

Vitamin D is Potentially Important for Cardiovascular Health: Special Implications for African Americans

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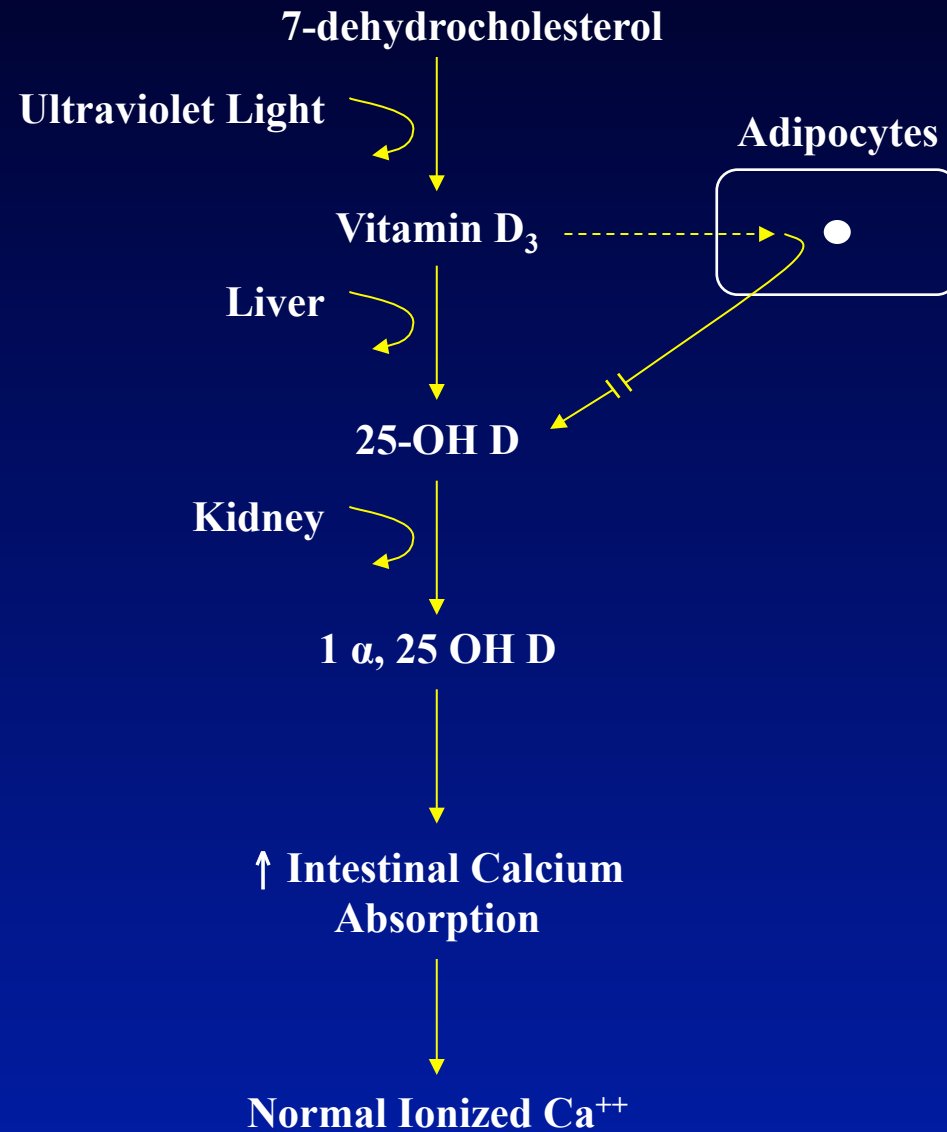
Vitamin D Facts

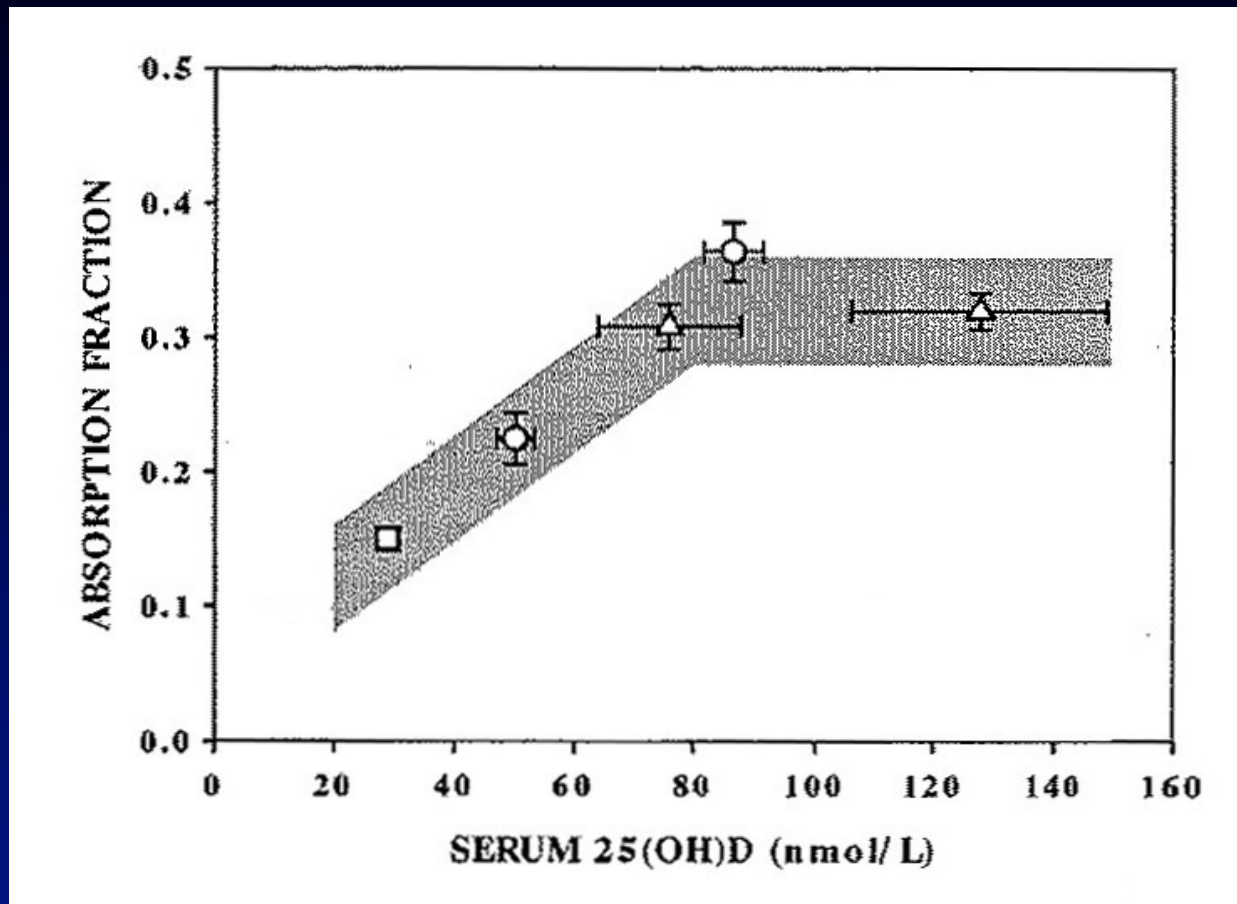
- Most persons obtain their vitamin D from sunlight exposure
- Though some foods are fortified with vitamin D, most foods contain very little vitamin D
- There are many undesirable associations with low vitamin D levels (e.g., hypertension, obesity); however, the only proven benefit of vitamin D supplementation is for bone health
- Supplementation studies with vitamin D will be necessary to prove the benefit of raising vitamin D levels

Institute of Medicine (IOM) Recommendations for Dietary Intakes of Vitamin D and Calcium

	Vitamin D (IU per day)	Calcium (mg per day)
Estimated Average Requirement	400	800
Recommended Dietary Allowance	600	1,000
Upper level intake	4,000	2,000

Highly Simplified Schema of Normal Calcium and Vitamin D Metabolism



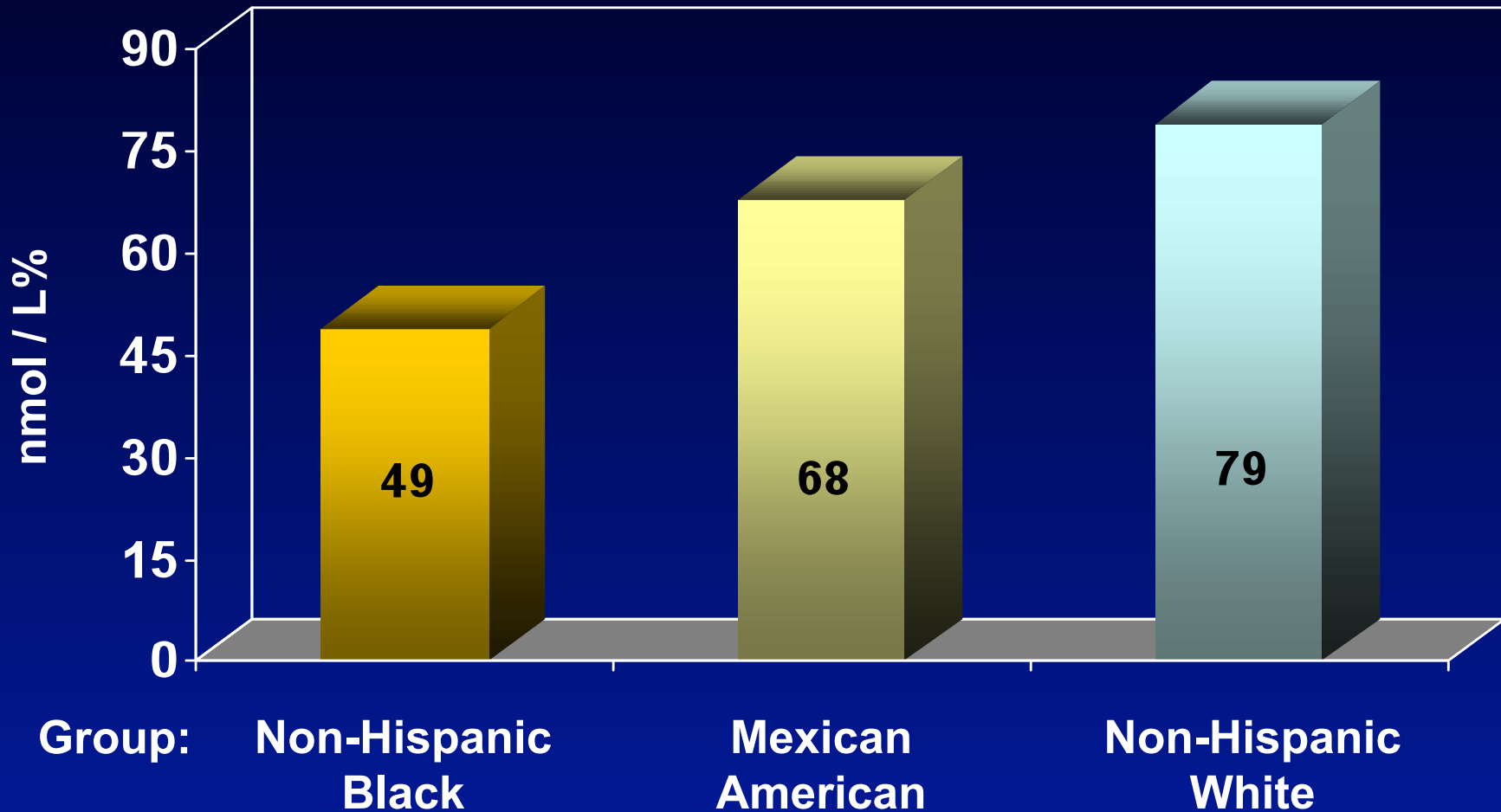


Calcium absorption fraction plotted as a function of serum 250HD concentration in three studies. The paired O symbols represent the data of one study [11]; the paired Δ symbols, a second [12], and the □ symbol is the estimated absorption for the subjects not treated with Vitamin D in the study of Bischoff et al. [13,31].

R Heaney, *J Steroid Biochemistry & Molecular Biology* 97 (2005) 13-19

Vitamin D Levels by Race/Ethnicity¹

NHANES III (1988-94)



¹ Analyses restricted to 12,644 adults 20 years and older not taking antihypertensive medication.

Scragg R et al. *Am J Hypertens* 2007;20(7):713-9

Serum 25-Hydroxyvitamin D [25(OH)D] Concentrations and Health*

nmol/L**	ng/mL	Health status
<30	<12	Associated with vitamin D deficiency, leading to rickets in infants and children and osteomalacia in adults
30-50	12-20	Generally considered inadequate for bone and overall health in healthy individuals
≥50	≥20	Generally considered adequate for bone and overall health in healthy individuals
>125	>50	Emerging evidence links potential adverse effects to such high levels, particularly >150 nmol/L (>60 ng/mL)

* Serum concentrations of 25(OH)D are reported in both nanomoles per liter (nmol/L) and nanograms per milliliter (ng/mL)

**1 nmol/L = 0.4 ng/mL

Institute of Medicine, Food and Nutrition Board. Dietary Reference Intakes for Calcium and Vitamin D. Washington, DC: *National Academy Press*, 2010.

Prevalence of Hypovitaminosis D in Women by Race: NHANES III 1998-1994

25 - OH (D) < 37.5 nmol/L Prevalence %	
African Americans	42.4 ¹
Whites	4.2

Amongst African Americans, hypovitaminosis D was independently associated with consumption of milk < 3 times/wk, no use of vitamin D supplements, season, urban residence, low BMI (<18.5 Kg/m²), and no use of oral contraceptives

Nesby-O'Dell S et al, *Am J Clin Nutr* 2002;76(1):3-4

¹Amongst African Americans taking vitamin D supplements (200 IU/D), prevalence of hypovitaminosis D was 28.2%

BMI=body mass index; NHANES=National Health and Nutrition Examination Survey

Dietary Sources of Vitamin D

Selected Food Sources of Vitamin D

Food	IUs per serving*	Percent DV**
Cod liver oil, 1 tablespoon	1,360	340
Salmon (sockeye), cooked, 3 ounces	447	112
Mackerel, cooked, 3 ounces	388	97
Tuna fish, canned in water, drained, 3 ounces	154	39
Milk, nonfat, reduced fat, and whole, vitamin D-fortified, 1 cup	115-124	29-31
Orange juice fortified with vitamin D, 1 cup (check product labels, as amount of added vitamin D varies)	100	25
Yogurt, fortified with 20% of the DV for vitamin D, 6 ounces (more heavily fortified yogurts provide more of the DV)	80	20

* IUs = International Units.

** DV = Daily Value. DVs were developed by the U.S. Food and Drug Administration to help consumers compare the nutrient contents among products within the context of a total daily diet. The DV for vitamin D is currently set at 400 IU for adults and children age 4 and older. Food labels, however, are not required to list vitamin D content unless a food has been fortified with this nutrient. Foods providing 20% or more of the DV are considered to be high sources of a nutrient, but foods providing lower percentages of the DV also contribute to a healthful diet.

U.S. Department of Agriculture, Agricultural Research Service. *USDA Nutrient Database for Standard Reference*, Release 23, 2011.

Selected Food Sources of Vitamin D (continued)

Food	IUs per serving*	Percent DV**
Margarine, fortified, 1 tablespoon	60	15
Liver, beef, cooked, 3.5 ounces	49	12
Sardines, canned in oil, drained, 2 sardines	46	12
Egg, 1 large (vitamin D is found in yolk)	41	10
Ready-to-eat cereal, fortified with 10% of the DV for vitamin D, 0.75-1 cup (more heavily fortified cereals might provide more of the DV)	40	10
Cheese, Swiss, 1 ounce	6	2

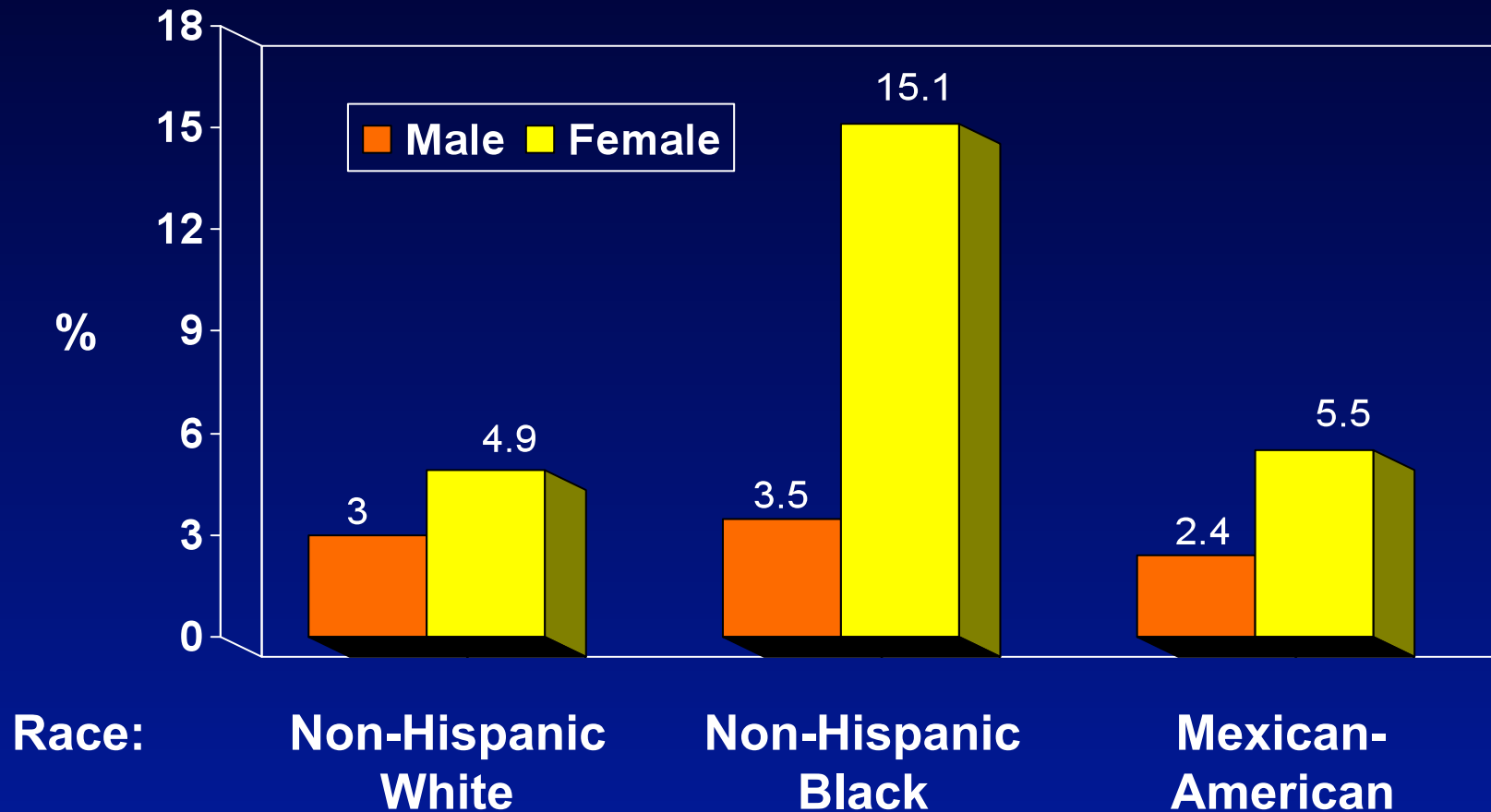
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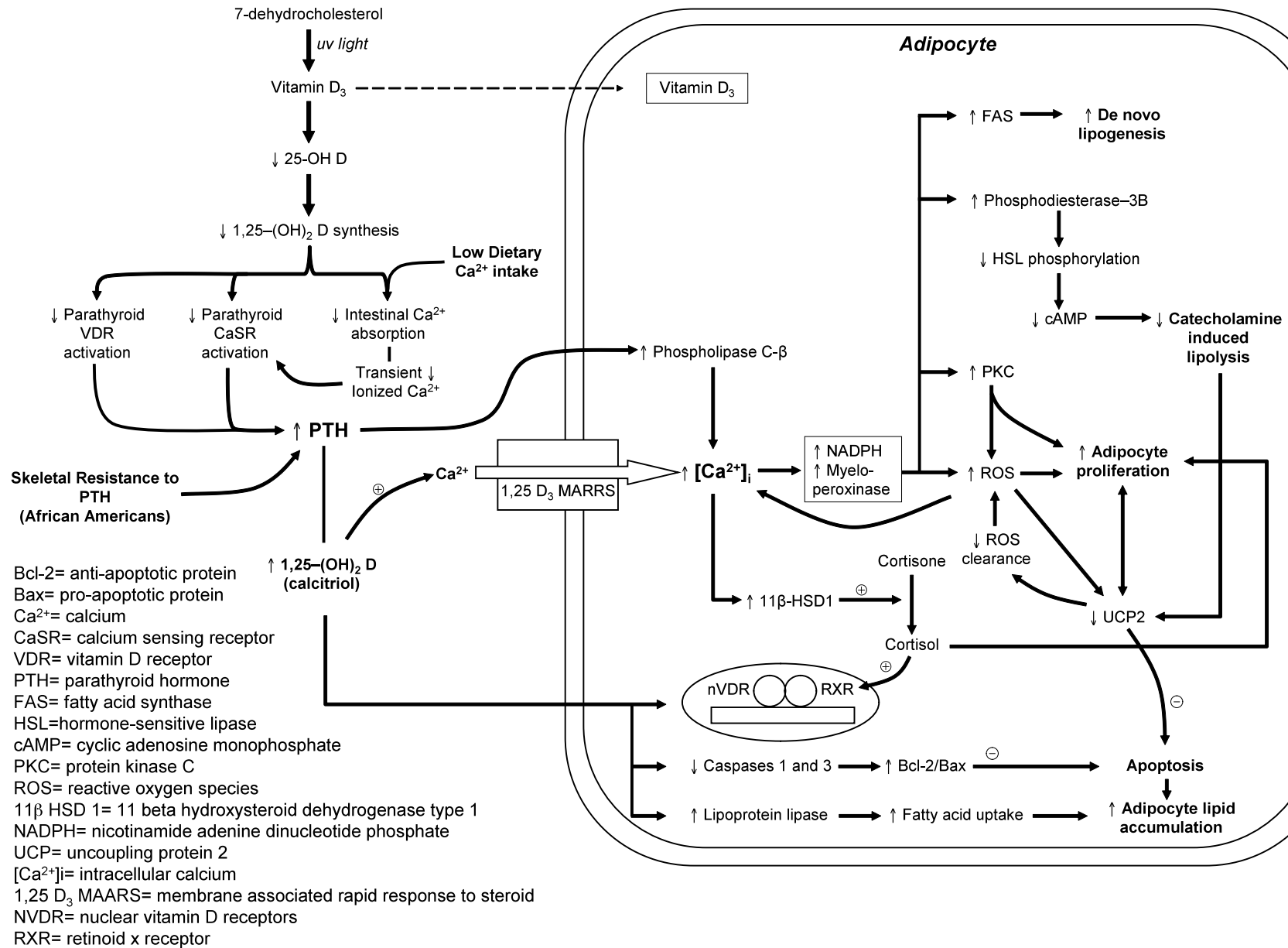
Obesity and Vitamin D

Prevalence of Extreme Obesity (BMI ≥ 40 kg/m²) in US Population (NHANES III, 1999-2000) by Sex and Race in Persons ≥ 20 Years



National Vital Statistics Report, Vol. 50, No. 15, Sept. 16, 2002

Integrated Overview of Pathways Linking Vitamin D, PTH, and Calcium to Adiposity and Reactive Oxygen Species (Oxidative Stress)



Vitamin D / PTH Categories

	N (%)	Vitamin D nmol / L	PTH pg / ml
Reference (Normal)	17 (23.3)	>50	< 45
Vitamin D ↓, PTH Normal	30 (41.1)	<50	< 45
Vitamin D ↓, PTH ↑	26 (35.6)	<50	> 45

Relationship Between Vitamin D and PTH to Weight and Body Composition in Healthy African Americans: CUAAH Center

Group	Weight (Kg)	BMI Kg/m ²	Body Mass		
			Lean	Fat	% Fat
0 (↔ PTH, ↔ Vit D)	84.6	29.3	53,043	29,079	35.7
1 (↔ PTH, ↓ Vit D)	88.9	32.6	54,247	32,878	38.0
2 (↑ PTH, ↓ Vit D)	91.5	33.2	54,093	34,998	39.6
P	0.17	0.0007	0.84	0.03	

↔ Vit D (normal vitamin D)= more than 50 nmol/L

↔ PTH (normal PTH)= less than 50 nmol/L

Means adjusted for age and sex (PROC GLM)

Lean and Fat Body Mass¹ (Kg) by Category of Vitamin D / PTH: ONOSS Project (N=65)

Vitamin D / PTH Category	Lean Mass	Fat Mass	% Fat
Normal	53.0	29.0	35.4
Vitamin D ↓, PTH Normal	54.2	32.6	37.6
Vitamin D ↓, PTH ↑	54.4	34.7	38.9
P-Value	0.80	0.05	

$\Delta=2.6\%$ (Lean Mass, Normal vs Vitamin D ↓, PTH Normal)
 $\Delta=19.7\%$ (Fat Mass, Normal vs Vitamin D ↓, PTH Normal)
 $\Delta=9.9\%$ (% Fat, Normal vs Vitamin D ↓, PTH Normal)

¹Data are adjusted for age, sex, and season

Relationship of Vitamin D / PTH Category with Weight, BMI, Waist Circumference and Waist-to-Hip Ratio

Vitamin D / PTH Category	Weight (Kg)	BMI (Kg/m ²)	Waist Circum (cm)	Waist : Hip Ratio
Normal	84.3	29.3	43.4	0.84
Vitamin D ↓, PTH Normal	88.9	32.5	44.8	0.88
Vitamin D ↓, PTH ↑	91.6	33.0	45.5	0.87
P-Value	0.17	0.003	0.10	0.18

$\Delta=12.6\%$

Data are adjusted for age, sex, and season

Extremity and Trunk Fat¹ (Kg) by Category of Vitamin D / PTH: ONOSS Project

Vitamin D / PTH Category	Fat Mass		
	Trunk	Extremity	T:E Ratio
Normal	13.1	14.9	0.879
Vitamin D ↓, PTH Normal	15.6	16.0	0.975
Vitamin D ↓, PTH ↑	16.5	17.2	0.959
P-Value	0.03	0.18	

$\Delta=26.0\%$ (Trunk), $\Delta=15.4\%$ (Extremity), $\Delta=9.1\%$ (T:E Ratio)

¹Data are adjusted for age, sex, and season

Vitamin D and Hypertension

Vitamin D and Blood Pressure/Hypertension

NHANES (1988-1994)

- ❑ 25-OH D levels > 80 nmol/L attenuated the age-related rise in SBP by 20% (versus those with levels < 50 nmol/L)¹
- ❑ Only 8% of blacks had 25-OHD levels > 80 nmol/L¹
- ❑ There was an inverse relationship between 25-OH D levels and SBP that remained significant ($p < 0.05$), though weakened, after adjustment for BMI
- ❑ The inverse association of 25-OH D and SBP was stronger in those 50 years and older versus younger persons ($p = 0.021$)
- ❑ Racial differences in 25-OH D explained $\sim 50\%$ of the racial differences in hypertension prevalence

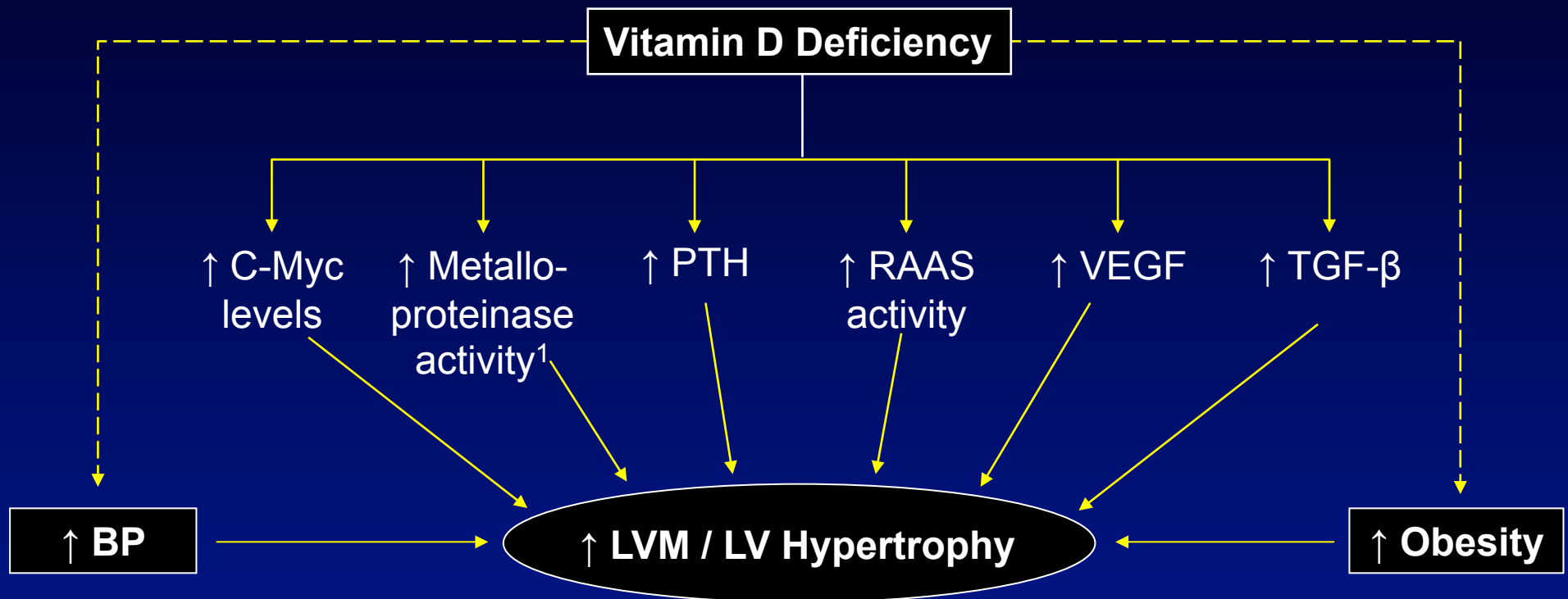
¹ Judd SE et al. *Am J Clin Nutr* 2008;87(1):136-41

² Scragg R et al. *Am J Hypertens* 2007;20(7):713-9

Age- and Sex-Adjusted Regression of Ambulatory Blood Pressure on Vitamin D and PTH Levels

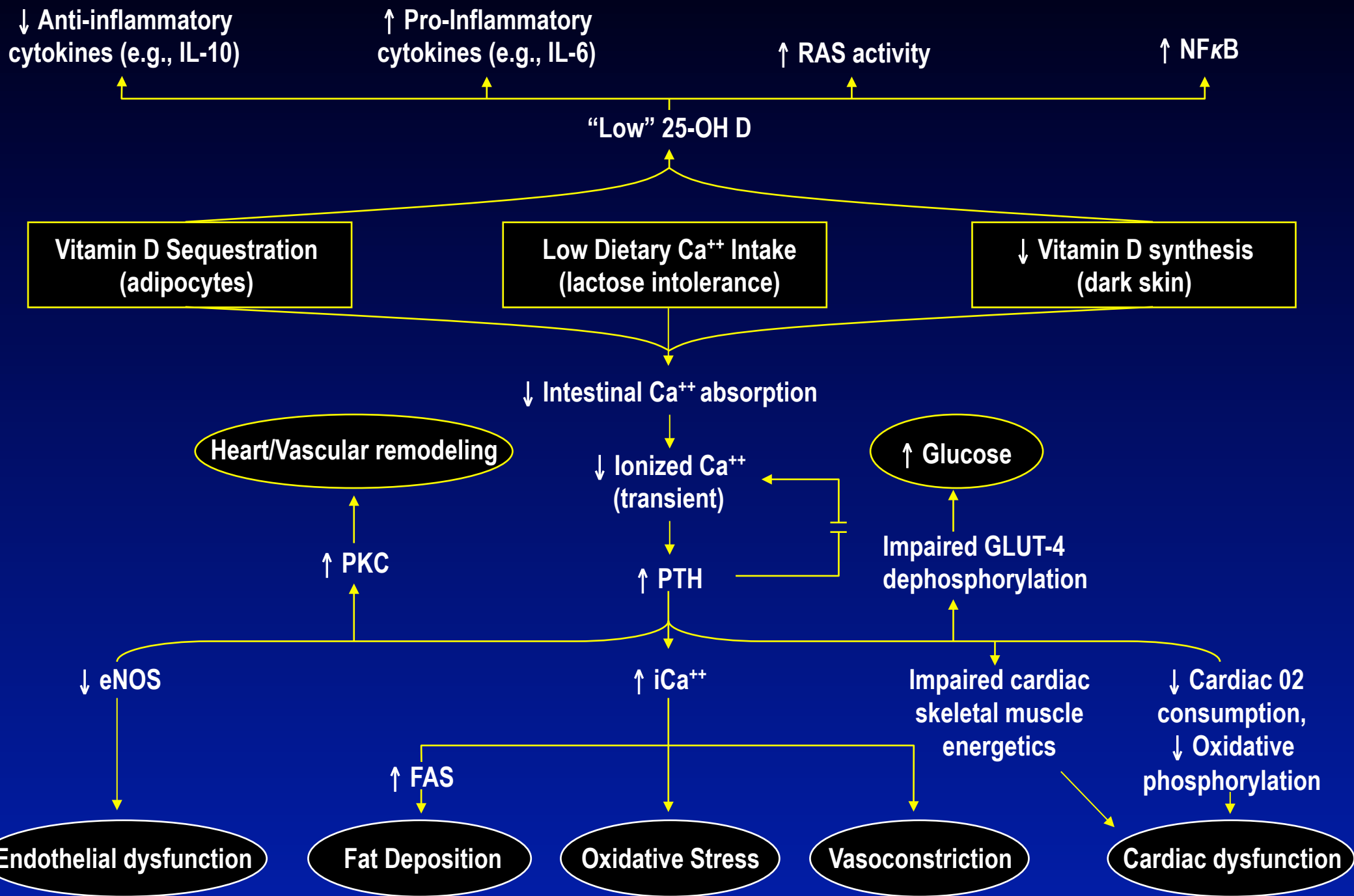
Dependent Variables (units) (sample size)	Independent Variables Coefficients (p-value)			
	Log vitamin D	Log PTH residual	Log PTH	Log vitamin D residual
ABPM daytime SBP (mmHg) (70)	-4.3 (0.11)	0.6 (0.82)	1.9 (0.39)	-4.0 (0.18)
ABPM nighttime SBP (mmHg) (57)	-3.6 (0.40)	-1.9 (0.63)	-0.4 (0.90)	-4.4 (0.35)
ABPM daytime DBP (mmHg) (57)	-4.7 (0.07)	-2.8 (0.26)	-0.8 (0.72)	-5.9 (0.04)
ABPM nighttime DBP (mmHg) (57)	-5.2 (0.15)	-4.3 (0.20)	-2.0 (0.51)	-7.1 (0.08)

Figure A. Conceptual Model Linking Vitamin D Deficiency to Left Ventricular Hypertrophy



Vitamin D= 25-OHD, C-myc=, PTH= parathyroid hormone, RAAS= renin angiotensin aldosterone system, VEGF= vascular endothelial growth factor, TGF-β= transforming growth factor beta,

¹Endogenous inhibitors of metalloproteinases increase during vitamin deficiency



Summary

- Most persons obtain their vitamin D from sunlight exposure and, in Michigan, there is inadequate sunlight to make vitamin D for much of the year
- Low vitamin D levels are associated with higher levels of blood pressure and greater body fat , two of the major contributors to heart enlargement and ultimately heart failure
- Understanding whether supplementation with vitamin D will lower blood pressure, reduce body fat, reduce heart size, etc. will require careful prospective studies
- With a higher level of proof of health benefits for vitamin D supplementation, more aggressive recommendations can be made for supplementation