

Exercise and Cardiometabolic Risk Reduction In Diabetes and Prediabetes A Web-Based Training

Presented by IHS Division of Diabetes
Treatment and Prevention
Indian Health Service
October 2010

Physical Activity for Managing Cardiometabolic Risk

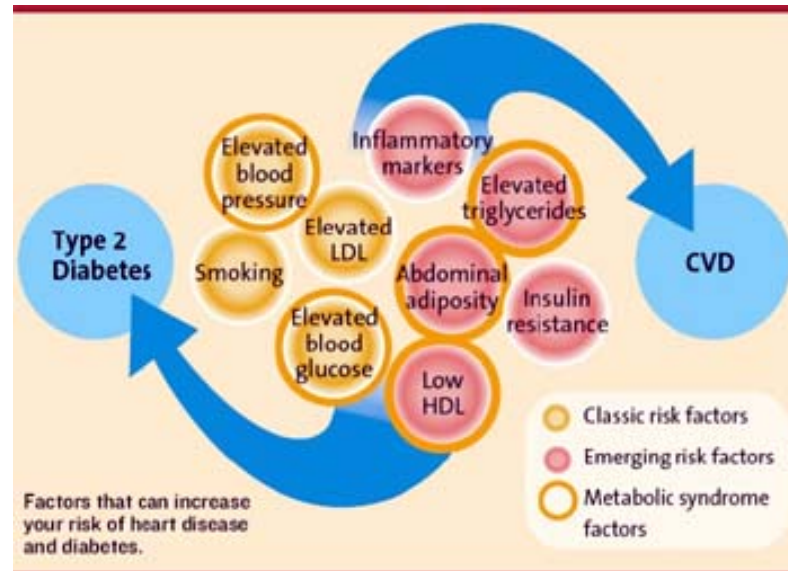
Ralph La Forge, MSc
Duke University - Endocrine Division
Durham NC

rlaforge@nc.rr.com

Agenda

- **Cardiometabolic risk and physical activity at a glance**
- **Energy expenditure guidelines: weight reduction vs CMR**
- **Modes of physical activity**
- **Exercise and weight loss considerations**
- **Serial anthropometric assessment of total body adiposity**
- **Select PA intervention strategies**
- **Exercise screening of high-risk prediabetes and diabetes patient**

Cardiometabolic Risk



Diabetes

Metabolic syndrome
Prediabetes

CVD

Traditional/Framingham
CVD risk factors

Physical activity vs. Fitness

Generalized physical activities irrespective of intensity



*Aerobic capacity
“capacity driven”*

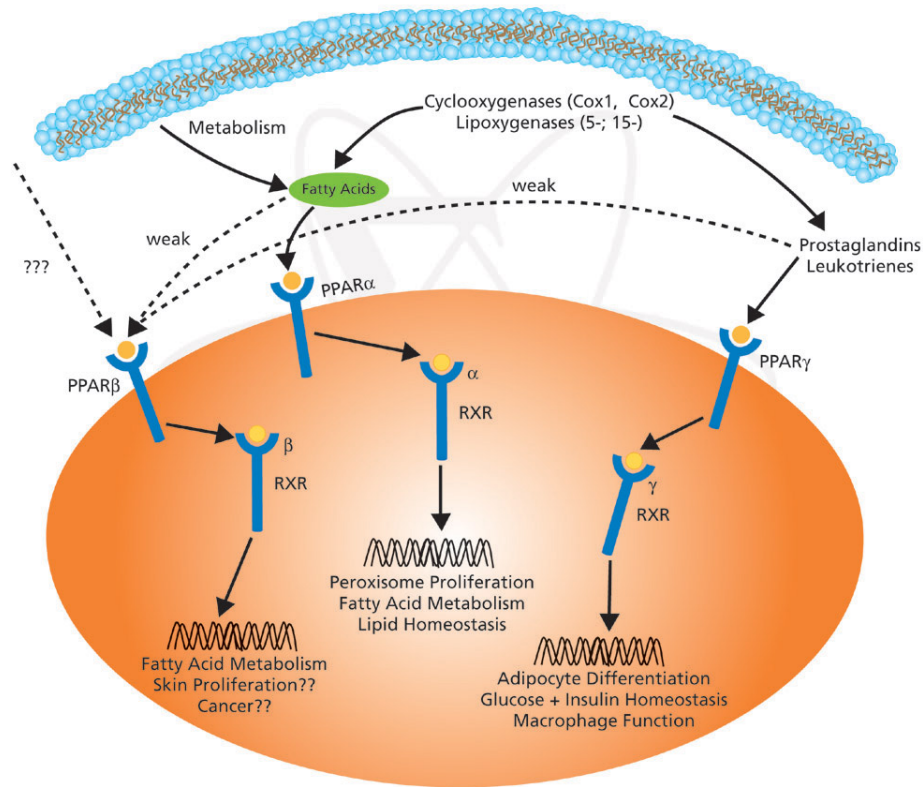


Modes of Physical Activity

- Aerobic (cardiorespiratory endurance)
- Resistance training
- Flexibility
- Utilitarian/domestic activity
- Sports/recreational
- Mindful exercise

Physical activity works via multiple biologic mechanisms

many of which are not inextricably tied to weight loss



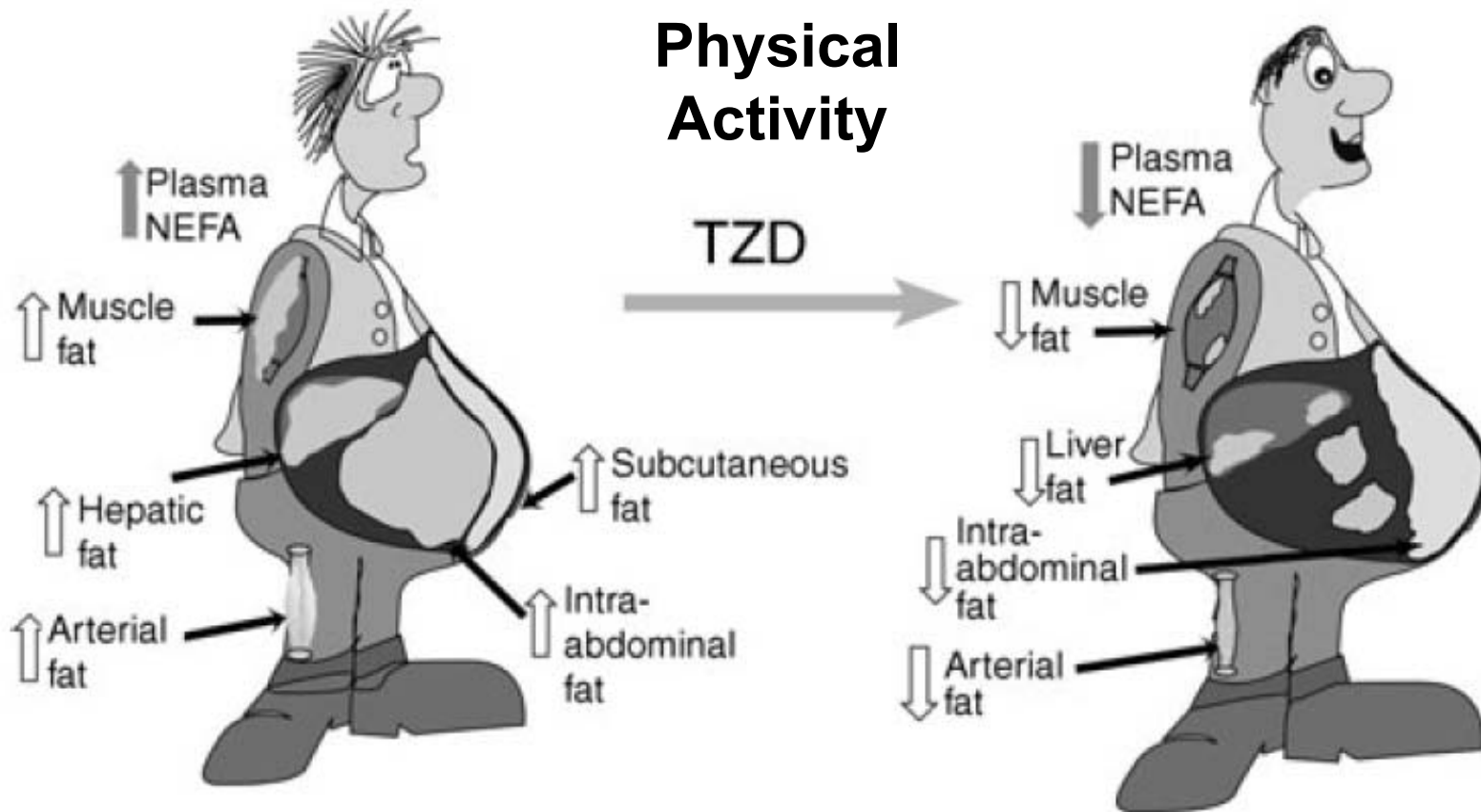
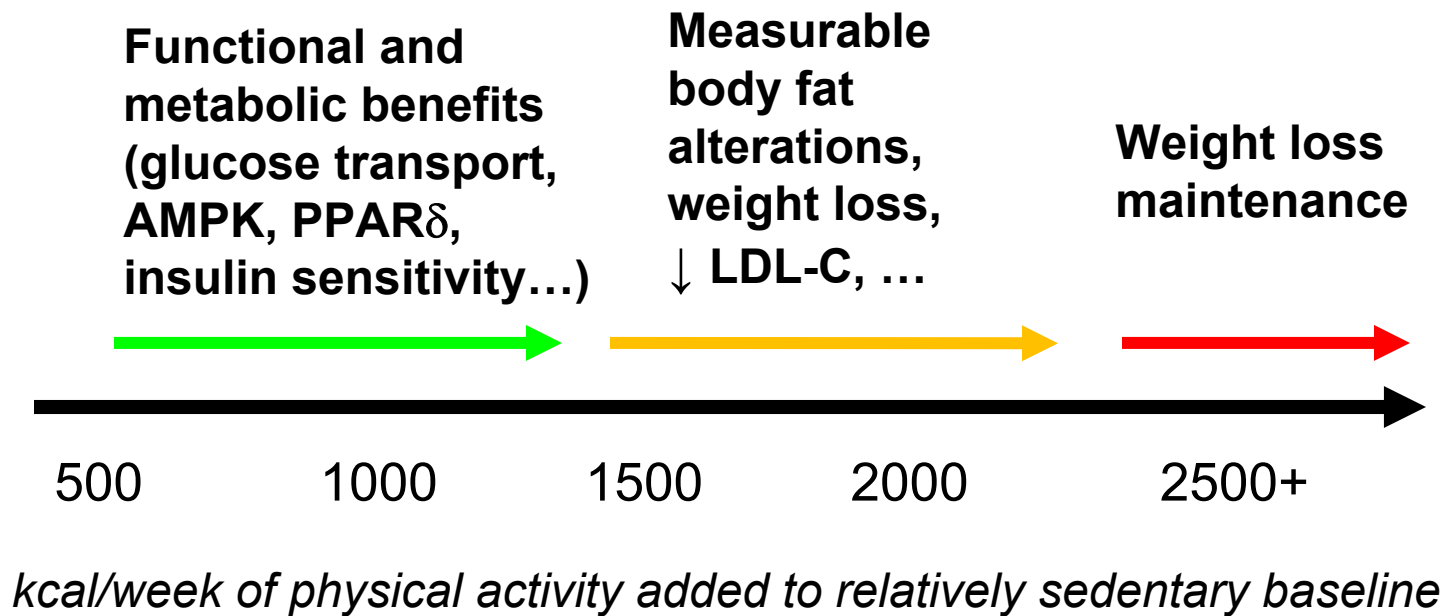


Fig. 8 Fat topography in type 2 diabetes and effect of thiazolidine-diones (TZD) (see text for a detailed discussion)

DeFronzo R. Diabetologia (2010)53:1270–1287





Weekly Physical Activity and Cardiometabolic Benefit

Physical Activity Energy Expenditure Requirements

Significant reduction in body weight

A bunch with caveats

Reduction in cardiometabolic risk

Not so much with fewer caveats

Physical Activity Recommendations– Weight Loss vs. Public Health

Weight Loss:

250-300 minutes/week = (≥ 60 min/day) x (5 or more days/wk)

~2,000 – 3,000 kcal/wk

Public Health:

150 minutes/week = (30 min/day) x (5 days/wk)

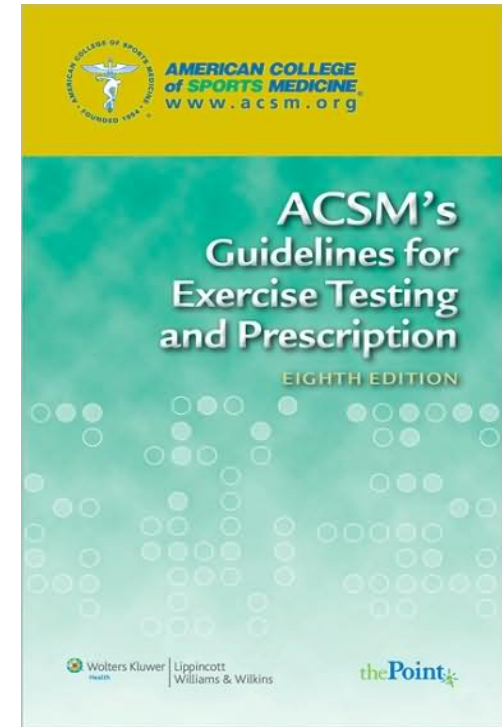
~1000 – 1,500 kcal/wk

Haskell WL, et al. Med Sci Sports Exerc. 2007;39:1423-34.

Donnelly JE, et al. Med Sci Sports Exerc. 2009;41:459-71.

ACSM's Guidelines for Exercise Testing and Prescription

- **Overweight or obese:***
 - **Primary activity: Aerobic exercise**
 - **Intensity: Moderate (40-60% $\dot{V}O_2\text{max}$)**
 - **MetSyn: Mod – vigor. (40-75% $\dot{V}O_2\text{max}$)**
 - **Frequency: 5–7 days a week**
 - **Duration: 30–60 min/day and progressing to 300 minutes/week[†]**



*Consistent with recommendations for long-term weight control: 200–300 minutes/wk moderate physical activity or $\geq 2,000$ kcal/wk. [†]60–90 min/day may be necessary in some individuals.

American College of Sports Medicine. Guidelines for Exercise Testing and Prescription. 8th ed. Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2009.

CAVEAT

Exercise intensity (speed, resistive load) in obese patients we should be more conservative (40–60% of aerobic capacity). This is particularly true for patients who are BMI >34.

Eventually obese patients may progress to 60–75% of aerobic capacity depending on cardiorespiratory responsiveness to lower levels of exercise.

What is ~1000 kcal of Physical Activity ?

(gross energy cost)

- 10 miles of walking at ~3 mph, 160 lb person
- 2.5–3 hours of continuous exercise at ~55–65% of effort maximum, 160 lb person
- Three 45–50 minute aerobics classes, 160 lb person
- 3-hour hike over variable terrain with 10 lb backpack, 160 lb person
- 3 hours of cycling at 10–12 mph, 160 lb person

* *Note that in persons with BMI's >35 the caloric cost of weight bearing exercise is considerably more – e.g., 130+ kcal/mile of walking*

Moderate vs. Vigorous Exercise

- **Moderate:**
40-60% of $\dot{V}O_{2max}$
or
3-6 METs
- **Vigorous:**
>60%+ of $\dot{V}O_{2max}$
or
6 METs

Moderate-intensity Physical Activity (Approximately 3-6 METs)	Vigorous-intensity Physical Activity (Approximately >6 METs)
Requires a moderate amount of effort and noticeably accelerates the heart rate.	Requires a large amount of effort and causes rapid breathing and a substantial increase in heart rate.
Examples of moderate-intensity exercise include:	Examples of vigorous-intensity exercise include:
• Brisk walking	• Running
• Dancing	• Walking / climbing briskly up a hill
• Gardening	• Fast cycling
• Housework and domestic chores	• Aerobics
• Traditional hunting and gathering	• Fast swimming
• Active involvement in games and sports with children / walking domestic animals	• Competitive sports and games (e.g. Traditional Games, Football, Volleyball, Hockey, Basketball)
• General building tasks (e.g. roofing, thatching, painting)	• Heavy shovelling or digging ditches
• Carrying / moving moderate loads (<20kg)	• Carrying / moving heavy loads (>20kg)

IHS Division of Diabetes
10/2010

Moderate vs. Vigorous Exercise

Prediabetic, metabolic syndrome, obese, and diabetic patients usually require *moderate intensity* activities (i.e., 40–60% of aerobic capacity) or *lower intensity* activities.

✓ If recommending *vigorous intensity* activities (>60% of aerobic capacity), consult the ACSM decision tree for preexercise program screening and GXT evaluation.

Intermittent vs. Continuous Exercise and Weight Loss

Short bouts of exercise result in similar reduction in body fat and improvement in fitness as *long bouts* of the same *total energy expenditure*.

Moderate intensity aerobic activity *may be accumulated* in different ways:

- In multiple daily bouts of at least 10 minutes in duration
- Through increases in moderate-intensity, domestic-lifestyle activities

Debusk RF, et al. *Am J Cardio*. 1990;65:1010. Haskell W. *Med Sci Ex Sports*. 1994;26:649. Murphy, et al. *Med Sci Ex Sports*. 1998;30:152. Jakicic. *JAMA*. 1999;282:1554. Schmidt D. *J Am Coll Nut*. 2001;20:494. Macfarlane D. *Prev. Med*. 2006;43:332.

American College of Sports Medicine. *Guidelines for Exercise Testing and Prescription*. 8th ed. Philadelphia, PA: Lippincott Williams &Wilkins; 2009.

Type 2 Diabetes

Key activity considerations for providers

- Blunted HR response (chronotropic incompetence)
- Blunted BP response
- Blunted V_{O2} response (inc. ventilation)
- Altered thermoregulatory response (hyperthermia)
- Peripheral neuropathy and weight-bearing exercise caution

RESISTANCE EXERCISE

Resistance Exercise Training

- The addition of resistance exercise training (RT) to energy restriction increases fat-free mass
- Compared to RT alone, RT combined with aerobic exercise may increase loss of fat mass
- RT may enhance muscular strength and physical function in overweight and obese people
- No evidence currently exists for
 - Prevention of weight regain after weight loss
 - A dose effect for RT and weight loss



RT Rx

- ✓ 2 to 3 sets of 8 to 12 repetitions
- ✓ at 60% to 80% 1-RMR
- ✓ 8 to 10 multijoint exercises of all major muscle groups in the same session (whole body) or sessions split into selected muscle groups

** Resistance training should be encouraged for people with diabetes mellitus in the absence of contraindications, retinopathy, and recent laser treatments.*

*** RepMin -10 rule for diabetes pts*

Physical Activity Patterns in the National Weight Control Registry

Victoria A. Catenacci¹, Lorraine G. Ogden², Jennifer Stuh³, Suzanne Phelan⁴, Rena R. Wing⁵, James O. Hill⁶ and Holly R. Wyatt¹

Obesity (2008) 16, 153–161

✓ NWCR* entrants report an average of 2,621 (+/- 2,252) kcal/week in physical activity.

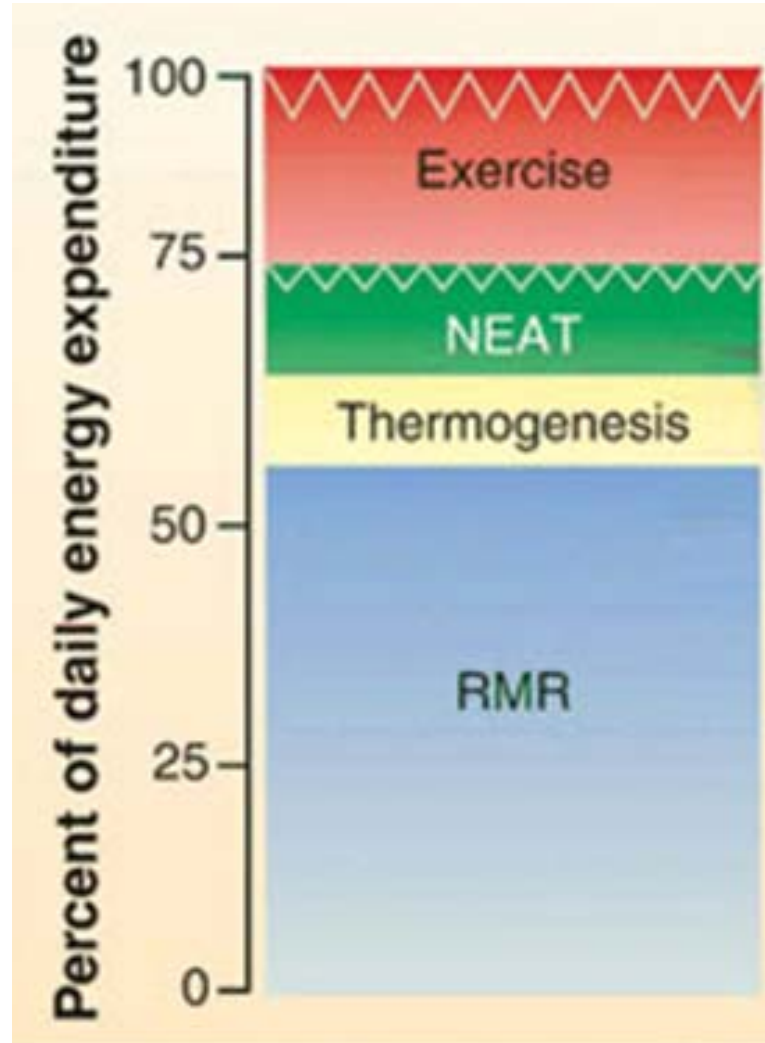
** Maintained ≥ 30 lb of weight loss for >1 year*

Why do exercise and exercise programs tend to generate less than expected (desired) weight loss ?

- Total daily energy expenditure impact
- Gender specificity (women tend to lose less)
- Energy conservation and compensation
- Body composition changes (increased lean weight)
- Muscle fiber type (heritable Type I/II ratios)

Boutcher et.al. Obesity Rev. 2009
Donnelly et.al. Arch Int. Med. 2003

✓ Total daily energy expenditure has to be reduced in order for weight loss to occur.



Men vs. Women in 16-week PA program

ExRx:

400 kcal/session, ~2000 kcal/wk walking

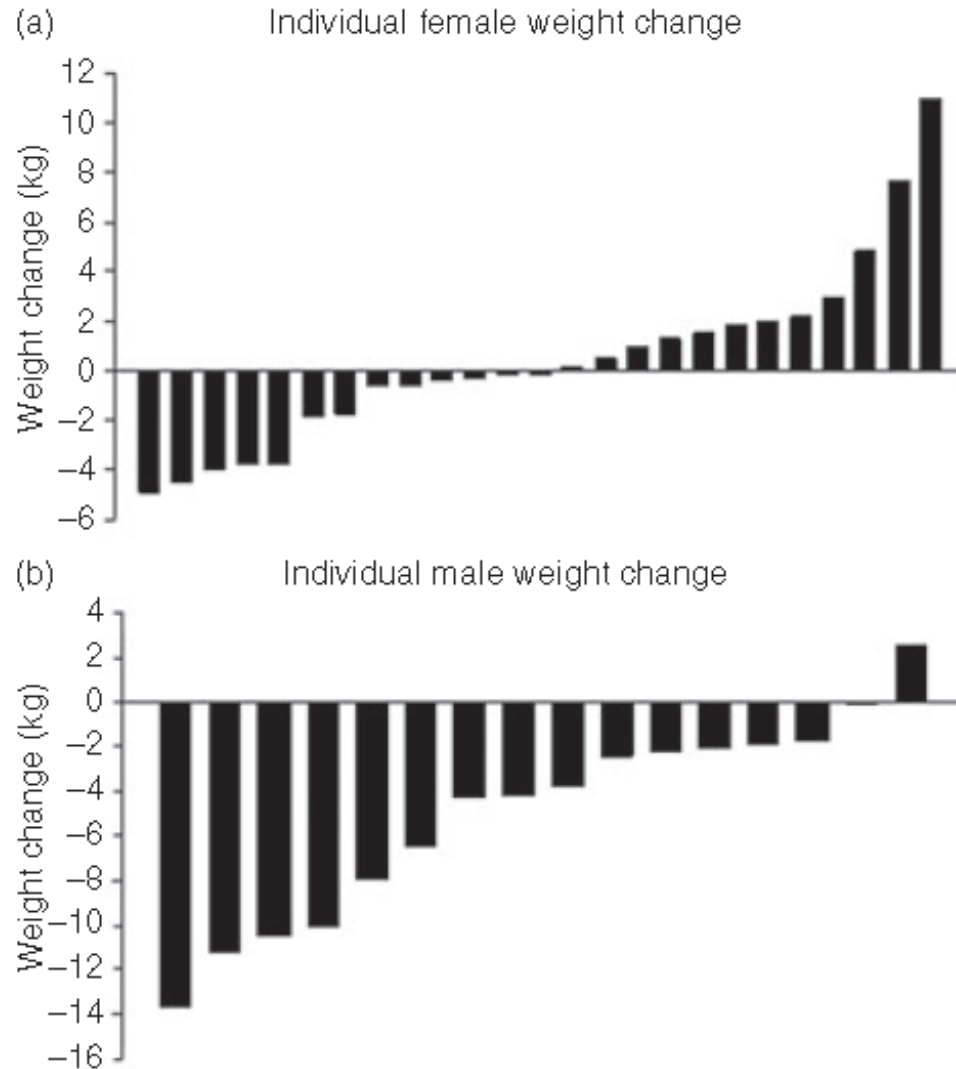


Figure 1 Individual 16-month weight change in exercise groups by gender: a, women; b, men [adapted from Donnelly *et al.* (14)].

Donnelly et. al. 2003

Variables That Determine Total Net Energy Expenditure

Energy Compensation

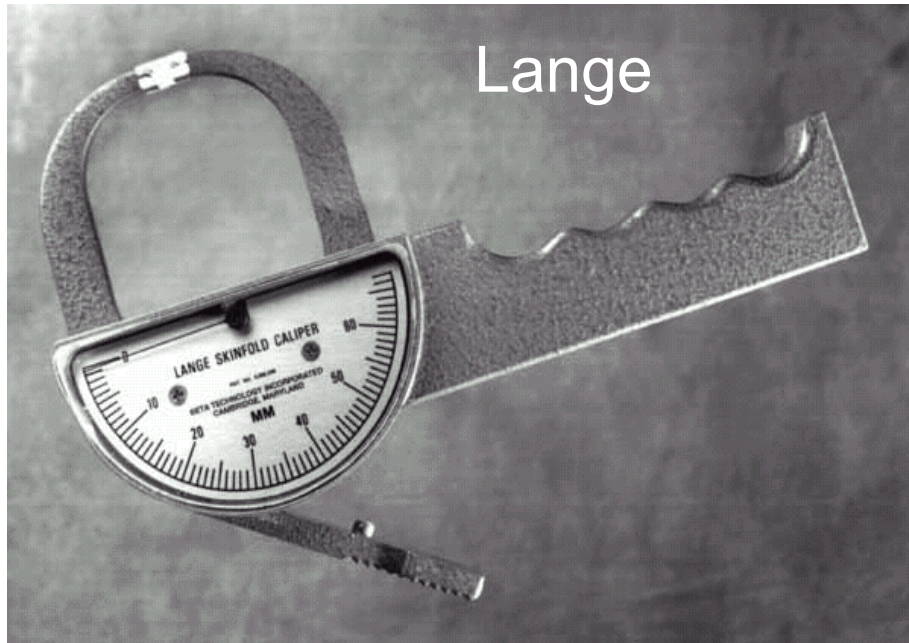
Increased food intake (CHO, beverages) as a result of appetite stimulation



Energy Conservation

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





Select skinfold assessment is a reliable means of assessing serial changes in total body adiposity in response to lifestyle therapy, particularly physical activity programs.



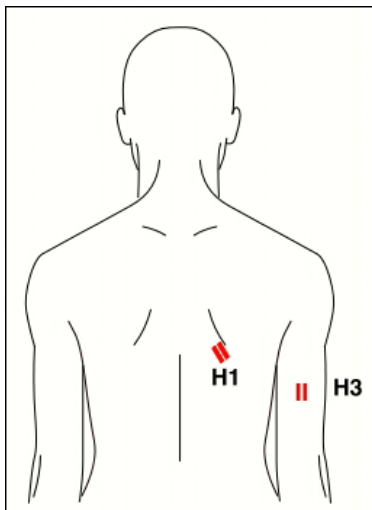
The most reliable skinfold site for reflecting changes in adiposity, including abdominal visceral adiposity, is the subscapular site with the tricep site as secondary.

Bray 1978

Subscapular skinfold thickness distinguishes between transient and persistent impaired glucose tolerance: Study on Lifestyle-Intervention and Impaired Glucose Tolerance

Mensink M et.al. Diabet Med. 2003 Jul;20(7):552-7. Netherlands





Adiposity was the strongest predictor of leptin, with triceps skinfold explaining 40.2 and 30.6% of leptin variance in males and females.

In females, subscapular skinfold was a significant predictor of leptin independent of triceps, while no anthropometric measure predicted leptin independent of triceps in males.

N=600 adolescents

Kuzawa CW et.al. 2007;AmJPhys Anthropol. Northwestern U

Reference curves for triceps and subscapular skinfold thicknesses in US children and adolescents

O Yaw Addo and John H Himes
Am J Clin Nutr 2010;91:635–42.

Smoothed percentiles for triceps skinfold-for-age (mm): boys aged 1.50–19.99 y¹

Age	<i>L</i>	<i>M</i>	<i>S</i>	Percentile									
				3rd	5th	10th	25th	50th	75th	85th	90th	95th	97th
1.50–1.99 y	–0.0982	9.7466	0.2464	6.20	6.55	7.14	8.27	9.75	11.52	12.62	13.43	14.74	15.66
2.00–2.49 y	–0.1065	9.6551	0.2495	6.11	6.46	7.05	8.17	9.66	11.44	12.55	13.37	14.69	15.63
2.50–2.99 y	–0.1229	9.4769	0.2559	5.94	6.29	6.87	7.99	9.48	11.28	12.41	13.25	14.60	15.57
3.00–3.49 y	–0.1392	9.3113	0.2626	5.77	6.12	6.70	7.82	9.31	11.14	12.29	13.14	14.54	15.53
3.50–3.99 y	–0.1555	9.1537	0.2698	5.62	5.96	6.54	7.65	9.15	11.01	12.18	13.06	14.50	15.53
4.00–4.49 y	–0.1715	8.9913	0.2778	5.45	5.79	6.36	7.48	8.99	10.88	12.08	12.98	14.47	15.54
4.50–4.99 y	–0.1871	8.8176	0.2866	5.28	5.61	6.18	7.29	8.82	10.74	11.97	12.90	14.44	15.56
5.00–5.49 y	–0.2021	8.6349	0.2963	5.09	5.42	5.99	7.10	8.63	10.59	11.86	12.82	14.42	15.60
5.50–5.99 y	–0.2164	8.4553	0.3071	4.91	5.23	5.80	6.90	8.46	10.45	11.76	12.76	14.44	15.67
6.00–6.49 y	–0.2298	8.2999	0.3189	4.73	5.06	5.62	6.73	8.30	10.35	11.70	12.75	14.51	15.82
6.50–6.99 y	–0.2423	8.1976	0.3314	4.59	4.91	5.47	6.59	8.20	10.32	11.73	12.83	14.71	16.11
7.00–7.49 y	–0.2540	8.1739	0.3445	4.49	4.81	5.38	6.52	8.17	10.39	11.88	13.06	15.07	16.59

✓ Although BMI is the recommended measure for determining overweight and obesity status, the percentiles and z scores of triceps and subscapular skinfold thicknesses will allow better assessment of adiposity. In children, skinfold thicknesses are more highly correlated with measures of total body fat than BMI.

Practical Physical Activity Intervention Strategies

- Systematic pedometry
- Household circuit activity
- Physical activity encounters

Systematic Clinical Pedometry

Definition

- The systematic use of well-engineered pedometers as objective cardiometabolic risk reduction outcomes measures



Physical activity levels in American-Indian adults: The Strong Heart Family Study

Storti KL, Howard BV, et.al. Am J Prev Med. 2009 Dec;37:481-7. Univ. Pittsburgh

2604 American-Indian adults, aged 18-91 years, from 13 American-Indian communities were assessed using Accusplit AE120 pedometers over a period of 7 days during 2001-2003.

RESULTS:

Daily pedometer steps ranged from 1001 to 38,755. Mean step counts by age group were:

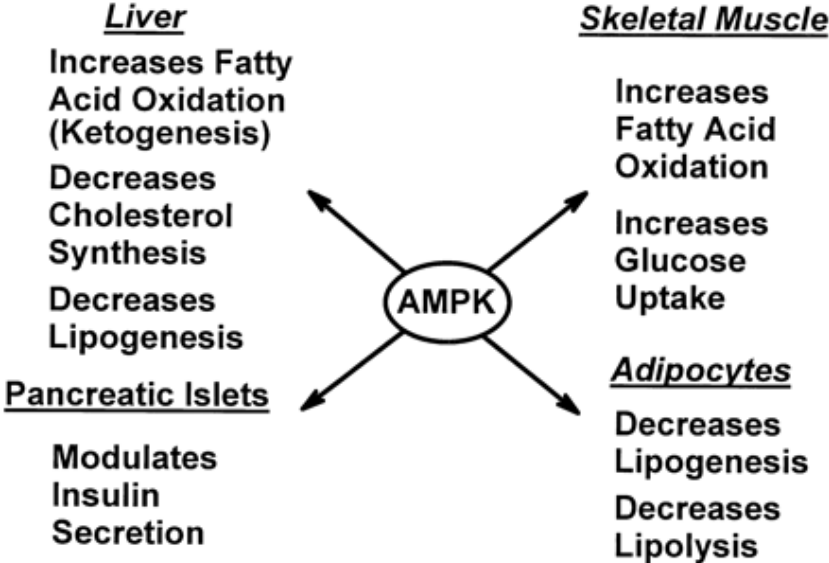
MEN		WOMEN		Sedentary Lifestyle Index
5384	(18–29yrs)	5038	(18–29yrs)	
5120	(30–39)	5112	(30–39)	
5040	(40–49)	5054	(40–49)	
4561	(50–59)	4582	(50–59)	
4321	(60–69)	4653	(60–69)	
3768	(≥70)	3770	(≥70)	

CONCLUSIONS: Objectively measured data suggest that inactivity is a problem among American-Indian adults and that a majority of American-Indian adults in the SHFS may not be meeting the minimum physical activity public health recommendations.

Steps = Muscle Contractions = Outcome Measures

Each weight-bearing muscular contraction (each walking step in a 2-mile walk) is an insulin-sensitizing event utilizing similar metabolic mechanisms as metformin and PPAR γ δ agonists.

1 step = .25 mg metformin



* Based on DPP energy expenditure and diabetes prevention outcomes and ex/pioglitazone studies (Shadid, LaForge 2006)

** ≥ 3000 steps/30 min

Preliminary Exercise Pedometry Guidelines for Managing Cardiometabolic Risk

- A minimum of 3000 steps in 30 minutes (~ 3mph for most individuals) on 5 days each week. Three bouts of 1000 steps in 10 minutes each day can also be used to meet the recommended goal.
- A relative increase in daily walking steps of $\geq 50\%$
- At least 10,000 steps per day for most adults with CMR
- For significant weight loss, there is preliminary support for:

Women:

18-40: 12,000 steps per day
40-50: 11,000
50-60: 10,000
60 plus: 8,000

Men:

18-50: 12,000
50 plus: 11,000



Marshall SJ, Ainsworth BE, et.al. AmJPrevMed 2009;36:410
Tudor-Locke C, Hatano Y et.al. Med Sci Sports Exerc. 2008;40:S537
Tudor-Locke C, Bassett, et.al. JPAH, 5(Supplement 1), 2008



Pedometer Characteristics



Accusplit® Eagle 2720

- Use well-engineered pedometers (\$10–22/each)
 - Characteristics: Reliable engine, durable, readable display, comfortable
 - Step-filter function for filtering spontaneous movements
 - Example reliable pedometer resources: Accusplit, NewLifestyles
- ~ 2000 steps/mile* walked (~100 kcal/mile)
- *1800–2300 steps/mile depending on height of patient*

Pedometer Trekking



3–10 customized paths/trails of varying length and terrain (1–6 miles) with known step count requirements

Trekking Levels/courses

Level 1: 1000–3000 steps (.5–1.5 mile courses)

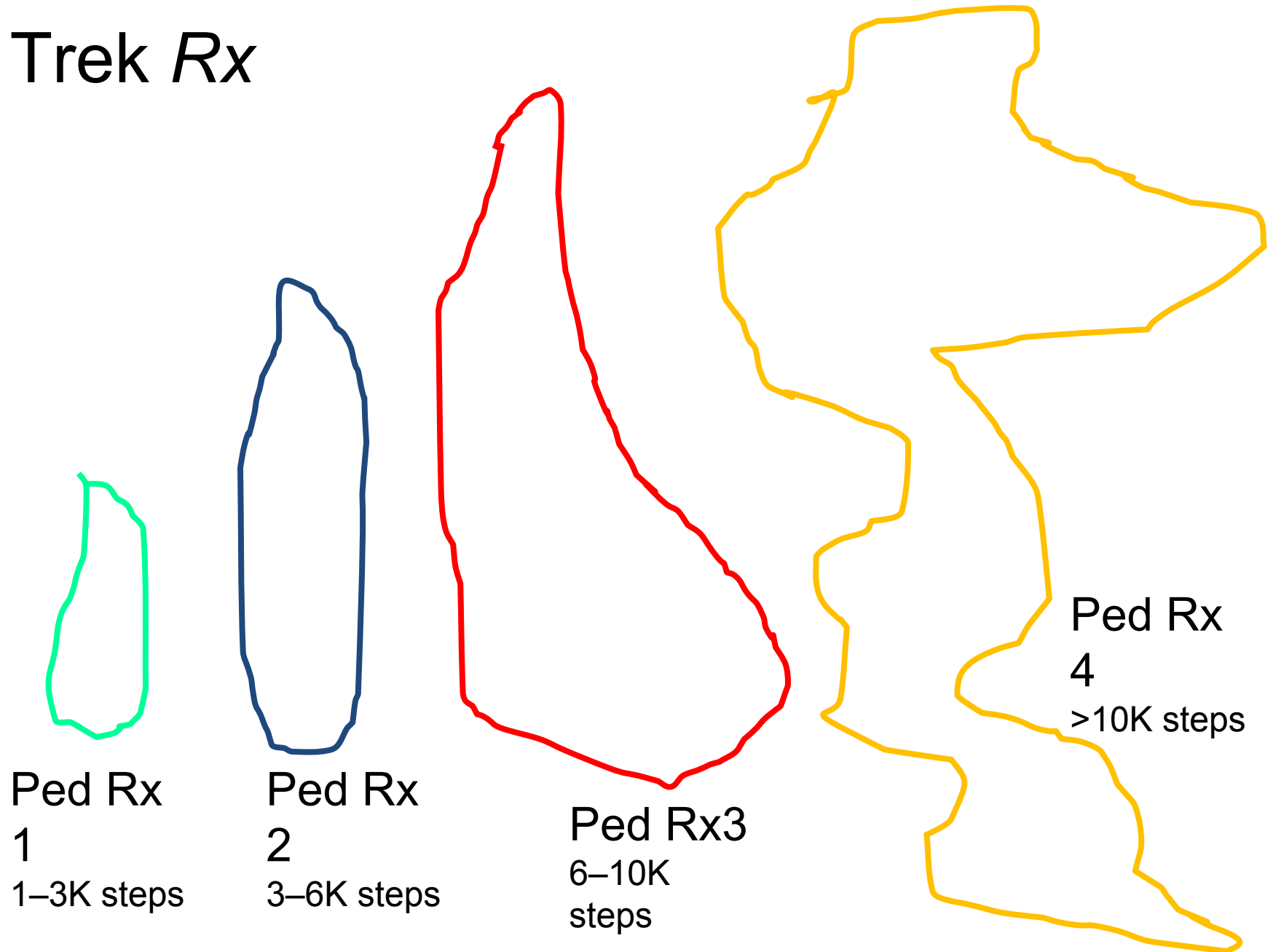
Level 2: 3000–6000 steps (1.5–3 miles)

Level 3: 6000–10,000 steps (3–5 miles)

Level 4: >10,000 steps (>5 miles)

Level of difficulty: Easy (minimum terrain/grade), Moderate (moderate terrain/grade), Difficult (significant variable terrain and grade)

Trek Rx





Prescription Form–Exercise Pedometry

Rx for Outpatient Exercise Pedometry

Patient name:

Date:

Therapeutic code:

Order for following patient physical activity pedometer:

•Pedometer: Eagle 2720 pedometer

Rx: steps/day _____ steps/week/month/

Other Rx:

Patient instructions: See attached physical activity and pedometer guidelines.

M.D.

Referring provider/physician

Workout



Utilitarian



Recreational/ sports



Household-Community Circuit Rx

Name _____
Date _____
Rx: _____

20–90 minutes

_____|_____

_____|_____

_____|_____

_____|_____



- 2-minute rest/water break between stations
- Always start and end session with warm-up/cool down exercise, as prescribed
- Do not continue exercise or go to the next station if you experience chest discomfort, palpitations, dizziness, or unusual fatigue.

_____|_____



_____|_____

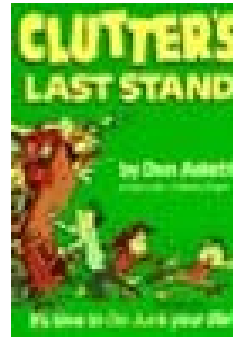
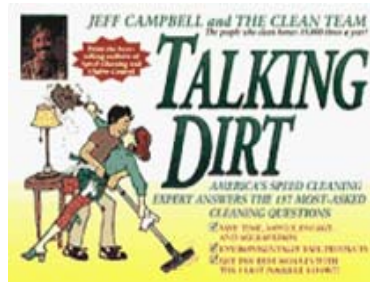
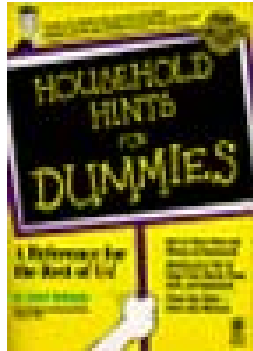
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_____|_____

Utilitarian-domestic Activities do Condition and Reduce Risk

- Yardwork
- Gardening
- Housework
- Painting, cleaning, shoveling, scrubbing, washing
- Repair work
- ADLs





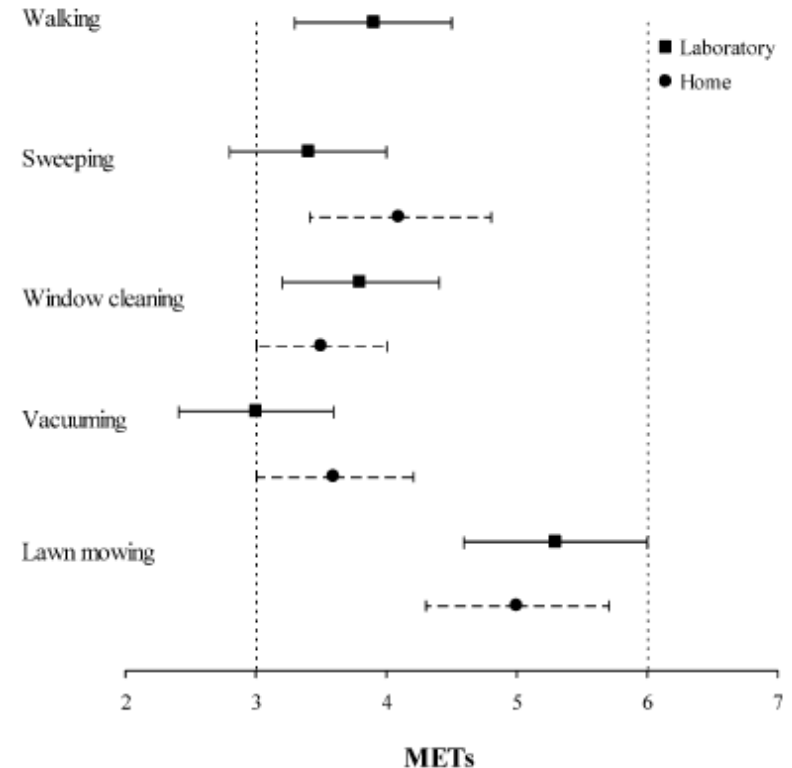
Energy Costs of Household Chores in 50 Men

Table 4 Comparison of energy expenditure means (METs) between age groups

	Laboratory		Home	
	35–45 years ^a	55–65 years	35–45 years ^a	55–65 years
Walking	3.8	3.9	Not measured	
Sweeping	3.5	3.3	4.1	4.1
Window cleaning	3.8	3.8	3.3	3.5
Vacuuming	3.0	3.0	3.5	3.6
Lawn mowing	5.6	5.3	4.8	5.0

^a(Gunn et al. 2004)

* $P < 0.001$



3.3–5.4 METs
4–7 kcal/min

Gunn SM et. al. 2005 Europ J Appl Physio. 94:476

Physical Activity Encounters

in 24-hr period



What is a PAE ?

~90+ seconds or more of sustained physical activity, e.g:

- One or two flights of stairs
- Walking one block
- Sweeping/vacuuming
- Walking an extra two isles in the grocery store
- Parking 20–40 spaces further away from your destination
- Brief activities of daily living (ADLs) involving arms and legs
- Moving furniture or appliances
- Taking trash/yard waste out

Example Mindful Exercise Modalities

A Simple Taxonomy

Classical

- Hatha yoga
- Tai Chi
- Qigong exercise
- Select ethnic and spiritual dance
e.g. Native American dance
- Breathwork therapies (pranayama)

Contemporary

- NIA
- Meditation walking
- Pilates
- Physiosynthesis
- Somatics
- E-motion
- Feldenkrais
- Alexander technique
- Laban movement
- Ideokinesis
- Composite forms

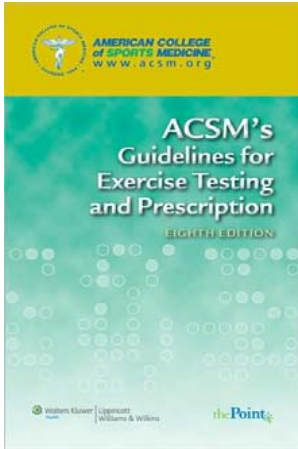


Native American Dance

Examples

Arrow Dance of the Navaho
Basket Dance of Cochiti
Basket Dance of Woodcraft
Bow & Arrow Dance of Jemez
Bow & Arrow Dance Woodcraft
Comanche Dance of Woodcraft
Comanche Dance of Zuni
2nd Comanche Dance of Zunis
Corn Grinding Dance Woodcraft
Corn Grinding Song of Zuni
Coyote Dance of Woodcraft
Dance of the Mudheads at Zuni
Deer
Dance of the Navahos
Deer Dance of San Juan

Dog Dance of San Juan
Dog Dance of Woodcraft
Doll Dance
Eagle Dance of Tesuque
Eagle Dance of Woodcraft
Green Corn of Santo Domingo
Harvest Dance of Zuni
Hoop Dance of Taos
Hoop Dance of Woodcraft
Hopi Snake Dance
Mountain Chant of the Navaho
Pipe Dance of San Juan
Rain Dance of Zuni
Yei-Be-Chi



Patient readiness for exercise

ACSM/AHA ExRisk Stratification

GXT with ECG

Low
Moderate
High



PAR-Q & YOU
(10 Questions for People Age 15 to 69)

Before starting a new exercise program, you should first answer the following questions. If you answer "yes" to any of the questions, you should consult your doctor before starting. If you answer "no" to all the questions, you may start your exercise program. However, you should still consult your doctor if you have any of the following conditions: heart disease, high blood pressure, diabetes, or other chronic conditions.

IF YOU ANSWER:

1. Has your doctor ever notified you have a heart condition and that you should stop all physical activity immediately? YES NO
2. In the past month, have you had chest pain when you were not being physically active? YES NO
3. In the past month, have you had dizziness or lightheadedness? YES NO
4. Do you have a history of fainting? YES NO
5. Are you taking any medicine for your heart, blood pressure, diabetes, or other chronic condition? YES NO
6. Do you have any other conditions that may affect your ability to exercise? YES NO

IF YOU ANSWER:

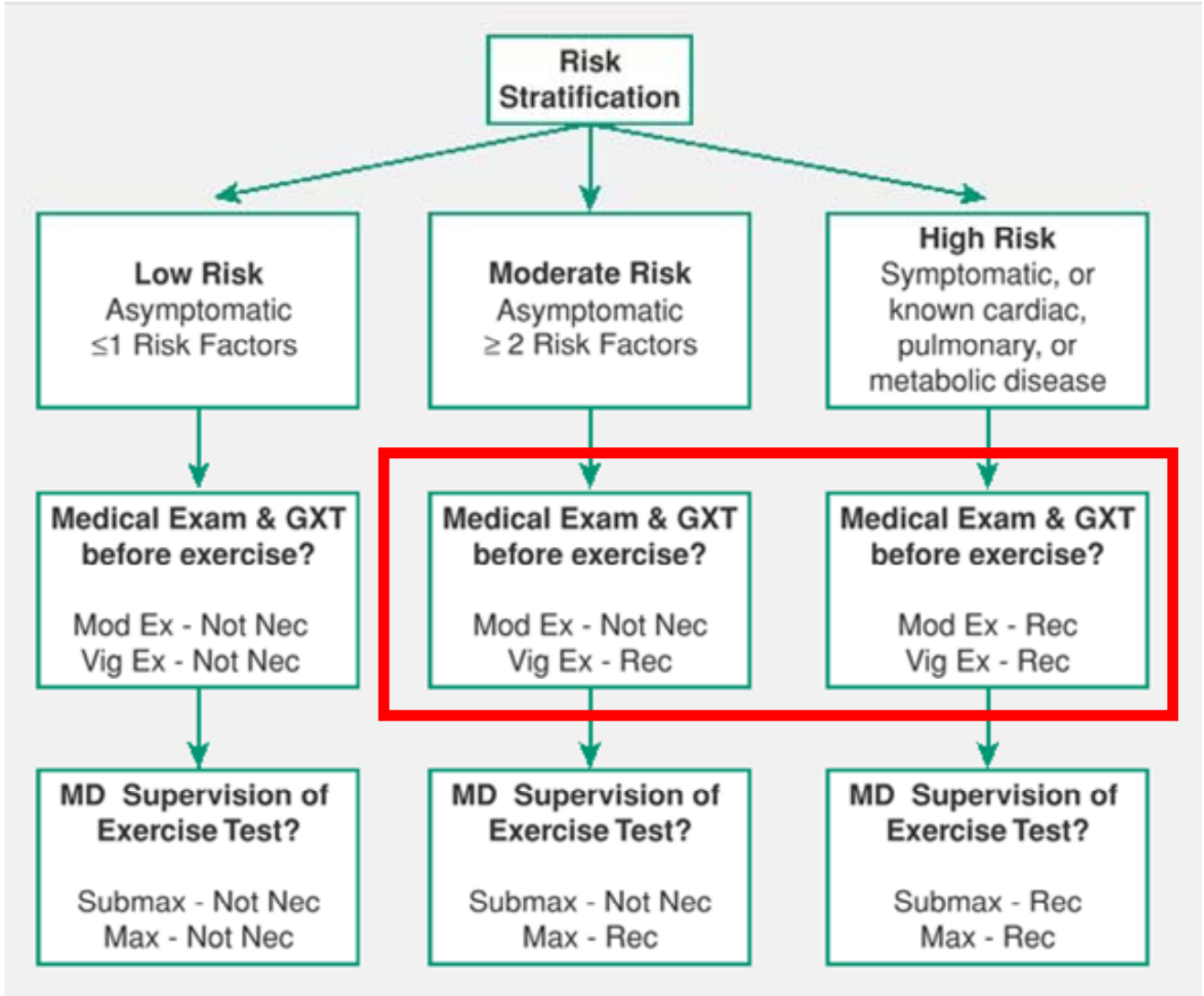
YES to one or more questions

Consult your doctor before starting an exercise program. If you answer "yes" to any of the questions, you should consult your doctor before starting. If you answer "no" to all the questions, you may start your exercise program. However, you should still consult your doctor if you have any of the following conditions: heart disease, high blood pressure, diabetes, or other chronic conditions.



American College of Sports Medicine. Guidelines for Exercise Testing and Prescription. 8th ed. Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams &Wilkins; 2009.

**ACSM
Exercise ECG
Testing
Requirements**



Moderate: 40–60% of V02 max
Vigorous: 60%+ of V02 max

Division of Diabetes Treatment and Prevention

Leading the effort to treat and prevent diabetes in American Indians and Alaska Natives

[tools](#) : quick guides

Quick Guides

Under each tab you will find a set of cards on various diabetes related topics. Each set includes an overview, resources and several 'how to' short video tutorials. Check back as new cards will be added.



<http://www.ihs.gov/MedicalPrograms/Diabetes/index.cfm?module=toolsQuickGuides>



Questions?



Exercise Science Resources?

rlaforge@nc.rr.com