



New Insights on Physical Activity & Weight Loss

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Key Considerations

Genes, obesity and PA

Total daily energy expenditure

Minutes, kcal, steps

Fat loss without weight loss

Preferential fat loss

Net vs gross cost of PA

Energy compensation & conservation

Resistance exercise

Time-efficient ExRx



Common conundrum (TL)

Why, after a weekend where she was really active, she gained 5 lbs in the next few days?

She swam, did hot yoga, played volleyball and went on a very long bike ride over the course of two days

Why did she gain?

Net EE of the PA

Energy compensation and conservation

Fluid compensation & retention

Menstrual cycle timing





Achieving a Healthy Weight

Food for life - healthy eating plan

Physical activity - every day

<https://www.cdc.gov/diabetes/managing/healthy-weight>

Johns D. Acad Nut Diet. (2014) 114:1557.



Genes, Obesity and PA

Those who have a genetic predisposition to obesity

By combining data from 218,166 adults from 45 studies, we confirm that PA attenuates the influence of *FTO* variation on BMI and obesity.

The association of the *FTO* rs9939609 variant with BMI and with the odds of obesity was reduced by approximately 30% in physically active compared to inactive adults.

Kilpelainen T et.al. Plos Med. 2011

Reddon H et.al. Sci Reports, 2016

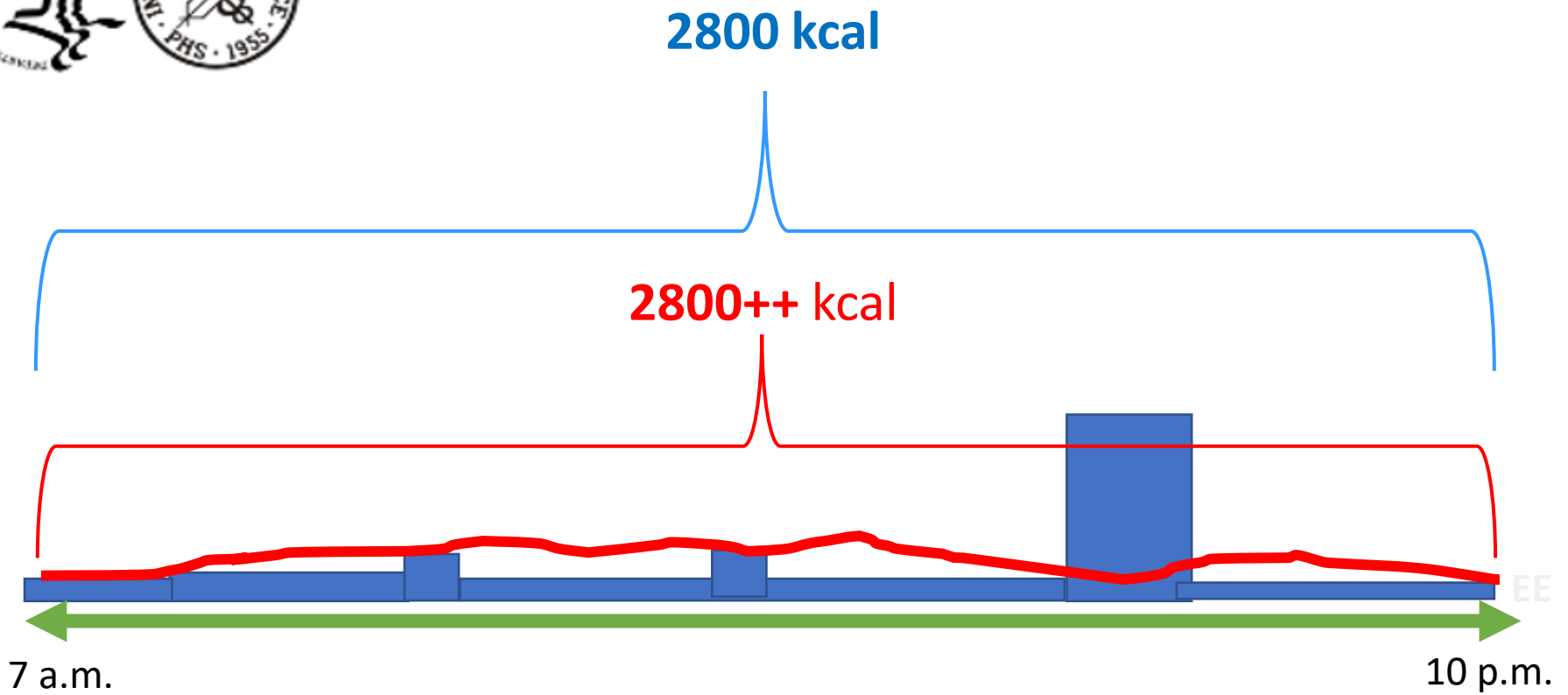
Apovian C. MedScape July, 2023



Total Daily Energy Expenditure plays a MAJOR Role in weight loss

Light intensity activity throughout the day may elicit less energy compensation, and therefore lead to greater increases in total daily energy expenditure and energy deficit.

Agbaje A Jo Clin Endo & Met. June 2023
Bouldier P Obesity Reviews. 2022;e13528.
Nieste I et.al. Prev Med. 148:2021



A physically active day vs
A sedentary day with an afternoon 400 kcal workout



MOVE-IT

(DDTP-style)

Ways to Move More to reduce sitting time

- Every hour, get up and move for 3-5 minutes
- Avoid sitting more than 60 minutes at one time
- Take the stairs when you can
- Stand instead of sit when you can
- Household chores count as activity
- Try 10-15 standing knee-bend exercises *every 60-90*





✓ Recent data show that promoting **Low intensity PA (30-40% V02max)** along with reducing Sedentary behavior are promising alternative strategies to increase total daily PA and EE that may not trigger spontaneous **energy compensations** to the same degree as more intense PA

Bouldier P Obesity Reviews. 2022;e13528.

Nieste I et.al. Prev Med. 148:2021



✓ A systematic review and meta-analysis of 9 studies in adults with both normal weight and overweight (aged 45.3 years) concluded that replacing sedentary time with standing (+1.33 h/day) was associated with reductions in body fat mass (0.55 lb) over several months.



Minutes & steps

Weekly Volume of PA for Weight Loss

For a weight loss of 5% of your present weight

- This will require 150-250 minutes a week of moderate level physical activity.
- A weight loss greater than 5% will require 250-300 minutes per week*. *or equal to about 10,000 steps daily.*

ACSM Guidelines for Ex Testing and Rx, 11th edition. 2022

Donnelly J. et.al. ACSM Position Stand on PA and Weight regain, Med. Sci. Sports, Ex. 2009;41:459



Changes in pedometer-measured physical activity are associated with weight loss and changes in body composition and fat distribution in response to reduced-energy diet interventions: The POUNDS Lost trial

N= 535 ob pts

✓ Each 1000-steps/d increment in PA was associated with a greater reduction in body weight (~ half-mile walk)

Xue O et.al. Diab Ob Met Feb 2022 (Pennington)

How much PA without dietary changes

To lose weight without changing dietary habits high PA levels (225 – 420 min/week of exercise) are necessary to achieve clinically significant weight loss

~ 1 hour a day of moderate intensity PA

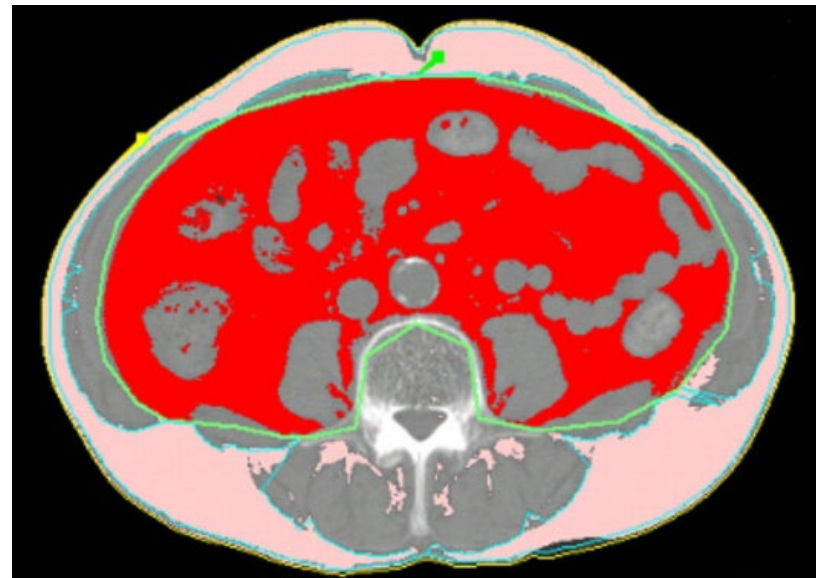


✓ The optimal volume of exercise to achieve sustained major weight loss is probably much larger than the amount required to achieve improved BG control and CV health

Boule N et.al. JAMA (2001)286:1218
ACSM/ADA 2011/22

✓ **Increasing physical activity can significantly reduce abdominal adipose tissue (including waist circumference) and improve insulin sensitivity *without significant changes in body weight and/or BMI***

Ekelund Am J Clin Nutr 2011;93:826–35.
Yates T et.al. Diabetes Care 2009;32:1404,
Velthuis MJ et.al. Menopause 2009;16:777
van der Heijden et.al. J Clin Endo Met. 2009;94:4292
Carey AL et.al. Exercise Mimetics, Diabetologia, 9/09
Hansen D Diabetologia 2009; 52:1789–1797
Brown R Med Sci Sports Ex 2009;41:497
Ribeiro ICD Med.Sci Spts Ex 2008;40:779
Despres JP SYNERGIE Trial EAS 2008
Misra A et.al. , Diabetes Care 2008;31:1282-1287
Bell LM et.al. J Clin Endo Met 2007;92:4230
Ekelund, U et.al. Diabetes Care 2007;30:2101
Dekker M Metabolism 2007;56:332
DiPietro L et. al. JAP 2006
Langeite. TM ArchPhysiol Biochem 2016
Lee SJ & Ross JAP 2005;99:1220
Wong SL et.al. Med Sci Sports Ex 2004;36:286
Duncan GE Diabetes Care 2003;26:557
Ross R et.al. *Obes Res.* 2004;12:789 –798.
Ross R et.al. Relat Met Dis 2003;27:204
Mourier A et.al. Diabetes Care 1997;20:385
Vergaegen et.al. Ob Res. 2016
Neeland I Lancet Diab Endocrin 2019
Ross R et.al. Ann Intern Med 2000;133:92





Fat Loss Without Weight Loss

Exercise without weight loss

Our finding that 3 months of exercise without weight loss was associated with a marked reduction in both total (6%) and visceral fat (17%) in middle-aged lean men and obese men

This is consistent with previous observations in obese men and women (Ross) and in black and white men and women across a wide range of adiposity











In the DPP: among participants who did not meet the weight loss goal, those who met the activity goal had a 44% reduction in diabetes incidence, independent of the small weight loss (−2.9 kg) that occurred.

The **Finnish Diabetes Prevention Study** also reported that individuals who met their physical activity goal (>4 h/week), but who did not meet the weight loss goal (>5% weight loss), had a 70% reduction in diabetes incidence after adjustment for baseline but not follow-up BMI.



Exercise training remodels subcutaneous adipose tissue in adults with obesity even without weight loss

Cheehoon Ahn^{1, #} , Benjamin J. Ryan^{1, #} , Michael W. Schleh¹, Pallavi Varshney¹, Alison C. Ludzki¹ , Jenna B. Gillen^{1, 2} , Douglas W. Van Pelt¹ , Lisa M. Pitchford¹, Suzette M. Howton¹, Thomas Rode¹, Scott L. Hummel^{3, 4} , Charles F. Burant⁵, Jonathan P. Little⁶  and Jeffrey F. Horowitz¹ 

¹Substrate Metabolism Laboratory, School of Kinesiology, University of Michigan, Ann Arbor, MI, USA

²Faculty of Kinesiology and Physical Education, University of Toronto, Toronto, ON, Canada

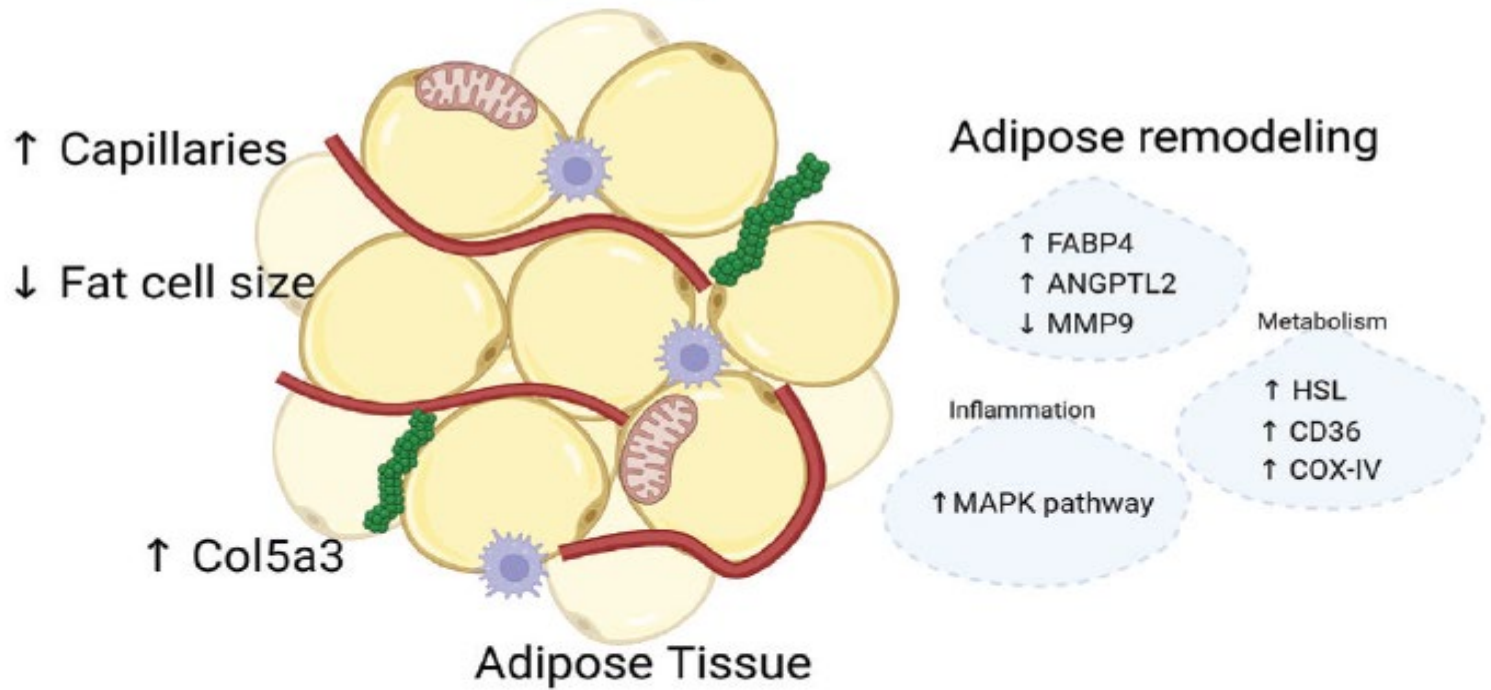
³Division of Cardiology, Department of Internal Medicine, University of Michigan, Ann Arbor, MI, USA

⁴Ann Arbor Veterans Affairs Health System, Ann Arbor, MI, USA

⁵Division of Metabolism, Endocrinology, and Diabetes, Department of Internal Medicine, University of Michigan, Ann Arbor, MI, USA

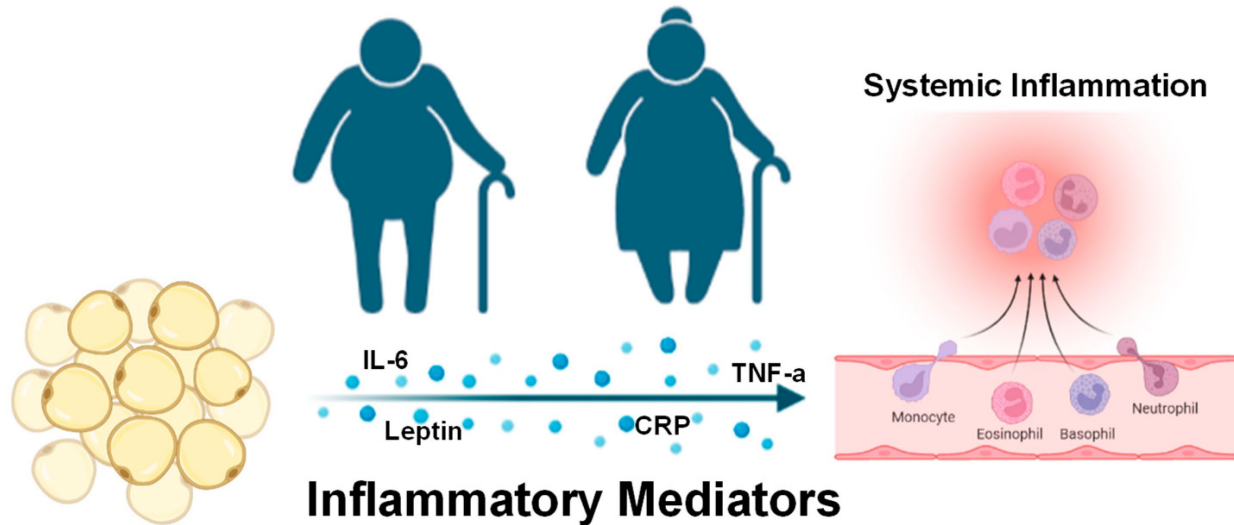
⁶School of Health and Exercise Sciences, University of British Columbia, Kelowna, BC, Canada

12 wks of MVPA or 12 wks of HIIT in 36 Ob adults



"Similar adaptations from MICT & HIIT"

Obesity in Older Adults

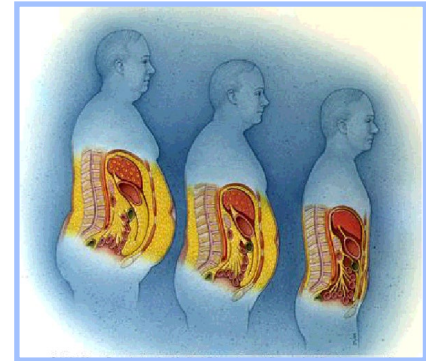


**Inflammatory Mediators
(e.g. adipokines and cytokines)**

Exercise Training



Abdominal Visceral Adipose Tissue: **Smoking Gun?**



Direct venous drainage to the liver via portal vein

Exposing liver to increased VLDL and cholesterol remnant production and high [FA] that can alter insulin signaling thus promoting hepatic insulin resistance

Dangerous intrinsic properties

- Higher rate of catecholamine-induced lipolysis
- May produce considerably more PAI-1

Hormones and proteins secreted by **visceral fat** are thought to be more pro-inflammatory than subcutaneous fat.

This is one of the reasons why excess visceral fat is more strongly associated with metabolic disease (i.e. – insulin resistance & type 2 diabetes) and cardiovascular disease, than excess subcutaneous fat.

Handy O et.al. Metabolic Obesity. Curr. Diab Rev. 2006(2):367.

Ibrahim M et.al. Obes Rev. 2010,11(1):11-8.



Preferential Fat Loss

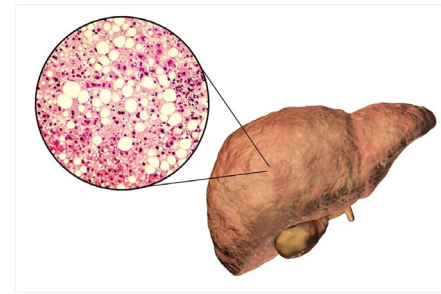
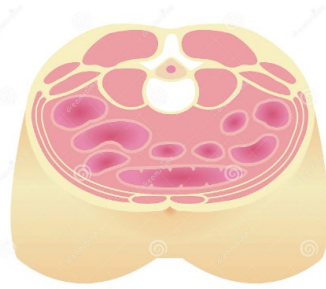
There is a preferential reduction in intramuscular fat and visceral adipose tissue with exercise-induced weight loss compared with caloric restriction particularly after 1 year of exercise training.

You T et.al. In J Obes. 2006

Murphy J et.al. J Appl Phys 2012

Bays H et.al. J Clin Lipid 2013

Exercise Training on Intramuscular and Liver Fat in Type 2 Diabetes



✓ The available data suggest that there is likely a benefit of exercise on ectopic fat which is independent of significant weight loss

Review of 16 RCT's

150 min/wk of MVPA

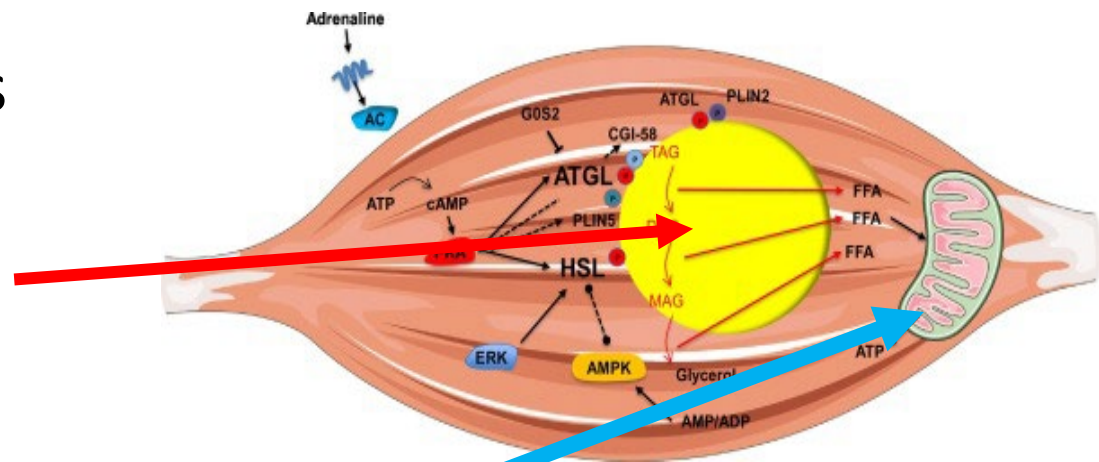
What fat stores are most available for exercise oxidation ?

Visceral & ectopic fat

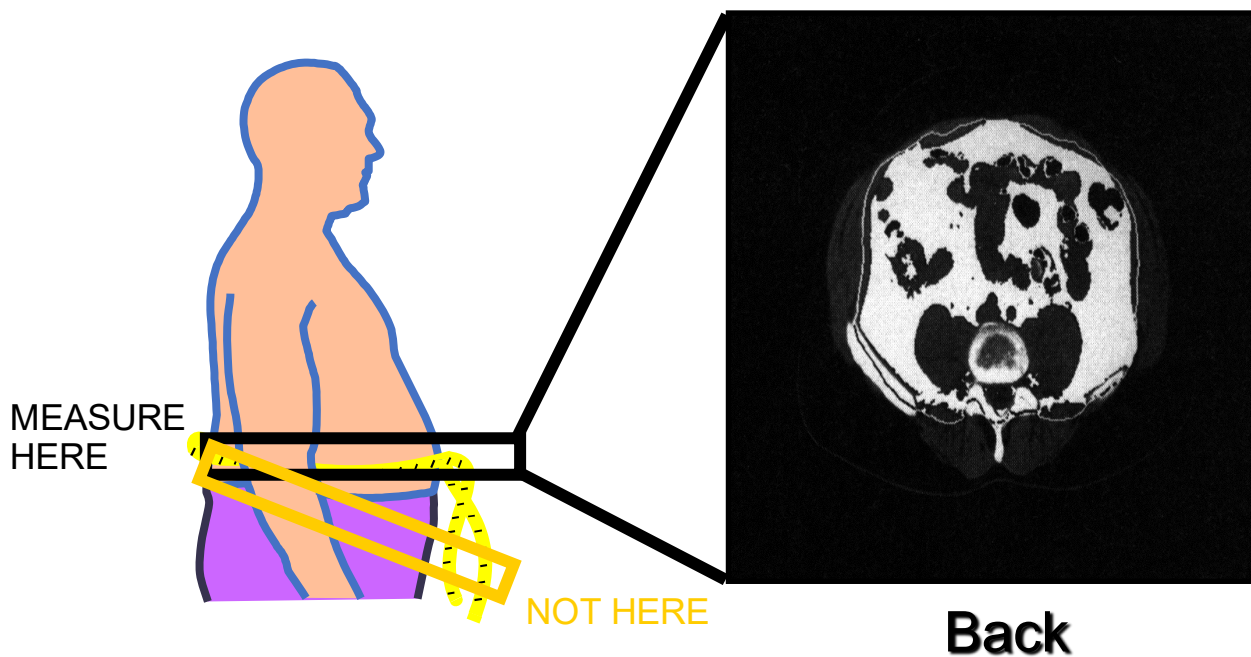
Blood triglycerides

Intramuscular TG

Fatty acid oxidation
in intramuscular
mitochondria



Waist Measures: The Critical Adipose Depot



- To measure waist circumference, place a measuring tape in a horizontal plane at the level of the iliac crest, without compressing the skin
- The value is read at the end of a normal expiration

Gulick Tape Measure





Key point

From a metabolic and CVD risk reduction perspective it is probably more judicious to target small incremental reductions in VAT than obsess with unrealistic goals in total body weight reduction

Shifting the primary focus from weight loss to fitness via increased PA

Gaesser G et.al. *iCell*, 24, Issue 10, October 2021 (ASU)

Gaesser G & Blair SN, *Med Sci Sports Ex.* 2019



Net vs. Gross Caloric Cost of Exercise of walking one mile

20-minutes of ADL ~ 35-40 kcal



20-minute 3 mph walk (1 mile) ~ 80 kcal

Net difference = ~ 40-45 kcal/mile

At moderate walking speeds the *net* energy cost for walking one mile is ~60% of the gross cost



Walking Energy Expenditure

- Net energy cost
~60% of running energy cost for a given distance
- Treadmill vs. land
treadmill kcal/min somewhat less
- **Variable terrain** adds at least 20% EE
- Footwear

NET vs GROSS

Energy Expenditure



Many assumptions
are made in energy
expenditure (kcal)
display

Energy Compensation

Increased food intake
as a result of appetite
stimulation



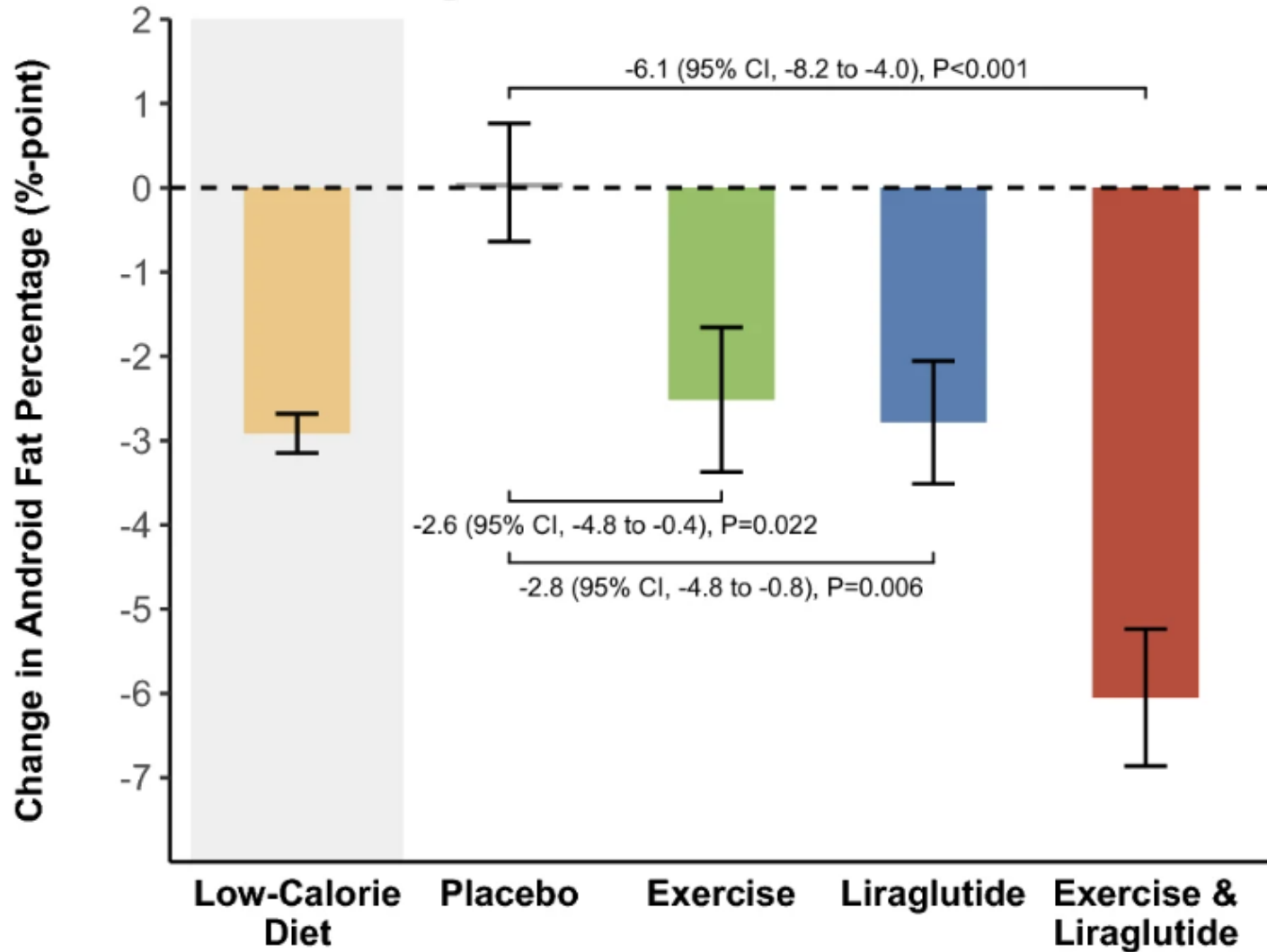
Energy Conservation

Decreased spontaneous
physical activity as a result
of “decreased energy”



GLP-1 + Exercise

Android Fat Percentage



Evidence statement:

ACSM 2009/22



Resistance training will not promote clinically significant weight loss - but that is not the whole story.

Evidence category A.

The ACSM Position Stand “Appropriate Intervention Strategies for Weight Loss and Prevention of Weight Regain for Adults”



Muscle group and repetition frequency EE

Lower body exercise presents a higher energy cost when compared with upper body exercise.

Half squat and leg extension involved the highest energy cost (~ 11 and ~ 8 kcal \cdot min $^{-1}$, respectively), contrasting with biceps curl and lat pull down (~ 3 and ~ 4 kcal \cdot min $^{-1}$, respectively).

Repetition frequency (5 - 10 – 15/min)



Unlike aerobic exercise, which results in significant increases in energy expenditure during, and for a short time following the activity, the energy expenditure during RT is relatively low,

- but the increase in energy expenditure after the cessation of the activity can be elevated.

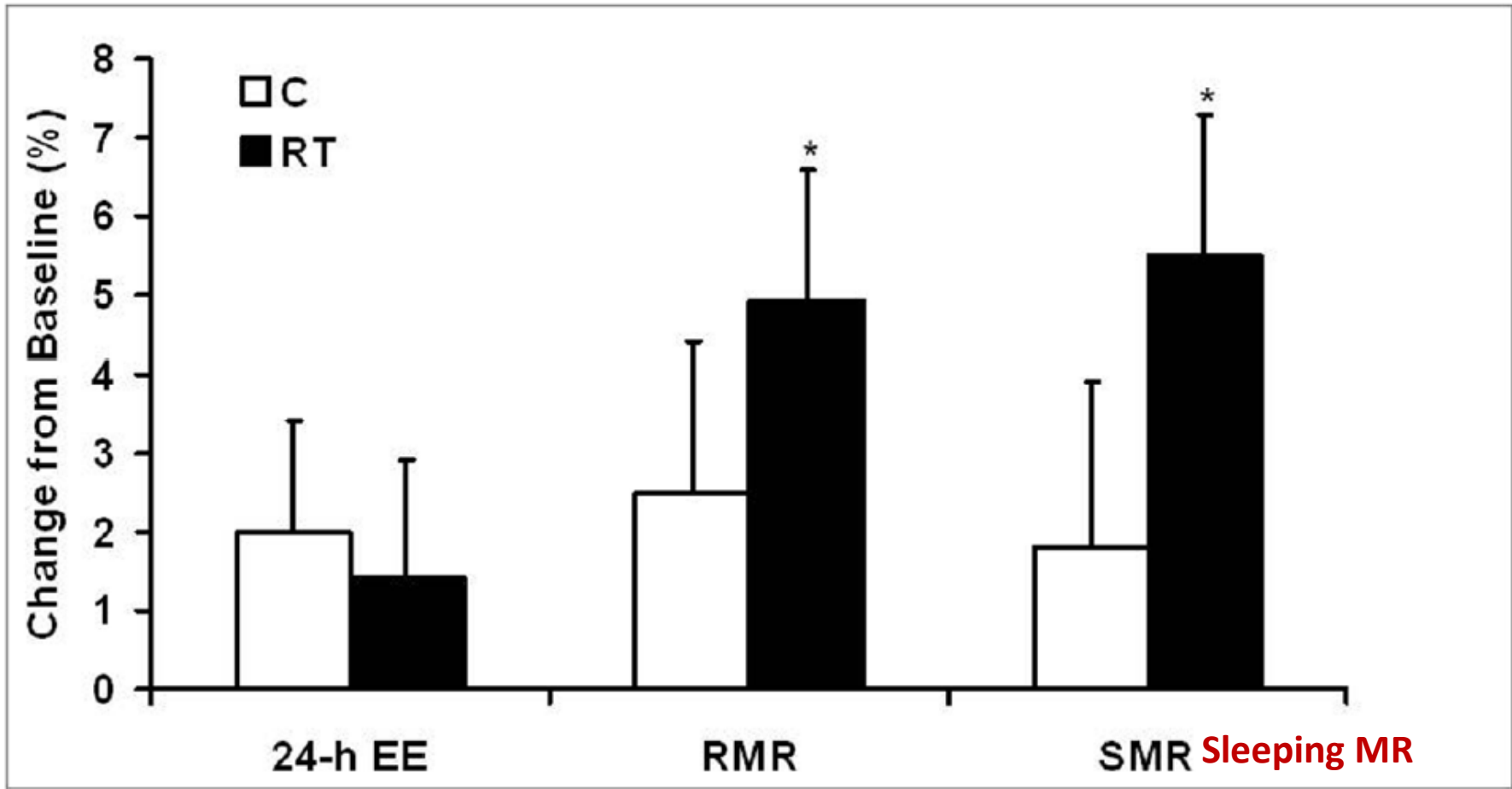
~50-150 kcal over 24 hr period

Kirk E et.al. Med Sci Sports Exerc. 2009; 41(5): 1122–1129.

Melby et.al. J Appl Physiol 1993;75:1847–1853

Taaffe et.al. J Am Geriatr Soc 1995;43:465–471

Resistance Training and EE



N=63 overweight men & women, 6 mo, 3X/wk, 9 ex, 3-6 RMax

Time-efficient 2000+ kcal (5 hr+) Weekly Program

Monday, Wednesday, Friday 20-min mod. inten. walk (or 5 x 4 min at work)

1 weekend day : 2hr+ drop-off *variable terrain walk-hike*

Tuesday & Saturday: 5-8 resistance exercises 30 min each session

Daily decrease in sedentary time by 30 minutes 7 X 30 kcal

**TOTAL EE: 400 + 1200 kcal + 210 kcal + 210
= 2000+ kcal *
≥300 min/wk**

* Add 10-20% kcal at BMI's > 34



ACSM'S

Guidelines for Exercise Testing and Prescription

Eleventh Edition

 Wolters Kluwer

Chap. 9

[ACSM's Guidelines for Exercise Testing and Prescription \(lww.com\)](http://lww.com)



Key Take Home

Light PA throughout the day can induce weight loss - **think increased total daily EE**

PA without significant weight loss should be considered – PA itself is a primary outcome – particularly so for T2D

PA without dietary changes requires at least 60 minutes a day for meaningful (10+%) weight loss

Energy compensation and conservation impact WL

Three days a week of moderate PA for 20-30 minutes + one weekend day of a 2-3 hour variable-terrain hike + decreased daily sedentary time can generate significant weight loss



PA caveats in those with diabetes

The risk of exercise-induced hypoglycemia particularly post exercise. Transient hyperglycemia can follow intense PA.

CGM can be helpful in assessing glucose response to PA

For significant volumes of MVPA afternoon exercise may improve glycemic control.

Resistance exercise prior to aerobic exercise may help lower the risk of post exercise hypoglycemia. Interval aerobic exercise may help reduce exercise induced hypoglycemia

Diabetes patients with uncontrolled hypertension or severe proliferative retinopathy should avoid resistance exercise