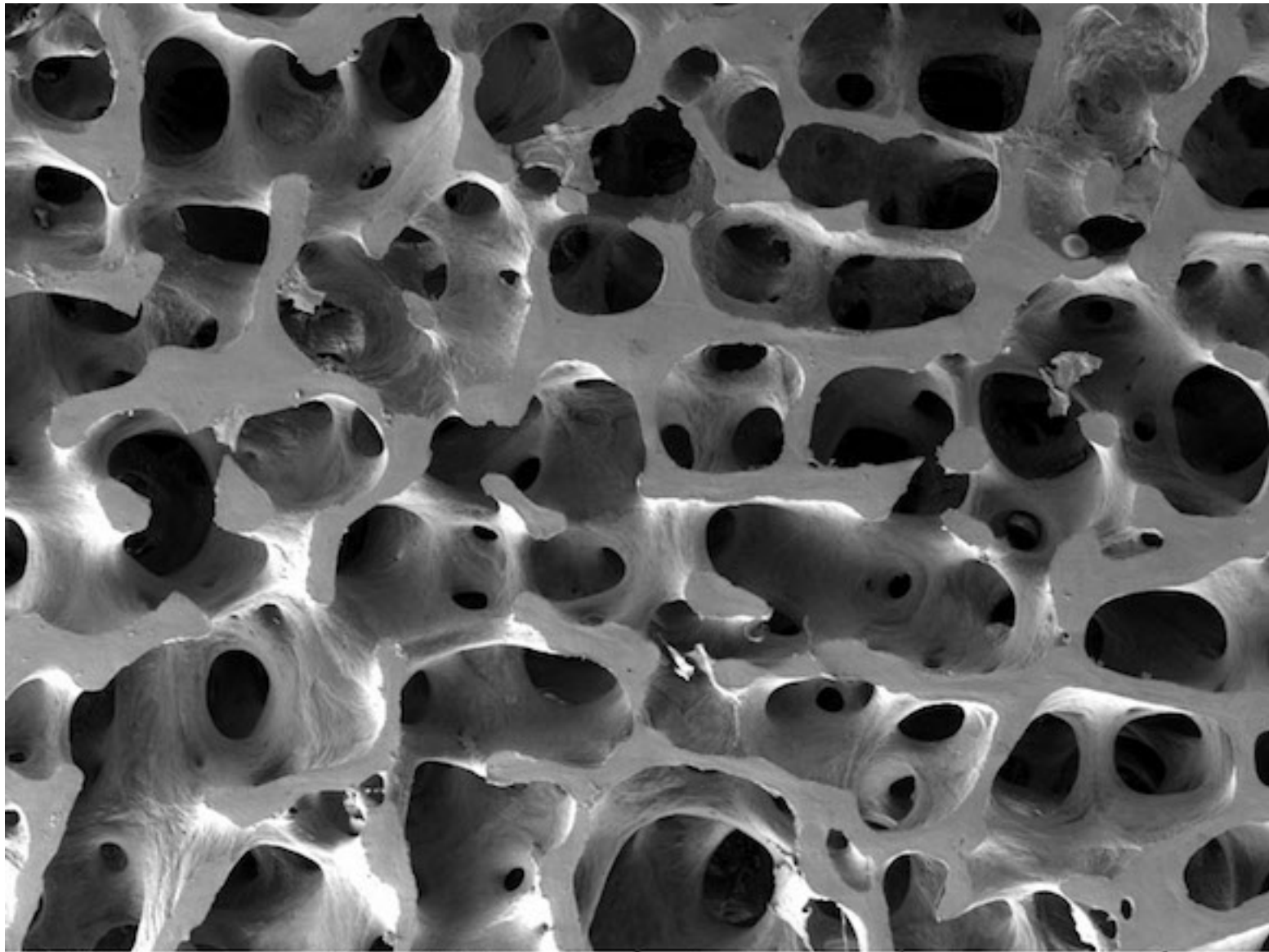
("Louisiana Osteoporosis Study")

The following Scanning Electron Microscope (SEM) images
were shared on Paul Hansma's website
(Dept. of Physics, University of California Santa Barbra)

SEM Image 1 = Male in his 20's

SEM Image 2 = Female in her 80's with Osteoporosis

~60 years apart (Hansma)

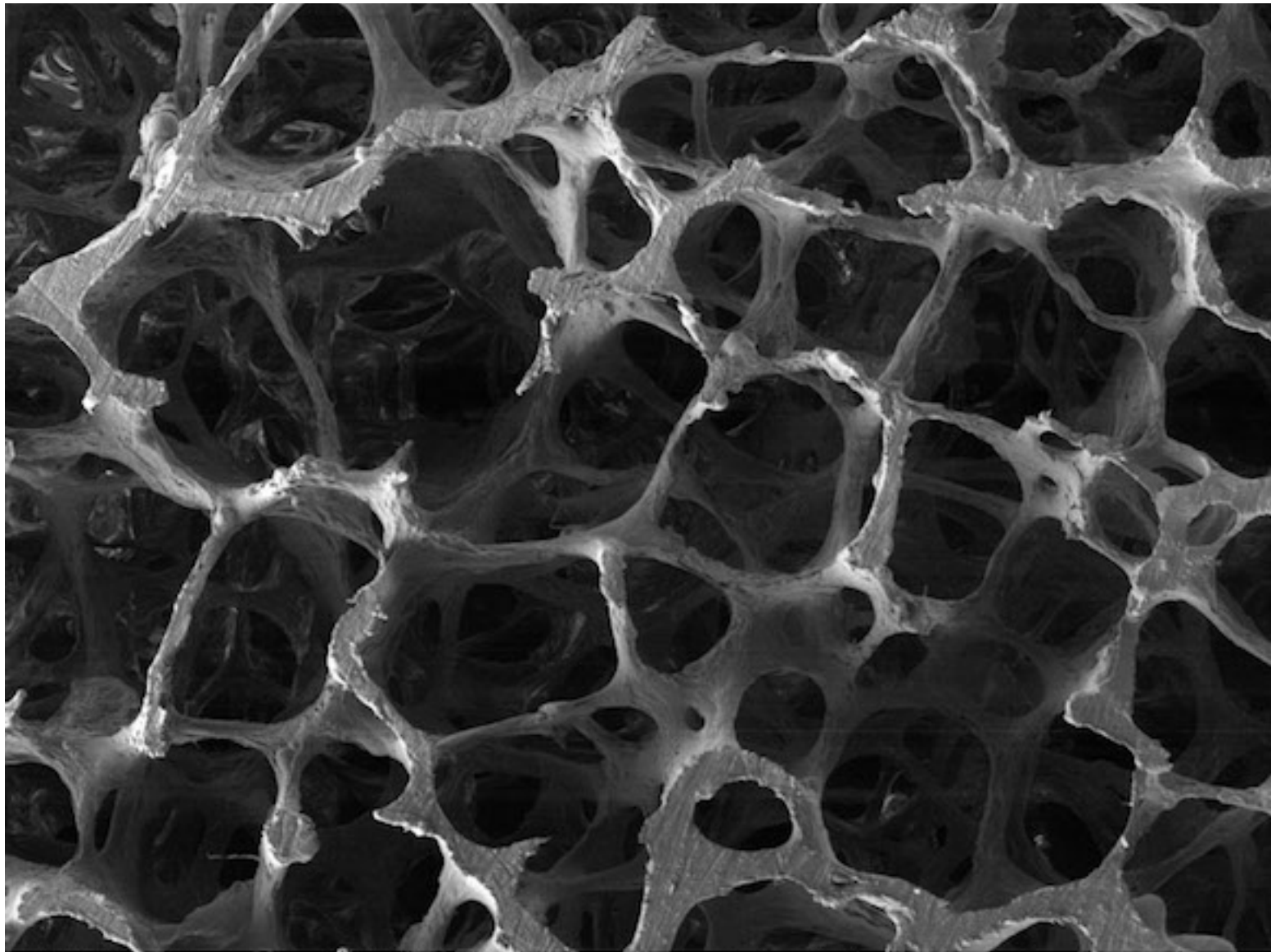


SEM MAG: 60 x
HV: 10.0 kV

DET: SE Detector
DATE: 01/21/04

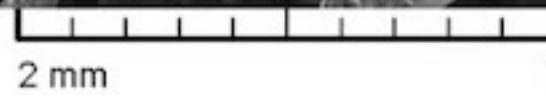
2 mm

Vega ©Tescan



SEM MAG: 50 x
HV: 10.0 kV

DET: SE Detector
DATE: 01/20/04



Vega ©Tescan

2) Chemistry Link
Macro/Major minerals relevant to bone health

Macro/Major Minerals relevant to bone health
in a 60kg (132lb) adult
Table 4.4 (Timberlake and Timberlake 141)

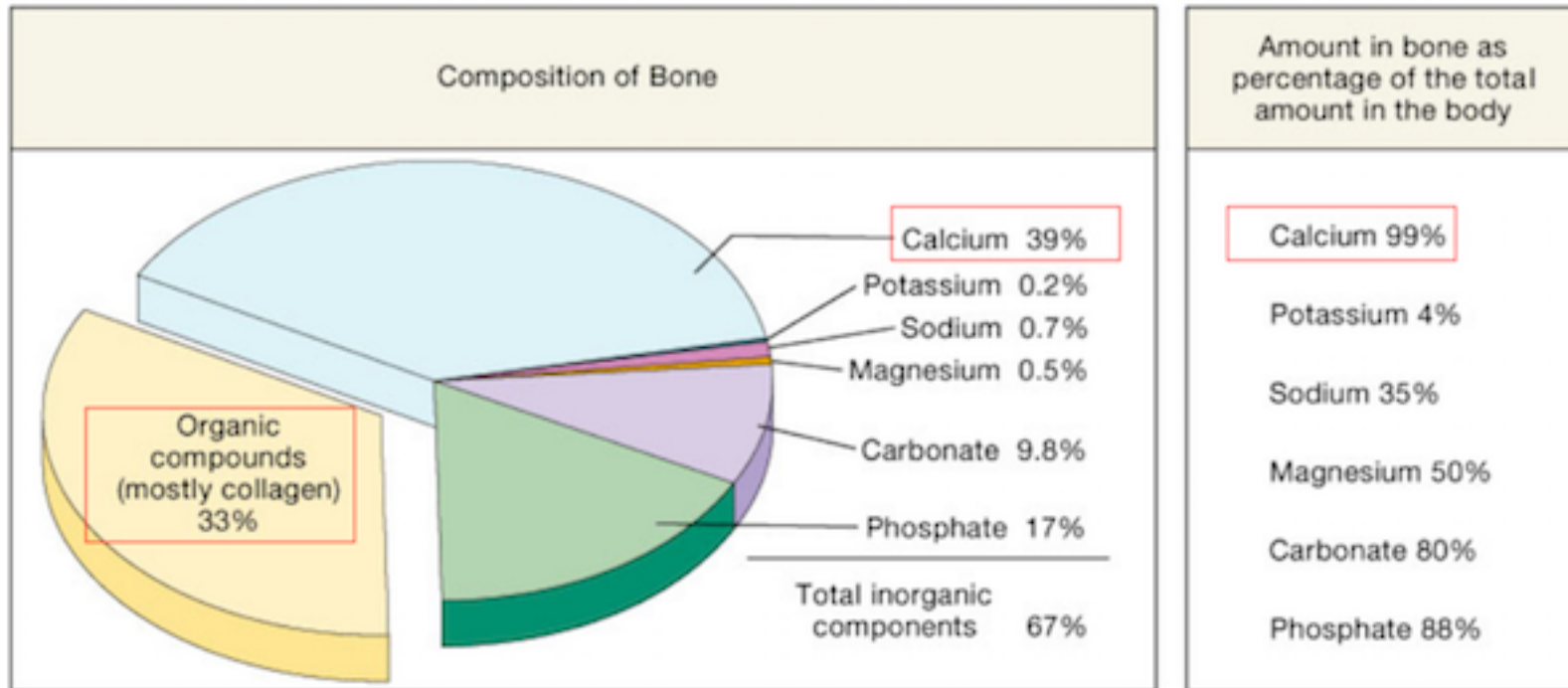
Major	(g)	Importance to humans
Ca	1000	Bones+teeth , nervous system, blood clotting
P	600	Bones+teeth , nucleic acids (incl. ADP/ATP, GDP/GTP)
Mg	36	Bones , metabolism

1kg or 2.2 lbs of Calcium in a 60kg (132lb) adult!

Wow!

3) What is bone made of?

Bone Composition:



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(Brulte)

Bone is a **Supportive Connective Tissue** (As you may have learned in Biology)

- 2 types of bone: **Compact** and **Spongy** (I won't go into the differences)
- 2 important bone cells: **Osteoclasts** liberate Calcium from bone. **Osteoblasts** create the bone matrix. (Biology)
- **Calcitonin**, a Thyroid hormone, and **Parathyroid Hormone** affect Calcium levels in blood (and bone) by inhibiting/stimulating activity of **Osteoclasts**

4) Calcium & Vitamin D intake (Maintaining Bone Density)

Calcium intake is important, but not too much!

~1g/day recommended

~2g/day maximum due to risk of disease (like kidney stones)

("Office Of Dietary Supplements - Calcium")

Vitamin D is also important for absorption and transport of Calcium to bones.

Daily Calcium and Vitamin D Requirements

Age and Gender:	Calcium	Vitamin D
1-3 years	700 mg	600 IU
4-8 years	1000 mg	600 IU
≥ 9-18 years	1300 mg	600 IU
19-50 years	1000 mg men, 1200 mg women	600 IU
50-70 years	1200 mg	600 IU
Over 70 years	1200 mg	800 IU
Post-menopausal women not receiving hormone replacement therapy	1500 mg	600-800 IU
Children receiving steroid therapy:		
1-5 years	1000 mg	600 IU
6-8 years	1200 mg	600 IU
≥ 9-18 years	1500 mg	800 IU
Adults diagnosed with osteopenia, osteoporosis or receiving steroid therapy	1500 mg	1000 IU

("Medical Nutrition Therapy Services (Calcium And Vitamin D)")

5) Exercise (Maintaining/Increasing Bone Density)

Weight/Resistance training increases **muscle** girth via **hypertrophy**.
Bone is constantly changing via **remodelling**.

In studying both muscle and bone loss, lack of mechanical stress causes the respective tissues to waste away or atrophy.

Example: A cast applied to a healing bone will cause the related muscles to atrophy while the bone heals and remodels.

Example: Astronauts lose bone density while in space, and counteract the loss of having to resist gravity with exercise. ("Preventing Bone Loss In Space Flight")

Therefore, the application of mechanical stress stimulates growth of muscle and bone.

The Spectrum of Individuals



Canadian Content

According to osteoporosis.ca



2 MILLION CANADIANS
are affected by osteoporosis

- **“Fewer than 20%** of fracture patients in Canada currently undergo diagnosis or adequate treatment for osteoporosis.”
- **“Without BMD testing,** 80% of patients with a history of fractures are not given osteoporosis therapies. Hundreds of thousands of Canadians needlessly fracture each year **because their osteoporosis goes undiagnosed and untreated.**”
- “Osteoporosis causes 70–90% of 30,000 hip fractures annually.”

(“Fast Facts”)

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