

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

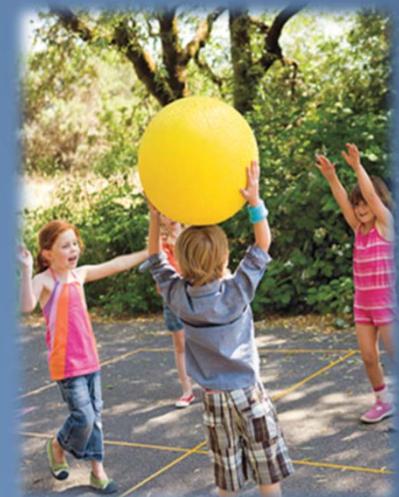
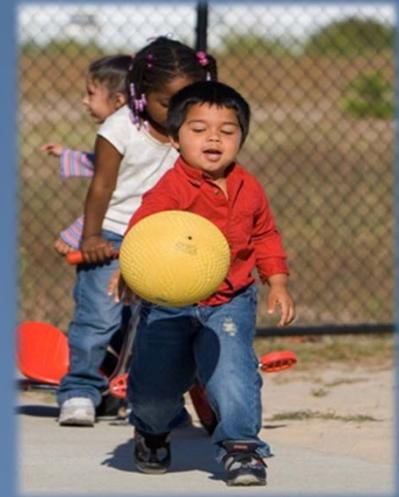
Any bodily movement produced by skeletal muscles that results in energy expenditure

Caspersen CJ, Powell KE, Christenson GM. Public Health Rep. 100(2):126-131, 1985.



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

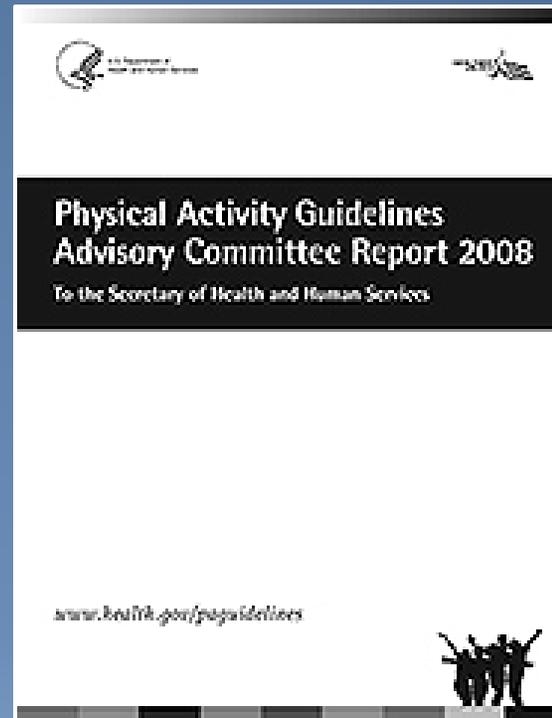
- Total Physical Activity
 - Time spent (per day) at intensities at or above 1.5 METs
- Moderate-to-Vigorous Physical Activity
 - Time spent (per day) at intensities at or above 3.0 METs
- Bouts of Physical Activity
 - Number (per day) of 5, 10, or 20 minute sustained periods of physical activity above 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

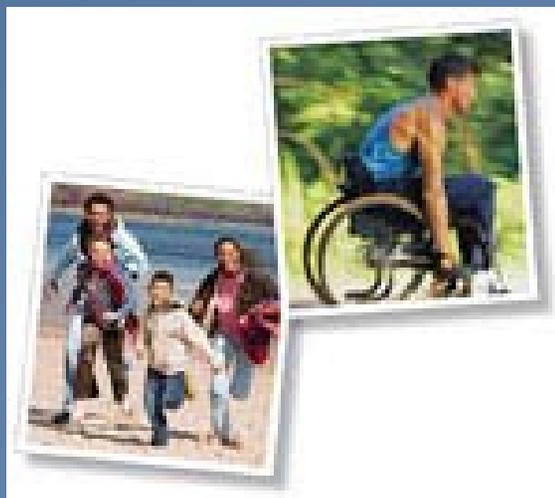
- **Moderate Evidence:**

- 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
 - Intervention trials
 - Prospective observational studies
 - Exposure variable
 - Experimental health outcome studies
 - 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)

Activities Scale

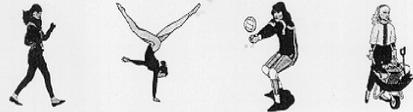
The purpose of this questionnaire is to estimate the amount of physical activity that you perform.
The name of each day (Tuesday, Monday, and Sunday) that you will describe is located in the top right hand corner of each time sheet.

- For each time period write in the activity number which corresponds to the main activity you actually performed during that particular time period.
- 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** - Hard breathing and quick movement.



Activity Numbers

Eating

- Eating a meal
- Snacking

Work

- Working (e.g., part-time job, child care) (list)

- Doing house chores (e.g., vacuuming, dusting, washing dishes, animal care, etc.)
- Yard Work (e.g., mowing, raking)

After School/Spare Time/ Hobbies

- Church
- Hanging around
- Homework
- Listening to music
- Marching band/flag line/drill team
- Music lesson/playing instrument
- Playing video games/surfing Internet
- Reading
- Shopping
- Talking on phone
- Watching TV or movie

Transportation

- Riding in a car/bus
- Travel by walking
- Travel by bicycling

Sleep/Bathing

- Getting dressed
- Getting ready (hair, make-up, etc.)
- Showering/bathing
- Sleeping

School

- Club, student activity
- Lunch/free time/ study hall
- P.E. class
- ROTC
- Sitting in class

Physical Activities and Sports

- Aerobics/aerobic dancing
- Basketball
- Bicycling
- Bowling
- Calisthenics (i.e., jumping jacks, sit-ups)
- Cheerleading
- Dancing (social, recreational)
- Dancing (ballet, jazz, modern, tap)
- Field hockey
- Frisbee
- Golf
- Horseback riding
- Ice/roller skating
- Jogging/running
- Karate/judo/martial arts/ self-defense
- Rollerblading
- Skateboarding
- Soccer
- Softball/baseball
- Stationary exercise machines (e.g., cycle, ski machine, stair climber, treadmill)
- Street hockey
- Swimming, water exercise
- Tennis
- Volleyball
- Walking (briskly)
- Weight/circuit training
- Other (list)

Sample activity time sheet:

The table below shows the correct way to fill out the activity time sheets.
Note that only one intensity level is checked for each activity.

	Activity Numbers	Light	Moderate	Hard	Very Hard
7:00-7:30	22	✓			
7:30-8:00	21	✓			
8:00-8:30	18		✓		
8:30-9:00	28	✓			
9:00-9:30	28	✓			
9:30-10:00	28	✓			
10:00-10:30	28	✓			

MONDAY

Put a ✓ to rate the intensity of each activity.

Write activity numbers in this column.

	Activity Number	Light	Moderate	Hard	Very Hard	
before school	7:00-7:30					
	7:30-8:00					
	during school	8:00-8:30				
		8:30-9:00				
		9:00-9:30				
lunch time	9:30-10:00					
	10:00-10:30					
	10:30-11:00					
	11:00-11:30					
	11:30-12:00					
after school	12:00-12:30					
	12:30-1:00					
	1:00-1:30					
	1:30-2:00					
	2:00-2:30					
supper time	2:30-3:00					
	3:00-3:30					
	3:30-4:00					
	4:00-4:30					
	4:30-5:00					
evening	5:00-5:30					
	5:30-6:00					
	6:00-6:30					
	6:30-7:00					
	7:00-7:30					
7:30-8:00						
8:00-8:30						
8:30-9:00						
9:00-9:30						
9:30-10:00						
10:00-10:30						
10:30-11:00						
11:00-11:30						
11:30-12:00						

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**



SAPAC

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

	Before School		After School	
T.V./Video	H.1	_____ hours _____ minutes	H.2	_____ hours _____ minutes
Video Games & Computer Games	H.3	_____ hours _____ minutes	H.4	_____ hours _____ minutes

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



EVALUATION OF ACTIVITY SURVEYS FOR YOUTH

Physical Activity Surveillance

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

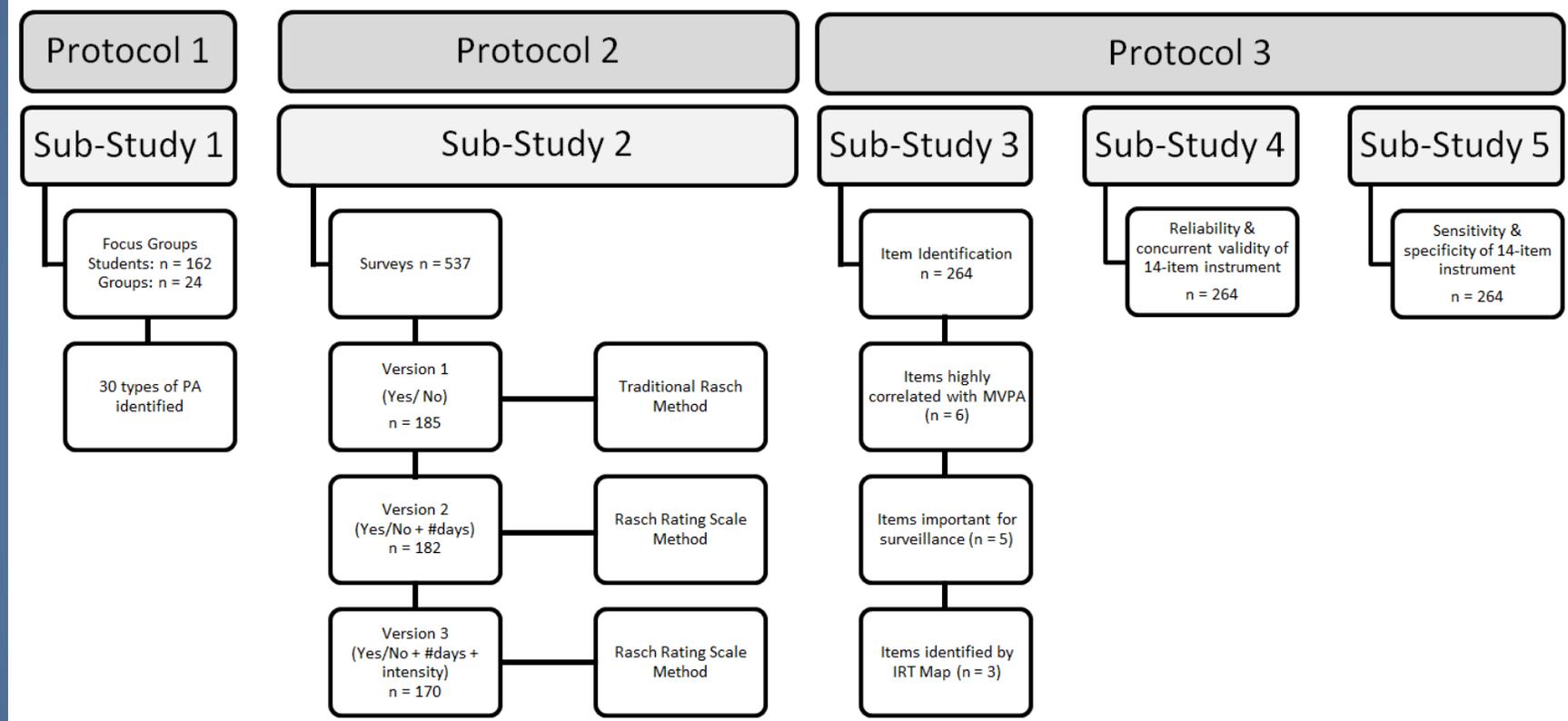
Purpose

- 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



Discussion



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? <i>(dance, tennis, karate, gymnastics, etc)</i>	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? <i>(scooter, skateboard, rollerblades, rollerskates, etc.)</i>	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)

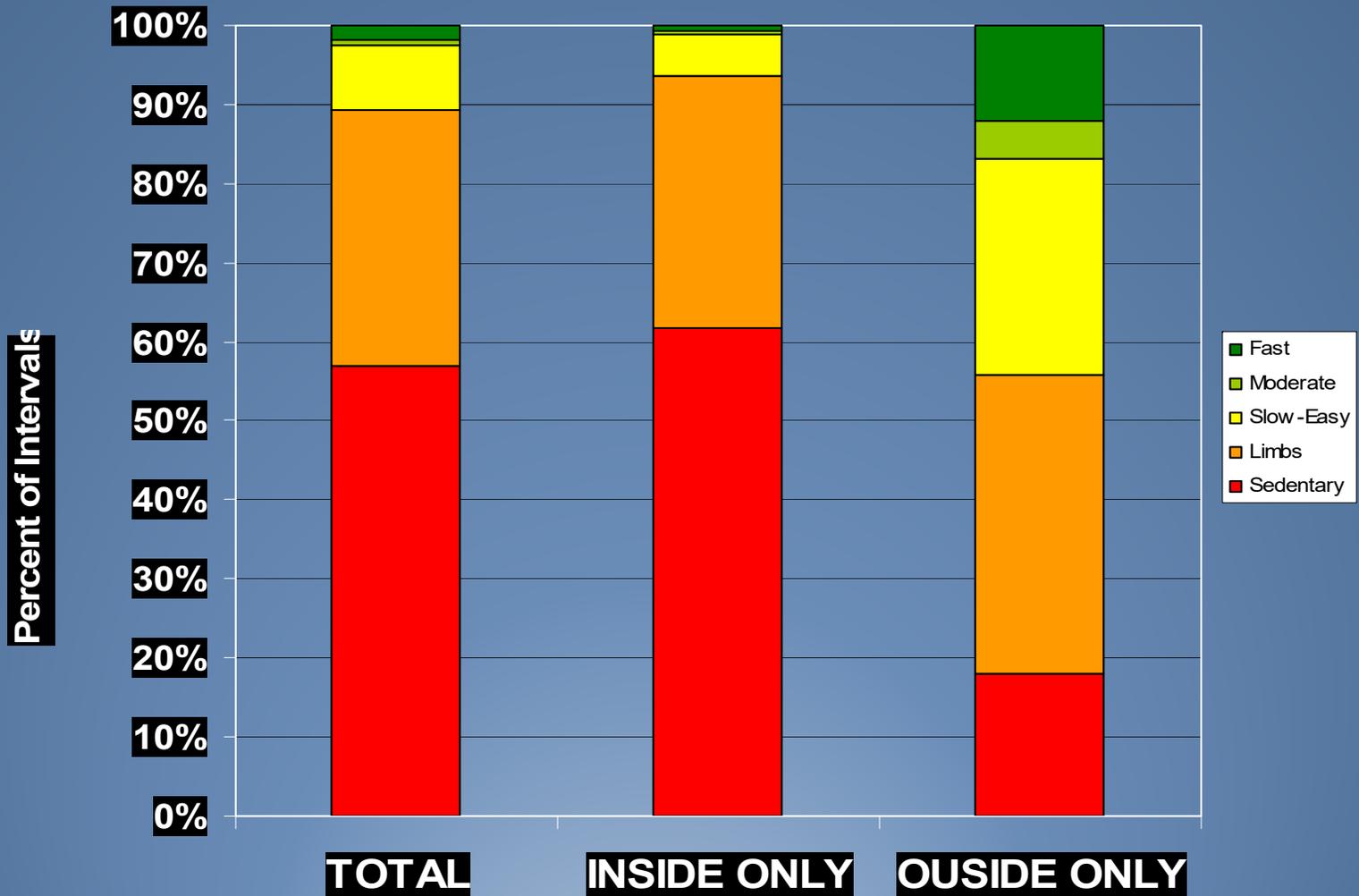
OSRAC-P

- 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

Physical Activity Levels of Preschoolers



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

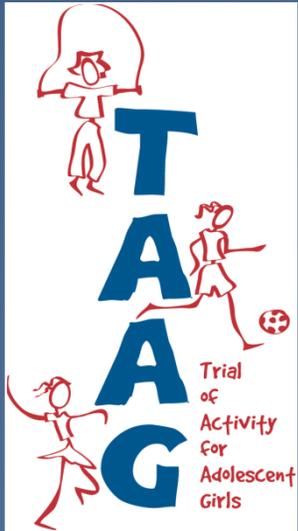


Accelerometer Placement



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



COSMED

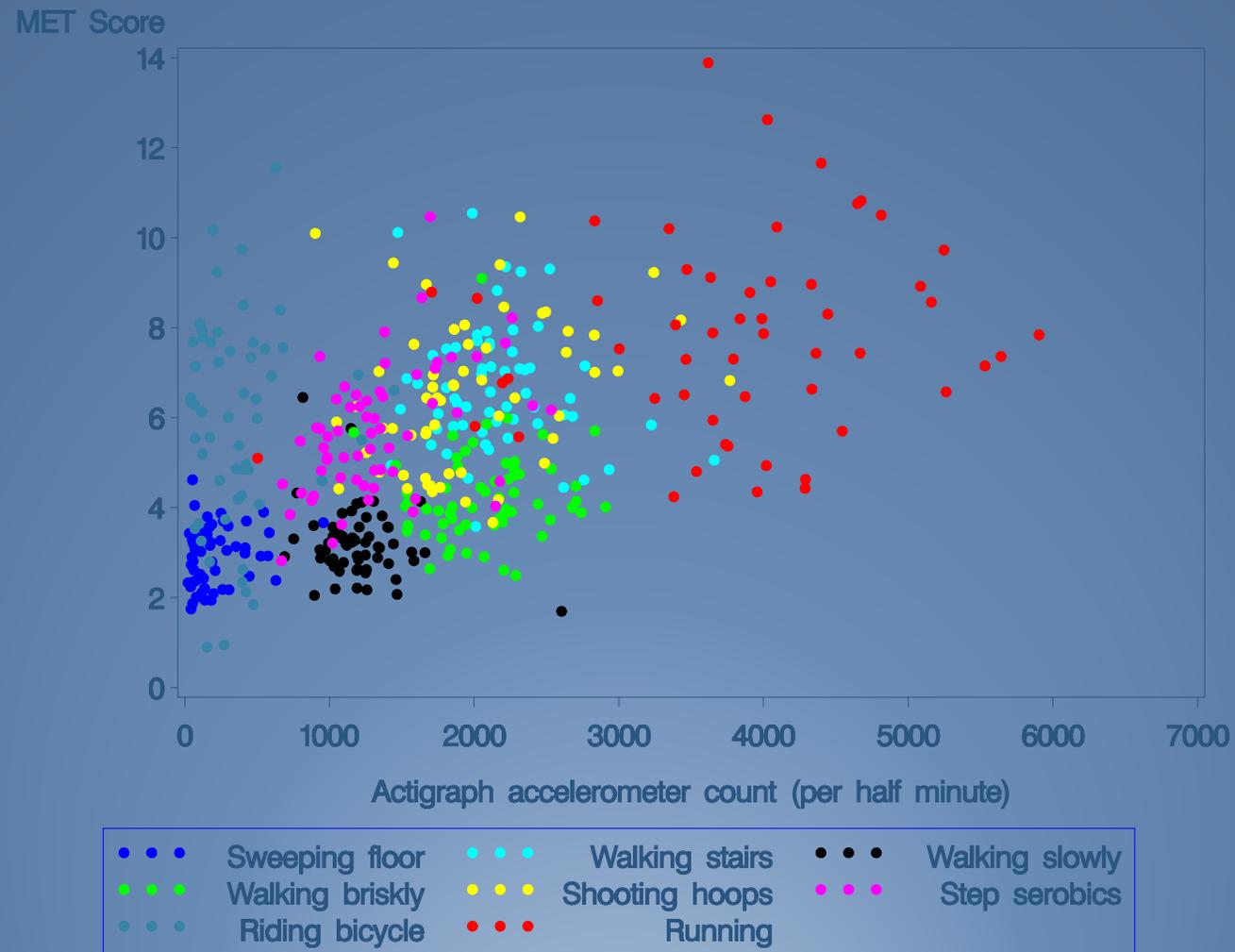


Calibration Results

Activity	Avg MET Score
Watching TV, computer game	1.1
Sweeping floor, walking slowly	3.2
Walking briskly	4.2
Walking stairs	6.7
Shooting hoops	6.6
Step aerobics	5.7
Riding bicycle	6.2
Running	7.9

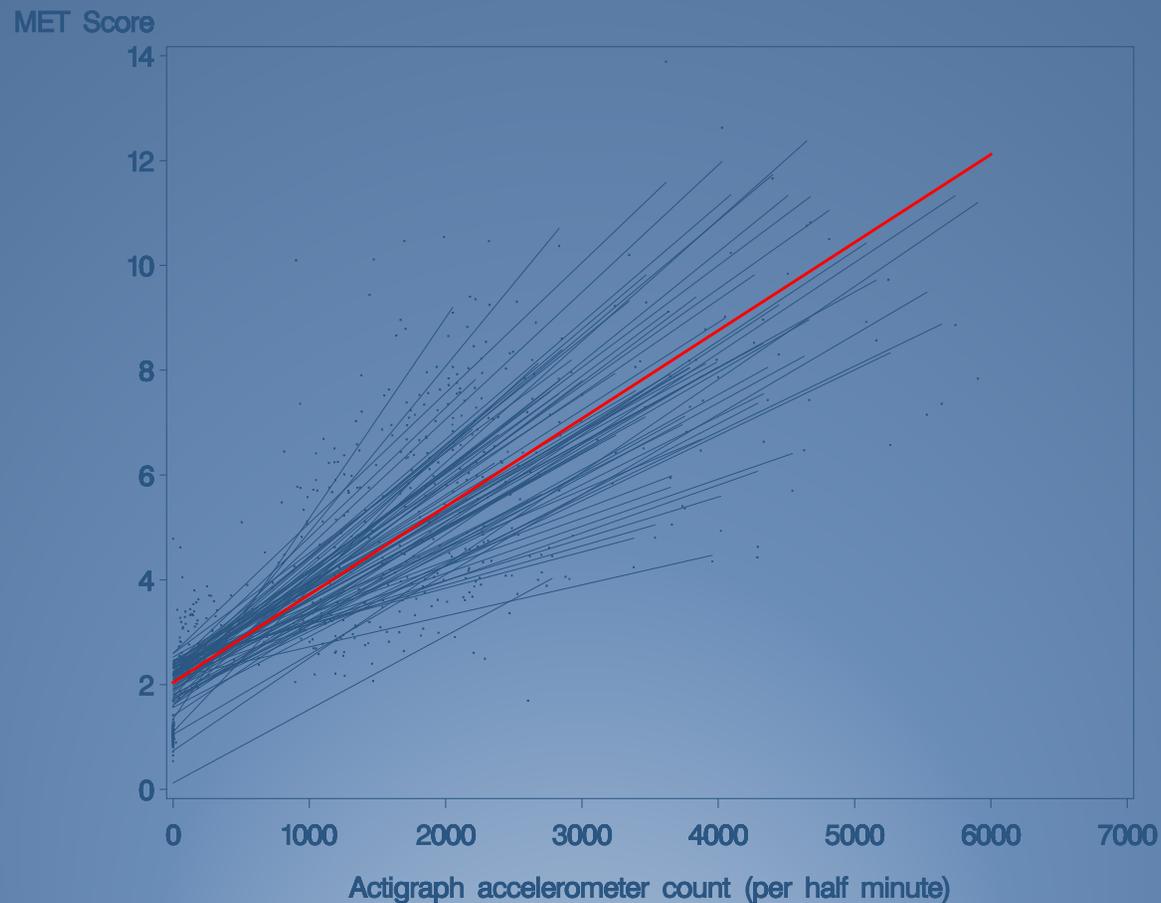
Met Score vs. Actigraph Counts

Excludes watching TV, computer games



MET Score vs. Actigraph Counts

Random regression lines for each girl and overall regression line



Results

- Regression equation
 - $\text{MET} = 2.03 + 1.67(\text{MTI counts/half min})$
- 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



ACTIVITYGRAM[®]



NCCOR

National Collaborative on Childhood Obesity Research

ICAMPAM 2017



5th International Conference
on Ambulatory Monitoring
of Physical Activity
and Movement



IntermountainSM
Healthcare

Resources

Evenson KR, et al. Calibration of two objective measures of physical activity for children. *J Sport Sci* 2008; 26(14): 1557-1565.

Trost SG, et al. Comparison of Accelerometer Cut Points for Predicting Activity Intensity in Youth. *Med Sci Sports Exerc* 2011; 43(7): 1360-1368.

Pate RR, et al. Validation and Calibration of an Accelerometer in Preschool Children. *Obesity* 2006; 14(11): 2000-2006.

Thanks!



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