Is weight the best indicator for health? Insights from the WHI

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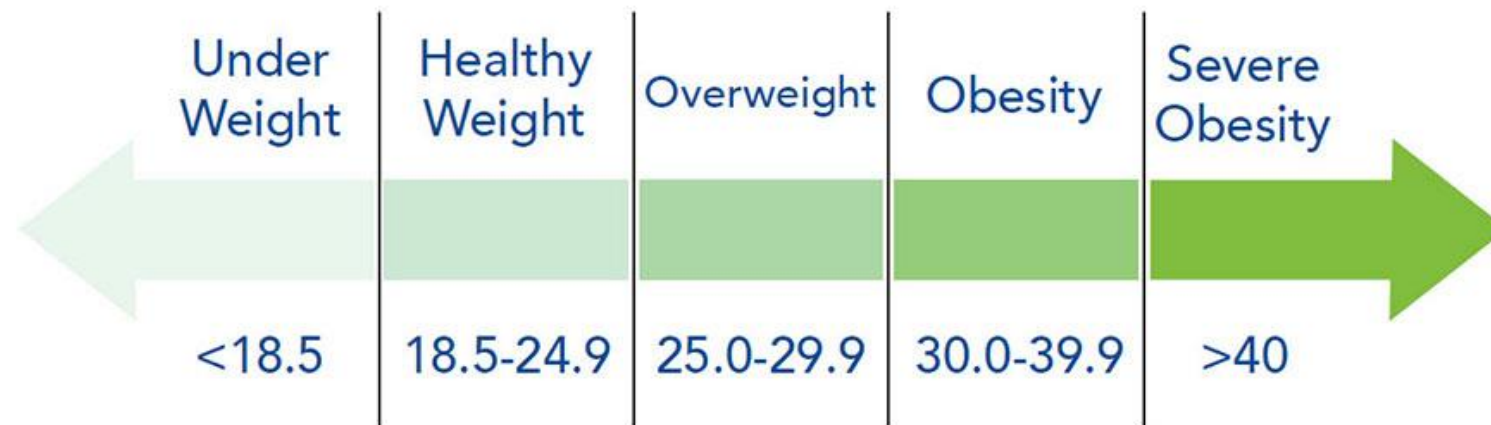
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What is overweight and obesity?

- The most used measure of weight status is the body mass index, or BMI
- BMI is a simple calculation based on the ratio of someone's weight to height (BMI = kg/m^2)

Weight Categories Based on BMI

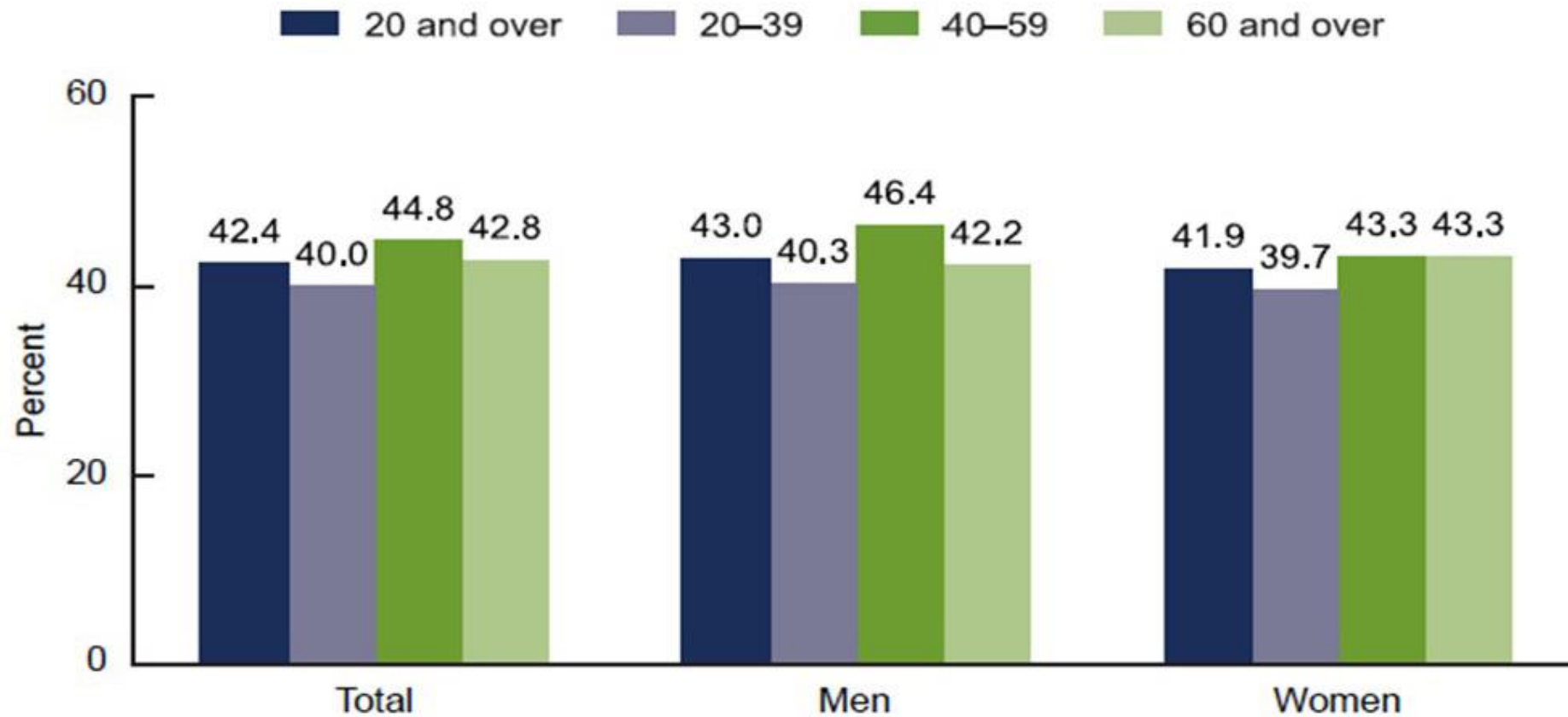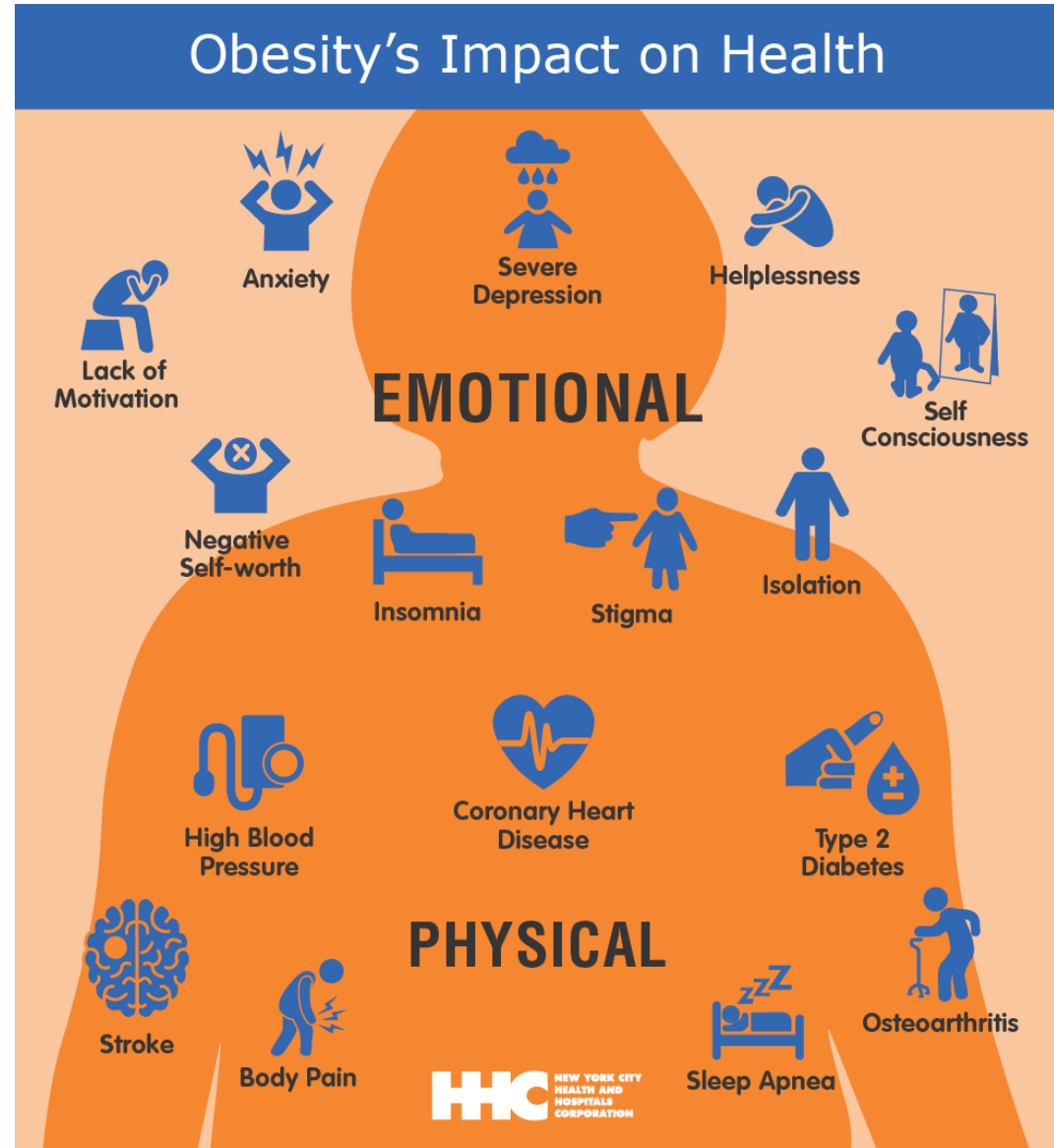| Under Weight	Healthy Weight	Overweight	Obesity	Severe Obesity
<18.5	18.5-24.9	25.0-29.9	30.0-39.9	>40

Obesity Medicine Association Definition

- "a chronic, relapsing, multifactorial, neurobehavioral disease, wherein an increase in body fat promotes adipose tissue dysfunction and abnormal fat mass physical forces, resulting in adverse metabolic, biomechanical, and psychosocial health consequences."
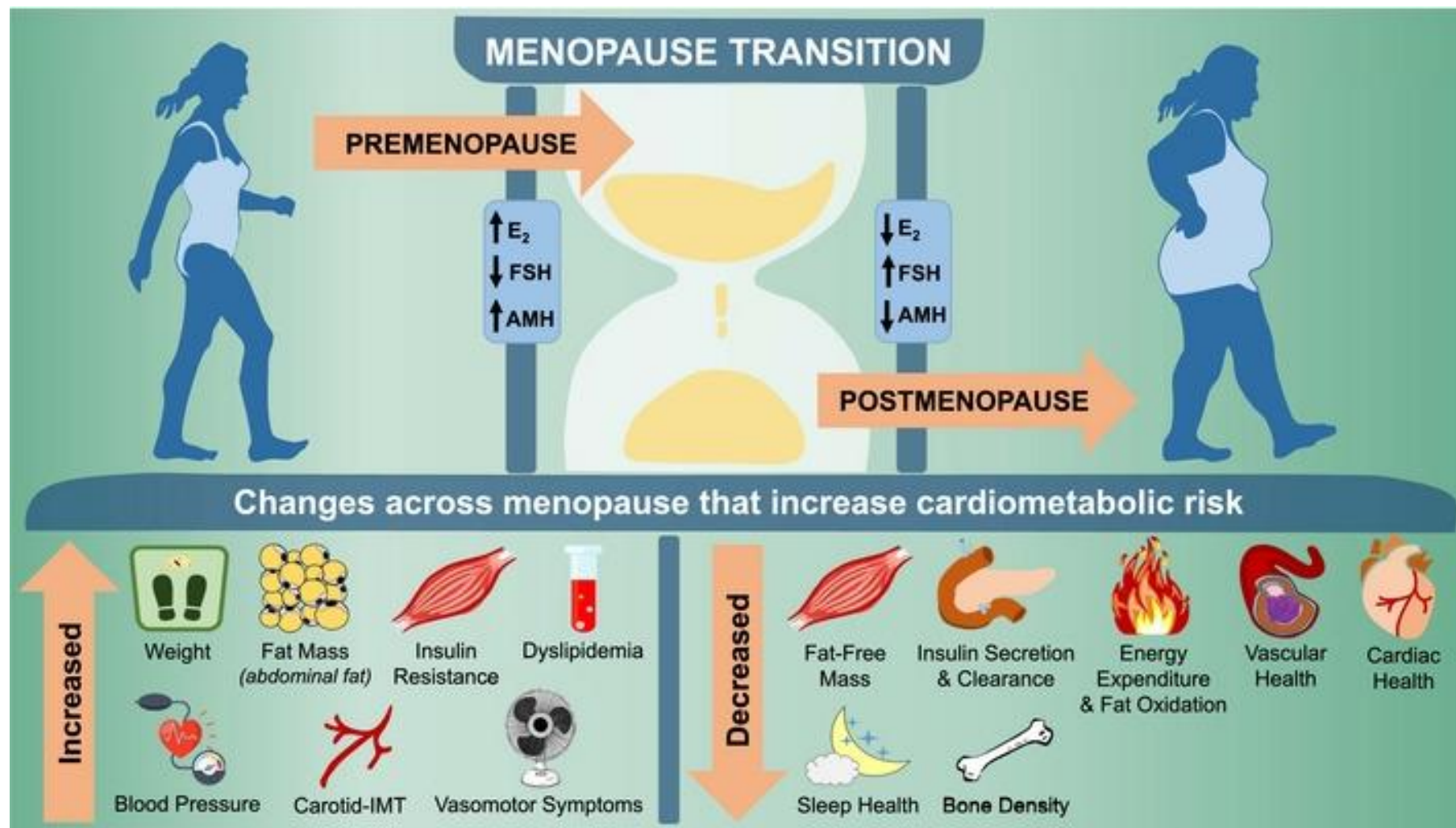
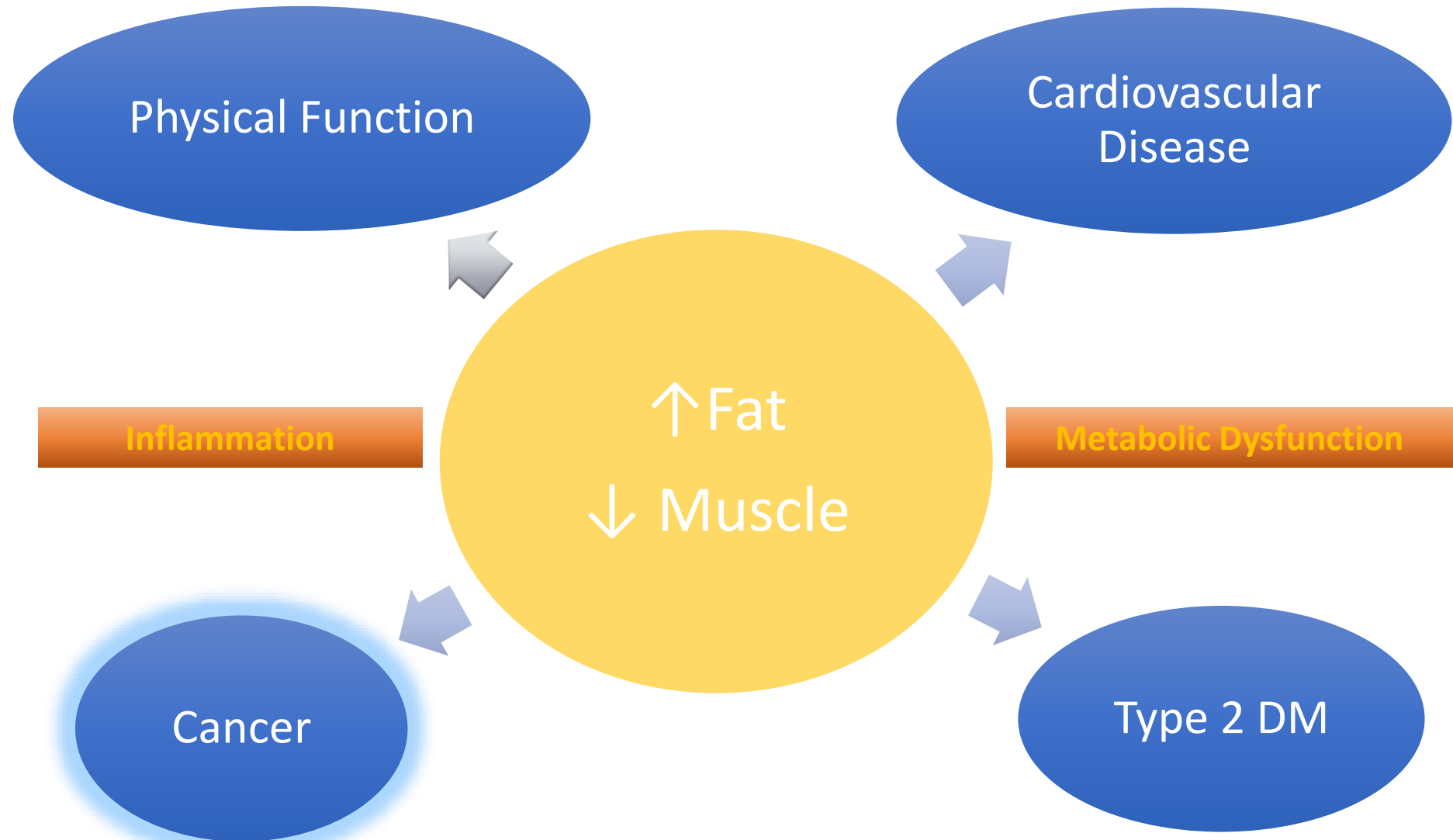# Prevalence of obesity among adults ages 20 and over, by sex and age: United States, 2017–2018

Impact of obesity on health

What about postmenopausal women?

Changes in the Body with Aging

Physical Function

Cardiovascular Disease

Inflammation

Metabolic Dysfunction

↑Fat
↓ Muscle

Cancer

Type 2 DM

Is body composition the same as BMI?   NO!

Body Mass Index (BMI)

- Obesity is defined by BMI ≥ 30kg/m^2
- BMI is a population-based proxy for body fat
- Simply weight/height^2
- Scale and height board used to measure and then compute
- Low cost, easy to measure
- Unreliable with aging
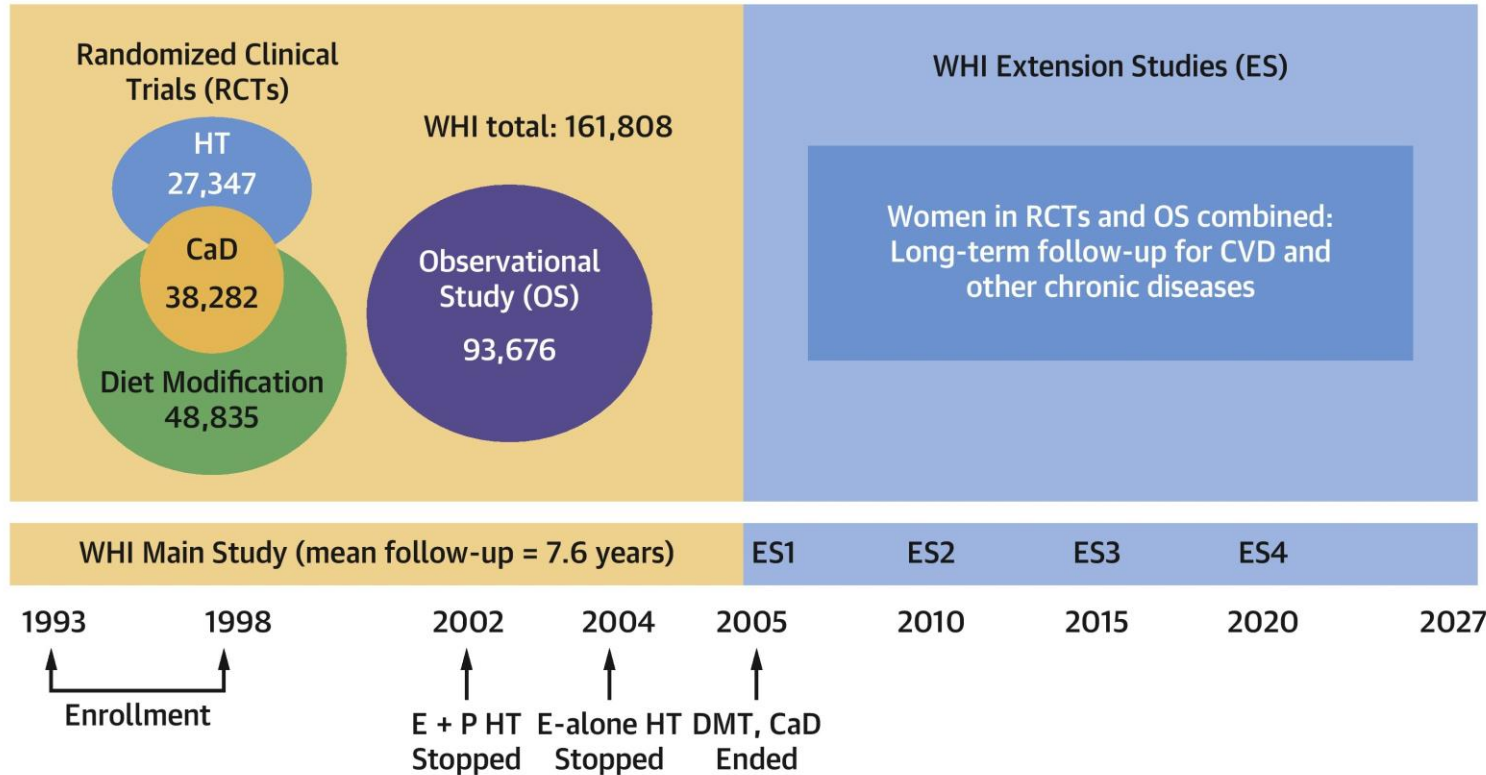
Body Composition

- Measured adipose tissue and skeletal muscle tissue
- Area, mass, or volume of these tissues can be obtained by DXA, CT, MRI, etc.
- Higher cost, requires large devices and trained technicians
- Radiation exposure with DXA (very low) and CT (higher)
- You can be "normal weight" and still have high fat mass and low skeletal muscle mass

Example		Standard Categories	
Height	Weight Range	**BMI**	**Weight Status**
5' 4"	107 lbs or less	Below 18.5	Underweight
	108 lbs to 145 lbs	18.5 to 24.9	Normal or Healthy Weight
	146 lbs to 174 lbs	25.0 to 29.9	Overweight
	175 lbs or more	30 or higher	Obese

Women's Health Initiative

- Postmenopausal women
- Aged 50-79yrs at baseline
- 40 Clinical Centers in US
- 3 DXA Centers
- Total and regional bone, lean, and fat
- Baseline, Years 1, 3, 6, and 9 of follow-up

CENTRAL ILLUSTRATION: Evolution of the Women's Health Initiative Study Program

Randomized Clinical Trials (RCTs)

HT 27,347

CaD 38,282

Diet Modification 48,835

WHI total: 161,808

Observational Study (OS) 93,676

WHI Extension Studies (ES)

Women in RCTs and OS combined: Long-term follow-up for CVD and other chronic diseases

WHI Main Study (mean follow-up = 7.6 years)   ES1   ES2   ES3   ES4

1993   1998   2002   2004   2005   2010   2015   2020   2027

Enrollment

E + P HT Stopped   E-alone HT Stopped   DMT, CaD Ended

LaMonte MJ, et al. J Am Coll Cardiol. 2022;80(3):256–275.

WHI Body Composition Measures

Region	BMC (grams)	Fat (grams)	Lean (grams)	Lean+BMC (grams)	Total (grams)	% Fat (%)
L Arm	161.7	598.6	1939.6	2101.3	2699.9	22.2
R Arm	161.3	655.9	1888.2	2049.5	2705.4	24.2
Trunk	566.2	4118.8	18941.4	19507.6	23626.4	17.4
L Leg	422.1	3097.6	6039.1	6461.2	9558.8	32.4
R Leg	419.2	3135.8	6361.5	6780.7	9916.5	31.6
SubTot	1730.4	11606.7	35169.8	36900.2	48506.9	23.9
~ Head	585.2	838.9	2901.8	3487.0	4325.9	19.4
TOTAL	2315.6	12445.6	38071.5	40387.2	52032.8	23.6

~assumes 17.6% brain fat
LBM 73.2% water
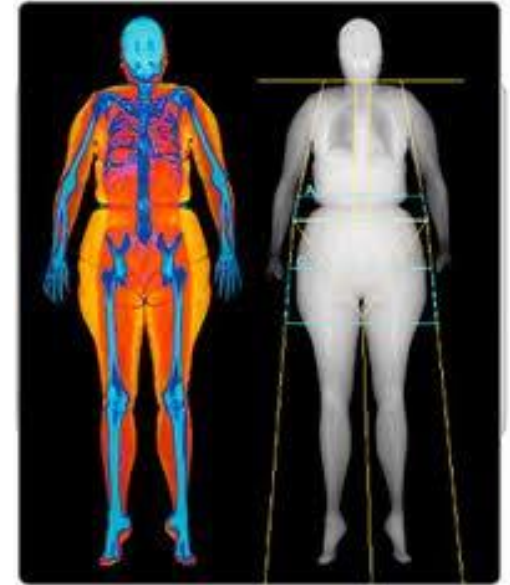
- 11,405 women
- Pittsburgh, Birmingham, Tucson/Phoenix
- Dual Energy X-ray Absorptiometry Scans
- Baseline, Year 1*, Year 3, Year 6, Year 9*
- Total & Regional: Bone, Lean, Fat

NEW Measures in the WHI DXA Cohort

➢Visceral Adipose Tissue

➢Subcutaneous Adipose Tissue depots

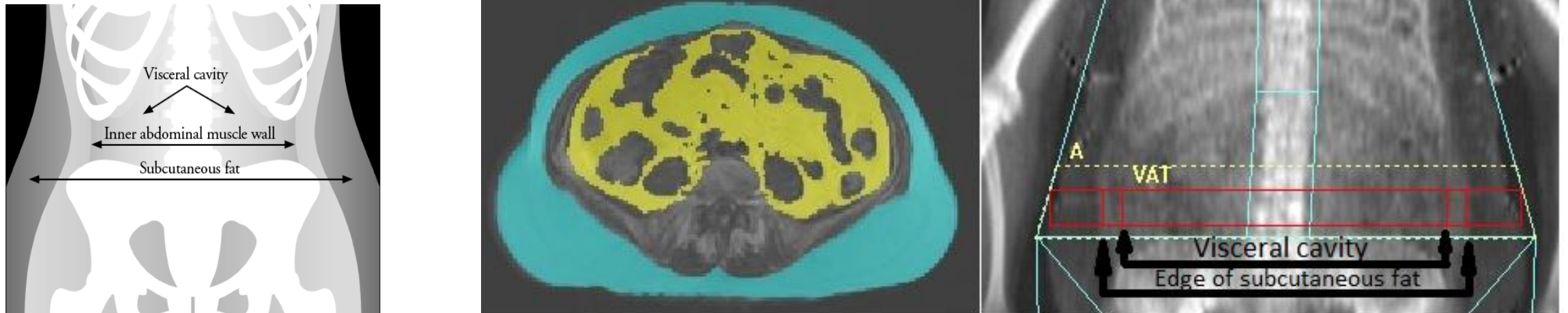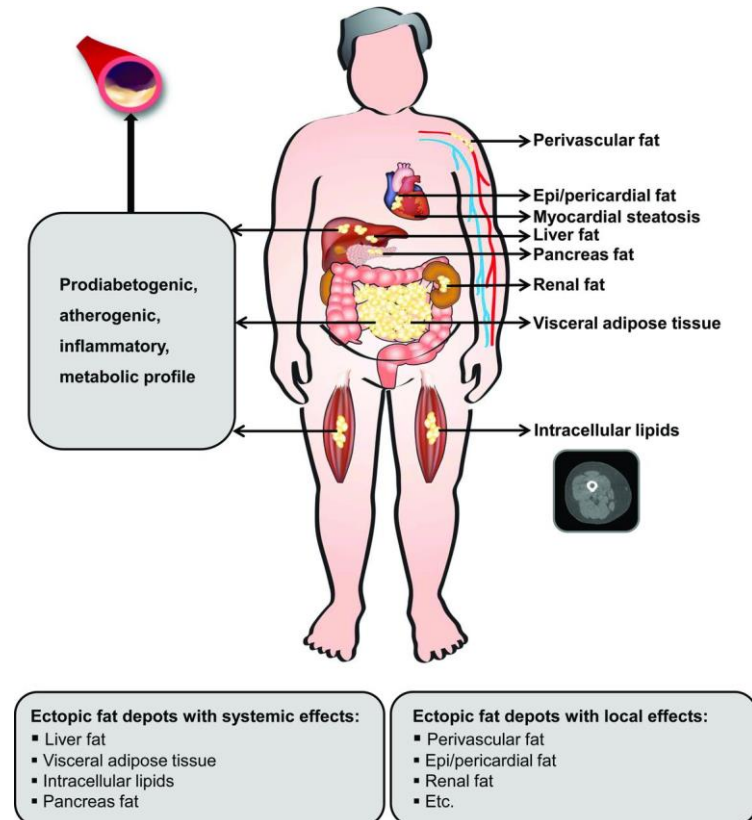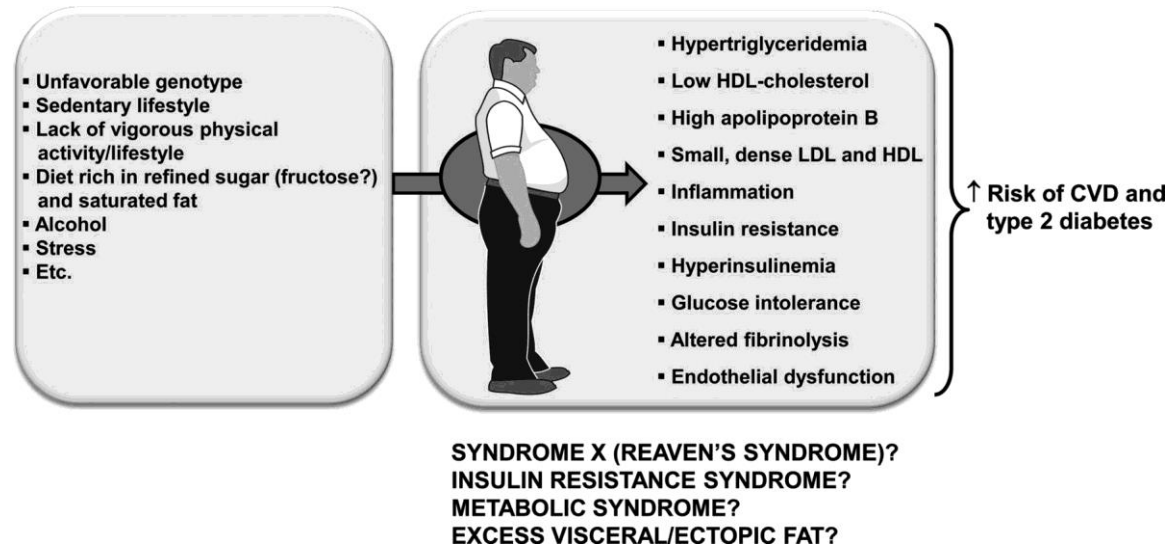➢Validation: MRI and DXA in subset with new software

Figure 1. Representative example of abdominal visceral and subcutaneous fat quantification by MRI and DXA techniques.
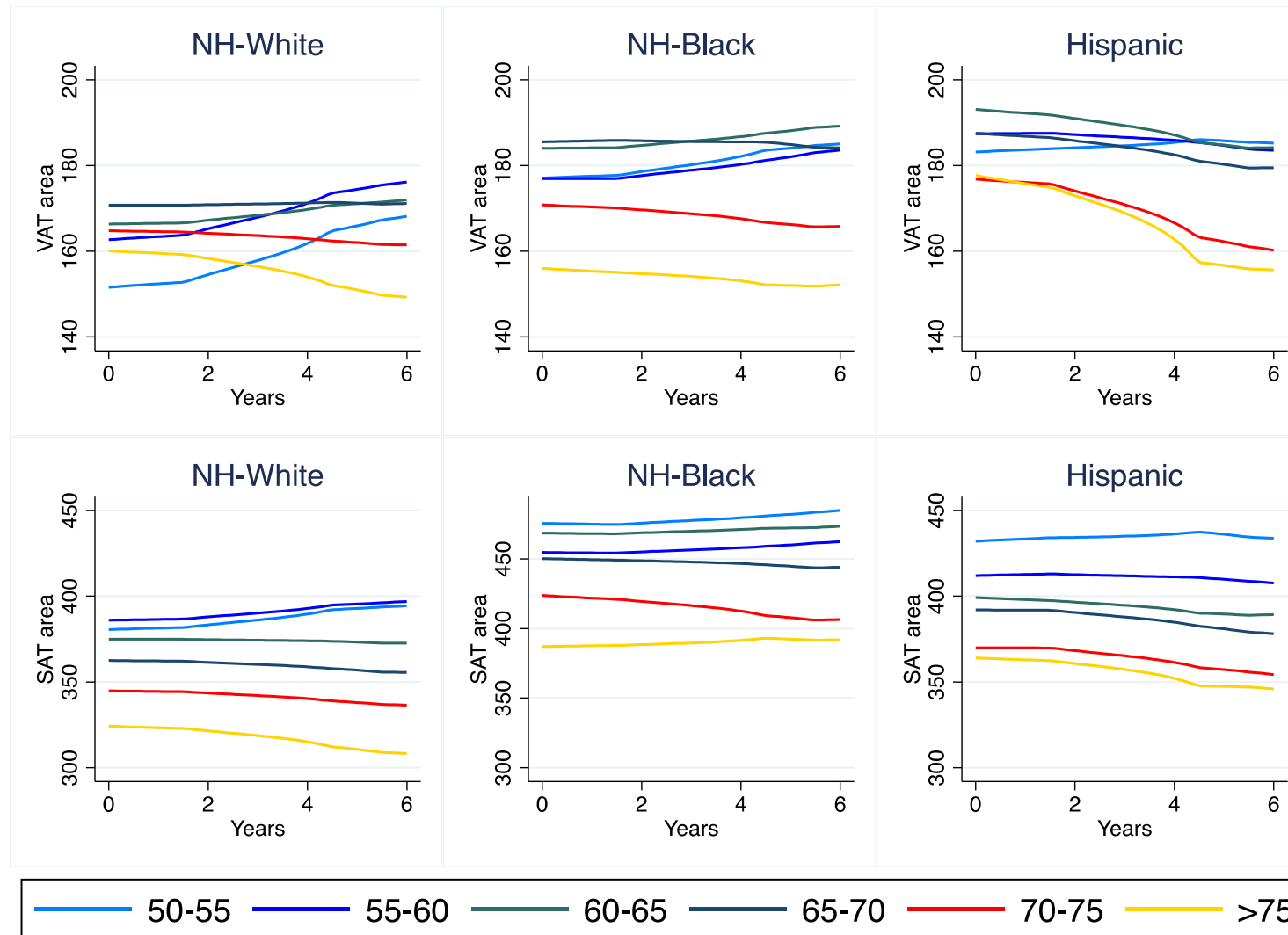The MRI image (left) represents an axial slice at the L3-L4 intervertebral space; slice thickness is 10mm. The visceral adipose tissue is colored in yellow and subcutaneous adipose tissue is colored in blue. The two-dimensional DXA (right) regions of interest for lateral subcutaneous adipose and total abdominal adipose are demarcated by the lines drawn at L4. Lateral subcutaneous adipose is used to approximate total subcutaneous adipose. Total subcutaneous adipose is then subtracted from total abdominal fat to derive the visceral adipose tissue estimate. DXA image: A, android subregion VAT, visceral adipose tissue

Bea JW, J Clin Densitom; *Under Review*

Obesity and adiposity – and what I think we're actually interested in measuring

**Visceral Adipose Tissue (VAT) and regional Subcutaneous Adipose Tissue (SAT) depots**

- Unfavorable genotype
- Sedentary lifestyle
- Lack of vigorous physical activity/lifestyle
- Diet rich in refined sugar (fructose?) and saturated fat
- Alcohol
- Stress
- Etc.

- Hypertriglyceridemia
- Low HDL-cholesterol
- High apolipoprotein B
- Small, dense LDL and HDL
- Inflammation
- Insulin resistance
- Hyperinsulinemia
- Glucose intolerance
- Altered fibrinolysis
- Endothelial dysfunction

↑ Risk of CVD and type 2 diabetes

SYNDROME X (REAVEN'S SYNDROME)?
INSULIN RESISTANCE SYNDROME?
METABOLIC SYNDROME?
EXCESS VISCERAL/ECTOPIC FAT?

Prodiabetogenic, atherogenic, inflammatory, metabolic profile

- Perivascular fat
- Epi/pericardial fat
- Myocardial steatosis
- Liver fat
- Pancreas fat
- Renal fat
- Visceral adipose tissue
- Intracellular lipids

Ectopic fat depots with systemic effects:
- Liver fat
- Visceral adipose tissue
- Intracellular lipids
- Pancreas fat

Ectopic fat depots with local effects:
- Perivascular fat
- Epi/pericardial fat
- Renal fat
- Etc.

What have we learned from the WHI:
Abdominal adipose tissue by age and race/ethnic group

Change in measures of body composition over 6 years
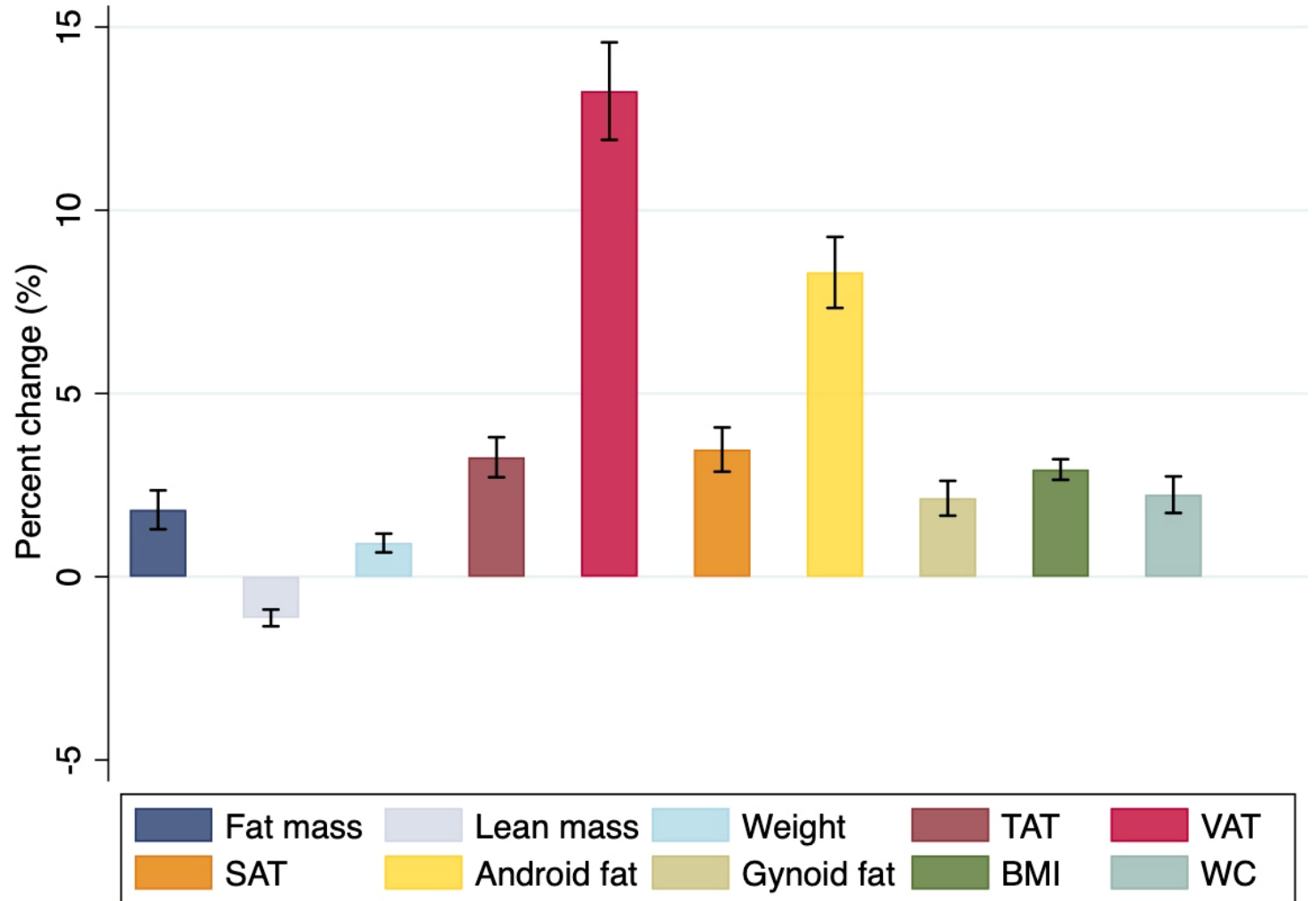
Results: Women life course events – age of menarche and reproductive lifespan
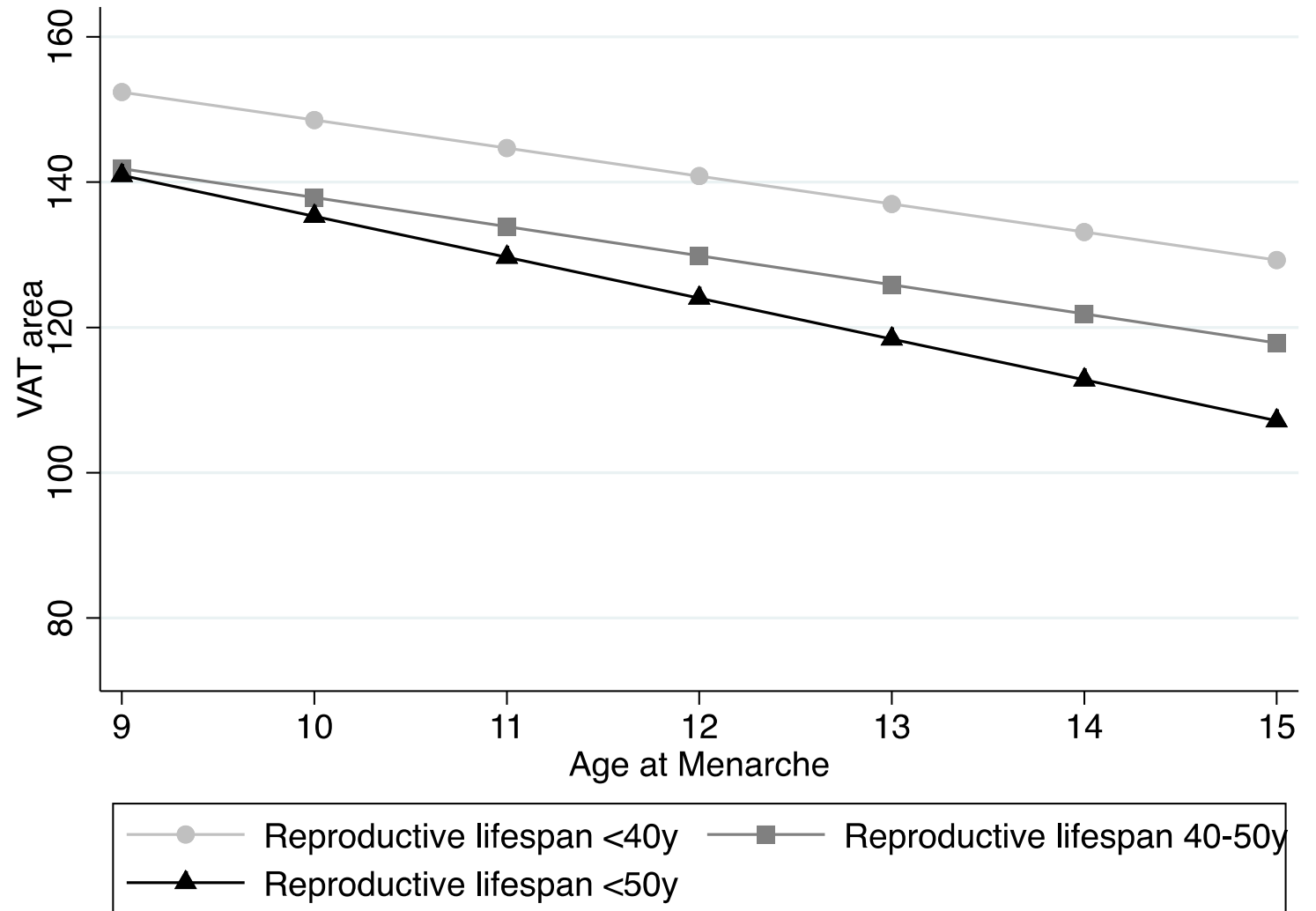
Results: Physical activity

- WHI participants with 30 minutes / week or more (150+ minutes **big benefits)** had much lower belly fat, overall body fat, more muscle/better bone mass density

MOVE YOUR WAY®

What types of physical activity do older adults need to stay healthy?

Moderate-intensity aerobic activity

Anything that gets your heart beating faster counts.

at least 150 minutes a week

Muscle-strengthening activity

Activities that make your muscles work harder than usual count.

at least 2 days a week

Mix in activities to improve your balance!

Aim for a mix of aerobic, muscle-strengthening, and balance activities.

Try activities that count as more than 1 activity type, like dancing, sports, or tai chi.
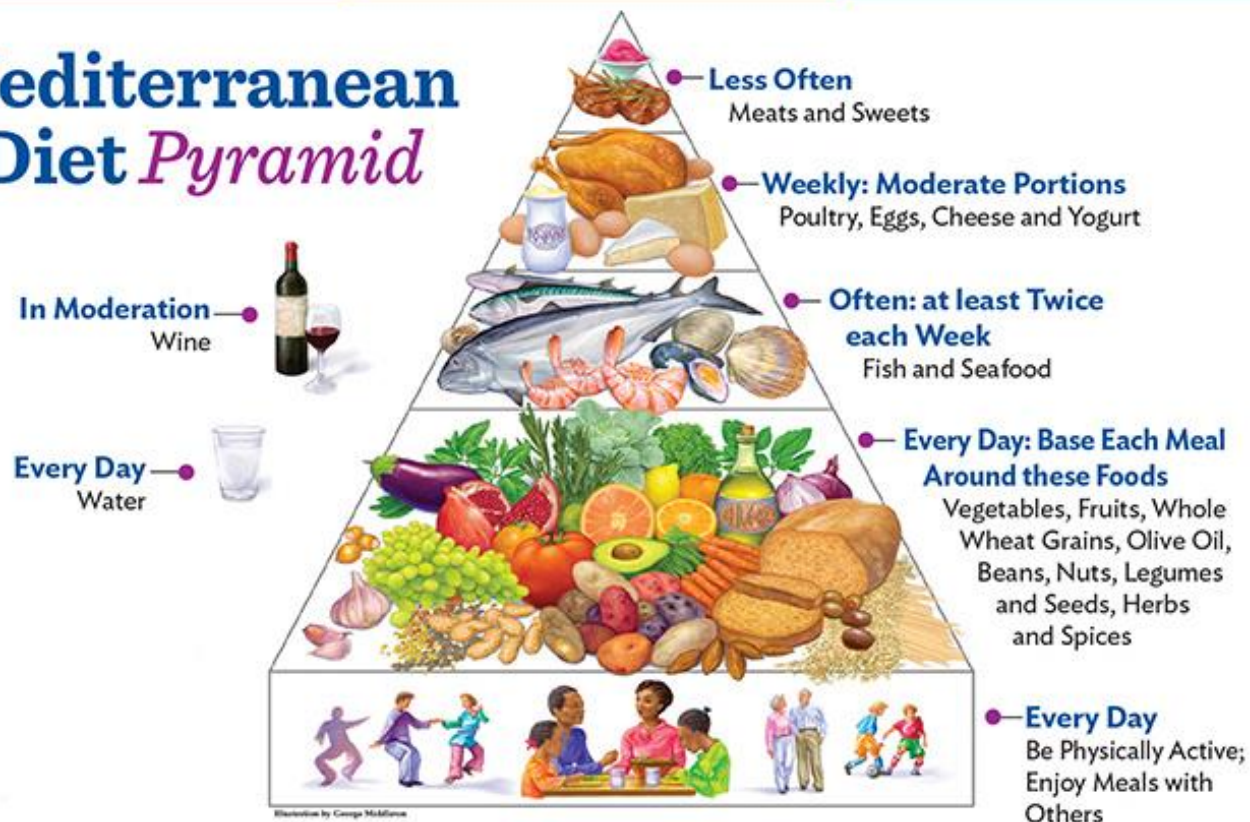
If that's more than you can do right now, **start slow and do what you can** — even 5 minutes of physical activity has real health benefits.

Walk. Run. Dance. Play. **What's your move?**

Results: Diet patterns good for preventing belly fat accumulation

Results: Sleep and insomnia symptoms

- Sleep is important for many health-related considerations!
- But we don't see any link between sleep and body composition

Risk for developing type 2 diabetes

- Comparing WHI participants in top 20% of BMI and overall body fat to lowest 20%: 3-4X the risk and # of cases of T2D

- Comparing WHI participants in top 20% of Visceral fat to lowest 20%, **> 10X the risk and # of cases**
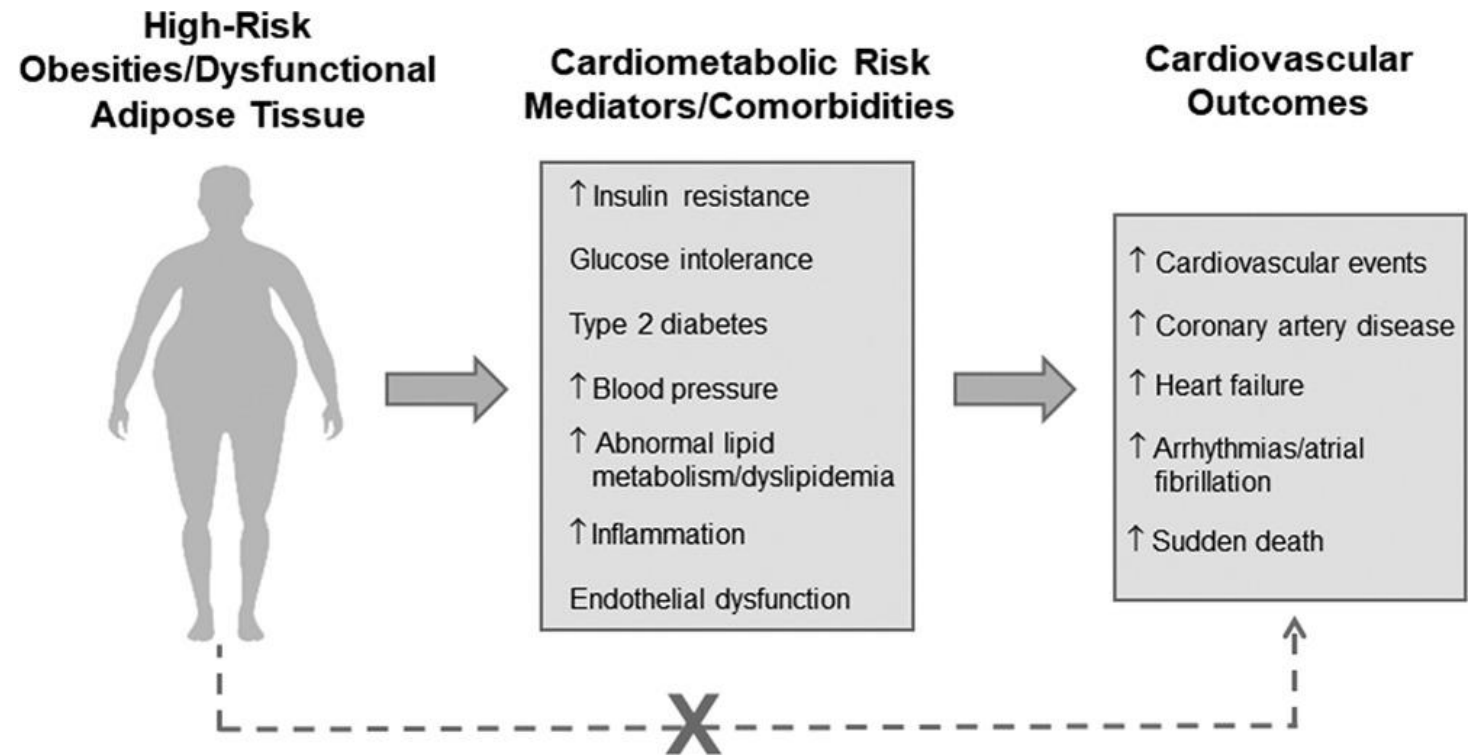

Marie-Eve Piché. Circulation Research. Obesity Phenotypes, Diabetes, and Cardiovascular Diseases, Volume: 126, Issue: 11, Pages: 1477-1500, DOI: (10.1161/CIRCRESAHA.120.316101)

Risk for Heart Disease

- Coronary Heart Disease: 2X risk and # of cases for VAT (1.5 for BMI)

- Stroke, Peripheral Vascular Disease no prediction in BMI or adipose tissue measures

CENTRAL ILLUSTRATION: Key Factors Involved in Visceral Obesity and Related Cardiometabolic Risk
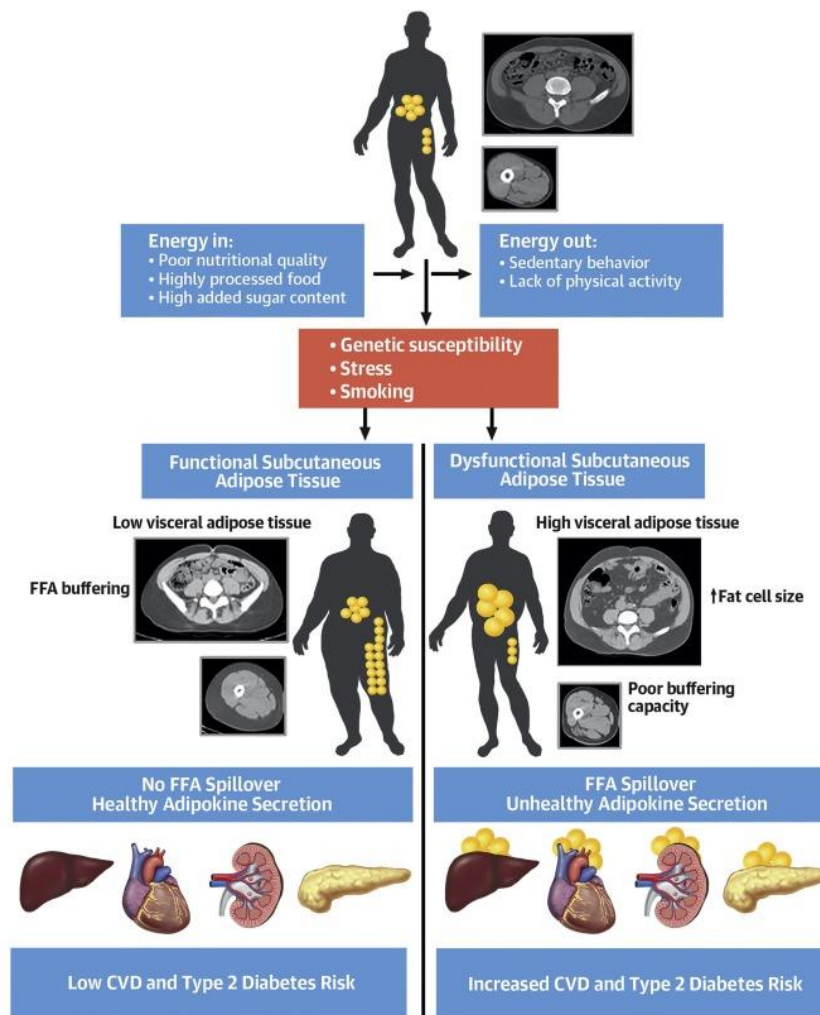
Després, J.-P. et al. J Am Coll Cardiol. 2021;78(5):513–31.

Summary

- Your life course is important for health
- Physical activity is a powerful tool to mitigate accumulation of belly fat and improve body composition
- A Mediterranean-like dietary pattern is healthful for adiposity
- More detailed measures > prediction than BMI, specifically, visceral adipose tissue much better predicts future risk of type 2 diabetes
- Detailed measures better for CHD than BMI – no prediction of stroke or peripheral arterial disease