Measurement of Physical Activity in Children and Youth

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Outline

• Background

• Settings
  – Research
  – Surveillance
  – Practice

• Methods
  – Self-Report
  – Surrogate Report
  – Direct Observation
  – Devices
Background

• Definitions and Constructs

• Physical Activity and Health in Children and Youth
Physical Activity

Any bodily movement produced by skeletal muscles that results in energy expenditure

Intensity of Physical Activity

• Rate of Energy Expenditure

• METs – Metabolic Equivalent

• Light – 1.5-2.9 METs

• Moderate – 3.0-5.9 METs

• Vigorous – 6.0+ METs
Constructs

• Total Physical Activity
  – Time spent (per day) at intensities at or above 1.5 METs

• Moderate-to-Vigorous Physical Activity
  – Time spent (per day) at intensities at or above 3.0 METs

• Bouts of Physical Activity
  – Number (per day) of 5, 10, or 20 minute sustained periods of physical activity above specified MET level
Kids Benefit from High Levels of Physical Activity
Physical Activity Guidelines Advisory Committee Report 2008

• The report was presented to the Secretary of Health and Human Services and published in June 2008.
Health Benefits of Physical Activity
Children and Adolescents

• **Strong Evidence:**
  • Improved cardiorespiratory endurance & muscular fitness
  • Favorable body composition
  • Improved bone health
  • Improved cardiovascular & metabolic health biomarkers

• **Moderate Evidence:**
  • Reduced symptoms of anxiety & depression
Physical Activity Guidelines for Americans
Children and Adolescents (6–17 years of age)

• Children and adolescents should do 1 hour (60 minutes) or more of PA every day.

• Most of the 1 hour or more a day should be either moderate- or vigorous-intensity aerobic PA.

• As part of their daily PA, children and adolescents should do vigorous-intensity activity on at least 3 days per week. They also should do muscle-strengthening and bone-strengthening activity on at least 3 days per week.
Reasons for Measuring Physical Activity in Youth

• Research
  – Dependent variable
    o Intervention trials
    o Prospective observational studies
  – Exposure variable
    o Experimental health outcome studies
    o Observational health outcome studies
  – Effect modifying or mediating variable
Reasons for Measuring Physical Activity in Youth

• Surveillance
  – Prevalence of Meeting Public Health Guidelines
  – Change in Population Physical Activity Levels
  – Targets for Public Health Interventions

• Practice
  – Education
  – Health Care
Measurement Methods
Measurement of Physical Activity in Children – Special Concerns

- Recall limitations
- “Packaging” of PA
- Forms of PA
- Compliance with measurement protocols
Self-Report Measures
3-Day Physical Activity Recall (3DPAR)

- **3DPAR**
  - 2 weekdays (Tuesday & Monday)
  - 1 weekend day (Sunday)

- **List of 55 activities**
  - Subject reported predominant activity for each 30 minute time block
  - from 7 am until 12 am
3-Day Physical Activity Recall (3DPAR)

Activity Scale

The purpose of this questionnaire is to estimate the amount of physical activity that you perform.

The name of each day (Tuesday, Thursday, and Sunday) that you will describe is located in the top right hand corner of each page.

1. For each time period, circle the activity number which corresponds to the main activity you actually performed during that particular time period.

2. Then rate how physically hard each activity was. Place a “✓” in the time table to indicate one of the following intensity levels for each activity:

   - Light - Slow breathing, little or no movement.

   - Moderate - Normal breathing and some movement.

   - Hard - Increased breathing and moderate movement.

   - Very Hard -Breathing and quick movement.

Activity Numbers

- Eating
  1. Eating a meal
  2. Snacking

- Work
  1. Working (e.g., part-time job, child care)
  2. Driving
  3. Using home stairs (e.g., vacuuming, washing, doing dishes, cleaning, etc.)
  4. Using home stairs (e.g., vacuuming, washing, doing dishes, cleaning, etc.)
  5. Yard Work (e.g., weeding, mowing)

- Physical Activity Outside Home
  1. Walking to/from school
  2. Swimming
  3. Running
  4. Biking
  5. Hiking
  6. Hiking around

- Household
  1. Lifting/moving/bending/standing
  2. Washing/vacuuming/mopping
  3. Mowing, raking, shoveling
  4. Doing household chores

- Transportation
  1. Driving in a car
  2. Walking to/from school
  3. Biking

- Sleep/Eating
  1. Getting up
  2. Getting ready (bath, shower, etc.)
  3. Sleeping

- Sample activity time chart:

<table>
<thead>
<tr>
<th>Activity Numbers</th>
<th>Light</th>
<th>Moderate</th>
<th>Hard</th>
<th>Very Hard</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-00-07:30</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>7:30-08:00</td>
<td>✓</td>
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<td></td>
</tr>
<tr>
<td>8:00-08:30</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8:30-08:00</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>8:30-08:30</td>
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<td>8:30-09:00</td>
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<td>9:00-09:30</td>
<td>✓</td>
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</tr>
<tr>
<td>9:30-10:00</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>10:00-10:30</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Only extremely hard activities for each category are included.
3-Day Physical Activity Recall (3DPAR)

• Each activity assigned a MET value

• Average over the 3 days

• Data reduced to number of “blocks” of physical activity
  – Moderate (3-5.9 METs)
  – Moderate-to-vigorous (≥ 3 METs)
  – Vigorous (≥ 6 METs)
Self-Administered Physical Activity Recall (SAPAC)

• Previous Day
  – Before school
  – During school
  – After school

• List of 21 activities
  – Child estimates amount of time

• Data reduction
  – Number of activities, minutes, Total MET-minutes

• Series of 1-day recalls

Sallis et al. 1993; Sallis et al. 1996
<table>
<thead>
<tr>
<th>A. Activity</th>
<th>B. Before School</th>
<th>C. None, Some, Most</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bicycling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Swimming Laps</td>
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</tr>
<tr>
<td>3. Gymnastics: bars, beam, tumbling, trampoline</td>
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<tr>
<td>4. Exercise: push-ups, sit-ups, jumping jacks</td>
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<tr>
<td>5. Basketball</td>
<td></td>
<td></td>
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<tr>
<td>6. Baseball/Softball</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Football</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Soccer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Volleyball</td>
<td></td>
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<tr>
<td>10. Racket Sports: badminton, tennis</td>
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<td></td>
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<tr>
<td>11. Ball Playing: Four Square, dodge ball, kickball</td>
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</tr>
<tr>
<td>12. Games: chase, tag, hopscotch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Outdoor Play: climbing trees, hide and seek</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Water Play: (swimming pool, ocean or lake)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Jump Rope</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Dance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Outdoor Chores: mowing, raking, gardening</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Indoor Chores: mopping, vacuuming, sweeping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Mixed Walking/ Running</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Walking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Running</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. Other: (physical activity classes, lessons or teams)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td></td>
<td></td>
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<tr>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
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</tr>
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</table>

<table>
<thead>
<tr>
<th>Before School</th>
<th>After School</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.V./Video</td>
<td>H.1 ___ hours ___ minutes</td>
</tr>
<tr>
<td>Video Games &amp; Computer Games</td>
<td>H.3 ___ hours ___ minutes</td>
</tr>
</tbody>
</table>
Youth Risk Behavior Surveillance System (YRBSS)

• During the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day? (Add up all the time you spent in any kind of physical activity that increased your heart rate and made you breathe hard some of the time.)
Youth Risk Behavior Surveillance System (YRBSS)

• During the past 7 days, on how many days did you do exercises to **strengthen or tone your muscles**, such as push-ups, sit-ups, or weight lifting?
Other Systems with Physical Activity Self-Reports

• NHANES

• National Survey of Children’s Health

• American Time Use Survey

• National Household Travel Survey
Physical Activity Surveillance

• An ideal surveillance instrument to monitor youth’s PA:
  – Valid estimate of current PA level
    o Provides the basis for determining compliance with PA guidelines
  – Information regarding specific types of PA
    o Informs public health initiatives to increase PA
  – Low participant burden
  – Useful in programmatic and clinical settings
Purpose

• To apply state-of-the-art psychometric methods in developing a youth physical activity self-report instrument that could be used in public health surveillance systems.
Study Design

- Mixed methods, qualitative and quantitative sequential research design
In the past week (7 days), did you… | Number of days
---|---
Have PE/gym classes? | No  Yes [1 2 3 4 5 6 7]
Play on an organized school sports team? | No  Yes [1 2 3 4 5 6 7]
Walk or bike to or from school? | No  Yes [1 2 3 4 5 6 7]
Play actively during recess or other free-time during the school day? | No  Yes [1 2 3 4 5 6 7]
Participate in physical activity in an afterschool program? | No  Yes [1 2 3 4 5 6 7]
Play on an organized, non-school sports team? | No  Yes [1 2 3 4 5 6 7]
Participate in physically active classes or lessons? *(dance, tennis, karate, gymnastics, etc)* | No  Yes [1 2 3 4 5 6 7]
Do weight training? | No  Yes [1 2 3 4 5 6 7]
Ride your bike or other wheeled toys for fun or exercise? *(scooter, skateboard, rollerblades, rollerskates, etc.)* | No  Yes [1 2 3 4 5 6 7]
Run or jog for fun or exercise? | No  Yes [1 2 3 4 5 6 7]
Walk for fun or exercise? | No  Yes [1 2 3 4 5 6 7]
Play actively at home? | No  Yes [1 2 3 4 5 6 7]
Play non-organized sports? | No  Yes [1 2 3 4 5 6 7]
Play actively in your neighborhood? | No  Yes [1 2 3 4 5 6 7]
Direct Observation Measures
Observational System for Recording Physical Activity in Children-Preschool Version (OSRAC-P)

- Momentary time sampling observation system
- 5-sec observe interval, then 25-sec record interval for each 30-second observation interval.
- PA level and activity type, social environment (e.g., initiator of activity, group composition), and nonsocial environment (e.g., child location and activity contexts)

OSRAC-P

• Physical activity levels
  – Level 1: Stationary
  – Level 2: Stationary with limb movement
  – Level 3: Light activity (slow, easy movement)
  – Level 4: Moderate activity
  – Level 5: Vigorous activity

• Sedentary Category: levels 1 & 2
• Active Category: levels 3, 4, 5
• MVPA Category: levels 4 & 5

OSRAC-P

• Observers had extensive training
• Reliability assessed during 12% of total observations
  – Inter-observer agreement (IOA) was good (83%-100%)
  – Kappa scores indicated good inter-observer reliability (0.80-0.95)
  – Mean Kappa for PA level was 0.82
  – Mean IOA was 91%

• INTMAN software with hand-held Dell Axim computers

Brown WH et al. RQES 2006; 77(2):167-76
<table>
<thead>
<tr>
<th>Act Level</th>
<th>Act Type</th>
<th>Location</th>
<th>Indoor</th>
<th>Outdoor/Gym</th>
<th>Act Initiator</th>
<th>Group</th>
<th>Prompts</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Climb</td>
<td>1 Inside</td>
<td>1 Art</td>
<td>1 Ball/Object</td>
<td>1 Adult</td>
<td>1 Solitary</td>
<td>1 None</td>
</tr>
<tr>
<td>2</td>
<td>Crawl</td>
<td>2 Outside</td>
<td>2 Books/Preacademic</td>
<td>2 Fixed</td>
<td>2 Child</td>
<td>2 1-1 Adult</td>
<td>2 TP-I</td>
</tr>
<tr>
<td>3</td>
<td>Dance/Exp</td>
<td>3 Transition</td>
<td>3 Gross Motor</td>
<td>3 Game</td>
<td>3 Can't Tell</td>
<td>3 1-1 Peer</td>
<td>3 TP-D</td>
</tr>
<tr>
<td>4</td>
<td>Jump/Skip</td>
<td>4 Can't Tell</td>
<td>4 Group Time</td>
<td>4 Open Space</td>
<td>99 ?</td>
<td>4 Grp-Adult</td>
<td>4 PP-I</td>
</tr>
<tr>
<td>5</td>
<td>Lie Down</td>
<td>99 ?</td>
<td>5 Large Block</td>
<td>5 Pool</td>
<td>5 Grp-Child</td>
<td>5 PP-D</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Pull/Push</td>
<td>6 Manipulative</td>
<td>6 Portable</td>
<td>6 Can't Tell</td>
<td>6 Can't Tell</td>
<td>6 Can't Tell</td>
<td></td>
</tr>
<tr>
<td>99 ?</td>
<td>R&amp;T</td>
<td>7 Music</td>
<td>7 Sandbox</td>
<td>99 ?</td>
<td>99 ?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Ride</td>
<td>8 Nap</td>
<td>8 Snacks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Rock</td>
<td>9 Self Care</td>
<td>9 SocioProps</td>
<td>10 TeacArranged</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Roll</td>
<td>10 Snacks</td>
<td>10 TeacArranged</td>
<td>11 Time Out</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Run</td>
<td>11 Sociodramatic</td>
<td>11 Time Out</td>
<td>13 Other</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>12</td>
<td>Sit/Squat</td>
<td>12 TeacArranged</td>
<td>12 Wheel</td>
<td>13 Other</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Stand</td>
<td>13 Time Out</td>
<td>14 N/A</td>
<td>14 N/A</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Swim</td>
<td>14 Transition</td>
<td>15 Can't Tell</td>
<td>99 ?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Swing</td>
<td>15 Videos</td>
<td>16 Other</td>
<td>99 ?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Throw</td>
<td>16 Other</td>
<td>17 N/A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Walk</td>
<td>17 N/A</td>
<td>18 Can't Tell</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Other</td>
<td>18 Can't Tell</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>19</td>
<td>Can't Tell</td>
<td>99 ?</td>
<td></td>
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</tr>
</tbody>
</table>
Physical Activity Levels of Preschoolers

- Fast
- Moderate
- Slow-Easy
- Limbs
- Sedentary

Percent of Intervals

TOTAL

INSIDE ONLY

OUTSIDE ONLY
SOFIT
System for Observing Fitness Instruction Time

T. McKenzie, et al
SOFIT

Purpose

• To obtain simultaneous objective data on student activity levels, lesson context in which they occur (i.e., how lesson content is delivered, including time for fitness, skill drills, game play, knowledge, and management), and teacher interactions relative to promoting physical activity and fitness. Teacher gender, class gender composition, and lesson location, and number of students in class are also recorded.
SOFIT Main Categories

• Student Physical Activity
  – Lying down, sitting, standing, walking, vigorous

• Lesson Context
  – Management, knowledges, fitness, skill drills, game play, other

• Instructor Behavior
  – Promotes PA (in class; outside)
Device-Based Measures
Types of Devices

• Heart Rate Monitors
• Pedometry
• Accelerometry
Accelerometry
Accelerometer Placement
Validation of Physical Activity Measures
Trial of Activity for Adolescent Girls

Accelerometer Calibration Sub-study
Primary Outcome Variable

• **Average daily minutes of:**
  - **intensity-adjusted** moderate-to-vigorous physical activity (MVPA)
  - using MTI accelerometer (model 7164)

• **Alternate**
  - Average daily minutes of MVPA
Description of Calibration Sub-study

• 74 girls from 3 sites (JHU, UMN, USC)

• 10 activities ranging from low to high intensity
  – watching TV, playing computer game,
  – sweeping floor, walking slowly
  – walking stairs, walking briskly,
  – shooting hoops, step aerobics, riding bicycle, running
Calibration Results

<table>
<thead>
<tr>
<th>Activity</th>
<th>Avg MET Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watching TV, computer game</td>
<td>1.1</td>
</tr>
<tr>
<td>Sweeping floor, walking slowly</td>
<td>3.2</td>
</tr>
<tr>
<td>Walking briskly</td>
<td>4.2</td>
</tr>
<tr>
<td>Walking stairs</td>
<td>6.7</td>
</tr>
<tr>
<td>Shooting hoops</td>
<td>6.6</td>
</tr>
<tr>
<td>Step aerobics</td>
<td>5.7</td>
</tr>
<tr>
<td>Riding bicycle</td>
<td>6.2</td>
</tr>
<tr>
<td>Running</td>
<td>7.9</td>
</tr>
</tbody>
</table>
Met Score vs. Actigraph Counts
Excludes watching TV, computer games
MET Score vs. Actigraph Counts

Random regression lines for each girl and overall regression line
Results

• Regression equation
  – MET = 2.03 + 1.67(MTI counts/half min)

• MET-minutes of MVPA
  – Sum of MET-half-minutes per day divided by 2

• Set threshold of MTI counts corresponding to moderate activity to 1500
  – Cut-point which best differentiates slow from brisk walking (National Guideline)
  – Gives equal weight to false positive/negative
Practice Applications
Resources


Thanks!

http://www.asph.sc.edu/USC_CPARG/