Exercise to Stay Healthy:
Keys to Longevity
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Disclosures: None.
Outline

1. Dangers of Physical Inactivity
2. Benefits of Regular Exercise
3. Components of an Exercise Prescription
Objectives

Part I
1. Learn health risks of inactivity
2. How to determine your own risk
3. How to self-evaluate your own fitness level
4. How to write yourself an individualized Exercise Prescription

Part II
1. Learn specifics of common musculoskeletal conditions → How to modify activities
2. Understand benefits of exercise → How it prolongs health and longevity
Part I
1. Health risks of Inactivity

WHY PROMOTE EXERCISE IN CLINICAL PRACTICE?
Overview

- Health care spending in US projected to reach $4.2 trillion by 2016 (CDC, 2011), with 70-90% of all health care costs stemming from preventable lifestyle-related diseases.

- Estimated 80% of all heart disease, type 2 DM, stroke could be prevented if Americans engaged in more physical activity, stopped smoking, maintained healthier diet (CDC, 2011).

- Regular physical activity clearly reduces risk of cardiometabolic disease, numerous cancers, enhancing bone health, muscle strength and mental health (USDHHS, 2008).
The 15 leading causes of death in 2013 were:

1. Heart Disease
2. Malignant neoplasms
3. Chronic lower respiratory diseases
4. Cerebrovascular diseases (stroke)
5. Accidents (unintentional injuries)
6. Alzheimer’s disease
7. Diabetes
8. Nephritis, nephrotic syndrome and nephrosis (kidney disease)
9. Influenza and pneumonia
10. Intentional self-harm (suicide)
11. Septicemia
12. Chronic liver disease and cirrhosis
13. Essential hypertension and hypertensive renal disease
14. Parkinson’s disease
15. Pneumonitis due to solids and liquids

Physical INACTIVITY-related diseases
How strong is the evidence for Exercise?
Physical Fitness: A Long-term Study Examining Health Outcomes

- 8-Year Study
- Study Group:
  - 10,224 men
  - 3,120 women

- **Physical Fitness:**
  - assessed by Maximal treadmill test (VO₂ max)

- Subjects grouped by fitness

**Fitness Groups:**
- Low: lowest 20%
- Moderate: middle 40%
- High: top 40%

Blair et al., 1989. *Journal of the American Medical Association*
Physical Fitness: Relationship To All-Cause Mortality

Blair et al. 1989 JAMA
Dose-Response of Fitness and Chronic Disease Mortality

Meyers et al., *NEJM*, 2002
Exercise, Obesity and Cancer Risk

THERE IS A STRONG LINK
between physical activity and a decreased risk of these cancers:
- Postmenopausal Breast
- Colorectal
- Endometrial

between body fatness and an increased risk of these cancers:
- Gallbladder
- Kidney
- Pancreatic
- Endometrial
- Esophageal

American Institute for Cancer Research 2013
Proportion of U.S. adults meeting both aerobic and muscle-strengthening physical activity guidelines* (CDC, 2011)

*150 min/week moderate-intensity aerobic physical activity + muscle-strengthening physical activity at least 2x/week

Overall, only 20.6% of American population meet guidelines

- Met aerobic: 39.0% Tennessee → 61.8% Colorado
- Met strengthening: 20.2% West Virginia → D.C. 36.1%
- Met both: 12.7% West Virginia → highest 27.3% Colorado
“The staggering $67.5 billion economic cost of physical inactivity worldwide to the health-care system through health-care expenditure and productivity losses should be a wake-up call for Ministries of Health.”

Ding Ding, Kenny D Lawson, Tracy L Kolbe-Alexander, Eric A Finkelstein, Peter T Katzmarzyk, Willem van Mechelen, Michael Pratt

The economic burden of physical inactivity: a global analysis of major non-communicable diseases

Simply put...

- Physical inactivity has an **astonishing** array of harmful health effects.
- Exercise is a **powerful** tool for both treatment and prevention of chronic disease & premature death.
- Physical inactivity is **THE** major public health problem of our time.
But... currently, most physicians fall short of even mentioning exercise to their patients.

Why?
Physician survey data show:

- 47% of PCPs include exercise history as part of initial exam
- 96% physicians feel it is their responsibility but only 28% feel confident in skills to prescribe exercise
- Only 30-40% physicians familiar with ACSM guidelines
- Only 13% of patients report physicians giving advice about exercise
- Only 17% of physicians reported having received any formal training on exercise counseling
- Only 10% of US medical school Deans perceive graduating students highly competent to design an exercise prescription

1Howe et al., 2010; 2Rogers, 2002; 3Costello 2012; 4Connaughton et al., 2001

Courtesy of Dr. Linda Hill and Dr. Jeanne Nichols
THEN WHAT ARE THE BARRIERS TO PRESCRIBING EXERCISE?
<table>
<thead>
<tr>
<th>Barrier</th>
<th>Number of studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of time</td>
<td>14</td>
</tr>
<tr>
<td>Lack of knowledge/training in PA counselling</td>
<td>8</td>
</tr>
<tr>
<td>Lack of success with changing patient behaviour</td>
<td>8</td>
</tr>
<tr>
<td>PA counselling not a priority/not relevant</td>
<td>7</td>
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<tr>
<td>Lack of financial incentive/reimbursement for counselling</td>
<td>5</td>
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<tr>
<td>Lack of counselling protocols</td>
<td>5</td>
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<tr>
<td>Organisational barriers</td>
<td>4</td>
</tr>
<tr>
<td>Lack of resources</td>
<td>3</td>
</tr>
<tr>
<td>Not enough evidence of benefits of PA</td>
<td>2</td>
</tr>
<tr>
<td>Educational materials for patients insufficient</td>
<td>2</td>
</tr>
<tr>
<td>Patients expect drug treatment</td>
<td>1</td>
</tr>
<tr>
<td>Lifestyle is personal choice so counselling not appropriate</td>
<td>1</td>
</tr>
</tbody>
</table>

Battling Tobacco; A Success Story

• Prior to 1953, doctors appeared in cigarette ads; many smoked.
• Not until late 60’s, did doctors begin to actively counsel quitting.
• 2004 was tipping point; first year ex-smokers outnumbered current smokers.
• It is time for exercise be pushed just as hard.
We have to get people moving

Regularly Active
Out of the chair & off the couch
Engaged in an Active, Healthy Lifestyle
Exercise is Medicine® is a global initiative to establish physical activity as a standard in healthcare. Established by the American College of Sports Medicine (ACSM) in 2007.

EIM mission:
To encourage physicians to assess and record physical activity as a vital sign during every patient visit, and to conclude each visit with an exercise prescription

www.exerciseismedicine.org  www.acsm.org
We need to “prescribe” exercise just like a medication.

UC San Diego Health
Exercise is a wonder Drug
Physicians should prescribe; Patients should take!

- Exercise is medicine that can prevent & treat chronic disease
- Those who take it LIVE LONGER
- “Imagine a pill that prevents & treats many chronic diseases, prolonging life?”
- Physicians would surely prescribe it to every patient
- Healthcare systems would surely pay for it and make sure every patient had access to this “wonder drug”
Taking a look at traditional drugs…

American Geriatrics Society Foundation for Health in Aging

People >65 be cautious about using following drugs:

1. **NSAIDS**: risk of indigestion, ulcers and bleeding, increase blood pressure, kidney damage, worsen heart failure, heart attack

2. **Muscle relaxants**: increase grogginess and confusion, increase risk of falls, constipation, dry mouth and urination problems

3. **Anti-anxiety/anti-insomnia** drugs: risk of falls, cause confusion

4. **Anticholinergics** *(e.g. benadryl)*: confusion, constipation, urination problems, blurry vision and low blood pressure
The Opioid Epidemic

In 2016...

- 116 People died every day from opioid-related drug overdoses
- 11.5 m People misused prescription opioids
- 42,249 People died from overdosing on opioids
- 2.1 million People had an opioid use disorder
- 948,000 People used heroin
- 170,000 People used heroin for the first time
- 2.1 million People misused prescription opioids for the first time
- 17,087 Deaths attributed to overdosing on commonly prescribed opioids
- 19,413 Deaths attributed to overdosing on synthetic opioids other than methadone
- 15,469 Deaths attributed to overdosing on heroin
- 504 billion In economic costs

“Every patient. Every visit. Every treatment plan.”

Physical activity should be a vital sign

We must begin to merge the healthcare industry with the fitness industry
Okay I get it, so Exercise “is” Medicine. But if I just start exercising, aren’t I “self-prescribing” which could be dangerous?
Part I

2. How to determine your own risk

How to determine Risk and Readiness for exercise
Patient Screening: Pre-Participation Evaluation

- To determine risks & readiness to participate in physical activity
  - Several questionnaires are in common use:
    1. PAR-Q
    2. Par Med-X
    3. ACSM Risk Stratification Flow Chart
ACSM Risk Stratification Flowchart

- **Known CV, Pulmonary, Metabolic Disease?**
  - **Yes**
  - CVD: cardiac, peripheral artery (PAD), or cerebrovascular disease.
  - Pulmonary: Chronic obstructive pulmonary disease (COPD), asthma, interstitial lung disease, or cystic fibrosis (CF)
  - Metabolic: Diabetes mellitus (type 1 or type 2), thyroid disorders, renal or liver disease.
  - **No**

- **Major Signs & Symptoms of CV, Pulmonary, Metabolic Disease?**
  - **Yes**
  - Pain, discomfort in the chest, neck, jaw, arms or other areas that may result from ischemia
  - Shortness of breath at rest or with mild exertion
  - Dizziness or syncope
  - Orthopnea or paroxysmal nocturnal dyspnea
  - Ankle edema
  - Palpitations or tachycardia
  - Intermittent claudication
  - Known heart murmur
  - Unusual fatigue or shortness of breath with usual activity
  - **No**

- **Cardiac Risk Factors ≥ 2 CHD risk factors**
  - **Yes**
  - Age
  - Smoking status
  - Obesity
  - Dyslipidemia
  - Family History
  - Sedentary Lifestyle
  - Hypertension
  - Pre-diabetes
  - **No**

- **High Risk**
  - Medical check-up recommended.
  - Doctor needed at maximal testing.
  - Doctor needed at sub-maximal test.

- **Moderate Risk**
  - Medical check-up not necessary for participation in moderate physical activity (40-60% VO₂R; 3-6 METs).
  - Medical check-up recommended for participation in vigorous physical activity (>60% VO₂R or > 6 METS).
  - Doctor needed at maximal test.
  - No doctor needed at sub-maximal test.

- **Low Risk**
  - No medical checkup needed for moderate or vigorous physical activity.
  - No doctor needed at maximal test.
  - No doctor needed at sub-maximal test.
Symptoms of major cardiovascular, pulmonary, metabolic disease

- Chest pain (and neck, jaw, arm symptoms), palpitations, heart murmurs
- Shortness of breath (at rest or exertion), orthopnea or paroxysmal nocturnal dyspnea
- Dizziness
- Syncope
- Intermittent claudication
- Leg edema

- **Cardiovascular Risk Factors**: Age (≥45 ♂/55 ♀), FH (≤55 ♂/65 ♀), Dyslipidemia, Sedentary lifestyle, Hypertension, Smoking, Prediabetes, Obesity
<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Defining Criteria</th>
</tr>
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<tbody>
<tr>
<td>Age</td>
<td>Men ≥ 45 yrs; Women ≥ 55 yrs</td>
</tr>
<tr>
<td>Family History</td>
<td>Heart attack, ‘Bypass surgery’, or sudden death before the age of 55 yrs for father/brother; or before 65 yrs for mother/sister.</td>
</tr>
<tr>
<td>Cigarette smoking</td>
<td>Current smoker, or have quit &lt; 6 months, or is exposed to environmental smoke.</td>
</tr>
<tr>
<td>Sedentary lifestyle</td>
<td><strong>Not participating in moderate (that makes you sweat) physical activity at least 3 days/week for 3-months.</strong></td>
</tr>
<tr>
<td>Obesity</td>
<td>Body mass index ≥ 30 kg/m² or waist girth &gt; 102 cm (40 in) for men and &gt; 88 cm (35 in) for women.</td>
</tr>
<tr>
<td>Hypertension</td>
<td>Systolic Blood Pressure ≥ 140 mmHg and or Diastolic ≥ 90 mmHg, or taking medication.</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>LDL ≥ 130 mg/dl, or HDL &lt; 40 mg/dl, or taking medication. Or TC &gt; 200 mg/dl</td>
</tr>
<tr>
<td>Pre-diabetes</td>
<td>IFG ≥ 100 mg/dl or OGGT ≥ 140 and ≤ 199 mg/dl confirmed by two different measurements.</td>
</tr>
<tr>
<td><strong>Negative Risk Factor</strong></td>
<td></td>
</tr>
<tr>
<td>HDL</td>
<td>≥ 60 mg/dl</td>
</tr>
</tbody>
</table>

*ACSM’s Guidelines for Exercise Testing & Prescription. LWW, 2014 (p. 27).*
**Mod Ex:** Moderate intensity exercise; 40-60% of VO2max; 3-6 METs; “an intensity well within the individual’s capacity, one which can be comfortably sustained for a prolonged period of time (~45 minutes)”

**Vig Ex:** Vigorous intensity exercise; > 60% of VO2max; > 6 METs; “exercise intense enough to represent a substantial cardiorespiratory challenge”

**Not Nec:** Not Necessary; reflects the notion that a medical examination, exercise test, and physician supervision of exercise testing would not be essential in the preparticipation screening, however, they should not be viewed as inappropriate
Part I
3. How to self-evaluate your fitness level

How to perform a *fitness evaluation*

1. Aerobic fitness
2. Muscular strength & endurance
3. Flexibility
4. Balance
How to perform a *fitness evaluation*

1. Aerobic fitness
CVD risk declines linearly with increasing PA, but drops precipitously from very lowest to the 25th percentile.

Fitness is an independent risk factor, should be considered in screening and intervention.

Compared to PA, PF is more sensitive to small changes at lower end of continuum.

Weight Independent Benefits of Physical Activity
Mortality outcomes after change in cardiorespiratory fitness

"Fat but Fit"

The best test: Max stress test with Indirect Calorimetry

- Gold standard
- Measures oxygen uptake (VO$_2$ in l/min or ml/kg/min)

- Used to assess:
  - **Maximal** aerobic power (VO$_{2\text{max}}$)
  - Peak oxygen consumption
  - Age, sex, & training level of the person performing the exercise influence results

- Direct measurement of VO2max is expensive, time consuming, requires technical knowledge and expertise, therefore not practical in many settings

- Sub-maximal testing another option
• **Estimated** VO$_2$\text{max} from final workload on a calibrated ergometer, e.g., treadmill, cycle or rowing ergometer, etc.

• Based on linear relationship between workload and oxygen consumption

• Stages 3min to ensure steady state HR

• Endpoint often 70% HRR or 85% HR$_{max}$

• Metabolic equations published for walking, running, leg or arm ergometry, and stepping

• Values expressed in VO$_2$ ml/kg/min, or in **METs**
Metabolic Equivalent Term

1 MET = "Basal" aerobic oxygen consumption at rest
   = 3.5 ml O2/Kg/min
2 METs = ~2 mph walking on level terrain
4 METs = ~4 mph on level terrain
< 5 METs = Poor prognosis (Groelicher et al Chest 1975)
10 METs = Predicts low mortality, even in the setting of significant CAD (as good prognosis w/ medical Tx as CABG)
13 METs = Excellent prognosis, regardless of other exercise responses
18 METs = elite endurance athlete
20 METs = world class athlete

Emerging data suggest that there are polarized risks:
Small increase in acute cardiac event risk above certain MET levels (however this is believed to be attenuated chronically by the benefits of sustained exercise training)

• Morris et al., Am Heart J 1991
• Robergs et al., Ex Phys 1997
• Myers NEJM 2002
• Bourque et al., J Am Coll Cardiol. 2009
• Bourque et al., J Nucl Cardiol. 2011
<table>
<thead>
<tr>
<th>&lt;5 METs</th>
<th>5-10 METs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking &lt;2 mph</td>
<td>Shoveling snow</td>
</tr>
<tr>
<td>2.0</td>
<td>6</td>
</tr>
<tr>
<td>Gardening, light</td>
<td>Singles tennis</td>
</tr>
<tr>
<td>2.0</td>
<td>7–12</td>
</tr>
<tr>
<td>General house</td>
<td>Strenuous hiking</td>
</tr>
<tr>
<td>cleaning</td>
<td>6–7</td>
</tr>
<tr>
<td>3.0</td>
<td>Swimming, crawl</td>
</tr>
<tr>
<td>3.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Walking briskly,3</td>
<td>Rowing or kayaking</td>
</tr>
<tr>
<td>mph</td>
<td>6–8</td>
</tr>
<tr>
<td>3.3</td>
<td>Running, 8 mph</td>
</tr>
<tr>
<td>3.3</td>
<td>13.5</td>
</tr>
<tr>
<td>Heavy yard work,</td>
<td>Skiing, downhill</td>
</tr>
<tr>
<td>gardening</td>
<td>6–8</td>
</tr>
<tr>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bicycling, 10–16mph</td>
</tr>
<tr>
<td></td>
<td>6–10</td>
</tr>
<tr>
<td></td>
<td>Aerobic calisthenics</td>
</tr>
<tr>
<td></td>
<td>6–10</td>
</tr>
</tbody>
</table>
Third-line: Estimate from Field Tests

• Very easy to perform
• Based on linear relationship between VO₂ and speed (0.1 ml O₂/meter/min for walking; 0.2 ml for running)
  – Correlates (~0.80-.90) with VO₂ max
  – Correlation with performance in races, from 10 km to marathon (0.62 - ~0.85)
    • Better correlation with trained athletes
    • They are used to running hard
    • Can pace appropriately

• Norms across the lifespan available
• Studies developed in 1968, 1970’s, Dr. Cooper from Air Force
Test Norms

Disclaimer:

• Field tests are very easy and convenient
• However, normative data can be outdated, maybe not generalizable to population
• *Initial studies developed in 1968, 1970’s, Dr. Cooper from Air Force*
• However may be very useful as a baseline, for “average person”
• If elite athlete, send them for formal metabolic performance testing
Field Tests of Aerobic Fitness

1. **Cooper 12-min run** (Fixed time test)
   - \( \text{VO}_{2\text{max}} = (35.97 \times \text{miles}) - 11.29 \)
   - 6-min walk test

2. **Cooper 1.5 mile run** (Fixed distance test)
   - Rockport 1-mile walk
   - 400m walk test

3. **3-min step test** (Heart rate recovery test)
   - Metronome to 96 bpm (24 steps/min), 12” step
   - Left ↑, Right ↑, Left ↓, Right ↓
   - At 3 min, sit and measure HR
   - Tests rate of recovery of HR related to \( \text{VO}_{2\text{max}} \)
### Cooper 1.5 mile run test

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>Very poor</th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>Excellent</th>
<th>Superior</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>&gt;16:01</td>
<td>16:00-14:01</td>
<td>14:00-12:01</td>
<td>12:00-10:46</td>
<td>10:45-9:45</td>
<td>&lt;9:44</td>
</tr>
<tr>
<td></td>
<td>Males</td>
<td>&gt;16:31</td>
<td>16:30-14:44</td>
<td>14:43-12:31</td>
<td>12:30-11:01</td>
<td>11:00-10:00</td>
<td>&lt;9:59</td>
</tr>
<tr>
<td>30-39</td>
<td>Females</td>
<td>&gt;19:31</td>
<td>19:30-19:01</td>
<td>19:00-16:31</td>
<td>16:30-14:31</td>
<td>14:30-13:00</td>
<td>&lt;12:59</td>
</tr>
<tr>
<td></td>
<td>Males</td>
<td>&gt;19:01</td>
<td>19:00-17:01</td>
<td>17:00-14:31</td>
<td>14:30-12:31</td>
<td>12:30-11:00</td>
<td>&lt;10:59</td>
</tr>
<tr>
<td>50-59</td>
<td>Females</td>
<td>&gt;20:31</td>
<td>20:30-20:01</td>
<td>20:00-19:01</td>
<td>19:00-16:31</td>
<td>16:30-14:30</td>
<td>&lt;14:29</td>
</tr>
<tr>
<td></td>
<td>Males</td>
<td>&gt;20:01</td>
<td>20:00-19:01</td>
<td>19:00-16:16</td>
<td>16:15-14:00</td>
<td>13:59-11:15</td>
<td>&lt;11:14</td>
</tr>
<tr>
<td>60-69</td>
<td>Females</td>
<td>&gt;21:01</td>
<td>21:00-20:30</td>
<td>20:31-19:31</td>
<td>19:30-17:30</td>
<td>17:30-16:30</td>
<td>&lt;16:29</td>
</tr>
</tbody>
</table>

1968, Dr. Cooper in Air Force  
Need to be able to run, and keep a steady pace
### Cooper 12-min run test

<table>
<thead>
<tr>
<th>Age</th>
<th>Very good</th>
<th>Good</th>
<th>Average</th>
<th>Bad</th>
<th>Very bad</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>2700+ m</td>
<td>2400 - 2700 m</td>
<td>2200 - 2399 m</td>
<td>2100 - 2199 m</td>
<td>2100- m</td>
</tr>
<tr>
<td>F</td>
<td>2000+ m</td>
<td>1900 - 2000 m</td>
<td>1600 - 1899 m</td>
<td>1500 - 1599 m</td>
<td>1500- m</td>
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<tr>
<td>M</td>
<td>2800+ m</td>
<td>2500 - 2800 m</td>
<td>2300 - 2499 m</td>
<td>2200 - 2299 m</td>
<td>2200- m</td>
</tr>
<tr>
<td>F</td>
<td>2100+ m</td>
<td>2000 - 2100 m</td>
<td>1700 - 1999 m</td>
<td>1600 - 1699 m</td>
<td>1600- m</td>
</tr>
<tr>
<td>M</td>
<td>3000+ m</td>
<td>2700 - 3000 m</td>
<td>2500 - 2699 m</td>
<td>2300 - 2499 m</td>
<td>2300- m</td>
</tr>
<tr>
<td>F</td>
<td>2300+ m</td>
<td>2100 - 2300 m</td>
<td>1800 - 2099 m</td>
<td>1700 - 1799 m</td>
<td>1700- m</td>
</tr>
<tr>
<td>M</td>
<td>2800+ m</td>
<td>2400 - 2800 m</td>
<td>2200 - 2399 m</td>
<td>1600 - 2199 m</td>
<td>1600- m</td>
</tr>
<tr>
<td>F</td>
<td>2700+ m</td>
<td>2200 - 2700 m</td>
<td>1800 - 2199 m</td>
<td>1500 - 1799 m</td>
<td>1500- m</td>
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<tr>
<td>M</td>
<td>2700+ m</td>
<td>2300 - 2700 m</td>
<td>1900 - 2299 m</td>
<td>1500 - 1899 m</td>
<td>1500- m</td>
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<tr>
<td>F</td>
<td>2500+ m</td>
<td>2000 - 2500 m</td>
<td>1700 - 1999 m</td>
<td>1400 - 1699 m</td>
<td>1400- m</td>
</tr>
<tr>
<td>M</td>
<td>2500+ m</td>
<td>2100 - 2500 m</td>
<td>1700 - 2099 m</td>
<td>1400 - 1699 m</td>
<td>1400- m</td>
</tr>
<tr>
<td>F</td>
<td>2300+ m</td>
<td>1900 - 2300 m</td>
<td>1500 - 1899 m</td>
<td>1200 - 1499 m</td>
<td>1200- m</td>
</tr>
<tr>
<td>M</td>
<td>2400+ m</td>
<td>2000 - 2400 m</td>
<td>1600 - 1999 m</td>
<td>1300 - 1599 m</td>
<td>1300- m</td>
</tr>
<tr>
<td>F</td>
<td>2200+ m</td>
<td>1700 - 2200 m</td>
<td>1400 - 1699 m</td>
<td>1100 - 1399 m</td>
<td>1100- m</td>
</tr>
</tbody>
</table>
### Norms for 3-Minute Step Test (Men)

<table>
<thead>
<tr>
<th>Fitness Category</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18-25</td>
</tr>
<tr>
<td>Excellent</td>
<td>&lt;79</td>
</tr>
<tr>
<td>Good</td>
<td>79-89</td>
</tr>
<tr>
<td>Above Average</td>
<td>90-99</td>
</tr>
<tr>
<td>Average</td>
<td>100-105</td>
</tr>
<tr>
<td>Below Average</td>
<td>106-116</td>
</tr>
<tr>
<td>Poor</td>
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<td>&gt;128</td>
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### Norms for 3-Minute Step Test (Women)

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<td>Poor</td>
<td>127-140</td>
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<tr>
<td>Very Poor</td>
<td>&gt;140</td>
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ACSM 2011 Position Stand

Cardiorespiratory Exercise

• 150 min moderate-intensity/week
• 75 min vigorous-intensity/week
• 30-60 min of moderate-intensity exercise 5 days/wk
• 20-60 min of vigorous-intensity exercise 3 days/wk
• 1 continuous session & shorter sessions (at least 10 min) both acceptable
• People unable to meet these minimums can still benefit from some activity
How to perform a fitness evaluation

1. Aerobic fitness
2. Muscular strength & endurance
Assessment of Muscular Strength and Endurance

• **Muscular Endurance:**
  - Push-up test
  - Curl-up (crunch) test
  - YMCA bench press test
    (80lb♂ 35lb♀ bar on
     60bpm cadence to failure)

• **Muscular Strength:**
  - **Hand grip** dynamometer
    commonly used

Other Strength tests:
  - **1-RM, 10-RM** bench press
    (convert 10-RM ➔ 1-RM
     estimate by 10-RM weight x
     0.75); often expressed
     strength/BW ratio
  - **Vertical and horizontal jump**
    (children, young adults, or
    athletes)
  - **Isokinetic testing, eg Cybex**
    and Biodex machines
    (used often in rehab)

UC San Diego Health
ACSM Push Up Test of Muscular Endurance

- Start in down position
  - Men on toes
  - Women on knees
- Chin (not stomach) should touch mat
- Test stops when client stops to rest or unable to maintain appropriate form within 2 reps
- Score = Max # consecutively without resting
ACSM Curl-up “crunch” Test

- Supine, knees 90°, arms at side
- Tape at finger level, tape 12cm distally (8cm if >45yo)
- Metronome 40bpm, curl up, curl down at cadence
- Until failure or reach max of 75 reps
- Test terminated if cadence broken

(Also YMCA sit-up test exists)
# ACSM Curl-up Test

**TABLE 4-10. Percentiles by Age Groups and Gender for Partial Curl-up***

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Gender</th>
<th>Age 20–29</th>
<th>Age 30–39</th>
<th>Age 40–49</th>
<th>Age 50–59</th>
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</table>

*Based on data from Canadian Standardized Test of Fitness Operations Manual, 3rd ed. Ottawa: Canadian Society for Exercise Physiology in cooperation with Fitness Canada, Government of Canada, 1986. See reference 40. The following may be used as descriptors for the percentile rankings: well above average (90), above average (70), average (50), below average (30), and well below average (10).
ACSM Grip Strength

- Client holds dynamometer at side, parallel with body
- Elbow flexed 90°
- Option for client to extend elbow
- Encouraged to squeeze as hard as possible without val salva
  - Coached to exhale throughout squeeze
  - Vocally encouraged to squeeze hard
- Score=highest of 3 attempts for each hand
Grip Strength and Mortality?

- Prospective Urban-Rural Epidemiology (PURE) study, 2015
- 142,861 participants
- Increased grip strength inversely associated with:
  1. CV mortality
  2. Non-CV mortality
  3. MI and stroke
  4. All cause mortality (!)
### NORMATIVE GRIP STRENGTH DATA:

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<thead>
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<th>Age</th>
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</tbody>
</table>

Resistance Exercise

- Each major muscle group 2-3 days/wk
- Variety of exercises and equipment
- Very light or light intensity best for older persons or previously sedentary adults
- 2-4 sets, 8-12 reps improve strength and power
  - 10-15 reps improve strength in middle-age and older persons starting exercise
  - 15-20 repetitions improve muscular endurance
- Wait at least 48 hrs between resistance training sessions
How to perform a *fitness evaluation*

1. Aerobic fitness
2. Muscular strength & endurance
3. Flexibility

*YOU MEAN THE ABILITY TO FLEX*
Flexibility Testing

• Standard: Goniometer for ROM of various joints (often in research and PT)

• Field test: Sit-and-Reach test

V-sit: Feet 8-12” apart, tape on floor at 15” mark of yardstick
ACSM Sit and Reach—Flexibility Assessment Protocol

• Participant should sit (without shoes) with soles of feet ~ 6 inches apart and placed flat against the sit and reach box.
  – Hands should be stacked on top of each other
• Participant should be coached to slowly reach forward with both hands as far as possible.
  – Be sure that the participant keeps the hands parallel
  – Do not allow participant to “bounce.” The stretch should be slow and controlled, and the final position should be held for ~2 seconds.
  – Do not allow the participant to bend their knees.
  – Score=Furthest distance that can be held for 2+ seconds
# Sit and Reach

Reaching to heel-line is 26cm

---

**TABLE 4-12. Percentiles by Age Groups for Trunk Forward Flexion Using a Sit-and-Reach Box (cm)**

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</table>

*Based on data from the Canada Fitness Survey, 1981. Reprinted from Canadian Standardized Test of Fitness (CSTF) Operations Manual, 3rd ed. With permission of Fitness Canada, Fitness and Amateur Sport Canada, Ottawa, 1986. The following may be used as descriptors for the percentile rankings: well above average (90), above average (70), average (50), below average (30), and well below average (10).

Note: These norms are based on a sit-and-reach box in which the “zero” point is set at 26 cm. When using a box in which the “zero” point is set at 23 cm, subtract 3 cm from each value in this table.
# V-Sit and Reach

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<th>WOMEN</th>
<th></th>
<th></th>
<th></th>
<th></th>
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<td>30's</td>
<td>40's</td>
<td>50's</td>
<td>60's</td>
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<tr>
<td>Excellent</td>
<td>22+</td>
<td>21+</td>
<td>21+</td>
<td>19+</td>
<td>17+</td>
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<tr>
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<td>18-21</td>
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<td>16-20</td>
<td>15-18</td>
<td>14-16</td>
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<td>11-14</td>
<td>9-13</td>
<td></td>
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<tr>
<td>Below Avg</td>
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<td>below 14</td>
<td>below 13</td>
<td>below 11</td>
<td>below 9</td>
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<tr>
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<td>60's</td>
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<td>23+</td>
<td>22+</td>
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<td>20 - 22</td>
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<tr>
<td>Below Avg</td>
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<td>below 16</td>
<td>below 14</td>
<td>below 14</td>
<td></td>
</tr>
</tbody>
</table>
ACSM 2011 Position Stand

Flexibility Exercise

- Target major muscle/tendon units of shoulder girdle, chest, neck, trunk, lower back, hips, legs, ankles
- 2-3 days/wk to improve ROM
- 10-30 seconds to point of tightness or slight discomfort
- Repeat stretch 2-4x, accumulating 60 seconds / stretch
- Static, dynamic, ballistic and PNF stretches all effective
- Most effective when the muscle is warm
- Try light aerobic activity or hot bath before stretching
How to perform a *fitness evaluation*

1. Aerobic fitness
2. Muscular strength & endurance
3. Flexibility
4. Balance
Why Test Balance?

- Impaired balance:
  - significantly impacts ADLs
  - increases fall risk
  - *can* be retrained in most individuals

- ACSM 2008 Physical Activity Guidelines:
  - 3 days a week for adults (≥65 yr)

- ACSM 2011 Position Stand:
  - renamed as *Neuromotor exercise*
  - Balance, agility, coordination and gait
  - Proprioceptive exercise training and multifaceted activities (tai chi and yoga)
  - “in older adults” (no age range)
Hip fracture and Mortality

• Hip fractures in US projected 840,000 by year 2040
• Hip fractures worldwide expected to surpass 6 million by year 2050
• Reported 1-year mortality after sustaining a hip fracture is extremely high
  – Estimated 14%-58% (Geriatr Orthop Surg Rehabil. 2010 Sep; 1(1): 6–14)
• And among those that survive, half of all patients are unfortunately never able to regain ability to live independently (Ann Intern Med. 1998;128(12 Pt 1):1010)
Gold Standard: Core Assessment Battery on the Balance Master

- Sensory Organization Test (SOT)
  - Isolates and assesses visual, somatosensory, and vestibular inputs

- Motor Control Test (MCT)
  - Ability to produce an appropriate response to recover and stabilize the COG over one’s base of support in response to a sudden change in standing surface.

- Limits of Stability (LOS)
  - Voluntary movement control to one’s perceived limits of stability

- Many more protocols
Field Tests of Balance (in Older Adults)

- Short Physical Performance Battery (SPPB)
  1. Standing balance (up to 10 sec each)
     • Feet side-by-side
     • Semi tandem
     • Tandem
  2. Gait speed (4 m)
  3. Chair stands (time to complete 5 reps)

In “older adults”:
- 0-6: higher fall risk, M and F
- 7-9: higher risk F
- 10-12: no fall risk
• Meta-analysis Pavasini et al, 2016

• Compared with score 10-12,
  – 0-3 had OR = 3.25 for *all cause mortality*
  – 4-6 had OR = 2.14
  – 7-9 had OR = 1.5
Neuromotor Exercise

- “Functional fitness training”, 2-3 days/wk
- Motor skills (balance, agility, coordination and gait)
- Proprioceptive exercise training and multifaceted activities (tai chi, yoga) to improve physical function and prevent falls in older adults
- 20-30 min/day is appropriate
Part I

4. How to write yourself an individualized Exercise Prescription

Prescribe Exercise!
The “Art” of Exercise Prescription: Putting it all together

• Ideal exercise prescription is:
  – Targeted to individuals
    • Interests of client
      – Improving Health? Performance?
      – Exercise preference?
    • Focus on fun
  • Needs
    – Cardiorespiratory
    – Strength
    – Flexibility
    – Balance

Use the “FITT” Principle
• Frequency
• Intensity
• Time (duration)
• Type
Frequency

- **Aerobic:**
  - 150min/week
  - At least 3 days a week *(Sedentary lifestyle risk)*
- **Strength:**
  - 2-3x/wk
- **Flexibility & Balance**
  - 2-3x/wk
- **Pick anything you like**
Intensity

• HR very common
  – Estimate max heart rate simply (220-age), take % of that
  – Heart Rate Reserve (HRR) better to account baseline fitness
    • HRR = HR$_{max}$ − HR$_{rest}$

• Recommended prescription ranges
  – ACSM: 65-90% HR max or 40-60% HRR (mod), 60-90% HRR (vigorous), 30-40% HRR if deconditioned
  – Intentionally broad range to include all categories, including very deconditioned

• Do not rely on HR alone
  – Even when max HR is known (vs. predicted), meds, climate, and other variables can have substantial effects

• Include subjective monitoring methods
  – Borg Rate of perceived exertion (RPE)
  – Talk test (Quinn, 2009), Counting Talk Test (Loose, 2012)
### Borg’s Rating of Perceived Exertion (RPE) Scale

<table>
<thead>
<tr>
<th>Perceived Exertion Rating</th>
<th>Description of Exertion</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>No exertion. Sitting &amp; resting</td>
</tr>
<tr>
<td>7</td>
<td>Extremely light</td>
</tr>
<tr>
<td>8</td>
<td>Very light</td>
</tr>
<tr>
<td>9</td>
<td>Light</td>
</tr>
<tr>
<td>10</td>
<td>Somewhat hard</td>
</tr>
<tr>
<td>11</td>
<td>Hard</td>
</tr>
<tr>
<td>12</td>
<td>Very hard</td>
</tr>
<tr>
<td>13</td>
<td>Extremely hard</td>
</tr>
<tr>
<td>20</td>
<td>Maximal exertion</td>
</tr>
</tbody>
</table>

### RPE Scale

<table>
<thead>
<tr>
<th>Intensity</th>
<th>Talk Test</th>
<th>RPE</th>
<th>%HRR</th>
<th>MET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>Able to sing</td>
<td>&lt;3</td>
<td>&lt;40%</td>
<td>&lt;3</td>
</tr>
<tr>
<td>Moderate</td>
<td>Able to talk, not sing</td>
<td>3-4</td>
<td>40-60%</td>
<td>3-6</td>
</tr>
<tr>
<td>Vigorous</td>
<td>Difficulty talking</td>
<td>5</td>
<td>&gt;60%</td>
<td>&gt;6</td>
</tr>
</tbody>
</table>
Time

• **Accumulate** 20-60 min/day
  – Intermittent exercise confers **same** health benefits
  – Minimum: 10 minute segments
  – At least 3 times a week
• More is better – but progression is key!
  – Every little bit counts
  – Work your way up
Type

- Aerobic activity (or activities)
- Use of large muscle groups, rhythmic movements
- High vs. low impact vs. non-weight bearing
- Based on medical history/conditions, accessibility, environmental conditions, enjoyment

*Include muscular strength activities
*Include flexibility, balance training
And don’t forget Progression

• Gradual progression of 4me, frequency, and intensity recommended for best adherence and least injury risk

• Initial conditioning stage: wks 1-4
  – Preparation for exercise (joints, ligaments)
  – Intensity and freq may be low

• Improvement stage: wks 5-24
  – Progression at faster rates
  – Deconditioned, elderly need more time for adaptation
  – Rule of thumb: <10% per week increase in duration, distance, etc.

• Maintenance stage: wk 24 on
  – May or may not increase; goal-dependent
  – Vary routine to keep interest up
# Exercise Prescription: The FITT Method

<table>
<thead>
<tr>
<th></th>
<th>Aerobic</th>
<th>Strength / Muscular Endurance</th>
<th>Flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Optimal</td>
<td>Minimum</td>
</tr>
<tr>
<td><strong>F (Frequency)</strong> (days/wk)</td>
<td>3</td>
<td>7 if moderate; 3-4 if vigorous</td>
<td>1</td>
</tr>
<tr>
<td><strong>I (Intensity)</strong></td>
<td>60% MHR, or RPE = 5 on 1-10 scale</td>
<td>80% MHR, or RPE = 7 on 1-10 scale</td>
<td>1 set of 15-20 reps</td>
</tr>
<tr>
<td><strong>T (Type)</strong></td>
<td>Any activity using large muscles</td>
<td>Any type of resistance exercise for all major muscles</td>
<td>Stretching exercises for all major muscles</td>
</tr>
<tr>
<td><strong>T (Time)</strong> (minutes/session)</td>
<td>3 x 10 min, or 30 min. continuous</td>
<td>45-60 min</td>
<td>6-8 exercises (approx 20 min)</td>
</tr>
</tbody>
</table>

*FITT = Frequency, Intensity, Type, Time  
** ‘Core’ and balance training will also be incorporated into the strength component.
Summary everything on 1 slide
Your “Homework”

- Risk Stratify:
  - ACSM Flow Chart

- Evaluate Fitness:
  1. Aerobic fitness: **Cooper 12-min run or 1.5 mile run, 3-min step test**
  2. Muscular strength: **grip strength, 1-RM, 10-RM**
     Muscular endurance: **push up test, curl-up test, YMCA bench press**
  3. Flexibility: **sit & reach**
  4. Balance: **SPPB**

- Prescribe: FITT
  1. **Cardiorespiratory**: 150min/wk, 40-60% HRR or use RPE, Talk test
  2. **Resistance**: 2-3x/wk, 2-4 sets 8-12 reps, variety, min 48 hrs b/w sessions
  3. **Flexibility**: 2-3x/wk, 10-30s totaling 1min/muscle, 2-4x
  4. **Neuromotor**: balance, agility, coordination, 2-3x/wk, 20-30min
Resources...

- **EIM**
  - [http://exerciseismedicine.org](http://exerciseismedicine.org)

- **ACSM ProFinder**
  - [http://certification.acsm.org/pro-finder](http://certification.acsm.org/pro-finder)

- **United States Registry of Exercise Professionals® (USREPS)**
  - [http://www.usreps.org/Pages/Default.aspx](http://www.usreps.org/Pages/Default.aspx)

- **YMCA**
  - Free wellness coaching sessions, group exercise classes, MobileFiT app

- **EPARC**
  - [http://eparc.ucsd.edu/](http://eparc.ucsd.edu/)
Contact us!

EPARC is located in the UCSD Division of Calit2, The California Institute for Telecommunications and Information Technology. This location facilitates collaboration of School of Medicine researchers in all of the programs in the Jacobs School of Engineering as well as with researchers in the broader San Diego region.

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La Jolla, CA 92093-0811
phone:  (858) 534-9315
e-mail:  eparc@ucsd.edu
fax:  (858) 534-9404
Part II

1. Common musculoskeletal pain

→ What exercises to do for back/shoulder/hip/knee pain

- I reviewed medical literature
- I surveyed numerous physical therapists
- I asked numerous athletic trainers and strength & conditioning specialists
How common?

**WHO February 2018**

- Up to 1 in 3 live with a painful & disabling musculoskeletal (MSK) condition
- MSK conditions 2nd largest contributor to disability worldwide
- MSK conditions not just older age –relevant across lifespan
  - Significantly limit mobility and dexterity
  - Leading to early retirement from work
  - Reduced accumulated wealth
  - Reduced ability to participate in social roles
### Extent of Pain-Related Disability Among Adults with Pain in the Last 3 Months, United States

<table>
<thead>
<tr>
<th>Location</th>
<th>Experienced in last 3 months</th>
<th>Difficulty with Basic Actions</th>
<th>Complex Activity Limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Back Pain</td>
<td>28.1%</td>
<td>51.6%</td>
<td>55.0%</td>
</tr>
<tr>
<td>Knee Pain</td>
<td>19.5%</td>
<td>37.3%</td>
<td>38.6%</td>
</tr>
<tr>
<td>Headache</td>
<td>16.1%</td>
<td>31.0%</td>
<td>33.5%</td>
</tr>
<tr>
<td>Neck Pain</td>
<td>15.1%</td>
<td>30.2%</td>
<td>34.4%</td>
</tr>
<tr>
<td>Shoulder Pain</td>
<td>9.0%</td>
<td>17.7%</td>
<td>21.4%</td>
</tr>
<tr>
<td>Hip Pain</td>
<td>7.1%</td>
<td>15.0%</td>
<td>18.4%</td>
</tr>
</tbody>
</table>

CDC and NCHS, 2010
Chronic shoulder pain: What exercises to do?

• It’s actually not about the shoulder muscles
  – Don’t have to do a lot of pushups, shoulder presses, “pushing” exercise
• It’s more about the upper back
  – Should focus more on the “pulling” & “posture”

1. Rowing exercises
   – Many variations, all aiming to promote strength around the shoulder blade
   – Raises up the “roof” of the shoulder joint, allows humeral head to move freely

2. Rotator cuff exercises
   – IR/ER exercises (0°, 45°, 90°)
   – “Scapation” exercise (thumbs up)
   – “YTWL”, “Thrower’s 10”, many others
   – Keeps humeral head well-situated in socket

3. Posture:
   – Avoid:
     • “FHP” Forward head posture
     • Rounded shoulders
   – Promote:
     • Chin tuck
     • Thoracic extension
Abduction at Glenohumeral Joint: The “Kinetic Arc”
Scapulohumeral Rhythm

- Serratus anterior
  - Inferior fibers
  - Most effective rotator due to its large moment arm
- Upper and lower trapezius
- Force-couple
- Coordinated rotational forces
- Coupled with glenohumeral abduction
Scapulothoracic Motions

“You can’t shoot a canon out of a canoe”
Chronic neck pain:
Exercises to do

1. Strengthen the “core” of the neck with better posture
   – Deep neck flexors
2. Reduce “Upper Crossed Syndrome”
3. Posture:
   – Avoid:
     • Forward head posture “FHP”
     • Rounded shoulders
   – Promote:
     • Chin tuck
     • Thoracic extension
• However, perhaps most important, better ergonomics may result in most improvement (learning to avoid triggering activities/positions)
  – Traditional weightlifting movements, when administered to neck, can be painful and does not reduce long-term neck pain
Upper Crossed Syndrome

BAD!

GOOD!
Chronic back pain

It’s all about the core

1. Front:
   - Strengthen abdominals (isometric exercises/planks/rollouts, crunches)
   - Not the traditional sit-up
   - *Also the quadriceps!*

2. Sides:
   - Strengthen obliques (planks)
   - *Also the hip abductors!*

3. Back:
   - Erector spinae muscles
   - *Also the gluteals! “Activate the glutes”*

Start with strengthening:
“McGill Big 3”

- Don’t need to *stretch* the back (too much)
  - Stretch the hip flexors and hamstrings
  - Reduce *lower crossed syndrome*

- Learn to *hinge at the hip*
- Focus is on *not* moving the back, but stabilizing it while moving other parts

UC San Diego Health
• "Imagine I've dropped a feather in front of your feet and asked to pick it up"
• "Usually everybody immediately moves their heads and looks down"
• "You've already started to bend incorrectly"
• Our backs curve into the leader "C"
• Other countries thing at the hip
• Toddlers naturally hip thing, by adulthood we get tightness
• To hip hinge though, must have enough hamstring flexibility
Chronic back pain

Back Mechanic

Praise for the “Back Mechanic”:

"Dr. McGill is a leading expert on back pain issues. His cutting-edge but practical advice has already helped our readers for more than a decade, and he even helped my own father avoid surgery and experience lasting relief! Dr. McGill is truly the last word in spine rehab."

Adam Campbell, Editor-in-Chief, Men’s Health

“There is no one better than professor Stuart McGill to advise on how to avoid and treat back injuries. He has created a scientific foundation of what causes back pain and has guided clinicians around the world.”

Chris McConville, Professor of Sport & Exercise Science, Bath University, UK

"Dr. McGill's work is making a huge impact on the health of the military and Amemiya, in the USAF. If you don’t know about the teachings of Stuart McGill, well let’s just say you don’t know.”

Philip Hargreaves, Chief Medical Officer, USAF

"He figured out my back and salvaged my Olympic career. The approach is in these pages, with many clear and helpful illustrations.”

Bethany Hirt, USA Olympic

"Dr. McGill is the most widely recognized spine researcher in the world. This book brings his knowledge straight to the people who need it most.”

William Meaigin, DC, Walter Reed National Military Medical Center, consultant to the White House

"He is the Dr’s back doctor, and in this pages guides the reader through the essential steps to become pain-free.”

Dr. Cleve Jay Muggs, Injury Prevention and Performance coordinator, St. Louis Cardinals, and Medical Director, Central Institute for Human Performance, St. Louis, USA

"Since implementing Dr. McGill’s treatment protocols, our worker compensation patients have returned to their job sooner. In this book, he explains back pain, and provides the reader with practical ideas toward recovery. Definitely recommended.”

John Repaci, CEO and Radio Louie, RN, Minnesota Health Network, USA

"Dr. McGill’s unique approach restored a pain-free back following a major back injury despite other experts telling me that my powerlifting career was finished. Once pain-free, I came back even STRONGER, and set scores in powerlifting.”

Brian Laush, Champion Powerlifter

www.backfitpro.com

Back Mechanic

The secrets to a healthy spine your doctor isn’t telling you

The step by step McGill Method to fix back pain

Stuart McGill PhD

ISBN: 978-0-9735018-2-7
Chronic hip pain

• Many people think to make the hip stronger, work on the hip muscles – ...the hip flexors?

1. Better to focus on hip abductors
   – Monster walks, clam shell, single-leg stand
   – Keeps pelvis aligned

2. Focus on hip extensors
   – Bridge variations (just don’t arch back, make sure it is hip)
   – Squats
     → Keeps ball well-situated in socket
     → Reduces anterior femoral glide

3. Balance exercises very important
   – Single leg standing exercises

4. Reduce lower crossed syndrome
   – Stretch hip flexors, hamstrings
Dr. Janda, Czech neurologist and physiatrist
Upper and Lower Crossed Syndrome

**Upper Crossed Syndrome**
- Inhibited
  - Deep cervical flexors
- Facilitated
  - SCM / Pectoralis

**Lower Crossed Syndrome**
- Inhibited
  - Abdominals
- Facilitated
  - Rectus Femoris / Iliopsoas

**Facilitated**
- Upper Trap / Levator Scapula
- Lower Trap / Serratus Ant.
- Thoraco-lumbar extensors
- Gluteus Min / Med/ Max

Figure 1: Janda's Muscle Imbalance Syndromes
Chronic knee pain

- Very similar to hip algorithm
  - Need to stabilize the hip otherwise just more stress on the already painful knee
  1. Strong hip abductors
  2. Strong hip glutes
  3. Strong quads
- Don’t need to stretch as much as you think
  4. Rather focus on balance, single-leg standing exercises
but what if it's the patellofemoral joint?

- Try to do the same things, but...

  - Patellofemoral pain very notorious for "getting worse with physical therapy"
  - Squats and lunges often very painful
  - Some 4Ps:
    - Reverse lunge rather than forward lunge
    - Upstairs bed than downstairs
    - Walk downstairs backwards? Huge fall risk
But what if it’s the patellofemoral joint?

• Some other options:
  – Box squat
  – Teaches you to squat using your back and hip muscles more
  – “Toilet squat”
• Point is, keep knee (relatively) behind toes when squatting
• Unfortunately, avoiding the triggering activity may end up best option
Summary: Strengthening

Goals:
- Stabilize the joint, so more stress put on muscles and tendons rather than the painful joint – "Tensional integrity"
- Studies showing strengthening can reduce JSN progression
- Exercise in orthogonal planes
  - Sagittal
  - Non-sagittal (lateral)
  - Just be careful as your joint may not be used to that motion
  - And watch out when trying to combine these in 1 exercise
  - Very often this is what results in a flare of pain, "therapy made it worse"
Summary: Stretching

- So many types of stretches
- Highest yield, top 3:
  - Thoracic extension
  - Hip flexors
  - Hamstrings
- Extras, also high yield:
  - Pec minor
  - Hip adductors
Summary: Posture

• Many classes, courses, sessions, certifications

• Goals is to improve:
  – Scapulohumeral rhythm in upper body
  – Lumbopelvic rhythm in lower body

• Or, more simply:
  – Upper crossed syndrome
  – Lower crossed syndrome
Summary: Balance

• High yield balance exercises:
• Anything on one leg
• Anything that involves a different limb
  – Sobriety tests are good example
  – Brushing teeth on one leg
  – Track stands
But I have really severe arthritis.

Management of OA (mainly hip and knee, but applicable to any joint)

OARSI Guidelines for the Non-surgical Management of Knee OA

Core Treatments
Appropriate for all individuals

- Land-based exercise
- Weight management
- Strength training
- Water-based exercise
- Self-mgmt and education

Recommended treatments*
Appropriate for the following OA types:

Knee-only OA without co-morbidities

- Biomechanical interventions
- Intra-articular Corticosteroids
- Topical NSAIDs
- Walking Cane
- Oral COX-2 Inhibitors (selective NSAIDs)
- Capsaicin
- Oral Non-selective NSAIDs
- Duloxetine
- Acetaminophen (Paracetamol)

Knee-only OA with co-morbidities

- Biomechanical interventions
- Walking Cane
- Intra-articular Corticosteroids
- Topical NSAIDs

Multi-joint OA without co-morbidities

- Oral COX-2 Inhibitors (selective NSAIDs)
- Intra-articular Corticosteroids
- Oral Non-selective NSAIDs
- Duloxetine
- Biomechanical interventions
- Acetaminophen (Paracetamol)

Multi-joint OA with co-morbidities

- Balneotherapy
- Biomechanical interventions
- Intra-articular Corticosteroids
- Oral COX-2 Inhibitors (selective NSAIDs)
- Duloxetine

*OARSI also recommends referral for consideration of open orthopedic surgery if more conservative treatment modalities are found ineffective.

Fig. 1. Appropriate treatments summary.
But I have really severe arthritis

- But it’s bone on bone!
  - “Motion is Lotion”
- Some other options to lessen the pain (esp. knee OA):
  - Walking:
    - With slightly wider BOS
    - Pointing toes slightly out
    - Some learn to walk with increased medial-lateral sway
  - Stairs:
    - Slightly wider BOS
    - Pointing toes slightly in
Okay, but I don’t have a joint problem, it’s the tendon

- Tendonitis, tendinosis, tendinopathy
- Also can be very painful
- If joint becomes so painful and arthritic, last resort is surgery
- But, no matter how painful, no surgery for chronic tendon
- Eccentric exercise
  - The most painful part of exercise
  - Expect it to hurt
  - That is the point
  - “Mechanotherapy”

Mechanotherapy

1. Cytoskeleton deformation triggers nucleus activation
2. Series of biochemical signaling via tensin

What about PRP and Stem Cells?

• Eccentric Exercise is what you need
  – Stimulates DNA to produce new collagen
  – Promotes collagen reorganization
  – Disrupts neovascularization (*reduces pain*)
  – “Tendons like Loads”

• “You don’t ‘need’ PRP or stem cells: you have direct access to your DNA through exercise”

Eccentric Programs

- **Alfredson et al. 1998**
  - Eccentric only
  - 3 x 15 reps, BID x 12 weeks
  - BW initially, then progress
  - “Heel drops”

- **Silbernagel et al. 2007**
  - Eccentric + concentric
  - QD x 3-6 months
  - BW initially, then progress

- **Kongsgaard et al. 2009, 2010**
  - Heavy slow resistance (HSR)
  - 70-85% of 1RM (4 x 6-15 reps)
  - 3up-3down
  - 3x/week

- **Beyer et al. AJSM 2015**
  - HSR
  - Similar outcomes to Alfredson
  - Better compliance
Part II

2. Benefits of exercise

→ How it prolongs life and longevity
We’ve known it for years...

- Bone mass peaks at age 20
  - Bone loss 1%/year, 10%/decade
- Muscle weakness starts at age 30
  - Lose muscle strength 15%/decade from 50-70, 30%/decade after that
- Endurance peaks age 25-35
  - Endurance athlete loses 10% VO2max from age 35→55
- From adulthood→retirement
  - Lose 8-10cm in sit & reach test
  - Decline in metabolic rate 10%, another 10% after retirement
- Loss of 2-3” height usual with aging
- Lose max performance in sports 2%/yr 50-70, up to 8%/yr 70-75
- Overall functional capacity declines ~1.0%/year after age 30

Pretty depressing...however:

- Exercise is an intervention that will help maintain and enhance functional ability as chronological age increases
  - Reduces age-related decline in VO2 max
  - Reduces mean blood pressure
  - Reduces systemic vascular resistance
  - Preserves lean body mass
  - Decreases fat deposits
  - Increases HDL
  - Decreases triglycerides
  - Increases bone mineral content
  - Improves basal metabolic rate
  - Increases muscle strength
  - Increases cognitive functioning

• Some benefits happen immediately
• A single bout of moderate-to-vigorous physical activity:
  – Reduce blood pressure
  – Improve insulin sensitivity
  – Improve sleep
  – Reduce anxiety symptoms
  – Improve cognition
  – On the day that it is performed!
How does resistance exercise help?

- *Reduces* pain scores, not worsens (over time)
- *Heavier* weights actually reduces pain scores more than lighter weights
  - 60% of a 1-rep max (1RM) vs. 10% of 1RM
  - 3 x 8 vs. 3 x 15
- Also increases compliance/adherence to exercise programs (less total workout time)
- Rebalances muscle activation patterns
  - Many with OA have weak “posterior chain” → malaligned knees, lax knees (which are risk factors for OA)
  - Increases proteoglycan synthesis (*if cyclical loading*)

How does resistance exercise help?

• Strength training:
  – Slows strength loss with normal aging
  – Slows joint space narrowing progression
  – Mainly related to amount of quadriceps strengthening

• Even if deconditioned, chronic illness, obesity
  – Associated with weaker quads and lumbar muscles
  – These weak muscles absorb less force, more force transmits to joint and cartilage
  – Altered biomechanics increase abnormal loading on the joint
  – Increased intramuscular fat & surrounding joint fat, more local joint compressive forces

How does resistance exercise help?

• Not only improves physical ability, but confidence & self-efficacy scores
  – Improves confidence with activities of daily living
  – Increases a patient’s control over one’s health, leads to increased amount of physical activity
  – Reduces pain-related activity avoidance (fear avoidance) & pain catastrophizing
  – Improves feeling of well-being (although not as much as aerobic exercise)
• 2x/week, 60% of 1RM, 3 x 8-12
• If you want, can progress to:
  – 3x/week, ~80% of 1RM, 3 x 8
Even if I’m about to have surgery?

• “Prehab” before surgery shown to:
  – Improve recovery after surgery
  – Enhance strength balance b/w operative and nonoperated limb
  – Improves outcomes after joint replacement
  – Reduces “arthrogenic muscle inhibition”: inhibition of full muscle activation due to joint injury or joint surgery
  – Helps maximize normalization of gait after surgery

PM R 2012;4:S45-52, PM R 2012;4:S141-144
How does aerobic exercise help?

- Regular aerobic exercise in research shown to reduce bone loss, promote cartilage growth, reduce pain, increase function, improve well-being

- Cartilage:
  - Immobilization for 6 days ↓ proteoglycan synthesis in cartilage by 41%
  - By 3 weeks, zero new proteoglycan synthesis
  - Cartilage thins under prolonged reduced loading
  - Is reversible: cast for 6 weeks → after resuming physical activity for 2 weeks, proteoglycan synthesis begins
  - However, top athletes do not display increased cartilage thickness
  - Exercise doesn’t increase cartilage but prevents loss ("use it or lose it!")

PM R 2012;4:S37-44
How does aerobic exercise help?

• Aerobic exercise:
  – Improves pain scores (more than strength training)
  – Improves well-being (more than strength training)
  – Dose-response effect, the more exercise → better patient outcomes

• How does aerobic exercise help in weight loss?
  – 5% loss typically feel less pain
  – 10% reduction in body weight very significant in terms of less joint loading
  – 1lb weight loss → 4lb reduction in knee joint forces

PM R 2012;4:S37-44
Lastly, what about too much exercise?

• Risk of disease progression?
  – IF no malalignment of limb, no increased risk of OA
  – Runners & non-runners have similar rates of OA
  – Quad strengthening, hip abductor strengthening reduces knee adduction forces to reduce OA
  – Contact sports do increase risk of hip OA
    • Some athletes may show less cartilage thickness & may have bone spurs, but those individuals usually have no joint space narrowing, overall better function, less pain (*tensional integrity*)

PM R 2012;4:S37-44
Thank you

- Get out there, and be safe!
85-year-old Ed Whitlock sets marathon world record; oldest person to run 26.2 miles under four hours

Hidekichi Miyazaki, Japan  
“Golden Bolt,” 107-years old

Charles Eugster, UK  
96-years old; bodybuilder and sprinter; multiple world records in his age group
airplane with a dead engine in 1931, he's had a taste for thrill rides.

On Saturday, he celebrated his 102nd birthday by setting the Guinness World Record for the oldest person to ride a zip line.
Resources

8. Sallis RE. Exercise is Medicine.
   http://www.instituteoflifestylemedicine.org/home/about-the-ilm/.
10. Lifestyle Medicine Education Collaborative, Dennis Muscato.
11. Exercise and Physical Activity Resource Center, EPARC.