Meeting 2

Welcome
Richard D. Olson, MD, MPH
Designated Federal Officer
PAGAC Public Meeting 2 Agenda

Day 1, Thursday October 27th

• Call to Order, Roll Call, and Welcome
• Public Oral Testimony
• Presentation and Discussion on Device-based vs. Reported Measurement of Physical Activity
• Committee Discussion
• Meeting Adjourn

Day 2, Friday October 28th

• Call to Order, Roll Call, and Welcome
• Introduction Subcommittee Presentations, Overarching Goals, and Committee Discussion
• Subcommittee Presentations
• Break
• Subcommittee Presentations
• Lunch
• Overall Question Prioritization
• Committee Discussion
• 3:15 pm Wrap Up and Next Steps
• Meeting Adjourn
Ken Powell, MD, MPH, Co-chair
Retired, CDC and Georgia Department of Human Resources

Abby C. King, PhD, Co-chair
Stanford University School of Medicine

David Buchner, MD, MPH, FACSM
University of Illinois

Wayne Campbell, PhD
Purdue University

Loretta DiPietro, PhD, MPH, FACSM
George Washington University

Kirk I. Erickson, PhD
University of Pittsburgh

Charles H. Hillman, PhD
Northeastern University

John M. Jakicic, PhD
University of Pittsburgh

Kathleen F. Janz, EdD, FACSM
University of Iowa

Peter T. Katzmarzyk, PhD
Pennington Biomedical Research Center

William E. Kraus, MD, FACSM
Duke University

Richard F. Macko, MD
University of Maryland School of Medicine

David Marquez, PhD, FACSM
University of Illinois at Chicago

Anne McTiernan, MD, PhD, FACSM
Fred Hutchinson Cancer Research Center

Russell R. Pate, PhD, FACSM
University of South Carolina

Linda Pescatello, PhD, FACSM
University of Connecticut School of Medicine

Melicia C. Whitt-Glover, PhD, FACSM
Gramercy Research Group
PA Assessment Mode Issues for Consideration: A View from NHANES

Richard P. Troiano, Ph.D.
Captain, USPHS
U.S. Adults Meeting PA Recommendations

BRFSS Self-Report*  NHANES Self-Report**  Accelerometer***

% meeting recommendation

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRFSS Self-Report*</td>
<td>49.9</td>
<td>46.4</td>
</tr>
<tr>
<td>NHANES Self-Report**</td>
<td>57.8</td>
<td>42.5</td>
</tr>
<tr>
<td>Accelerometer***</td>
<td>3.8</td>
<td>3.2</td>
</tr>
</tbody>
</table>

* BRFSS 2005 (30 min x 5d moderate or 20 min x 3 d vigorous)
** NHANES 2003-2004 (150 min/week moderate or greater intensity)
*** NHANES 2003-2004, 20-59 y (30 min x 5d moderate or greater, Troiano et al. 2008)
Presentation Overview

1. NHANES questionnaire and accelerometer protocol

2. Within-person activity time comparisons from 2003-2006 NHANES

3. Evolving thoughts about self-report and objective measures

4. Accelerometer relation with biomarkers and mortality
NHANES 2003-2006

• Nationally representative survey
  – Complex, multi-stage probability sample
  – Population racial-ethnic subgroups
    • Non-Hispanic White
    • Non-Hispanic Black
    • Mexican-American

• Interview in household

• Examination at mobile center
NHANES Physical Activity Questionnaire

• Administered in household interview

• Activities that last “at least 10 minutes”

• Past 30 days reference period
  – Report times per day, week as desired

• Contexts:
  – Transportation
  – Household tasks
  – Recreational exercise, sports, active hobbies
    • Vigorous and moderate intensity separately
    • Frequency & duration for specific activities engaged for 10+ min
  – Note: no occupational activity questions
Objective Measurement by Accelerometer
PA Monitors in NHANES 2003-2006

- Ages 6 y +
  - Wheelchair-bound/non-ambulatory excluded
- Ask for 7 d of wear while awake
  - Take off for water activities (swim, bathe)
- Mail back monitor
- Response rate ~90% (any data provided/eligible)

- Valid day
  - 10 h of wear
- Valid record for analysis
  - 4 or more valid days
- Waist-worn
  - Locomotor cutpoints
COMPARISON OF SELF-REPORT AND ACCELEROMETER
### Category Agreement (%) (~ PAG Adherence)

<table>
<thead>
<tr>
<th>Reported minutes</th>
<th>Bouted accelerometer minutes</th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-149</td>
<td>150-300</td>
<td>301 +</td>
<td></td>
</tr>
<tr>
<td>0-149</td>
<td>37.8</td>
<td>1.0</td>
<td>0.3</td>
<td>39.1</td>
</tr>
<tr>
<td>150-300</td>
<td>16.6</td>
<td>0.8</td>
<td>0.4</td>
<td>17.9</td>
</tr>
<tr>
<td>301 +</td>
<td>36.0</td>
<td>5.0</td>
<td>2.0</td>
<td>43.0</td>
</tr>
<tr>
<td>Total</td>
<td>90.4</td>
<td>6.9</td>
<td>2.7</td>
<td>100</td>
</tr>
</tbody>
</table>

40.6% categorically agree

60.9% report meeting PAG

9.6% have 150 + bouted minutes by accelerometer

NHANES 2003-6 age 18+, weighted, n= 6576
A Deeper Dive

- 6092 adults (ages 20 y +) with questionnaire data and accelerometer wear for 4-7 days
- Questionnaire (Q)
  - Summed all minutes reported as moderate or greater intensity
- Accelerometer (A)
  - Summed moderate intensity or greater (AC > 2020) minutes in “bouts”
- Categorized by zero, non-zero minutes from Q and A
  - Calculated minutes of moderate or greater intensity PA within each category and instrument
  - Divided non-zero groups into quintiles for classification agreement
Many Minutes Are Reported with Zero Measured Bouts

Percent with no measured bouts

- Men 20-59 y: 39.2%
- Men 60+ y: 66.2%
- Women 20-59 y: 52.8%
- Women 60+ y: 74.1%
## Category Agreement: Men Ages 20-59 y

<table>
<thead>
<tr>
<th>Accel. Categ</th>
<th>Category Based on Self-Report</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>4.89</td>
<td>9.61</td>
<td>7.52</td>
<td>5.36</td>
<td>6.39</td>
<td>5.42</td>
<td>39.20</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>1.71</td>
<td>1.95</td>
<td>2.61</td>
<td>2.23</td>
<td>2.06</td>
<td>1.78</td>
<td>12.34</td>
</tr>
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<td>2</td>
<td></td>
<td>1.33</td>
<td>2.06</td>
<td>1.95</td>
<td>2.73</td>
<td>1.56</td>
<td>2.42</td>
<td>12.04</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>0.94</td>
<td>2.12</td>
<td>2.22</td>
<td>2.10</td>
<td>2.65</td>
<td>2.21</td>
<td>12.24</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>0.58</td>
<td>1.44</td>
<td>2.14</td>
<td>2.83</td>
<td>2.58</td>
<td>2.49</td>
<td>12.07</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>0.76</td>
<td>0.89</td>
<td>1.46</td>
<td>2.68</td>
<td>2.72</td>
<td>3.59</td>
<td>12.11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>10.22</td>
<td>18.08</td>
<td>17.90</td>
<td>17.94</td>
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<td>17.90</td>
<td>100.0</td>
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Values are weighted percent within each cell.
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17.1% agree
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Values are weighted percent within each cell

48.7 % agree +/- 1 category
## Category Agreement: Men Ages 20-59 y

The table below represents the agreement between accelerometer categories and self-report categories for men ages 20-59 years. The values are weighted percent within each cell. The note at the bottom of the table highlights the distribution across accelerometer categories for low active individuals.

<table>
<thead>
<tr>
<th>Accel. Categ</th>
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Note: Distribution across accelerometer categories for low active individuals. Values are weighted percent within each cell.
Effect of Relaxing Intensity and Bout Criteria

Men, 20-59 years

<table>
<thead>
<tr>
<th>% Agree</th>
<th>2020 Cutpoint</th>
<th></th>
<th>760 Cutpoint</th>
<th></th>
</tr>
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<tbody>
<tr>
<td></td>
<td>10 min</td>
<td>5 min</td>
<td>10 min</td>
<td>5 min</td>
</tr>
<tr>
<td>Exactly</td>
<td>17.1</td>
<td>20.2</td>
<td>21.7</td>
<td>20.2</td>
</tr>
<tr>
<td>+/- 1 category</td>
<td>48.7</td>
<td>52.3</td>
<td>55.3</td>
<td>53.4</td>
</tr>
</tbody>
</table>

Women, 20-59 years

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<td></td>
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<td>5 min</td>
</tr>
<tr>
<td>Exactly</td>
<td>20.8</td>
<td>23.6</td>
<td>23.8</td>
<td>22.0</td>
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<td>+/- 1 category</td>
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CONCEPTUALIZATION
Physical Activity Conceptual Framework

Related, but not quantitatively identical

Pettee Gabriel et al., 2012 JPAH
A Conceptual Model for Measurement of Physical Activity

Heather Bowles & James McClain, National Cancer Institute

Behavior
- Actions and inactions of people (individuals or groups) in response to internal and/or external stimuli
- The propensity of an individual to move rather than the actual quantification of movement
- Blends psychosocial/environmental context with groupings of activities

Activities
- Complex skills formed by fundamental movement patterns: locomotor (e.g., walking, running), non-locomotor (e.g., balancing, twisting), and manipulative (e.g., kicking, throwing) – or, in some cases, simply the fundamental movements
- Movement in the context of space, effort, quality, and relationship of body parts

Motion
- Instantaneously detected bodily acceleration signals
Sources of Poor Agreement

• Intensity assessment
  – Accelerometer – Absolute intensity ~3 MET
  – Questionnaire – Relative intensity

• Bout length assessment
  – Questionnaire asks for activities of at least 10 minutes
  – Activities with movement patterns of shorter duration may get included

• Behavior and motion are related, but not equivalent
ACCELEROMETER AND BIOMARKERS
### Stronger Biomarker Associations

<table>
<thead>
<tr>
<th>Biomarker</th>
<th>Self-report</th>
<th>Accelerometer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Beta (SE)</td>
<td>Adj. Wald F</td>
</tr>
<tr>
<td>SBP</td>
<td>0.01 (0.03)</td>
<td>0.23</td>
</tr>
<tr>
<td>BMI</td>
<td>-0.04 (0.01)</td>
<td>14.95***</td>
</tr>
<tr>
<td>HDL (mg/dL)</td>
<td>0.10 (0.03)</td>
<td>8.54**</td>
</tr>
<tr>
<td>Glycohemoglobin</td>
<td>-0.004 (0.001)</td>
<td>7.91**</td>
</tr>
<tr>
<td>Glucose</td>
<td>0.01 (0.07)</td>
<td>0.06</td>
</tr>
<tr>
<td>Insulin (μU/mL)</td>
<td>-0.08 (0.03)</td>
<td>10.15**</td>
</tr>
</tbody>
</table>

** p < 0.01  
*** p < 0.001  
**** p < 0.0001  

Minutes in bouts, Beta per 10 min unit  
Atienza et al., 2011 MSSE
DOSE AND MORTALITY
One (of several) Mortality Analyses

Accelerometer-measured dose-response for physical activity, sedentary time, and mortality in US adults¹–³

Charles E Matthews,⁴* Sarah Kozey Keadle,⁴ Richard P Troiano,⁵ Lisa Kahle,⁷ Annemarie Koster,⁹ Robert Brychta,⁸ Dane Van Domelen,¹⁰ Paolo Caserotti,¹⁰ Kong Y Chen,⁸ Tamara B Harris,¹¹ and David Berrigan⁶

- NHANES 2003-2006 participants ages 40 y+ (n=4840 analyzed)
- Followed for mortality until 12/31/2011
- 700 deaths

- Isotemporal substitution model

AJCN in press
Suppl Figure 5. Association between moderate-vigorous (AC ≥2020) time and mortality (HR [solid line], 95% CI [dashed lines]).

Adjusted for age, race, education, smoking, alcohol, diabetes, CHD, cancer, stroke, mobility limitations, BMI. Model fit is non-linear and non-wear time was trimmed at the 1st and 95th percentiles.
C. Moderate-vigorous intensity (AC $\geq 760$)

- No adjust sedentary time
- Adjust sedentary time (continuous)

Hazard Ratio vs. Moderate-vigorous (hrs/d)

Reference hazard ratio is 1.0.
Other Issues to Name-Check

• Absolute vs. relative intensity
• Device plus algorithm/cutpoint, not device alone
• Accuracy vs precision (or research vs consumer devices)
  – Especially in light of devices for self-monitoring
• Effect of wear location for devices
  – What is measured at wrist vs waist?
• Most important type of PA may not be aerobic
Thank you

Discussion
Meeting 2

Committee Discussion
Physical Activity and Musculoskeletal Health

Kathy Janz, Ken Powell, Rick Troiano

Lab, animal, & clinical studies indicate that **osteogenic** activities are high impact forces and/or high muscle forces applied rapidly, oddly, and with breaks.

These activities effect the material, geometry, & micro architecture of whole bone.

*Scans Khan et al. 2001 ; Nelson 1998*
Animal, lab, & clinical studies indicate an impact* force threshold ~ 3 x BW needed to improve bone strength.

*Note High Muscle Forces (Power) Also Improve Bone Strength.
Multiple bone attributes define bone strength.

- **Material**: bone mineral mass and density
- **Geometry**: size, shape, distribution of whole bone
- **Micro-architecture**: porosity of trabecular & cortical bone
What we hope to accomplish.

• Better quantification of physical activity dimensions that influence musculoskeletal health.
  – Improve understanding of dose-response

• Challenge to create dose measures of forces (impact & muscle) that can be understood outside of resistance training and accomplished safely during daily activity.
What we are asking (with a focus on adult literature):

1. What are the most helpful physical activities for bone health and muscle strength?
2. Why those activities?
3. How much and how strong is the evidence to support dose for these activities?
Who we are asking:

• Wendy Khort, University of Colorado, physiology of aging, 2008 PAG, 2004 ACSM Position
• Jon Tobias, University of Bristol, everyday quantification bone loading
• Heather McKay, Director Hip Health & Mobility Centre, University of British Columbia
• Katherine Brooke-Wavell, Loughborough University, interventions athletes and adults
Meeting Adjourned
Richard D. Olson, MD, MPH
Designated Federal Officer