December 6, 2017

Connecting you with experts. Exploring the latest childhood obesity news and research.

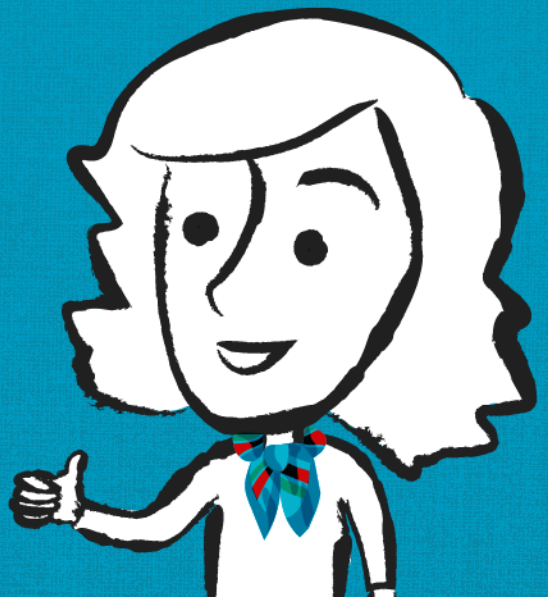
We will begin at 3:05 to allow participants time to join the webinar.

NCCOR
National Collaborative on Childhood Obesity Research

NATIONAL COLLABORATIVE ON
CHILDHOOD OBESITY RESEARCH

1. Spotlight
   - A Revised Youth Compendium of Physical Activities
   - Youth Compendium of Physical Activities: Data Sources, Activity Codes, and Metabolic Intensities
   - Use of the Compendium for Tracking Physical Activity in Youth
2. One on One
3. NCCOR Announcements

TODAY'S PROGRAM



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Today's Speakers

Elaine Arkin
National Collaborative on Childhood Obesity Research

Nancy Butte
Distinguished Emeritus Professor
Baylor College of Medicine

Karin Pfeiffer
Associate Professor of Kinesiology
Michigan State University

Scott Crouter
Associate Professor of Exercise Physiology
University of Tennessee, Knoxville

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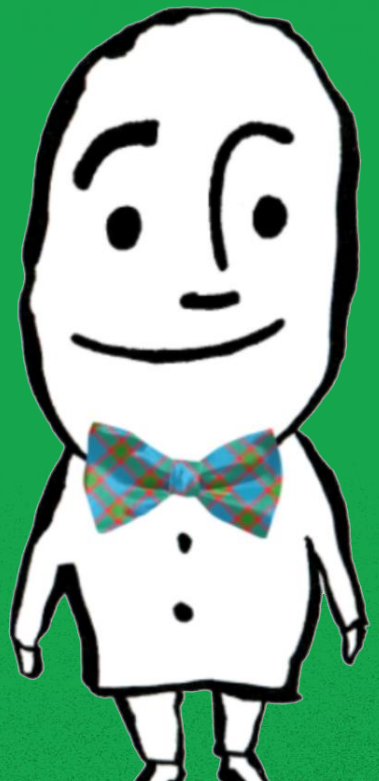
INTERACTIVE POLL



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SPOTLIGHT

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A Revised Youth Compendium of Physical Activities

Karin Allor Pfeiffer, PhD
Associate Professor of Kinesiology
Michigan State University

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What is a Compendium of Physical Activities?

- A list of values noting energy cost of various physical activities
- Currency = Metabolic Equivalent (MET)
- MET values are presented as multiples of resting metabolic rate
- Created for adults (1993)
- Youth-based version published later (2008)

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The Process

1. **Establish the need**
2. Determine the best units/metric AND determine how to represent any age factor
3. Data sources
4. Development of the Youth Compendium
5. Applications and limitations

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Youth Compendium Workshop Participants 2012

- **Research Group** – Barbara Ainsworth, PhD, MPH (Arizona State University); David Bassett, PhD (University of Tennessee); David Berrigan, PhD (National Cancer Institute); **Nancy Butte**, PhD (Baylor College of Medicine); **Scott Crouter**, PhD (University of Tennessee); Janet Fulton, PhD (CDC); Steve Herrmann, PhD (Sanford Health Organization); Kate Heywood (Ridley), PhD (Flanders University, Australia); Robert McMurray, PhD (University of North Carolina); **Karin Pfeiffer**, PhD (Michigan State University); Stewart Trost, PhD (Queensland University of Technology); and Kathleen Watson, PhD (CDC)

- **Imputation** – Issa Zakeri, Zekarias Berhane, Alexander Long (Drexel)
- **FHI 360 Staff** – Todd Phillips, LaVerne Canady, Amanda Samuels, Adee Kennedy
- **Data and Bibliography** – Penny Randall-Levy, Kyle Sprow

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Why not simply use the Adult MET?

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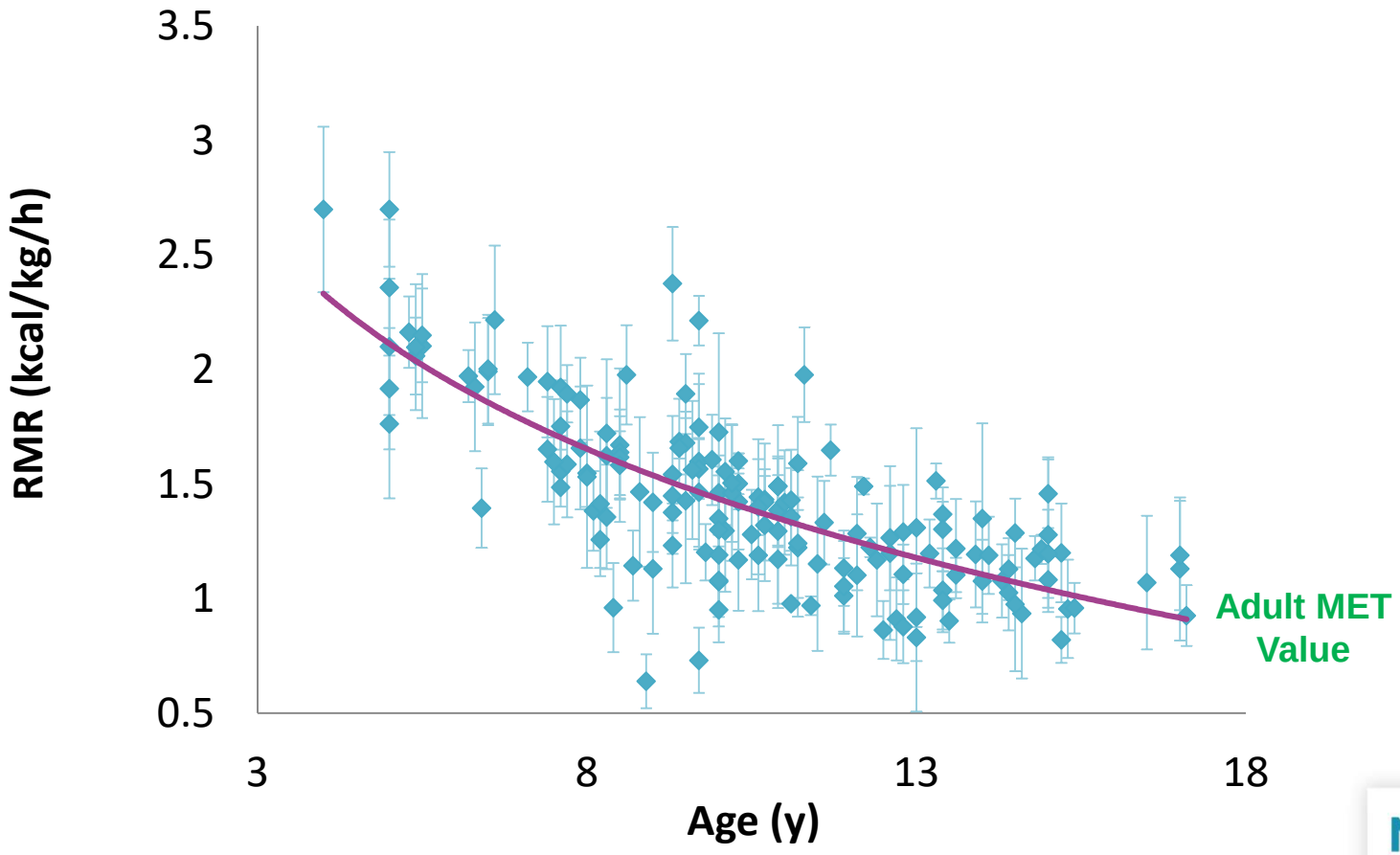
What is a MET for Children?

Relationship Between Resting Metabolic Rate (RMR) and Age in Youth



Hermann, McMurray, et al. *J Human Biol*. 2017

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Ideal Metric

- Age independent
- Mass specific
- Low variance
- Simple to use
- Composed of existing measurements

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Metrics Previously Reported in Literature

ml/min	Activity-related oxygen uptake (VO_2)
ml/kg/min	Activity VO_2 per unit body mass
ml/cm/min	Activity VO_2 per cm in height
mL/m^2	Activity VO_2 per unit of body surface area
$ml/kg^{0.67}/min$	Activity VO_2 scaled to 0.67 of body mass
$ml/kg^{0.75}/min$	Activity VO_2 scaled to 0.75 of body mass
VO_2net	Activity Related VO_2 - Rest
Youth MET	(ml/kg/min)/Child-specific RMR
Adult MET	3.5 ml/kg/min for all

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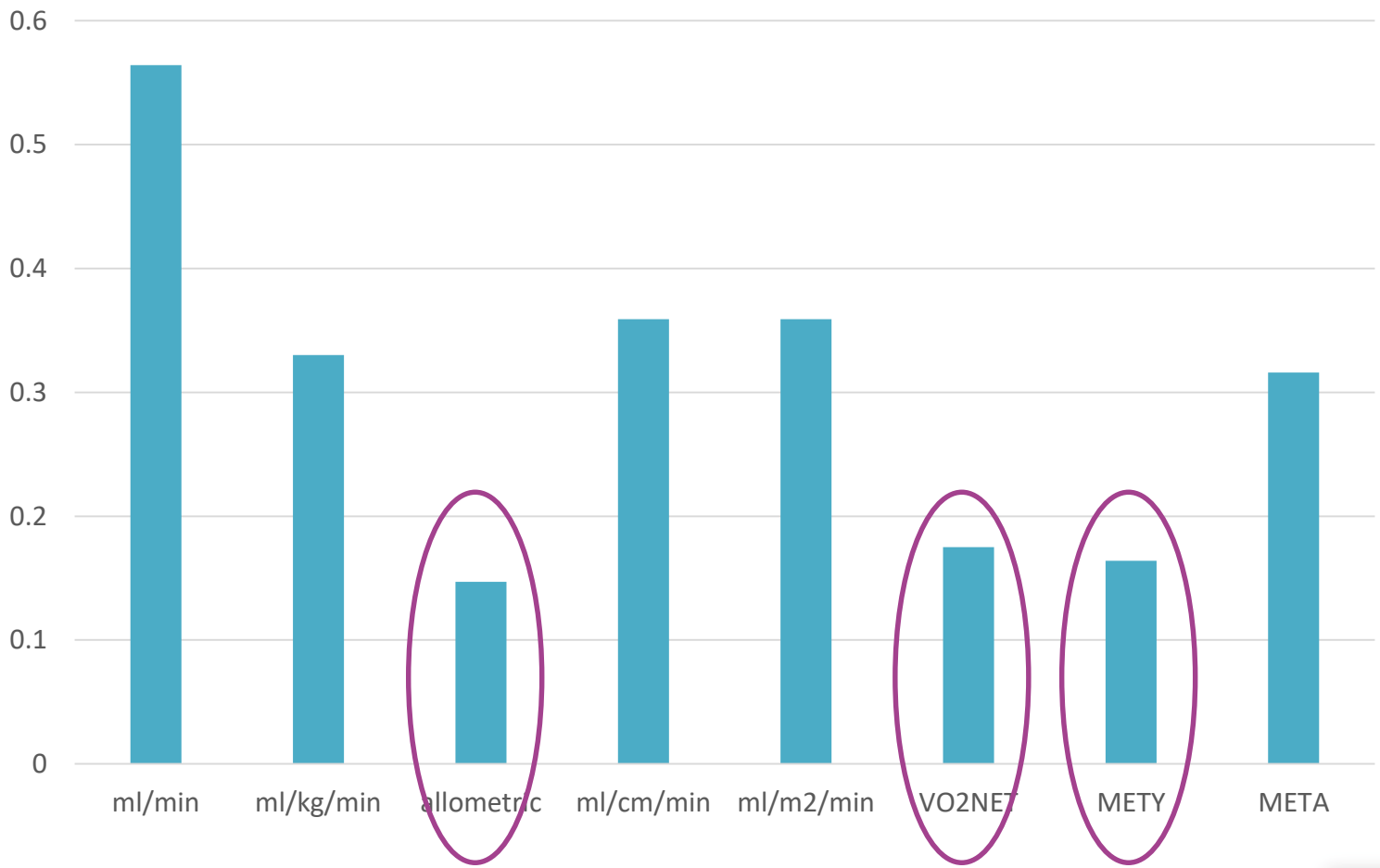
Total Variance (R^2) Accounted for the Effect of Age, Height, Mass, and Sex Presented by Each Metric



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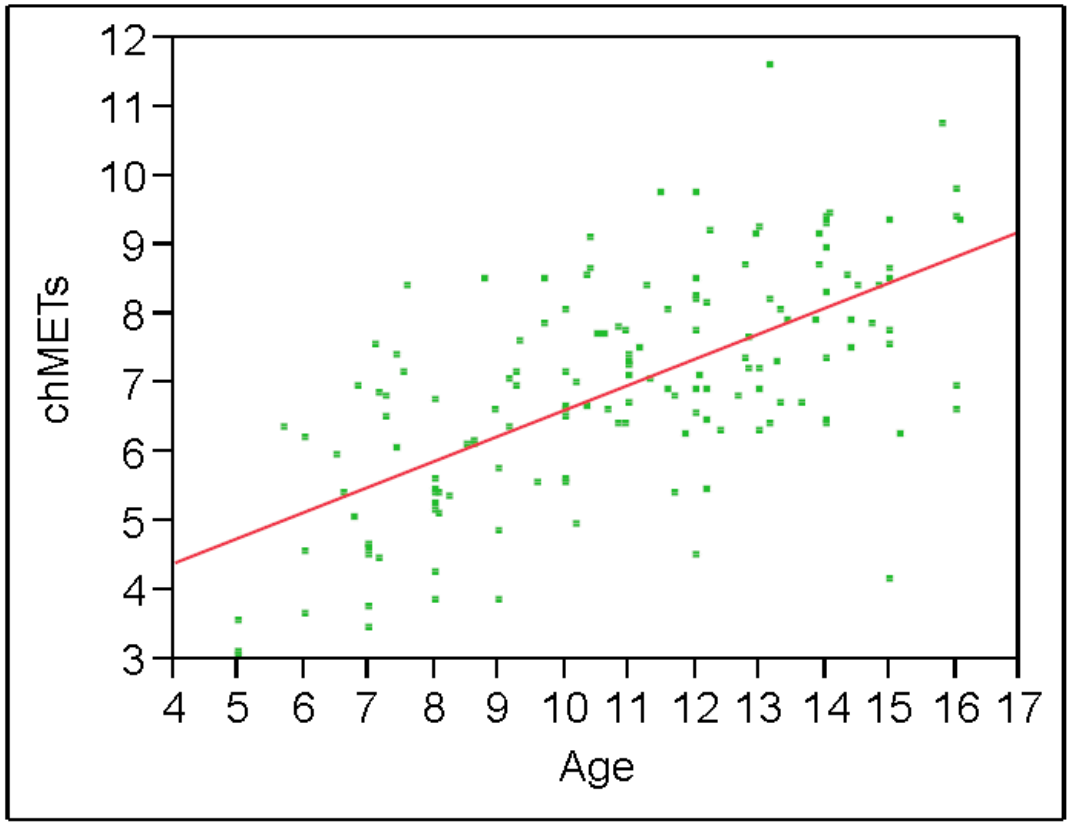
Example of Effects of Age Dependence of the MET_y on Boys Basketball



Average MET Score = 6.9

Predicted METs by Age

6 = 5.1

11 = 7.0

16 = 8.8

$MET_y = 2.9 + 0.37*Age$

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Conclusion Regarding Best Unit

- No one metric is optimal, but the preferred metric appears to be: YOUTH-MET

- No metric completely took away the effects of age.

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Taking Remaining Age Differences into Account

- Three approaches to accounting for age
  1. Constant value
  2. Age group values: 6-9, 10-12, 13-15, 16-18 years
  3. Age-specific values: one-year increments
- Regression to estimate error for the two methods accounting for age versus the constant value
- Calculated percent reduction in residual variance for age groups and age in years

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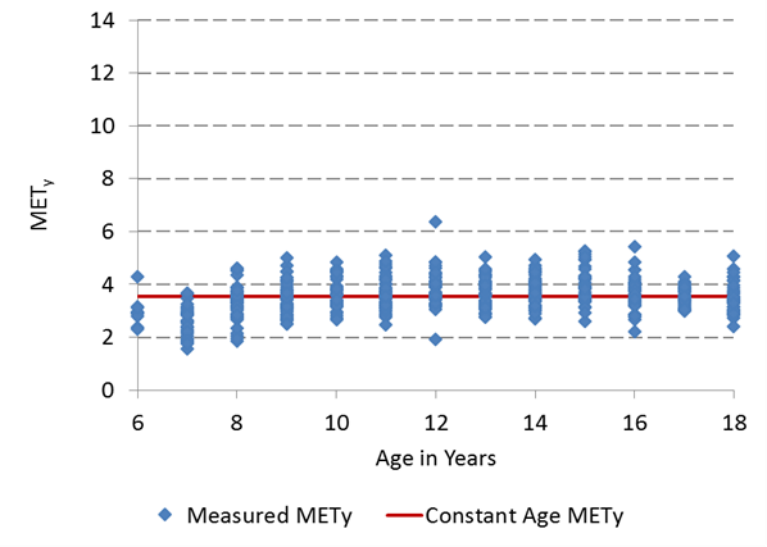
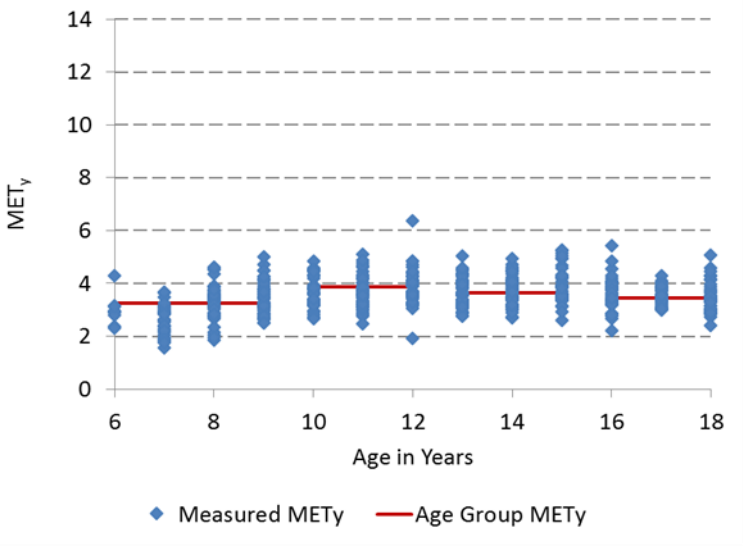
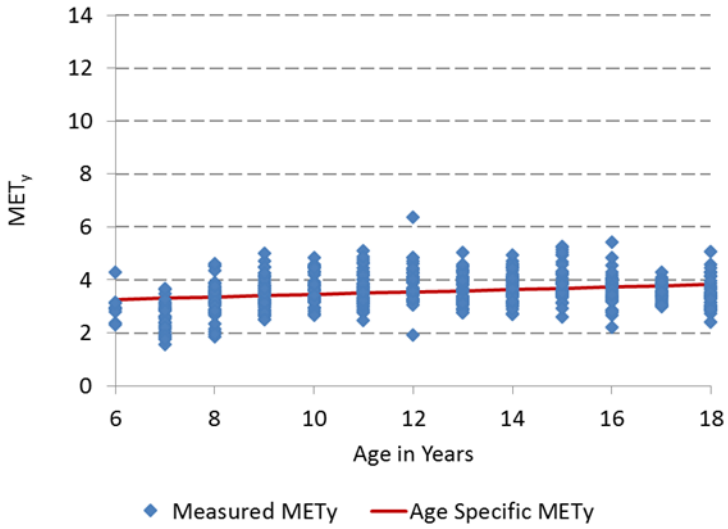
Walk at 2 MPH







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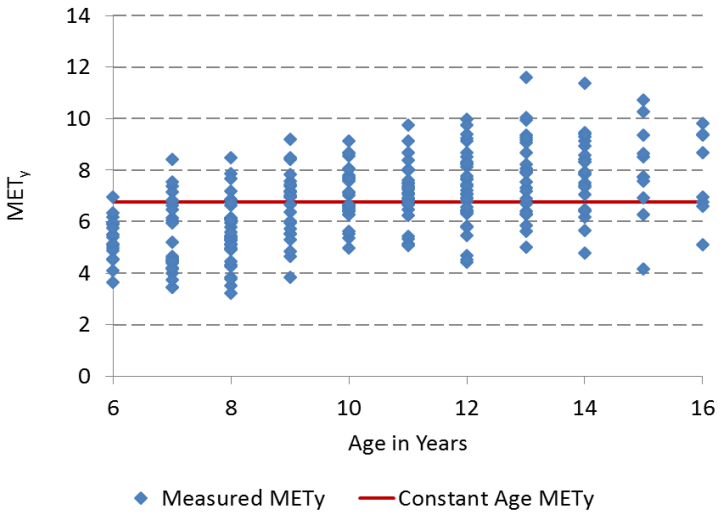
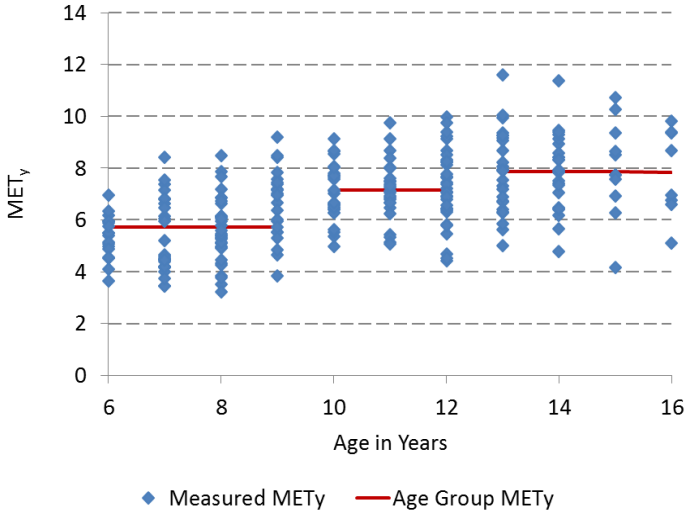
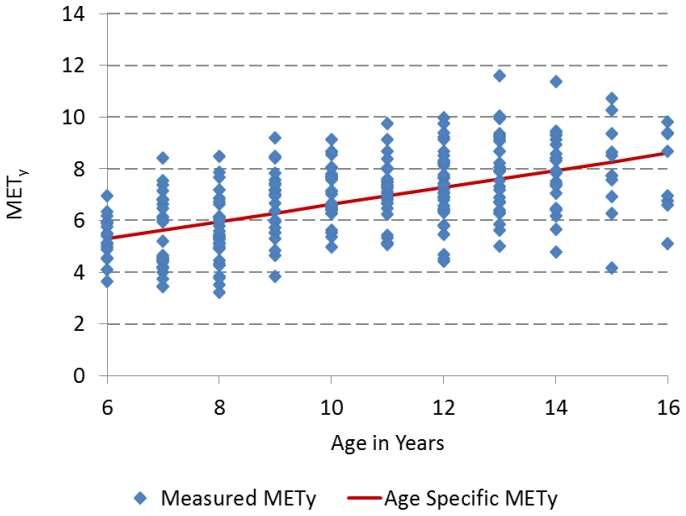
Basketball







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Summary of Best Unit and Accounting for Age Differences

Youth MET: MET_y

1. In general, lowest difference scores with measured energy expenditure (EE), particularly in models where age is considered
2. Best correlations with measured EE
3. Best approach for low-intensity activities
4. Takes age-associated change with resting EE into account
5. People fundamentally understand the value
6. Closer to how Adult Compendium is organized

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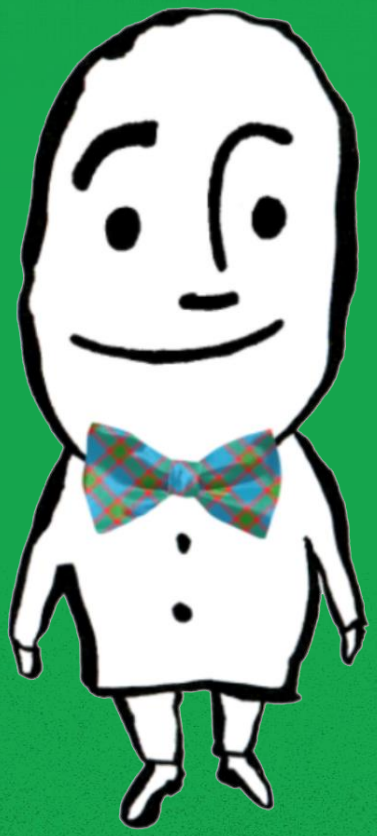
QUESTIONS?

Please type your question(s) in the chat box located on the right.



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Youth Compendium of Physical Activities

Data Sources, Activity Codes, and Metabolic Intensities

Nancy Butte, PhD
Distinguished Emeritus Professor
Baylor College of Medicine

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The Process

1. Establish the need
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Data Sources for Youth Compendium

- Conducted a systematic literature review
  - Included about 90 studies
- Pooled individual dataset
  - Used energy costs of physical activities from 933 children from four studies
- Developed Journal of Physical Activity and Health Supplement
  - Used energy costs of physical activities from 17 articles

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Systematic Literature Review

- 71 studies not included in 2008 Youth Compendium
- 347 new unique mean energy costs values

Activity Category	Number of mean energy cost values	% of total new data points
Active video games	79	22.8%
Sedentary screen time	61	17.6%
Lying/sitting/standing quietly	44	12.7%
Simulated sports/games	39	11.2%
Dance/aerobics/calisthenics/gymnastics	27	7.8%
Active outdoor play	18	5.2%
Chores	15	4.3%
Reading/writing/academic pursuits	15	4.3%
Sedentary play	15	4.3%

Note: Remaining ~10% of activities spread across remaining activity categories

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Pooled Individual Dataset

Activity	Boys (n) / Girls (n)	Study Site Contributing Data*	Age Range (y)
Sedentary			
Computer games	210 / 174	B,M,MS,O	5 – 18
Television viewing	235 / 216	B,M,NC	5 – 18
Light-intensity			
Housework	127 / 116	M,MS,O	5 – 16
Sweeping	271 / 256	M,MS,NC,O	5 – 18
Wii® Play	108 / 81	B,M	5 – 18
Non-weight bearing			
Cycling ~10 mph	144 / 152	NC	5 – 18
Moderate-to-vigorous intensity			
Aerobics	195 / 182	All	5 – 17
Dance	110 / 87	B,M	5 – 18
Walk - 2 mph	445 / 417	All	5 – 18
Walk - 3 mph	443 / 426	All	5 – 18
Run - 4 mph	235 / 223	All	5 – 18
Run - 5 mph	80 / 54	B, M,MS,O	6 – 18
Skilled			
Basketball	161 / 123	MS,O,NC	7 – 16
Rope Skipping	145 / 133	NC	8 – 18

*Working data from Baylor Medical Center (B), Michigan State University (MS), Oregon State University (O), University of Massachusetts at Boston (M), and University of North Carolina at Chapel Hill (NC)

Journal of Physical and Health Supplement Highlights

Study	Sample Size	Age Group
1	40	5-12
2	28	3-6
3	37	5-15
4	11	3-6
5	30	12
6	27	9-11
7	24	10-17
8	105	7-13
9	28	10-11
10	36	9-18
11	119	3-5
12	53	9-15.5
13	178	8-18
14	106	6-18
15	32	4th-5th grade
16	209	6-18
17	57	5-12

- About 250 activities reported
- Ages range from 3-18 years
- Sample sizes vary from 11-209 participants

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4. **Development of the Youth Compendium**
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Development of Youth Compendium

- **Step 1**. Classification of activities into 16 major categories by age groups
- **Step 2.** Profile plots constructed for 16 major categories
- **Step 3.** Multiple imputation of missing MET_y values for specific activities within each activity category
- **Step 4.** Review of observed and imputed MET_y values
- **Step 5.** Smoothing observed and imputed MET_y values

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Youth Compendium

- MET_y for 196 physical activities
  - Extracted from 137 pediatric studies
  - Included 37,000 observations

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Major Activity Categories

Lying	**Playing and Sports**
Sitting	• Calisthenics/gymnastics
• Quiet play/schoolwork/TV	• Weight lifting
• Computer games	• Sports/games
Standing	• Dance/aerobics/steps
• Standing	• Bike/scooter riding
• Housekeeping/work	• Active play
• Active video games (upper body)	• Swimming
• Active video games (full body)	**Walking and Running**
	• Walking 0.5-5 mph
	• Running 3-8 mph

Data Computations

$MET_y = EE_{activity}$ / Basal Metabolic Rate (BMR)

BMR calculated using age-, sex-, and mass-specific Schofield equations:

- Ages 3-10 years
  - **Boys** BMR (kcal/min) = [22.706 × Weight (kg) + 504.3]/1440
  - **Girls** BMR (kcal/min) = [20.315 × Weight (kg) + 485.9]/1440

- Ages 10-18 years
  - **Boys** BMR (kcal/min) = [17.686 × Weight (kg) + 658.2]/1440
  - **Girls** BMR (kcal/min) = [13.384 × Weight (kg) + 692.6]/1440

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Examples of Missing MET_y Data

Activity	Mean	Age Group			
		5-9	10-12	13-15	16-18
Schofield RMR (ml/kg/min)	4.3	5.3	4.2	3.8	3.6
Aerobics	3.8	3.6	3.9	4.1	
Basketball	5.6	5.1	5.6	6.4	7.4
Cycling 8-10 mph	5.1		5.1	5.5	5.5
Computer Games	1.2	1.2	1.2	1.2	1.4
Dance	3.4		3.2	4.2	
Vacuuming	3.5			3.6	3.3
Roller Skating	7.1	6.0	6.7	7.8	
Sweeping	2.9			2.9	2.8
Television	1.0	1.0	1.1	1.1	1.1
WII® Interactive Games	2.5	2.6	2.4	2.6	
Walk 2 mph	3.1	2.8	3.2	3.2	3.0
Walk 3 mph	4.3	4.2	4.4	4.4	4.7
Run 4 mph	7.6	6.62	8.30	7.93	6.24
Run 5 mph	8.5	7.53	8.37	9.00	8.90

Imputation

- Fit linear and quadratic regression models to fit MET_y values vs. age for each activity
- Adjusted r^2 used to compare linear and quadratic regression models
- Mixed linear regression model used to impute missing values for each of 16 major activity categories

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Youth Compendium

- MET_y for 196 physical activities
  - 397 observed mean MET_y values (51%)
  - 380 imputed mean MET_y values (49%)

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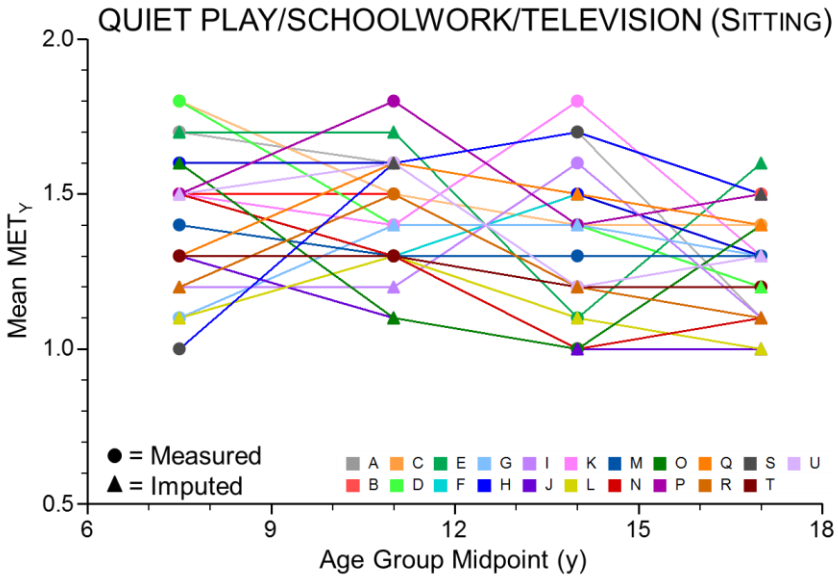
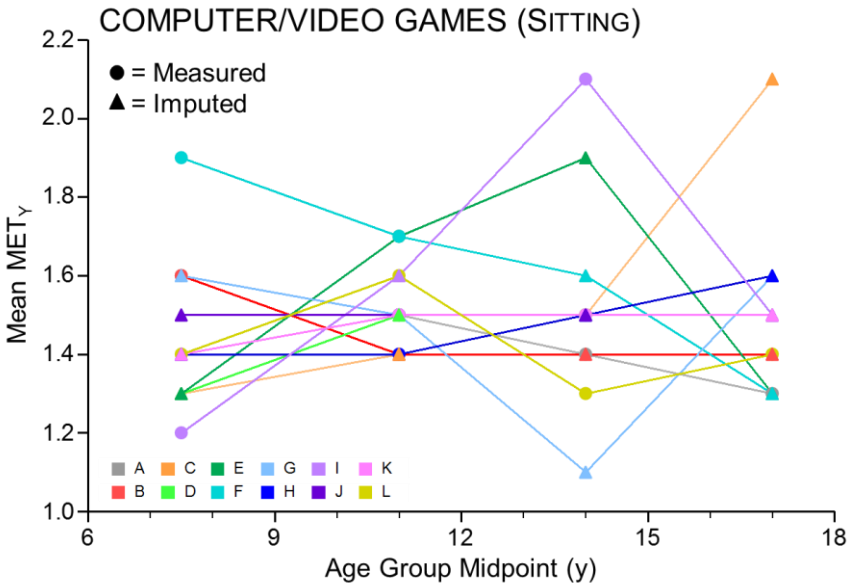
Sitting





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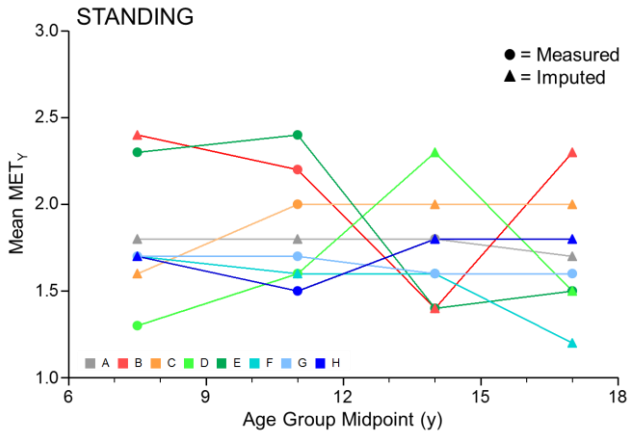
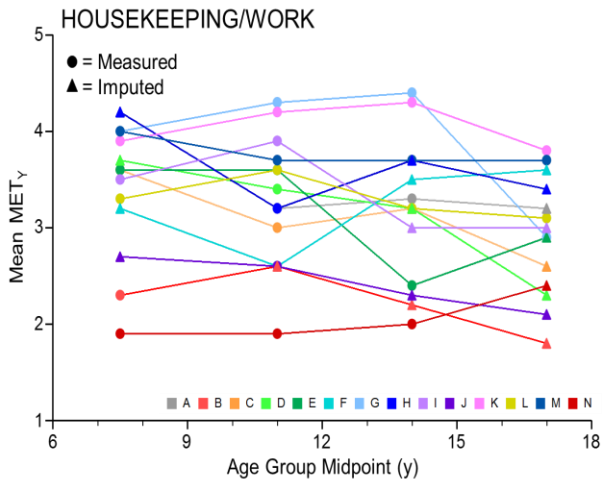
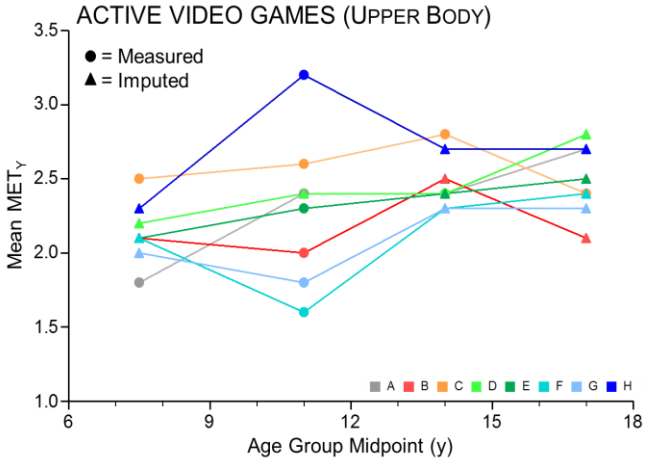
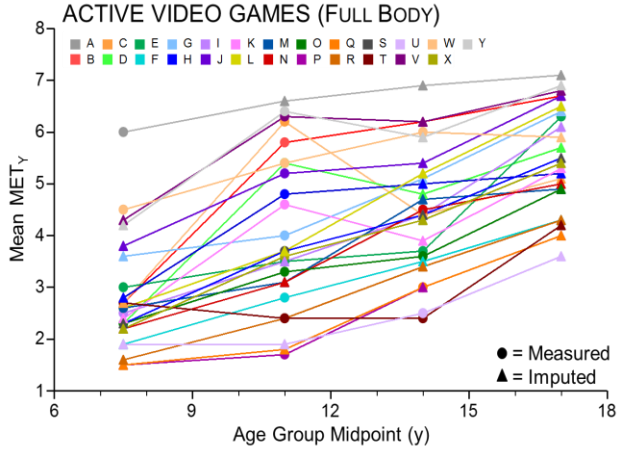
Standing









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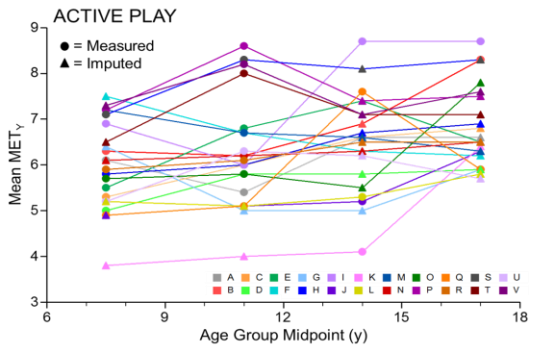
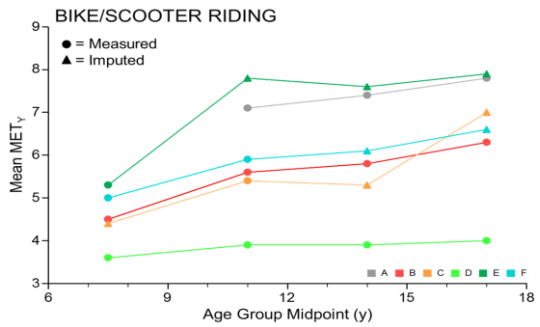
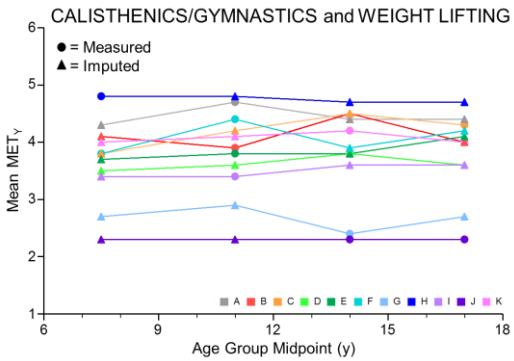
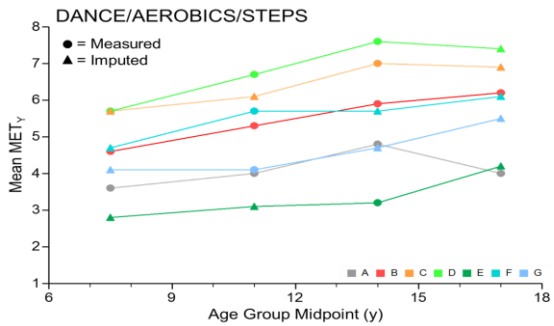
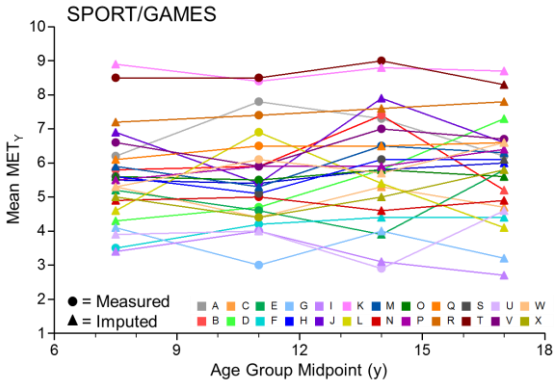
Play and Sports

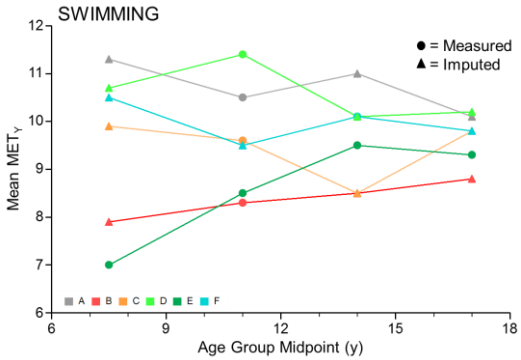












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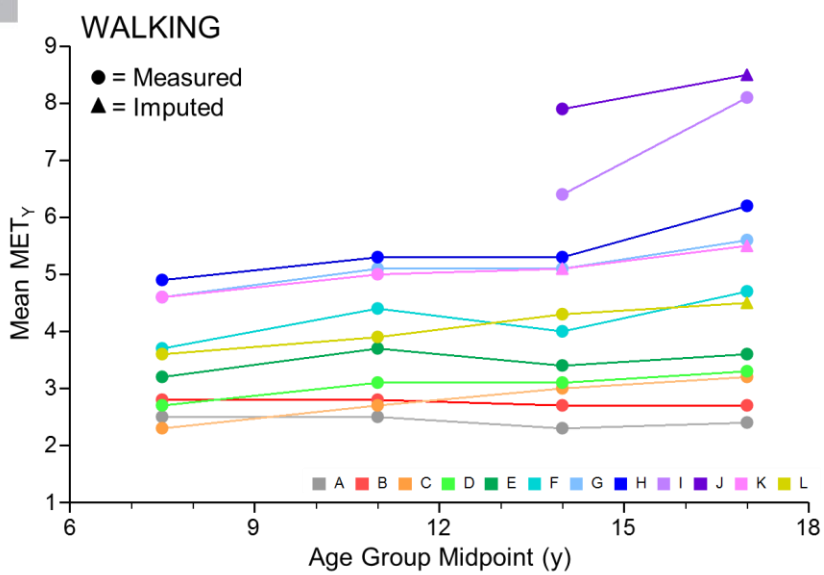
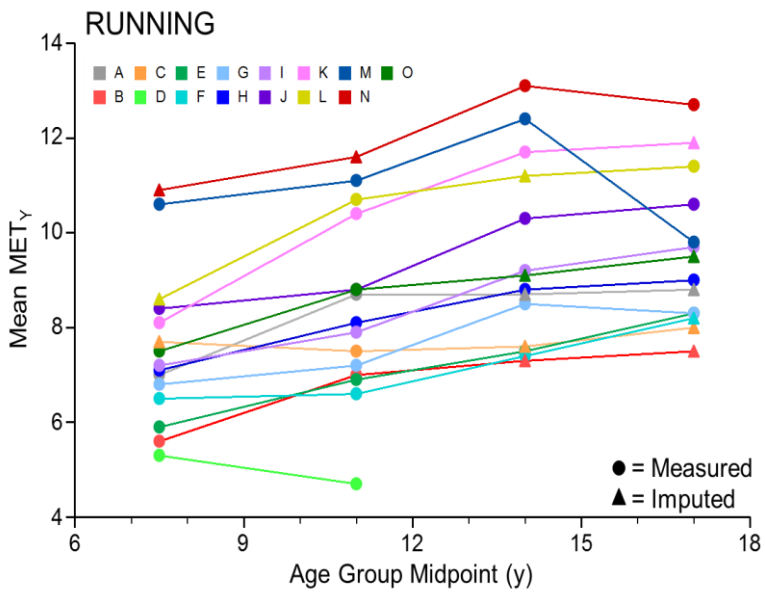
Walking and Running





Walking 0.5 - 5 mph
Running 3 - 8 mph

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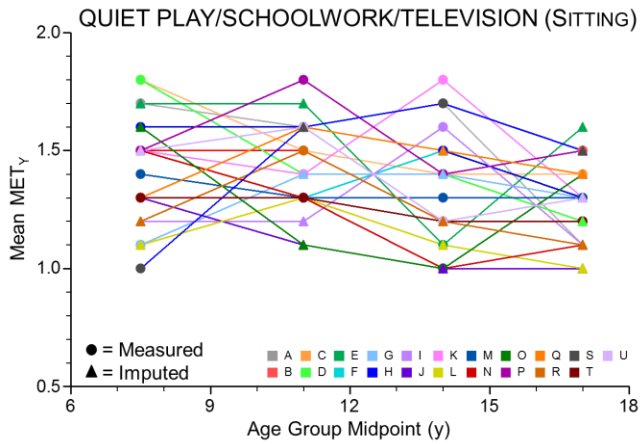
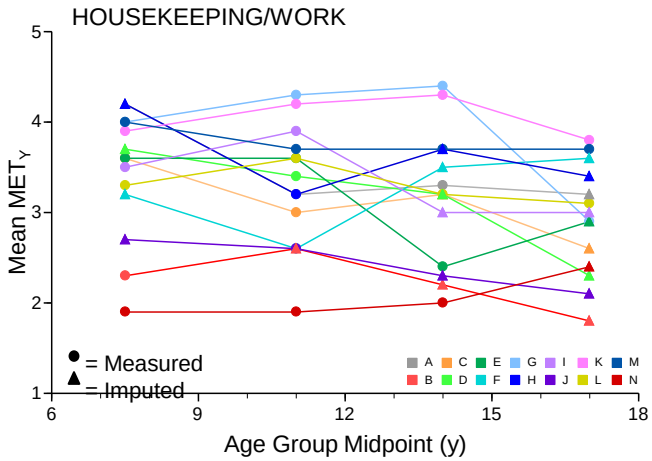
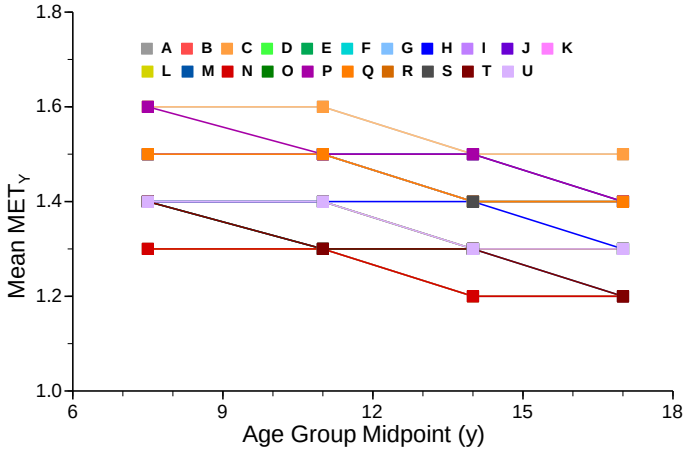
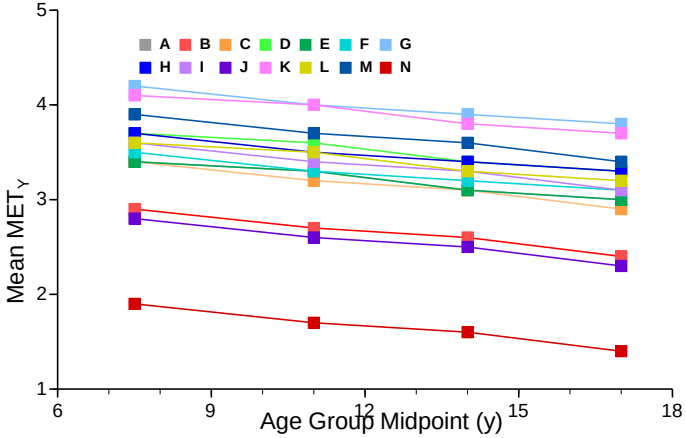
Observed and Imputed MET_y Values



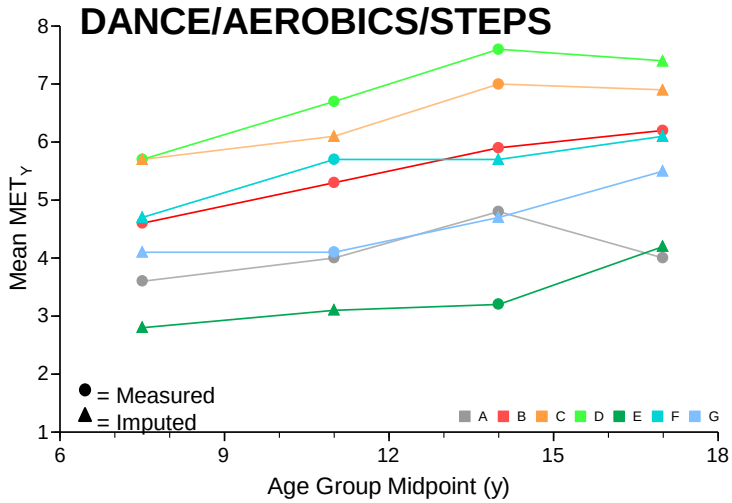


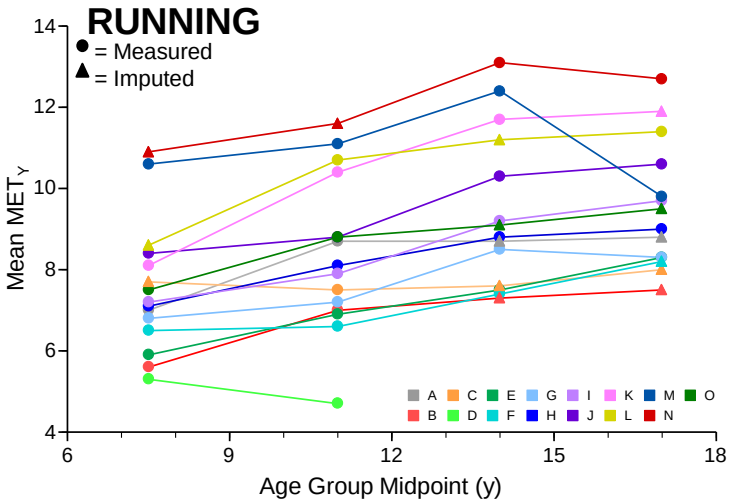
Model-based Smoothed MET_y Values



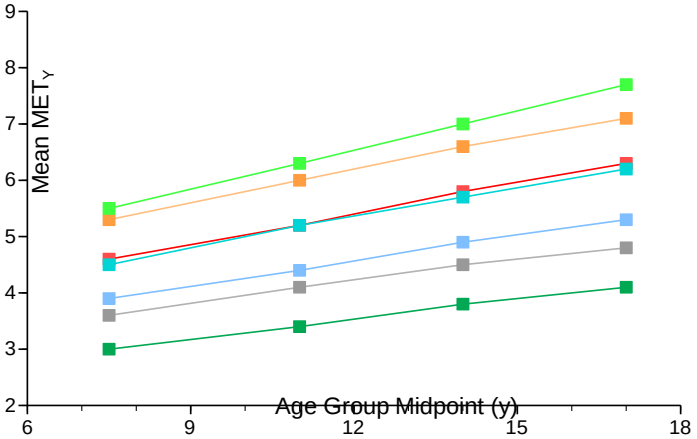


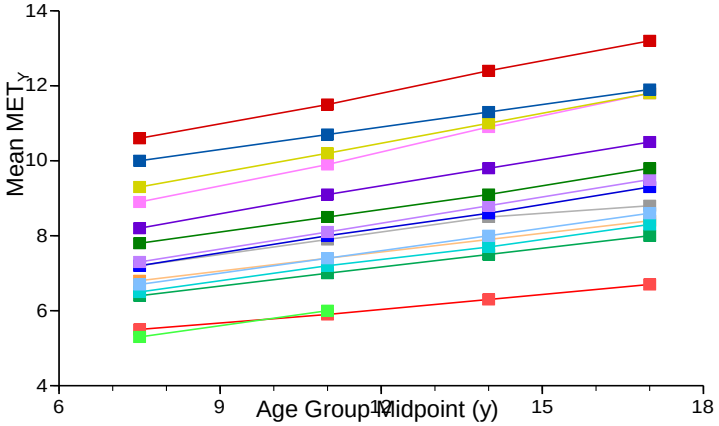
Observed and Imputed MET_y Values





Model-based Smoothed MET_y Values





Future Research

- More MET_y data from different populations
  - Young children < 6 years
  - Groups differing in function/biomechanics
  - Groups of varying body mass index (BMI)
- Novel MET_y data
  - Occupational activities
  - Graded activities (e.g., walking and running)
- Enhanced modeling of MET_y values based on additional child characteristics, performance, context

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Summary

- The Youth Compendium presents MET_y values for 196 activities across four age group categories

- The Youth Compendium can be used to standardize scoring and interpretation of youth physical activity data in research and public health surveillance applications

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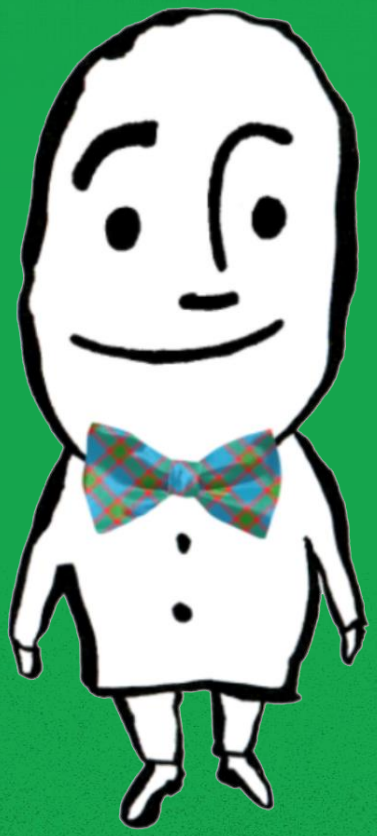
QUESTIONS?

Please type your question(s) in the chat box located on the right.



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Use of Compendium for Tracking Physical Activity in Youth

Scott Crouter, PhD, FACSM
Associate Professor of Exercise Physiology
University of Tennessee, Knoxville

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The Process

1. Establish the need
2. Determine the best units/metric AND determine how to represent any age factor
3. Data sources
4. Development of the Youth Compendium
5. **Applications and limitations**

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Overview

- Who can use the Youth Compendium
- Youth Compendium layout
- How to use
  - Age groups
  - Finding activities
  - Limitations
  - Estimates of intensity and energy expenditure

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Who Can Use the Youth Compendium?

- Researchers
- State and local health departments
- Clinicians
- Educators
- Fitness professionals
- Nutritionists
- Commercial sector

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Example Uses of Youth Compendium

- Summarize energy expenditure from activities reported in physical activity questionnaires
- Contribute to the design of physical activity interventions via the selection of physiologically comparable programmatic elements
- Help in the design of fitness programs
  - Activities to help meet the physical activity guidelines
  - Clinical populations and monitoring intensity
- Aid in the comparison and evaluation of school- and community-based programs and activities

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Youth Compendium Resources

- **Youth Compendium of Physical Activities: Activity Codes and Metabolic Intensities** – *Butte et al. 2017 MSSE (published ahead of print)*
- **Online Resource:** NCCOR Youth Compendium of Physical Activities 2017 nccor.org/youthcompendium

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YOUTH COMPENDIUM of PHYSICAL ACTIVITIES

The Youth Compendium of Physical Activities provides a list of 196 common activities in which youth participate and the estimated energy cost associated with each activity. It can be used by a wide variety of people—including researchers, health care professionals, teachers and coaches, and fitness professionals—and in a variety of ways—including research, public health policy making, education, and interventions to encourage physical activity in youth.

The Youth Compendium provides energy cost values for:

- Sedentary activities, such as lying down or watching TV
- Standing, doing household chores, and playing active video games
- Playing and participating in games and sports activities
- Walking and running

The youth MET (MET_y) values in the Youth Compendium were derived from literature reviews, data analysis, and imputation (Butte et al., 2017).

SEARCH THE
Youth Compendium

Website Search Tips

1. Search the Youth Compendium to view the smoothed data for all activities or activities within a specific category.
2. Go to How to Access These Data for tips and guidance to make the most of your search.

For questions and comments, contact:
nccor@fhi360.org

Youth Compendium Coding

- Codes = 6 digits
- First 2 digits = activity category
- Next 3 digits = specific activity
- Last digit = age group
  - 2 (6-9 years), 3 (10-12 years), 4 (13-15 years), and 5 (16-18 years)

Code	Activity Category	Specific Activity	Age Group
80 160 4	80 (Walking)	160 (Walking 2.0 mph)	4 (13-15 years)

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View by Individual Category

ACTIVE OUTDOOR PLAY

ACTIVE VIDEO GAMES (FULL BODY)

ACTIVE VIDEO GAMES UPPER BODY

BIKE/SCOOTER

METy Code	Specific Activity	Ages 6-9	Ages 10-12	Ages 13-15	Ages 16-18
25100X	Bike Riding - Fast Speed	--[a]	7.3	7.4	7.8
25120X	Bike Riding - Medium Speed	4.4	5.9	6.2	6.3
25140X	Bike Riding - Slow Speed	3.6	3.9	3.9	4.0
25160X	Mini-Scooter Riding	5.3	4.6	4.9	4.8
25180X	Scooter Riding	5.0	5.9	5.6	6.3

CALISTHENICS/GYMNASTICS

COMPUTER/VIDEO GAMES (SITTING)

Downloads

Data

- Table format with columns for age just as on site (MS Excel)
- "Analysis Table" – one row per Met value with age column and imputation column
- File of all References
  - Text
  - End-note

Current Papers and Reports

- Ridley et al. reports
  - Diverse activities — Report 1
  - Walking and Running — Report 2
- McMurray et al.
- Pfieffer et al paper 2
- Butte et al. paper 3
- Past Adult and Youth Compendia
  - Ridley et al. 2008
  - Ainsworth et al. 2011

Other Relevant Resources

- Schofield Equation

Overlapping Age Groups

- When possible use the appropriate age category to assign MET_y value
  - Example, you have a sample of 8-11 year-olds
    - Assign 8 and 9 year-olds the 6-9 age group value and 10 and 11 year-olds the 10-12 age group value
- If this is not possible, use the average of the two age categories that apply

MET_y Code	Activity Category	Specific Activity	Ages 6-9	Ages 10-12	Ages 13-15	Ages 16-18
80160x	Walking	Walk 2.0	2.8	3.0	3.2	3.4

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Cannot Find the Right Activity

- Search for a similar activity in terms of sitting/standing or active, and use the MET_y value associated with that activity
  - Example: raking leaves
    - Could use sweeping as a substitute

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Limitations

- Values should be used to track movement time during an activity not total activity time
  - 60 minutes of playing soccer versus 30 minutes on the field and 30 minutes on the sideline
- Estimates do not account for differences in body mass, adiposity, economy of movement, age-dependent levels of skill, etc.

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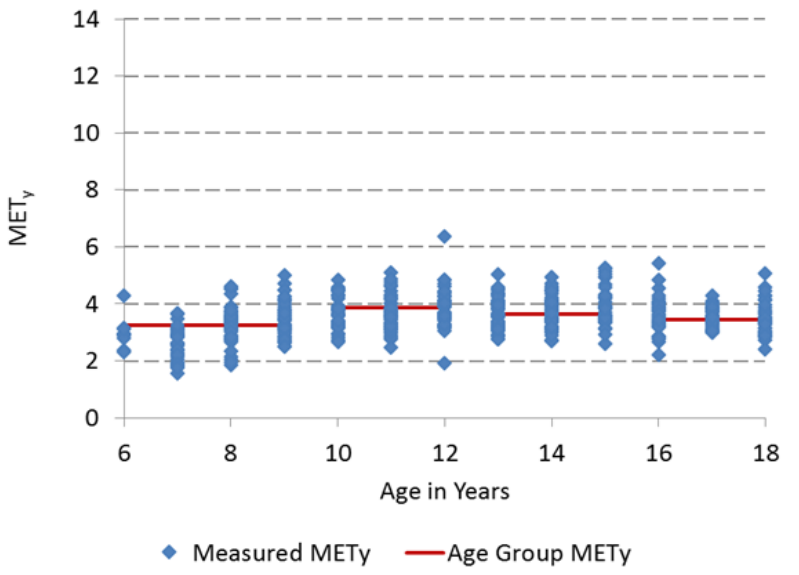
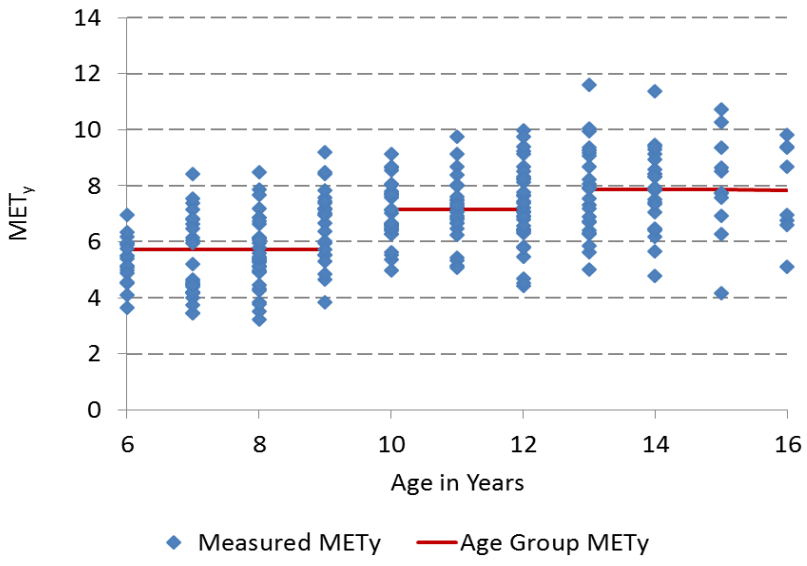
Use of Energy Expenditure and Intensity

Walk 2 mph



Basketball



- Not developed to determine precise energy cost of physical activities within an individual
- Best used to classify intensity of activities at a group level

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Calculation of Energy Expenditure

Total energy cost (kcal) = MET_y x BMR (kcal/min) x duration (min)

- Example
  - 14 year old girl (weighs 40 kg) walking at 3 mph for 20 minutes
  - 4.3 x BMR x 20
    - Where BMR = (13.384 x 40 kg + 692.6)/1440 = .853
  - 4.3 x .853 x 20 = 73.3 kcal

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Funding Agencies

Division of Nutrition,
Physical Activity, and Obesity

NCCOR
National Collaborative on Childhood Obesity Research

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QUESTIONS?

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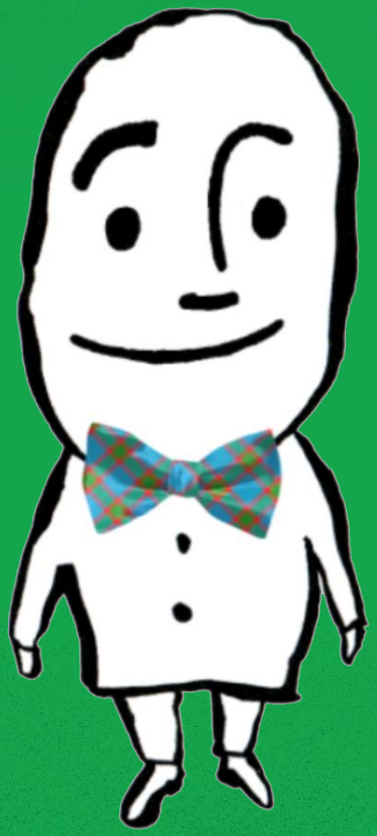

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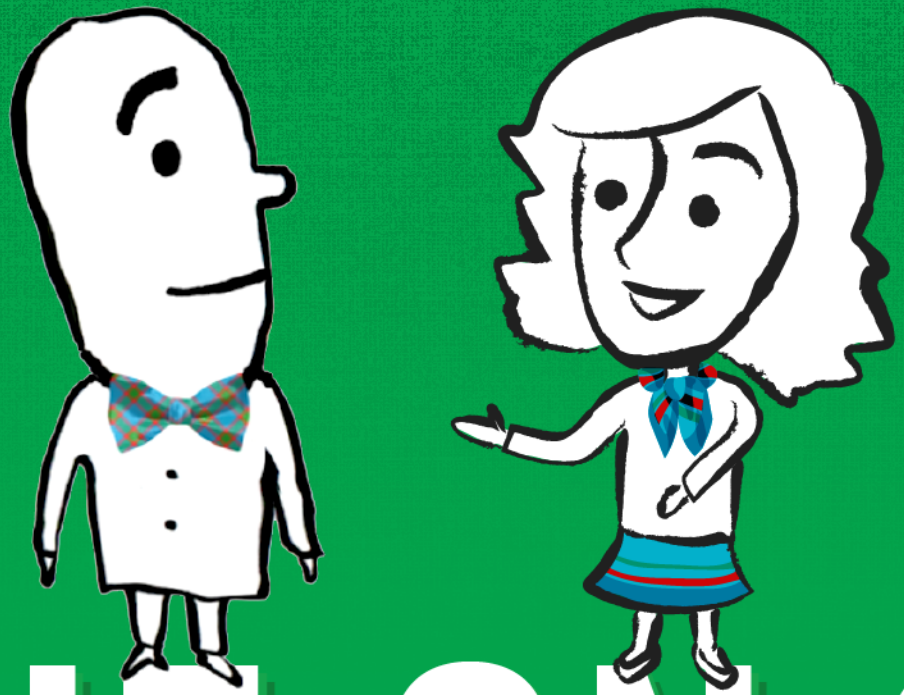

ONE ON ONE

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FURTHER QUESTIONS?

Other questions about NCCOR or upcoming activities?

Email the NCCOR Coordinating Center
nccor@fhi360.org

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NCCOR is now on Facebook!

Follow and like the page

f @NCCOR.org

Follow @NCCOR

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WHAT'S HAPPENING IN
NCCOR NEWS

NCCOR, The JPB Foundation strengthen alliance to support Measures Registry

NCCOR hosts National Childhood Obesity Awareness Month social media activities

NCCOR helps communities evaluate their progress in reducing childhood obesity

Healthy Communities Study findings on relationship between community policies and programs and childhood obesity

U.S. Preventive Services Task Force update on obesity screening recommendation

Connect & Explore

Upcoming Webinars

Mark your calendar for these upcoming Connect & Explore webinars!

OCT 11 Built Environment Interventions to Increase Physical Activity: Community Preventive Services Task Force Recommendations

THANK YOU!

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