Physical Activity as a “Vital Sign” : Really It Does Matter.

Jong-Young LEE, MD, PhD

Division of cardiology, Kangbuk Samsung hospital, Sungkyunkwan University School of Medicine, Seoul, Korea
Components of typical total daily energy expenditure

Modified from McArdle et al
Definition of physical activity

- Defined as “any bodily movements produced by skeletal muscles that result in energy expenditure.”

- Either be classified as structured or incidental
  - structured or exercise - planned, purposeful activity to promote health and fitness
  - incidental – not planned and usually the result of daily activities at work, at home or during transport
(1) Adults should avoid inactivity (i.e., some physical activity is better than none)

(2) Substantial health benefits are obtained from accumulating, in bouts of ≥10 minutes, 150 minutes per week of moderate-intensity or 75 minutes per week of vigorous-intensity aerobic activity, or an equivalent combination of both.

(3) Additional and more extensive health benefits are obtained by increasing aerobic physical activity to 300 minutes per week at moderate intensity or 150 minutes per week at vigorous intensity, or an equivalent combination of both.

(4) Muscle-strengthening activities of moderate to high intensity should be performed ≥2 days per week.
### Cause of Death in the World

#### Leading Causes 1990
1. Lower respiratory infections
2. Neonatal preterm birth complications
3. Diarrhoeal diseases
4. Protein-energy malnutrition
5. Malaria
6. Self-harm
7. Other neonatal disorders
8. Neuritis
9. Tetanus
10. Lower respiratory infections

#### Median all-cause and age-standardized % change

#### Leading Causes 2005
1. Ischaemic heart disease
2. Lower respiratory infections
3. Cerebrovascular disease
4. Chronic obstructive pulmonary disease
5. Lower respiratory infections

#### Median all-cause and age-standardized % change

#### Leading Causes 2015
1. Ischaemic heart disease
2. Cerebrovascular disease
3. Lower respiratory infections
4. Chronic obstructive pulmonary disease
5. Lower respiratory infections

#### Median all-cause and age-standardized % change

#### Leading Causes 2010
1. Lower respiratory infections
2. Neonatal preterm birth complications
3. Diarrhoeal diseases
4. Protein-energy malnutrition
5. Malaria

#### Median all-cause and age-standardized % change

#### Leading Causes 2015
1. Ischaemic heart disease
2. Cerebrovascular disease
3. Lower respiratory infections
4. Chronic obstructive pulmonary disease
5. Lower respiratory infections

#### Median all-cause and age-standardized % change

---

**Lancet 2015; 380: 2095–128**
Ischemic Heart Disease Mortality

“Evolution or Regression” of Physical Activity
The “Diseasome” of Physical Inactivity

Physical inactivity and muscle disuse lead to metabolic deterioration.

The “Diseasome” of Physical Inactivity

- Obesity
- Metabolic Syndrome
- Coronary Artery Disease
- Type 2 Diabetes

Physical Inactivity
Diminished Physical Activity Creating A Disaster!

Risk factor for mortality

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Deaths (millions)</th>
<th>Percentage of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 High blood pressure</td>
<td>7.5</td>
<td>12.8</td>
</tr>
<tr>
<td>2 Tobacco use</td>
<td>5.1</td>
<td>8.7</td>
</tr>
<tr>
<td>3 High blood glucose</td>
<td>3.4</td>
<td>5.8</td>
</tr>
<tr>
<td>4 Physical inactivity</td>
<td>3.2</td>
<td>5.5</td>
</tr>
<tr>
<td>5 Overweight and obesity</td>
<td>2.8</td>
<td>4.8</td>
</tr>
<tr>
<td>6 High cholesterol</td>
<td>2.6</td>
<td>4.5</td>
</tr>
<tr>
<td>7 Unsafe sex</td>
<td>2.4</td>
<td>4.0</td>
</tr>
<tr>
<td>8 Alcohol use</td>
<td>2.3</td>
<td>3.8</td>
</tr>
<tr>
<td>9 Childhood underweight</td>
<td>2.2</td>
<td>3.8</td>
</tr>
<tr>
<td>10 Indoor smoke from solid fuels</td>
<td>2.0</td>
<td>3.3</td>
</tr>
</tbody>
</table>

(Lee et al., 2012)

- Premature death 9%
- Breast cancer 10%
- Colon cancer 10%
- Diabetes 7%
- CAD 6%

Dramatic Increase in Chronic Disease Conditions!
Physical activity Participation in USA

- Prevalence of Leisure-Time PA (Age > 18)

- Regular LTPA: 30.8%
- NO LTPA: 69.2%
How many physician recommended physical activity in USA??

- In 2010, only about one-third of US adults being advised by their physician to begin or continue an exercise program,
- published by the National Center for Health Statistics in 2012.

30% engaged in leisure time PA
1/3 recommended to engage adequate PA by their doctor
Physical Activity in Korean National Statistics (2013)

Participation in moderate intensity physical activity

annual
Participation in resistance exercise
The Global Epidemic of Physical Inactivity

USA

US Adults MET-hours/week of All Physical Activity, and Hours/Week of Time in Sedentary Behavior: Measured, 1965–’09; Forecasted, 2010–’30

Physical Inactivity & Chronic Diseases: A Global Problem
Therefore, it becomes paramount that all domains be captured; otherwise the assessment of total physical activity will be incomplete.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Contextual Definition or Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupational</td>
<td>Work-related: involving manual labor tasks, walking, carrying or lifting objects</td>
</tr>
<tr>
<td>Domestic</td>
<td>Housework, yard work, child care, chores, self-care, shopping, incidental</td>
</tr>
<tr>
<td>Transportation/utilitarian</td>
<td>Purpose of going somewhere: walking, bicycling, climbing/descending stairs to public transportation, standing while riding transportation</td>
</tr>
<tr>
<td>Leisure time</td>
<td>Discretionary or recreational activities: sports, hobbies, exercise, volunteer work</td>
</tr>
</tbody>
</table>
# Physical Activity Dimensions

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Definition and Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode (type)</td>
<td>Specific activity performed (e.g., walking, gardening, cycling). Mode can also be defined in the context of physiological and biomechanical demands/types (e.g., aerobic versus anaerobic activity, resistance or strength training, balance and stability training).</td>
</tr>
<tr>
<td>Frequency</td>
<td>Number of sessions per day or per week. In the context of health-promoting physical activity, frequency is often qualified as number of sessions (bouts) ≥10 min in duration/length.</td>
</tr>
<tr>
<td>Duration</td>
<td>Time (minutes or hours) of the activity bout during a specified time frame (e.g., day, week, year, past month).</td>
</tr>
<tr>
<td>Intensity</td>
<td>Rate of energy expenditure. Intensity is an indicator of the metabolic demand of an activity. It can be objectively quantified with physiological measures (e.g., oxygen consumption, heart rate, respiratory exchange ratio), subjectively assessed by perceptual characteristics (e.g., rating of perceived exertion, walk-and-talk test), or quantified by body movement (e.g., stepping rate, 3-dimensional body accelerations).</td>
</tr>
</tbody>
</table>
Classification of physical activity intensity

**Relative Intensity**

<table>
<thead>
<tr>
<th>Intensity</th>
<th>$V_{O_{2}}$max (%)</th>
<th>Maximal Heart Rate Reserve, %</th>
<th>%</th>
<th>RPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very light</td>
<td>&lt;25</td>
<td>&lt;30</td>
<td>&lt;9</td>
<td></td>
</tr>
<tr>
<td>Light</td>
<td>25–44</td>
<td>30–49</td>
<td>9–10</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>45–59</td>
<td>50–69</td>
<td>11–12</td>
<td></td>
</tr>
<tr>
<td>Hard</td>
<td>60–84</td>
<td>70–89</td>
<td>13–16</td>
<td></td>
</tr>
<tr>
<td>Very hard</td>
<td>≥85</td>
<td>≥90</td>
<td>&gt;16</td>
<td></td>
</tr>
<tr>
<td>Maximal</td>
<td>100</td>
<td>100</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

**Absolute Intensity**

<table>
<thead>
<tr>
<th>Intensity</th>
<th>METs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary</td>
<td>1–1.5</td>
</tr>
<tr>
<td>Light</td>
<td>1.6–2.9</td>
</tr>
<tr>
<td>Moderate</td>
<td>3.0–5.9</td>
</tr>
<tr>
<td>Vigorous</td>
<td>≥6.0</td>
</tr>
</tbody>
</table>

-One MET represents the resting energy expenditure during quiet sitting and is commonly defined as 3.5 mL O₂·kg⁻¹·min⁻¹ or ≈250 mL/min of oxygen consumed, which represents the average value for a standard 70-kg person.

- METs can be converted to kilocalories (1 MET=1 kcal·kg⁻¹·h⁻¹).
What is cardiorespiratory fitness (maximal oxygen consumption)?

A reduction in VO2peak can occur as a result of any disease affecting the ability of the body to transport O2 and CO2 between the air and skeletal muscle cells, or a result of diseases affecting skeletal muscle function.

Maximal oxygen consumption (ml.kg.min); 3.5ml/kg/min (1 METs)
How can we measure maximal oxygen consumption?

The gold standard for fitness assessment is the graded maximal exercise test on a treadmill or cycle ergometer, in which VO2 is measured using expired gas analysis.

Directly measured maximal oxygen consumption

Indirectly estimated maximal oxygen consumption from work performed

High Correlation

Men (r=0.92)
Women (r=0.94)
Why cardiorespiratory fitness is an important?

• Since fitness can be modified through changes in routine physical activity, it is regarded as a surrogate for habitual physical activity.

• Habitual physical activity is better represented by fitness than by self-report physical activity.

• Fitness is not only determined by current physical activity level, but also by environmental and genetic factors; the proportion of fitness attributable to genetics is hypothesized as being relatively smaller than that proportion caused by physical activity.

• Fitness determined by maximal exercise test has been shown to be a stronger predictor of CVD outcomes vs. self-report physical activity.
Cardiorespiratory fitness vs. Habitual physical activity

The relations of lifestyle, established and novel risk factors, and cardiovascular disease
We have focused on dyslipidemia, hypertension, and diabetes mellitus but not on the underlying causes: poor dietary habits, inadequate physical activity, and adiposity.

Pharmacological treatment of blood pressure, blood lipids, & glucose levels only incompletely treat adverse consequences of unhealthy lifestyle habits.

The clinical evaluation and treatment of dietary, physical activity and smoking habits must become as routine and familiar as assessment of blood pressure, cholesterol, and glucose levels.
AHA’s “Life’s Simple 7”
Health and Behavior Factors

- Don’t smoke
- Manage blood pressure
- Take charge of cholesterol
- Keep blood sugar at healthy levels
- Maintain healthy bodyweight
- Engage in regular physical activity
- Eat a healthy diet
Lifestyle factors and survival

Additional years of life according to age associated with adoption or maintenance of a favorable physical-activity (≥4.5 metabolic equivalents, or METS) level and other characteristics between 1962 or 1966 and 1977, as estimated from mortality rates among 10,269 male Harvard alumni from 1977 through 1985.

The risk of dying prematurely declines as people become physically active

Physical activity level and mortality

Circulation. 2016;133:2297-2313
Physical Activity has declined in our work and in our daily lives

Daily activity must be obtained from “leisure-time physical activity” .... “Exercise”

Or we must add physical activity back into our non leisure-time (i.e. work, school, commuting, etc) .....“lifestyle PA”
Leisure time physical activity and mortality

J Am Coll Cardiol. 2014;64(5):472-481
Fitness as a quantitative predictor of all-cause mortality and CV events in healthy men and women: a meta-analysis

Each 1-MET increase: 13% - 15% improvement in all-cause mortality and CHD/CVD events

Kodama S et al. 2009 JAMA
Peak Aerobic Capacity Predicts Prognosis

PROGNOSTIC VALUE OF **CHANGE** IN PEAK VO$_2$

1 % ↑ peak VO$_2$
2 % ↓ Mortality


17 % ↑ peak VO$_2$
with Cardiac Rehab

How much should we improve fitness?

No evidence of an upper threshold for all-cause mortality benefit at high levels of cardiorespiratory fitness.

2316 patients with DM, 16 years F/U, 179 CVD Deaths

37,855 patients with free of known CVD from the Henry Ford Exercise Testing Project, 11 years F/U
Biophysiologic Effects of Exercise Training

- Anti-atherogenic Effects
- Anti-thrombotic Effects
- Endothelial Alternation
- Autonomic Functional Changes
- Anti-ischemic Effects
- Anti-arrhythmic Effects
- Anti-inflammatory Effects
- Reduction in age-related disability
- Decreased BP and HR
- Increased stroke volume, cardiac output, VO2 max, A-V oxygen difference

Circulation 2013;128:873-934
Exercise is Medicine

Exercise can be viewed as a preventive medical treatment, like a “pill” that should be taken on an almost daily basis.

By 2013 AHA scientific statement
Patient who suffering from angina "who set himself the task of sawing Wood for half-an-hour every day and was nearly cured."
Core Components of Cardiac Rehabilitation

AHA/AACVPR SCIENTIFIC STATEMENT

Core Components of Cardiac Rehabilitation/Secondary Prevention Programs: 2007 Update

A Scientific Statement From the American Heart Association Exercise, Cardiac Rehabilitation, and Prevention Committee, the Council on Clinical Cardiology; the Councils on Cardiovascular Nursing, Epidemiology and Prevention, and Nutrition, Physical Activity, and Metabolism; and the American Association of Cardiovascular and Pulmonary Rehabilitation

Gary J. Balady, MD, FAHA, Chair, Mark A. Williams, PhD, Co-chair, Philip A. Ades, MD, Vera Bittner, MD, FAHA, Patricia Comoss, RN, Jo Anne M. Foody, MD, FAHA, Barry Franklin, PhD, FAHA, Bonnie Sanderson, RN, PhD, and Douglas Southard, PhD, MPH, PA-C

- Patient assessment
- Nutritional counseling
- Lipid management
- Blood pressure management
- Weight management
- Diabetes management
- Tobacco cessation
- Psychosocial management
- Physical activity counseling
- Exercise training

Cardiopulm Rehabil Prev. 2007;27:121-29
Exercise-based Cardiac rehab for CHD

and meta-analysis

How Ex/PA Much is Enough?
### The "Traditional" Exercise Prescription

#### TABLE 7-2. Summary of General Exercise Programming

<table>
<thead>
<tr>
<th>Components of Training Program</th>
<th>Frequency (sessions·wk$^{-1}$)</th>
<th>Intensity</th>
<th>Duration</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiorespiratory</td>
<td>3–5 d·wk$^{-1}$</td>
<td>40%/50%–85% HRR or VO$<em>2$R &lt;br&gt;55%/65%–90% HR$</em>{max}$ 12–16 RPE</td>
<td>20–60 min</td>
<td>Large muscle groups Dynamic activity</td>
</tr>
<tr>
<td>Resistance</td>
<td>2–3 d·wk$^{-1}$</td>
<td>Volitional fatigue (MMF) (e.g., 19–20 RPE) or Stop 2–3 reps before volitional fatigue (e.g., 16 RPE)</td>
<td>1 set of 3–20 repetitions (e.g., 3–5, 8–10, 12–15)</td>
<td>8–10 exercises Include all major muscle groups</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Minimal 2–3 d·wk$^{-1}$ &lt;br&gt;Ideal 5–7 d·wk$^{-1}$</td>
<td>Stretch to tightness at the end of the range of motion but not to pain</td>
<td>15–30 seconds 2–4 x/stretch</td>
<td>Static stretch all major muscle groups</td>
</tr>
</tbody>
</table>

Abbreviations: HRR, heart rate reserve; VO$_2$R, maximal oxygen uptake reserve; MMF, momentary muscular fatigue.
### Table 3
General Training Guidelines for Improving Health and Aerobic Fitness

<table>
<thead>
<tr>
<th>Training factor</th>
<th>Guidelines*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensity</td>
<td>60–85% of peak HR 50–80% of HRR</td>
</tr>
<tr>
<td>Frequency</td>
<td>4–6 days/week</td>
</tr>
<tr>
<td>Sessions/day</td>
<td>One</td>
</tr>
<tr>
<td>Duration</td>
<td>≥ 8 weeks</td>
</tr>
<tr>
<td>Duration/Session</td>
<td>≥ 30 min/session</td>
</tr>
</tbody>
</table>

* Target goal is 150 Kcal • day\(^{-1}\) (1000 Kcal • wk\(^{-1}\)). HR, heart rate and HRR, heart rate reserve. = “Dose”
## The New Ex Rx Paradigm: Focus on “Dose”

<table>
<thead>
<tr>
<th>Kcal/wk</th>
<th>Intensity</th>
<th>min/wk</th>
<th>min/day</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>Moderate</td>
<td>200</td>
<td>30</td>
<td>↑ fitness; ↓ CV risk factors;</td>
</tr>
<tr>
<td></td>
<td>Vigorous</td>
<td>140</td>
<td>20</td>
<td>↓ mortality; CAD progression</td>
</tr>
<tr>
<td>1500</td>
<td>Moderate</td>
<td>280</td>
<td>40</td>
<td>↑↑ fitness; ↓↓ CV risk factors; ↓↓ mortality</td>
</tr>
<tr>
<td></td>
<td>Vigorous</td>
<td>200</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>Moderate</td>
<td>400</td>
<td>60</td>
<td>same as above;</td>
</tr>
<tr>
<td></td>
<td>Vigorous</td>
<td>280</td>
<td>40</td>
<td>↓ CV mortality</td>
</tr>
<tr>
<td>2200</td>
<td>Moderate</td>
<td>440</td>
<td>65</td>
<td>same as above;</td>
</tr>
<tr>
<td></td>
<td>Vigorous</td>
<td>315</td>
<td>45</td>
<td>CAD regression</td>
</tr>
</tbody>
</table>

1. Structured exercise, plus leisure time physical activity.
2. Moderate intensity ≈5 METs; vigorous intensity ≈7 METs.
Example:

Tennis (at ~ 7 METs) for 30 minutes on 3 days per week:

7 METs x 30 minutes x 3 times per week = 630 MET min • week


Optimal Dose of Exercise

≥ 500-1,000 MET-min/week
1,000 Kcal /week
~150 minutes/week
≥10,000 steps/day on pedometer
Quantifying Exercise Dose

Total time: 2 hr/wk

Energy expended:
- Level 1: 16 MET-hr/wk (16 kcal/kg/wk)
- Level 3: 960 kcal/wk

Frequency 4 workouts/week
Duration 30 min/workout
Intensity 8 METs (8 kcal/hr)
Body weight 60 kg

Activity Logs

Questionnaires

Activity Monitors

"Dose" or "Volume"
Build a Physical Activity Pyramid!

**Each week, try to increase your physical activity using this guide. Here’s how to start...**

**If you are inactive**
- Increase daily activities at the base of the Activity Pyramid by:
  - Taking the stairs instead of the elevator.
  - Hiding the TV remote control.
  - Making extra trips around the house or yard.
  - Stretching while standing in line.
  - Walking whenever you can.

**If you are consistent**
- Choose activities from the whole pyramid by:
  - Changing your routine if you start to get bored.
  - Exploring new activities.

**Cut down on**
- Watching TV.
- Computer games.
- Sitting for more than 30 minutes at a time.

**Flexibility and strength**
- Stretching/yoga.
- Push-ups/curl-ups.
- Weight lifting.

**Aerobic exercise**
- Brisk walking.
- Cross-country skiing.
- Bicycling.
- Swimming.

3-5 times a week

**Everyday**
- Walking the dog.
- Take longer routes.
- Take the stairs instead of the elevator.

Be creative in finding a variety of ways to stay active.

**Recreational**
- Soccer.
- Hiking.
- Basketball.
- Tennis.
- Martial arts.
- Dancing.

Above all... Have fun and good luck!
Examples of moderate Physical Activity

- Washing and waxing a car for 45-60 minutes
- Washing windows or floors for 45-60 minutes
- Playing volleyball for 45 minutes
- Playing touch football for 30-45 minutes
- Gardening for 30-45 minutes
- Wheeling self in wheelchair for 30-40 minutes
- Walking 1 3/4 miles in 35 minutes (20 min/mile)
- Basketball (shooting baskets) for 30 minutes
- Bicycling 5 miles in 30 minutes
- Dancing fast (social) for 30 minutes
- Pushing a stroller 1.5 miles in 30 minutes
- Raking leaves for 30 minutes
- Walking 2 miles in 30 minutes (15 min/mile)
- Water aerobics for 30 minutes
- Swimming laps for 20 minutes
- Wheelchair basketball for 20 minutes
- Basketball (playing a game) for 15-20 minutes
- Bicycling 4 miles in 15 minutes
- Jumping rope for 15 minutes
- Running 1.5 miles in 15 min (10 min/mile)
- Shoveling snow for 15 minutes
- Stairwalking for 15 minutes

A moderate amount of physical activity is roughly equivalent to physical activity that uses approximately 150 calories (kcal) of energy per day, or 1000 calories per week.

Some activities can be performed at various intensities; the suggested durations correspond to the expected intensity of effort.
Core Program Components and Staff Competencies in Cardiac Rehab:

Physical Activity
Importance of Physical Activity

- We have made a strong evidences for the relative value of Physical Activity (PA)

- Clinicians – ‘what can be do for our patients’
- Important to empower patients to be a partner in their treatment
  - Physical Activity of ‘vital’ importance
Core Competencies for PA

Core Component: Assessments

- “Assess current physical activity level using both questionnaires and available activity-monitoring devices”
- Pedometer, multisensing tools, accelerometers

Remember, that after Assessment, the Core Components also include:

- Interventions
- Expected Outcomes
Assess current PA level; (domestic, occupational, recreational)

Evaluate activities relevant to age, gender, and daily life, such as driving, sexual activity, sports, gardening, and household tasks

Assess readiness to change behavior, self-confidence, barriers to increased PA, and social support in making positive changes
Core: PA Counseling Interventions

- PA a part of initial evaluation, provide education, individualize exercise program (considers for patients with heavy labor jobs)

- Goal: accumulate 30-60 min/day of moderate-intensity PA, ≥5 day/week, also increased PA in daily routine
  - gradual increasing PA volume over time

- Caution patients to avoid performing unaccustomed vigorous PA

Circulation. 2007;115:2675-2682
Core: PA Counseling

Expected Outcomes

- Increased participation in domestic, occupational, and recreational activities
- Improved psychosocial well-being, reduction in stress, facilitation of functional independence, prevention of disability, and enhancement of opportunities for independent self-care
- Lower coronary risk - Improved aerobic fitness and body composition
  - HTN, Lipids, Glucose

Circulation. 2007;115:2675-2682
Performing PA Assessment

- Not as simple as just asking a few general questions during patient assessment
- Multiple Options (Subjective vs. Objective)
- Strengths / Weaknesses of each

At present, there is little information available to guide the selection of a physical activity assessment method that is appropriate for the wide variety of potential applications.
### Table 4. Available Sample of Subjective Physical Activity Assessment Methods

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Number of Items</th>
<th>Administration Mode</th>
<th>Summary Score</th>
<th>Dimensions Assessed*</th>
<th>Domains Assessed†</th>
<th>Setting</th>
<th>Population</th>
<th>Key References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise Vital Sign</td>
<td>2</td>
<td>Self</td>
<td>min/wk</td>
<td>5</td>
<td>2</td>
<td>Clinic</td>
<td>Adults</td>
<td>26</td>
</tr>
<tr>
<td>EPIC PAQ</td>
<td>4</td>
<td>Self</td>
<td>min/wk, MET·h⁻¹·wk⁻¹</td>
<td>1, 3, 4</td>
<td>2, 3, 4</td>
<td>Community</td>
<td>Adults</td>
<td>27, 28</td>
</tr>
<tr>
<td>Godin Leisure Time Exercise</td>
<td>4</td>
<td>Self</td>
<td>Total leisure activity score</td>
<td>1, 2, 3</td>
<td>3</td>
<td>Worksite, community</td>
<td>Adults, men, women, white, black, Asian, Latino, MS patients</td>
<td>23, 29–33</td>
</tr>
<tr>
<td>Lipid Research Clinics</td>
<td>4</td>
<td>Self, interviewer</td>
<td>Activity score</td>
<td>5</td>
<td>3, 4</td>
<td>Community</td>
<td>Adults, older adults, men, women, white</td>
<td>23, 34–37</td>
</tr>
<tr>
<td>Minnesota Heart Health</td>
<td>4</td>
<td>Self</td>
<td>5-Point score</td>
<td>4</td>
<td>3</td>
<td>Community</td>
<td>Adults, men, women, white</td>
<td>23, 37, 38</td>
</tr>
<tr>
<td>Physical Activity Vital Sign</td>
<td>2</td>
<td>Self, interviewer</td>
<td>min/wk</td>
<td>5</td>
<td>2</td>
<td>Clinic</td>
<td>Adults</td>
<td>39</td>
</tr>
<tr>
<td>Rapid Assessment of Physical Activity</td>
<td>7 (9)</td>
<td>Self, telephone</td>
<td>Active score</td>
<td>5</td>
<td>2</td>
<td>Clinic, community</td>
<td>Older adults</td>
<td>40, 41</td>
</tr>
</tbody>
</table>
On average, how many days per week do you engage in moderate to strenuous exercise (like a brisk walk)?

On average, how many minutes do you engage in exercise at this level?

Responses can be multiplied (days × minutes) to estimate minutes of moderate to vigorous activity such as (MVPA)/week.
INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE (IPAQ)

- 4 questions:
- During the last 7 days, on how many days and for how much time ...
- did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?
- did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.
- did you **walk** for at least 10 minutes at a time?
- did you spend **sitting** on a **week day**?
**IPAQ Activity Classifications**

- **Inactive** (Category 1)
  - Not active enough to meet criteria for Categories 2 or 3

- **Minimally Active** (Category 2)
  - ≥3 days of vigorous activity of ≥20 min/d **OR**
  - ≥5 days of moderate activity or walking of ≥30 min/d **OR**
  - ≥5 days of any combination of walking, moderate or vigorous activity achieving ≥600 MET-min/wk

- **HEPA (health enhancing PA) Active** (Category 3)
  - Vigorous activity ≥3 d/wk achieving ≥1500 MET-min/wk **OR**
  - ≥7 days of any combination of walking, moderate or vigorous activity achieving ≥3000 MET-min/wk
# Objective Methods – Monitors

| Table 5. Available Objective Methods to Assess Physical Activity: Accelerometers |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Acical                          | ActiGraph                       | ActivPAL                        | GENEActiv                      | Lifecorder Plus                 | RT3                             |
| Size, mm                        | 29×37×11 mm                     | 4.6×3.3×1.1 cm                  | 53×35×7 mm                     | 43×40×13 mm                     | 7.25×4.2×1.8 cm                 | 7.1×5.3×2.8 cm                 |
| Weight, g                       | 16                              | 19                              | 15                              | 14                              | 48                              | 65                              |
| Battery                         | CR2025 lithium                  | Rechargeable lithium            | Rechargeable lithium            | Rechargeable lithium            | CR2032 lithium                  | AAA battery                    |
| Memory                          | 32 MB                           | 512 MB                          | 16 MB                          | 16 MB                           | 500 MB                          | N/A                            |
| Recording time                  | Raw: 12 d; 1 s Steps: 194 d     | Raw: 40 d at 30 Hz              | 8 d                            | 45 d at 10 Hz; 7 d at 100 Hz    | 7-d LCD display; 60-d internal memory |
| Modes for sampling              | Raw + steps: 1, 2, 5, 15, 30, 60 s (counts) epochs | Raw acceleration | Raw acceleration | Raw acceleration | Steps, intensity 1 (low) to 9 (high), proprietary algorithm from raw acceleration | Counts |
| Interface                       | USB                             | USB                             | USB                            | USB                             | USB                             | USB with docking unit           |
| Number of axes                  | Omnidirectional                 | Triaxial                        | Uniaxial                        | Triaxial                        | Uniaxial                        | Triaxial                        |
| Placement                       | Hip, wrist, ankle               | Hip, wrist, ankle               | Thigh                          | Wrist, ankle, hip, thigh,       | Steps, moderate to vigorous physical activity, total energy expenditure | Hip                             |
| Outcome measures                | Physical activity energy expenditure, steps | Energy expenditure, steps, physical activity intensity, body position | Sitting/lying, standing, time, steps, step rate, number of posture changes, MET hours, physical activity level | Physical activity, activity type, posture | Energy expenditure, METs, activity counts |

Also have options for Pedometers and Multi-sensing devices
### Strengths and Limitations to Objective and Subjective Methodologies

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Questionnaire</th>
<th>Diaries/Logs</th>
<th>Observation</th>
<th>Indirect Calorimetry</th>
<th>DLW</th>
<th>HR</th>
<th>Accelerometer</th>
<th>Pedometer</th>
<th>Multisensing Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
<td>Low cost</td>
<td>Low cost</td>
<td>No recall</td>
<td>Highly</td>
<td><em>Gold</em></td>
<td></td>
<td>Low burden for</td>
<td></td>
<td>Low cost</td>
</tr>
<tr>
<td><strong>Weaknesses</strong></td>
<td>Recall and social desirability bias can occur</td>
<td>Very high burden on patients and participants</td>
<td>High burden on the observer</td>
<td>Expensive</td>
<td></td>
<td></td>
<td>Concurrent</td>
<td></td>
<td>Accuracy</td>
</tr>
<tr>
<td></td>
<td>Needs to be population and culture specific</td>
<td>Complex and time-consuming data reduction and analysis</td>
<td>Training essential to successfully administer this technique</td>
<td>High degree of technical expertise required</td>
<td>Expensive</td>
<td></td>
<td>Cannot account for nonactivity stimuli (emotion, medication, caffeine)</td>
<td></td>
<td>Higher cost</td>
</tr>
<tr>
<td></td>
<td>Low validity for assessing incidental or lifestyle physical activity</td>
<td>Similar to questionnaires, they should be population and culture specific</td>
<td>Can alter individual behavior of the one being assessed</td>
<td>Measures of resting metabolic rate and thermic effect of food required to derive PAEE</td>
<td>Expensive</td>
<td></td>
<td>Weak relationship at low end of intensity realm</td>
<td></td>
<td>Increased burden of wear for some devices</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Subject to interference with signal</td>
<td></td>
<td>Depending on device, technical expertise is essential</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Unable to discern dimensions or domains</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Data reduction, transformation, and processing take time</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Data reduction, transformation, and processing take time</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Decision matrix guide to selecting a physical activity (PA) measurement instrument

1. PA questionnaire
2. Logs/diaries
3. Heart rate monitoring
4. Pedometer
5. Accelerometer
6. Multi-unit sensors
7. Doubly labeled Water
Physical Activity – Research
Comparison of Cardiorespiratory fitness between USA and Korea

: Data from KISS-FitS & NHANES

Korea (solid lines)
USA (dashed lines)

Men

Women

Acceptd, and In Press
IMPACT OF CHANGE IN EXERCISE DOSE ON RISK OF NEWLY DEVELOPED HYPERTENSION AND DIABETES MELLITUS IN KOREAN MEN

Jong-Young LEE, Ki-Chul SUNG, MD, PhD

Division of cardiology, Kangbuk Samsung hospital, Sungkyunkwan University School of Medicine, Seoul, Korea

Accepted, and In Press
## Risk of incident DM according to the baseline exercise frequency

<table>
<thead>
<tr>
<th>Exercise frequency (per week)</th>
<th>Person-years</th>
<th>Number of events</th>
<th>incident (100,000 person-year)</th>
<th>Age-sex adjusted HR (95% CI)</th>
<th>Multivariate HR* (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>0</td>
<td>564,725.7</td>
<td>2,747</td>
<td>486.4</td>
<td>1.00(reference)</td>
<td>1.00(reference)</td>
</tr>
<tr>
<td>1-2</td>
<td>282,415.7</td>
<td>1,915</td>
<td>678.1</td>
<td>1.06(1.00-1.13)</td>
<td>1.11(1.04-1.19)</td>
</tr>
<tr>
<td>3-4</td>
<td>100,031.6</td>
<td>648</td>
<td>64.8</td>
<td>1.02(0.93-1.11)</td>
<td>1.09(0.98-1.20)</td>
</tr>
<tr>
<td>5-7</td>
<td>36,158.5</td>
<td>234</td>
<td>647.2</td>
<td>1.00(0.88-1.15)</td>
<td>1.13(0.96-1.32)</td>
</tr>
</tbody>
</table>

P for trend: 0.403 0.009 0.152 0.103

Model 1: adjustment for age, sex, center, year of screening exam, smoking status, alcohol intake, education level
Model 2: model 1 adjustments plus adjustment for BMI, FHx of DM glucose
Model 3: model 2 adjustments plus adjustment for hsCRP
Risk of incident HTN according to the baseline exercise frequency

<table>
<thead>
<tr>
<th>Exercise frequency (per week)</th>
<th>Person-years</th>
<th>Number of events</th>
<th>incident (100,000 person-year)</th>
<th>Age-sex adjusted HR (95% CI)</th>
<th>Multivariate HR’(95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>0</td>
<td>529,328.6</td>
<td>10,470</td>
<td>1,978.0</td>
<td>1.00(reference)</td>
<td>1.00(reference)</td>
</tr>
<tr>
<td>1-2</td>
<td>256,286.1</td>
<td>7,261</td>
<td>2,833.2</td>
<td>1.09(1.06-1.13)</td>
<td>1.06(1.02-1.10)</td>
</tr>
<tr>
<td>3-4</td>
<td>90,861.3</td>
<td>2,617</td>
<td>2,880.2</td>
<td>1.16(1.11-1.21)</td>
<td>1.15(1.09-1.20)</td>
</tr>
<tr>
<td>5-7</td>
<td>33,186.9</td>
<td>928</td>
<td>2,796.3</td>
<td>1.13(1.06-1.21)</td>
<td>1.15(1.06-1.24)</td>
</tr>
<tr>
<td>P for trend</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Model 1: adjustment for age, sex, center, year of screening exam, smoking status, alcohol intake, education level
Model 2: model 1 adjustments plus adjustment for BMI, systolic BP
Model 3: model 2 adjustments plus adjustment for hsCRP
### Risk of incident DM according to the change in exercise frequency

<table>
<thead>
<tr>
<th>Exercise (per week)</th>
<th>Person-years</th>
<th>Number of events</th>
<th>Incident rate (100,000 person-year)</th>
<th>Age-sex adjusted HR (95% CI)</th>
<th>Multivariate HR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Model 1</td>
</tr>
<tr>
<td>decreased</td>
<td>165,804.4</td>
<td>817</td>
<td>492.8</td>
<td>1.00 (reference)</td>
<td>1.00 (reference)</td>
</tr>
<tr>
<td>no change</td>
<td>453,924.5</td>
<td>2,025</td>
<td>446.1</td>
<td>0.93 (0.85-1.00)</td>
<td>0.85 (0.78-0.93)</td>
</tr>
<tr>
<td>increased</td>
<td>191,466.1</td>
<td>898</td>
<td>469.0</td>
<td>0.98 (0.89-1.08)</td>
<td>0.92 (0.82-1.02)</td>
</tr>
<tr>
<td>P for trend</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.733</td>
</tr>
</tbody>
</table>

**Model 1:** adjustment for age, sex, center, year of screening exam, smoking status, alcohol intake, education level, baseline exercise frequency  
**Model 2:** model 1 adjustments plus adjustment for BMI, FHX of DM glucose  
**Model 3:** model 2 adjustments plus adjustment for hsCRP
Risk of incident HTN according to the change in exercise frequency

<table>
<thead>
<tr>
<th>Exercise (per week)</th>
<th>Person-years</th>
<th>Number of events</th>
<th>incident rate (100,000 person-year)</th>
<th>Age-sex adjusted HR (95% CI)</th>
<th>Multivariate HR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>decreased</td>
<td>150,132.6</td>
<td>2,356</td>
<td>1,569.3</td>
<td>1.00 (reference)</td>
<td>1.00 (reference)</td>
</tr>
<tr>
<td>no change</td>
<td>411,984.3</td>
<td>6,002</td>
<td>1,456.9</td>
<td>0.99 (0.94-1.04)</td>
<td>0.93 (0.88-0.98)</td>
</tr>
<tr>
<td>increased</td>
<td>174,169.3</td>
<td>2,514</td>
<td>1,443.4</td>
<td>0.96 (0.91-1.02)</td>
<td>0.94 (0.88-1.00)</td>
</tr>
<tr>
<td>P for trend</td>
<td></td>
<td></td>
<td></td>
<td>0.160</td>
<td>0.064</td>
</tr>
</tbody>
</table>

Model 1: adjustment for age, sex, center, year of screening exam, smoking status, alcohol intake, education level, baseline exercise frequency
Model 2: model 1 adjustments plus adjustment for BMI, systolic BP
Model 3: model 2 adjustments plus adjustment for hsCRP
Conclusion

• Just, measurement of exercise dose on at one time, could not predict the incident risk of hypertension or DM in our study.

• But, change in exercise frequency was significantly associated with the risk of newly developing hypertension and DM in relatively healthy, middle-aged Korean men.
Impact of Physical Activity and Inflammation on All-cause, Cardiovascular-related and Cancer-related Mortality

Jong-Young LEE, Ki-Chul SUNG, MD, PhD

Division of Cardiology, Kangbuk Samsung Hospital, Sungkyunkwan University School of Medicine, Seoul, Korea

Mayo Clinic Proceedings accepted
### Hazard Ratio (95% Confidence Interval) of Mortality According to Baseline Physical Activity Level\(^a\)

<table>
<thead>
<tr>
<th>Mortality Rate (10,000 Person-Years)</th>
<th>Person-Years</th>
<th>Number of Events</th>
<th>Age- and Sex-Adjusted HR (95% CI)</th>
<th>Multivariable-Adjusted HR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Model 1(^b)</td>
<td>Model 2(^b)</td>
</tr>
<tr>
<td><strong>All-Cause Mortality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sedentary PA</td>
<td>1,083,112.1</td>
<td>1,146</td>
<td>1.00 (reference)</td>
<td>1.00 (reference)</td>
</tr>
<tr>
<td>insufficient PA</td>
<td>575,418.2</td>
<td>568</td>
<td>0.83 (0.75–0.92)</td>
<td>0.93 (0.82–1.04)</td>
</tr>
<tr>
<td>sufficient PA</td>
<td>225,014.4</td>
<td>217</td>
<td>0.68 (0.59–0.79)</td>
<td>0.84 (0.71–0.99)</td>
</tr>
<tr>
<td>health-enhancing PA</td>
<td>93,337.4</td>
<td>131</td>
<td>0.68 (0.57–0.82)</td>
<td>0.75 (0.66–0.94)</td>
</tr>
<tr>
<td>P for trend</td>
<td></td>
<td></td>
<td>&lt;.001</td>
<td>.002</td>
</tr>
<tr>
<td><strong>Cardiovascular-Related Mortality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sedentary PA</td>
<td>1,083,112.1</td>
<td>179</td>
<td>1.00 (reference)</td>
<td>1.00 (reference)</td>
</tr>
<tr>
<td>insufficient PA</td>
<td>575,418.2</td>
<td>85</td>
<td>0.80 (0.62–1.04)</td>
<td>0.94 (0.70–1.27)</td>
</tr>
<tr>
<td>sufficient PA</td>
<td>225,014.4</td>
<td>33</td>
<td>0.66 (0.46–0.96)</td>
<td>0.83 (0.54–1.27)</td>
</tr>
<tr>
<td>health-enhancing PA</td>
<td>93,337.4</td>
<td>14</td>
<td>0.44 (0.26–0.76)</td>
<td>0.58 (0.31–1.07)</td>
</tr>
<tr>
<td>P for trend</td>
<td></td>
<td></td>
<td>&lt;.001</td>
<td>.08</td>
</tr>
<tr>
<td><strong>Cancer-Related Mortality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sedentary PA</td>
<td>1,083,112.1</td>
<td>547</td>
<td>1.00 (reference)</td>
<td>1.00 (reference)</td>
</tr>
<tr>
<td>insufficient PA</td>
<td>575,418.2</td>
<td>249</td>
<td>0.77 (0.66–0.90)</td>
<td>0.81 (0.67–0.96)</td>
</tr>
<tr>
<td>sufficient PA</td>
<td>225,014.4</td>
<td>101</td>
<td>0.67 (0.54–0.83)</td>
<td>0.82 (0.64–0.98)</td>
</tr>
<tr>
<td>health-enhancing PA</td>
<td>93,337.4</td>
<td>73</td>
<td>0.77 (0.60–0.99)</td>
<td>0.77 (0.57–0.98)</td>
</tr>
<tr>
<td>P for trend</td>
<td></td>
<td></td>
<td>&lt;.001</td>
<td>.01</td>
</tr>
</tbody>
</table>
Hazard Ratio (95% Confidence Interval) of Mortality According to High-Sensitivity C-Reactive Protein Level and Baseline Physical Activity Level<sup>a</sup>

<table>
<thead>
<tr>
<th></th>
<th>Person-Years</th>
<th>Number of Events</th>
<th>Mortality Rate (100,000 Person-Years)</th>
<th>Age- and Sex-Adjusted HR (95% CI)</th>
<th>Multivariate-Adjusted HR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Model 1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Model 2&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>All-Cause Mortality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low hsCRP&lt;sup&gt;c&lt;/sup&gt; with regular PA</td>
<td>649,684.4</td>
<td>524</td>
<td>80.5</td>
<td>1.00 (reference)</td>
<td>1.00 (reference)</td>
</tr>
<tr>
<td>High hsCRP&lt;sup&gt;c&lt;/sup&gt; with regular PA</td>
<td>244,085.6</td>
<td>392</td>
<td>160.6</td>
<td>1.47 (1.29–1.68)</td>
<td>1.41 (1.21–1.64)</td>
</tr>
<tr>
<td>Low hsCRP with no regular PA</td>
<td>793,104.8</td>
<td>582</td>
<td>73.4</td>
<td>1.23 (1.10–1.39)</td>
<td>1.14 (0.99–1.30)</td>
</tr>
<tr>
<td>High hsCRP with no regular PA</td>
<td>290,007.3</td>
<td>564</td>
<td>194.5</td>
<td>1.96 (1.73–2.21)</td>
<td>1.57 (1.36–1.81)</td>
</tr>
<tr>
<td><strong>Cardiovascular-Related Mortality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low hsCRP with regular PA</td>
<td>649,684.4</td>
<td>75</td>
<td>11.5</td>
<td>1.00 (reference)</td>
<td>1.00 (reference)</td>
</tr>
<tr>
<td>High hsCRP with regular PA</td>
<td>244,085.6</td>
<td>57</td>
<td>23.3</td>
<td>1.45 (1.02–2.04)</td>
<td>1.47 (1.00–2.16)</td>
</tr>
<tr>
<td>Low hsCRP with no regular PA</td>
<td>793,104.8</td>
<td>87</td>
<td>11.0</td>
<td>1.31 (0.96–1.79)</td>
<td>1.17 (0.82–1.66)</td>
</tr>
<tr>
<td>High hsCRP with no regular PA</td>
<td>290,007.3</td>
<td>92</td>
<td>31.7</td>
<td>2.16 (1.58–2.94)</td>
<td>1.68 (1.17–2.42)</td>
</tr>
<tr>
<td><strong>Cancer-Related Mortality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low hsCRP with regular PA</td>
<td>649,684.4</td>
<td>231</td>
<td>35.6</td>
<td>1.00 (reference)</td>
<td>1.00 (reference)</td>
</tr>
<tr>
<td>High hsCRP with regular PA</td>
<td>244,085.6</td>
<td>192</td>
<td>78.7</td>
<td>1.60 (1.32–1.94)</td>
<td>1.51 (1.21–1.89)</td>
</tr>
<tr>
<td>Low hsCRP with no regular PA</td>
<td>793,104.8</td>
<td>278</td>
<td>35.1</td>
<td>1.34 (1.12–1.60)</td>
<td>1.28 (1.05–1.57)</td>
</tr>
<tr>
<td>High hsCRP with no regular PA</td>
<td>290,007.3</td>
<td>269</td>
<td>92.8</td>
<td>2.06 (1.72–2.46)</td>
<td>1.77 (1.43–2.18)</td>
</tr>
</tbody>
</table>
Conclusions

- In a large population-based cohort of middle-aged men, a higher PA level was significantly associated with dose-dependent lower risks of all-cause, cardiovascular, and cancer-related mortality.

- The subjects with high hsCRP level but no regular PA were exposed to the highest risk of mortality.

- Specifically, the risk of dying from CVD associated with high hsCRP was attenuated in participants who reported regular PA.
Effect of exercise on the development of new fatty liver and the resolution of existing fatty liver

Ki-Chul SUNG, Jong-Young Lee, MD, PhD

Division of cardiology, Kangbuk Samsung hospital,
Sungkyunkwan University School of Medicine, Seoul, Korea
Physical Activity and Fatty liver

Table 3. Risk of incident fatty liver according to baseline number of exercise sessions (per week).

<table>
<thead>
<tr>
<th>Exercise sessions (per week)</th>
<th>Person-years</th>
<th>Number of events</th>
<th>Incident (100,000 person-year)</th>
<th>Age-sex adjusted HR (95% CI)</th>
<th>Multivariate HR* (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Incident fatty liver</td>
<td>Incident fatty liver</td>
<td>Incident fatty liver</td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>0</td>
<td>371,025.9</td>
<td>15,083</td>
<td>4065.2</td>
<td>1.00 (reference)</td>
<td>1.00 (reference)</td>
</tr>
<tr>
<td>1-2</td>
<td>163,943.7</td>
<td>9220</td>
<td>5623.9</td>
<td>1.04 (1.01-1.07)</td>
<td>1.04 (1.00-1.07)</td>
</tr>
<tr>
<td>3-4</td>
<td>66,092.2</td>
<td>3488</td>
<td>5217.0</td>
<td>1.06 (1.02-1.10)</td>
<td>1.07 (1.02-1.12)</td>
</tr>
<tr>
<td>≥5</td>
<td>27,148.6</td>
<td>1263</td>
<td>4652.2</td>
<td>0.98 (0.93-1.04)</td>
<td>1.03 (0.96-1.11)</td>
</tr>
</tbody>
</table>

*p value for trend

Model 1: adjustment for age, sex, center, year of screening exam, smoking status, alcohol intake, education level; Model 2: model 1 adjustments plus adjustment for BMI, diabetes, HTN, CVD; Model 3: model 2 adjustments plus adjustment for change in BMI between baseline and follow-up.
Physical Activity and Fatty liver

Table 6. Associations between number of sessions of exercise per weeks and resolution of fatty liver at follow-up.

<table>
<thead>
<tr>
<th>Exercise sessions (per week)</th>
<th>Person-years</th>
<th>Number of events</th>
<th>Incident (100,000 person-year)</th>
<th>Age-sex adjusted HR (95% CI)</th>
<th>Multivariate HR* (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Resolution of fatty liver</td>
<td>Resolution of fatty liver</td>
<td>Resolution of fatty liver</td>
<td></td>
<td>Model 1</td>
</tr>
<tr>
<td>0</td>
<td>98,400.7</td>
<td>7677</td>
<td>7801.8</td>
<td>1.00 (reference)</td>
<td>1.00 (reference)</td>
</tr>
<tr>
<td>1-2</td>
<td>60,514.3</td>
<td>4699</td>
<td>7765.1</td>
<td>1.04 (1.00-1.08)</td>
<td>1.03 (0.98-1.07)</td>
</tr>
<tr>
<td>3-4</td>
<td>17,872.4</td>
<td>1571</td>
<td>8790.1</td>
<td>1.10 (1.04-1.16)</td>
<td>1.07 (1.00-1.15)</td>
</tr>
<tr>
<td>≥5</td>
<td>5556.2</td>
<td>567</td>
<td>10,204.8</td>
<td>1.19 (1.09-1.30)</td>
<td>1.21 (1.08-1.34)</td>
</tr>
<tr>
<td>*p value for trend</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
<td>0.001</td>
</tr>
</tbody>
</table>

*Model 1: adjustment for age, sex, center, year of screening exam, smoking status, alcohol intake, education level; Model 2: model 1 adjustments plus adjustment for BMI, diabetes, hypertension, CVD; Model 3: model 2 adjustments plus adjustment for change in BMI between baseline and end of study.
Conclusions

• Moderate to vigorous physical activity is beneficial in decreasing risk of development of new fatty liver or improving resolution of existing fatty liver during 5 years of follow-up.
PA is clearly linked to cardiovascular health and mortality.

PA is a Core Component for CR Programs.

PA Assessment is a Core Competency for CR Program Staff.

Initiating or improving standardized PA is an important for all CR Programs.

PA could be a “vital sign” in management.
Benefits of Exercise Training in “Secondary” Prevention Of CAD

TABLE 3. Benefits of Cardiac Rehabilitation and Exercise Training Programs

<table>
<thead>
<tr>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improvement in exercise capacity</td>
</tr>
<tr>
<td>Estimated METs: +35%</td>
</tr>
<tr>
<td>Peak VO₂: +15%</td>
</tr>
<tr>
<td>Peak anaerobic threshold: +11%</td>
</tr>
<tr>
<td>Improvements in lipid profile</td>
</tr>
<tr>
<td>Total cholesterol: −5%</td>
</tr>
<tr>
<td>Triglycerides: −15%</td>
</tr>
<tr>
<td>HDL-C: +6% (13%-16% increase in subgroups with low HDL-C levels)</td>
</tr>
<tr>
<td>LDL-C: −2%</td>
</tr>
<tr>
<td>LDL-C/HDL-C: −5% (higher in some subgroups)</td>
</tr>
<tr>
<td>Reduction in obesity indices</td>
</tr>
<tr>
<td>Body mass index: −1.5%</td>
</tr>
<tr>
<td>Percent fat: −5%</td>
</tr>
<tr>
<td>Metabolic syndrome: −37%</td>
</tr>
<tr>
<td>Reduction in inflammation (hs-CRP level: −40%)</td>
</tr>
<tr>
<td>Improvement in autonomic tone</td>
</tr>
<tr>
<td>Improvement in blood rheology and viscosity</td>
</tr>
<tr>
<td>Reduction in homocysteine levels</td>
</tr>
<tr>
<td>Improvements in behavioral characteristics (depression, anxiety, somatization, and hostility)</td>
</tr>
<tr>
<td>Improvements in overall quality of life and its components</td>
</tr>
<tr>
<td>Reduction in hospitalization costs</td>
</tr>
<tr>
<td>Reduction in overall morbidity and mortality (especially that associated with depression and psychological distress)</td>
</tr>
</tbody>
</table>
Energy Expenditure and Cardiovascular Disease

- <1,000 kcal/week has been associated with CAD progression
- Higher levels of PA/exercise (1,500 – 2,200 kcal/week) have been associated with stability and regression of CAD, respectively.
- Structured bouts of PA = <300 kcal/energy expenditure, thus, traditional exercise programs (3x - 30-40 minute/week) will not reach energy expenditure targets associated with CAD stability/regression (nor wt. loss!)
- Traditional exercise programs do not produce a high enough “dose” of PA and must be modified to increase duration and/or frequency.
All cardiac rehabilitation/secondary prevention programs should contain specific core components that aim to optimize cardiovascular risk reduction, foster healthy behaviors and compliance to these behaviors, reduce disability, and promote an active lifestyle for patients with cardiovascular disease.
Pedometer Features

- **Pros**
  - Accurately quantifies ambulatory activity
  - Relatively inexpensive
  - Provides immediate feedback
    - Potential to produce behavior change

- **Cons**
  - Applicable only for ambulatory activity
  - Not as accurate at slow walking speeds (≤2.0 mph)
  - Spring Type: waistband tilt with obese patients - inaccuracies
  - No information about intensity
Step Indices

- Step indices have been developed based on currently available research
  - <5,000 steps/d  
    - Sedentary
  - 5,000-7,499 steps/d  
    - Low Active
  - 7,500-9,999 steps/d  
    - Somewhat Active
  - 10,000-12,499 steps/d  
    - Active
  - >12,500 steps/d  
    - Highly Active

- Developed by Tudor-Locke and Bassett
Accelerometer Features

Pros

- assess the intensity of the movement
- store data and report frequency, intensity, and duration
- Can be analyzed for intermittent activity and 10 min bout time
- Can be worn on wrist or ankle or hip
- Most models also can provide step count data
- assess sedentary behaviors via inclinometers (sitting, lying)

Cons

- Capturing differing activity types (cycling, upper body, uphill walking, etc.) may require multiple units (waist, wrist, ankle)
- More expensive than pedometers
- No immediate feedback (needs to be downloaded)
Cardiorespiratory fitness and mortality

The graph shows the cumulative mortality rate over years of follow-up, categorized by quartiles. The cumulative mortality is measured in percent on the y-axis, and the years of follow-up are on the x-axis.