College of Health Solutions
Arizona State University

Novel Methods and Analytics for Assessing Behaviors across the 24 hours

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"I probably shouldn't wake him. He needs the exercise."

"Here—go make Daddy's Fitbit think he's exercising."

Growth of wearable sensors

Oh my how they have grown ☺

Jawbone circa 2013

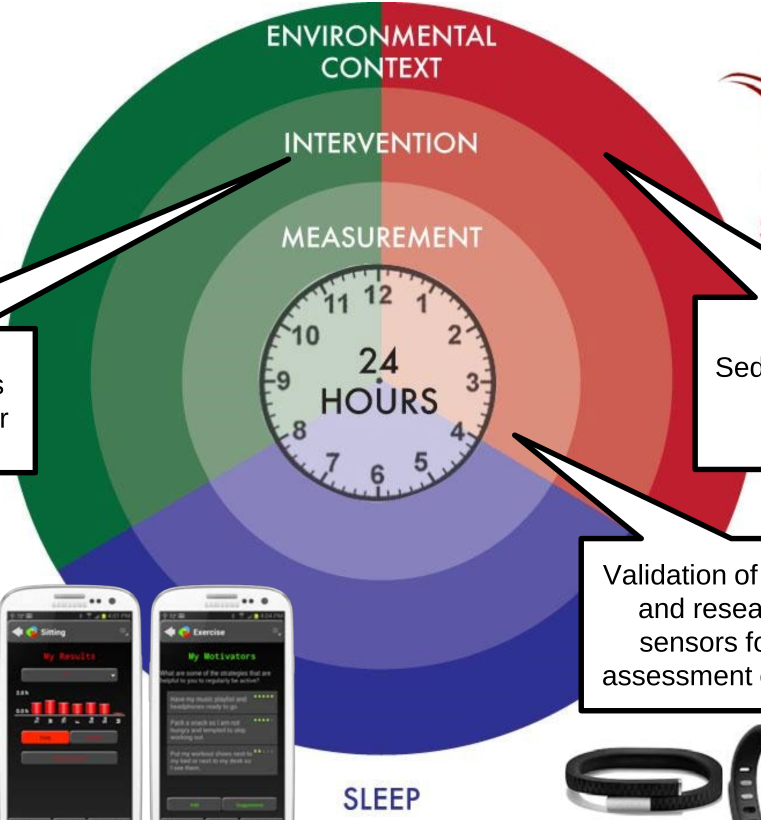
Garmin 2018

Health Outcome	Physical Activity
All-cause mortality	✔
Cardiovascular disease	✔
Stroke	✔
Hypertension	✔
Atherogenic dyslipidemia	✔
Type 2 diabetes	✔
Obesity	✔
Bone health	✔
Physical function/falls	✔
Some cancers	✔
Cognitive function	✔
Depression	✔

Health Outcome	Physical Activity	Sedentary Behavior
All-cause mortality	✔	✔
Cardiovascular disease	✔	✔
Stroke	✔	✔
Hypertension	✔	✔
Atherogenic dyslipidemia	✔	✔
Type 2 diabetes	✔	✔
Obesity	✔	✔
Bone health	✔	✔
Physical function/falls	✔	✔
Some cancers	✔	✔
Cognitive function	✔	✔
Depression	✔	✔

Health Outcome	Physical Activity	Sedentary Behavior	Sleep
All-cause mortality	✔	✔	✔
Cardiovascular disease	✔	✔	✔
Stroke	✔	✔	✔
Hypertension	✔	✔	✔
Atherogenic dyslipidemia	✔	✔	✔
Type 2 diabetes	✔	✔	✔
Obesity	✔	✔	✔
Bone health	✔	✔	✔
Physical function/falls	✔	✔	✔
Some cancers	✔	✔	✔
Cognitive function	✔	✔	✔
Depression	✔	✔	✔

"…understanding the dynamic interplay of sleep, sedentary, and more active behaviors, and how collectively these behaviors may be harnessed for health promotion and disease prevention."



Smartphone 'apps' for behavior change across the 24-hour spectrum for cardiometabolic health

Sedentary behavior in the workplace

Validation of commercial- and research-grade sensors for 24-hour assessment of behaviors.

BeWell24

Outline for today's talk

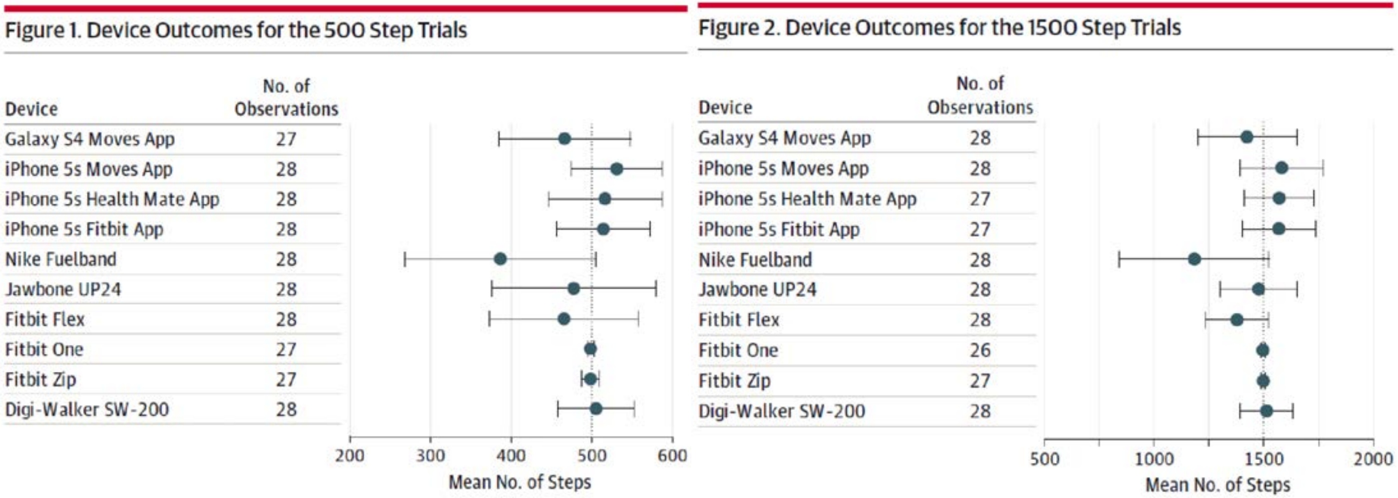
1. Using wearables to <u>assess and monitor</u> 24h behaviors

2. <u>Novel analytics</u> in 24h data

3. Using wearables (and smartphones) to <u>intervene</u> across the 24h

Using wearables to assess and monitor behaviors across the 24 hours

Accuracy of smartphone applications and wearable devices for tracking physical activity data

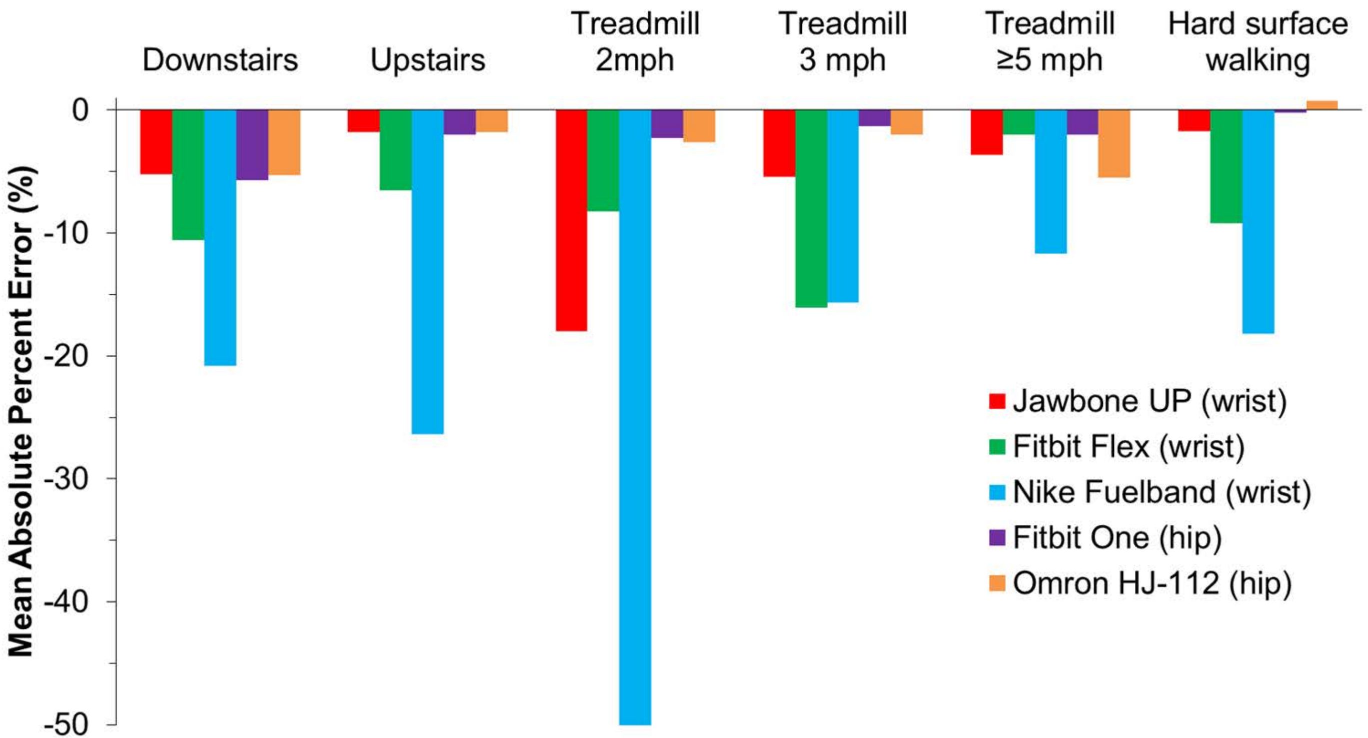


JAMA 2015; 3313(6): 626

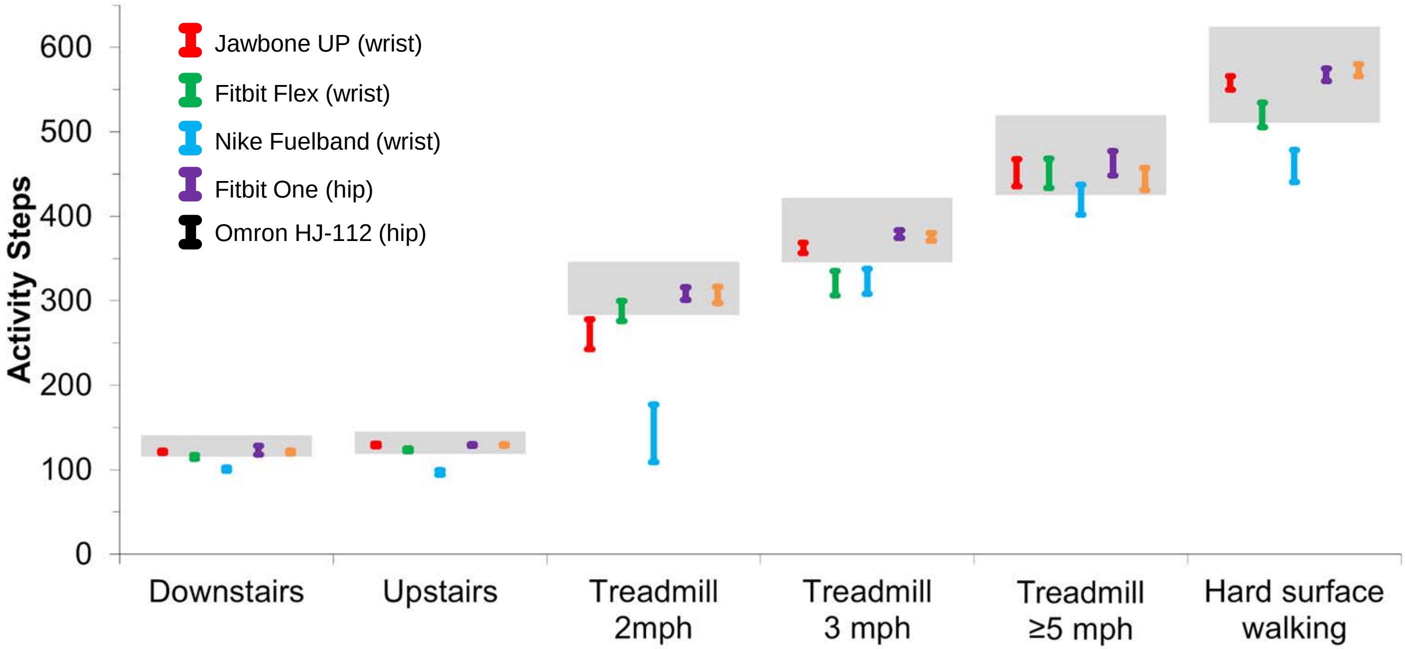
Validation of wearable monitors

10 sensors	23 activities	3 Sub-studies	Sample
Stepwatch Omron HJ-112 Actigraph GT3x+ Fitbit One Jawbone UP Fitbit Flex Nike Fuelband Geneactiv Sensewear Zephyr Bioharness	Free ambulation (8) Graded ambulation (4) Treadmill (8) Non ambulatory (3)	Lab-based validation Free-living validation - with sleep (n=30) Ongoing monitoring (behavior change)	48 normal weight 48 overweight 48 obese 24 tall 24 elite runners 96 seniors **288 total**

Results Percent Error (%)

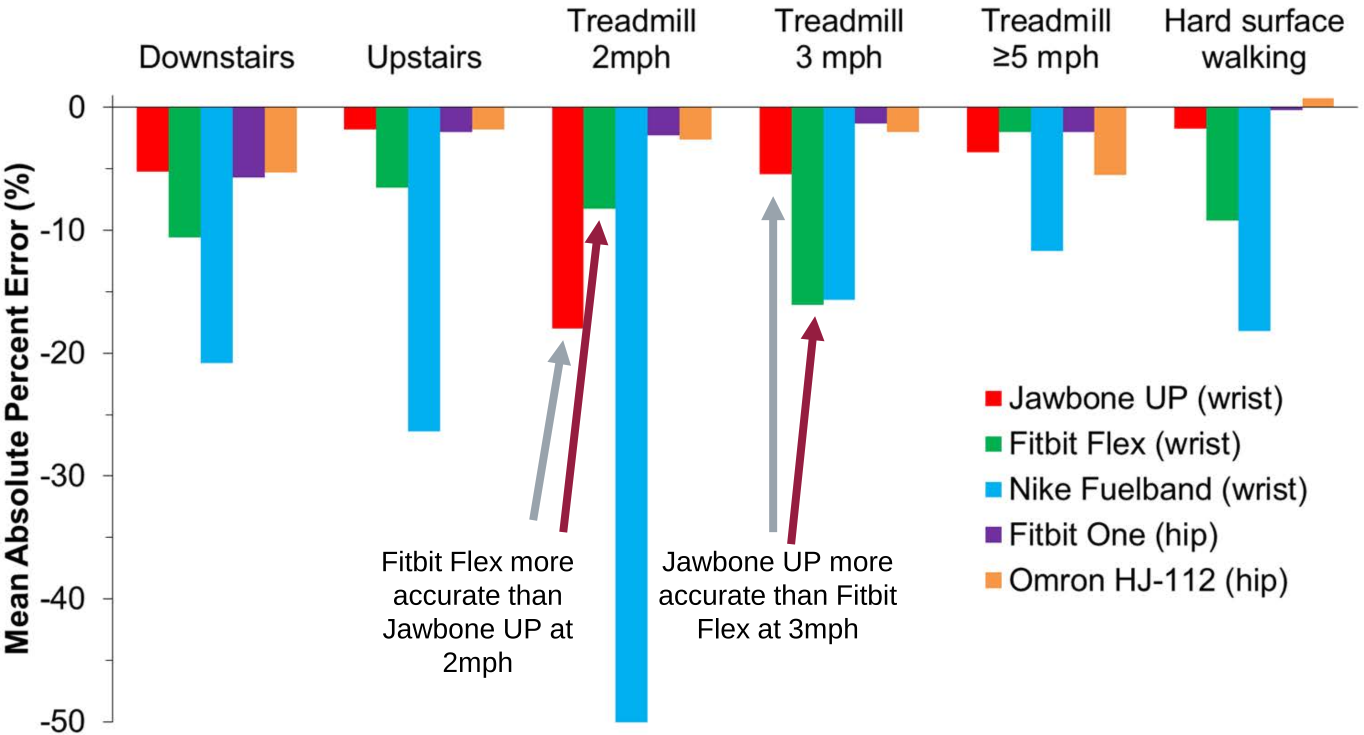


Equivalency (N=160)



Grayed regions indicate proposed equivalence range (±10% of direct observation mean);
Error bars indicate 90% confidence interval for accelerometer means

Proprietary algorithms



Twenty-four Hours of Sleep, Sedentary Behavior, and Physical Activity with Nine Wearable Devices

ROSENBERGER, M. E., M. P. BUMAN, W. L. HASKELL, M. V. MCCONNELL, and L. L. CARSTENSEN. Twenty-four Hours of Sleep, Sedentary Behavior, and Physical Activity with Nine Wearable Devices. *Med. Sci. Sports Exerc.*, Vol. 48, No. 3, pp. 457–465, 2016. Getting enough sleep, exercising, and limiting sedentary activities can greatly contribute to disease prevention and overall health

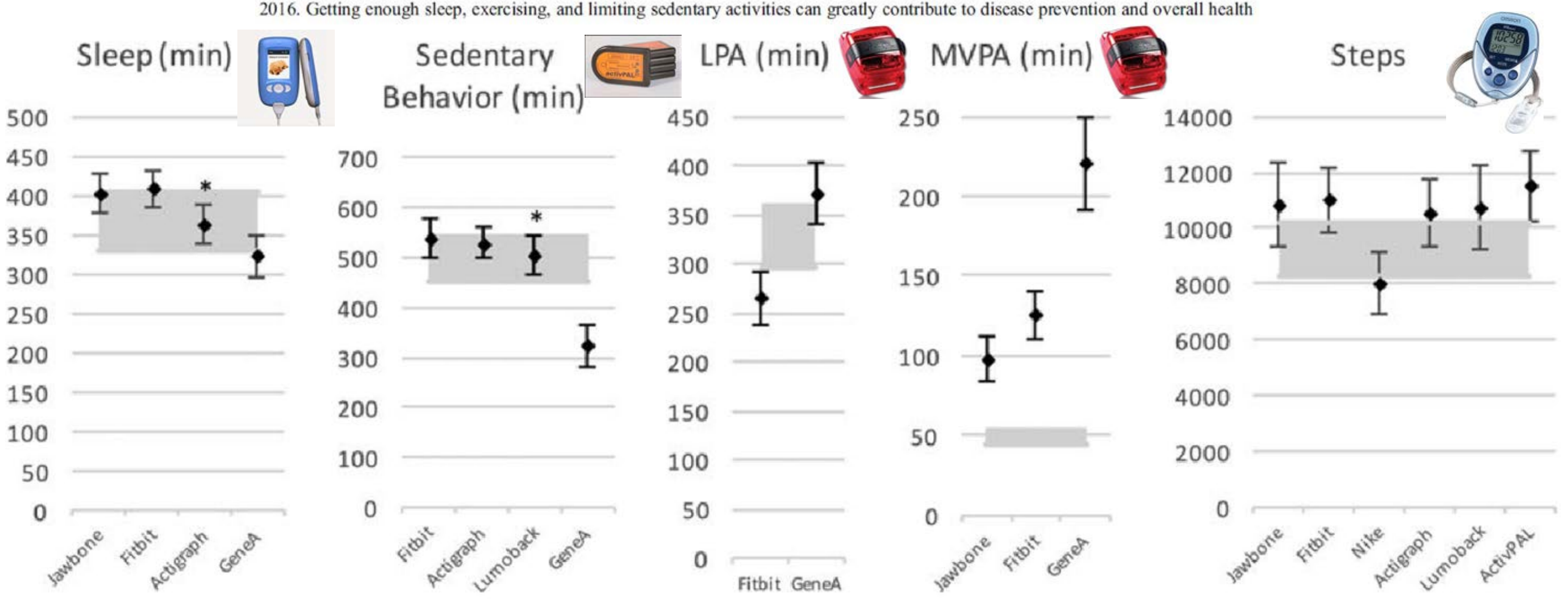


FIGURE 3—Equivalence testing for all of the devices in all domains. *Shaded areas* are equivalence zones (±10% of the mean), and *error bars* indicate the 90% confidence interval for the mean measurement. *Equivalent measures.

Some questions/reflections on these data (and others)

1. How accurate is accurate enough?
2. How much does wearability matter?
3. Do they change behavior?

Journal of Black Studies
1–16

DOI: 10.1177/0021934716653349
jbs.sagepub.com
SAGE

Wearable Devices to Improve Physical Activity and Sleep: A Randomized Controlled Trial of College-Aged African American Women

Bridget F. Melton[1], Matthew P. Buman[2], Robert L. Vogel[1], Brandonn S. Harris[1], and Lauren E. Bigham[3]

Abstract

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that the intervention group decreased step counts relative to the comparison app (9,378 vs. 11,287 steps; p = .02). For sleep, neither group demonstrated any changes in sleep duration, sleep onset latency, wakefulness after sleep onset, or sleep efficiency at the 6-week posttest or 8-week follow-up. This

This study found no evidence for initial efficacy as a stand-alone tool for increasing physical activity or improving sleep.

JAMA | Original Investigation

Effect of Wearable Technology Combined With a Lifestyle Intervention on Long-term Weight Loss
The IDEA Randomized Clinical Trial

John M. Jakicic, PhD; Kelliann K. Davis, PhD; Renee J. Rogers, PhD; Wendy C. King, PhD; Marsha D. Marcus, PhD; Diane Helsel, PhD, RD; Amy D. Rickman, PhD, RD, LDN; Abdus S. Wahed, PhD; Steven H. Belle, PhD

RESULTS Among the 471 participants randomized (body mass index [BMI], 25 to <40; age range, 18-35 years; 28.9% nonwhite; 77.2% women), 470 (233 in the standard intervention group, 237 in the enhanced intervention group) initiated the interventions as randomized, and 74.5% completed the study. Weight change at 24 months differed significantly by intervention group (difference, 2.4 kg [95% CI, 1.0-3.7]; $P = .002$). Both groups had significant improvements in body composition, fitness, physical activity, and diet, with no significant difference between groups.

	Standard Intervention	Enhanced Intervention
Weight, mean (95% CI), kg		
Baseline	95.2 (93.0-97.3)	96.3 (94.2-98.5)
24 mo	89.3 (87.1-91.5)	92.8 (90.6-95.0)
Estimated weight loss, mean (95% CI), kg	5.9 (5.0-6.8)	3.5 (2.6-4.5)

CONCLUSIONS AND RELEVANCE Among young adults with a BMI between 25 and less than 40, the addition of a wearable technology device to a standard behavioral intervention resulted in less weight loss over 24 months. Devices that monitor and provide feedback on physical activity may not offer an advantage over standard behavioral weight loss approaches.

Novel analytics for wearable data across the 24 hours

Isotemporal Substitution Method

- 24h day is distributed between sleep, sedentary, and active behaviors
- Time in finite; increasing one behavior means decreasing another

Target Behavior	Replace with…	Health Outcome
↓Television viewing	↑Brisk walking ↑Desk work ↑Sleep ↑Household chores	??? ??? ??? ???
↓Sleep	↑Running ↑Sitting	??? ???

American Journal of Epidemiology

DOI: 10.1093/aje/kwp163

Practice of Epidemiology

Isotemporal Substitution Paradigm for Physical Activity Epidemiology and Weight Change

Rania A. Mekary, Walter C. Willett, Frank B. Hu, and Eric L. Ding

Initially submitted December 22, 2008; accepted for publication May 18, 2009.

For a fixed amount of time engaged in physical activity, activity choice may affect body weight differently depending partly on other activities' displacement. Typical models used to evaluate effects of physical activity

For a fixed amount of time engaged in physical activity, activity choice may affect body weight differentially depending partly on other activities' displacement. Typical models used to evaluate effects of physical activity on body weight do not directly address these substitutions.

(−1.14 kg, 95% confidence interval: −1.75, −0.53) and with even lower weight when substituted for TV watching. Similar heterogeneous relations with weight change were found for each activity type (TV watching, slow walking, brisk walking, jogging/running) when displaced by other activities across these various models. The isotemporal substitution paradigm may offer new insights for future public health recommendations.

American Journal of Epidemiology

DOI: 10.1093/aje/kwt292

Original Contribution

Reallocating Time to Sleep, Sedentary Behaviors, or Active Behaviors: Associations With Cardiovascular Disease Risk Biomarkers, NHANES 2005–2006

Matthew P. Buman*, Elisabeth A. H. Winkler, Jonathan M. Kurka, Eric B. Hekler, Carol M. Baldwin, Neville Owen, Barbara E. Ainsworth, Genevieve N. Healy, and Paul A. Gardiner

Nutritional and Health Examination Survey (NHANES)

(N=2185 adults >20 years of age)

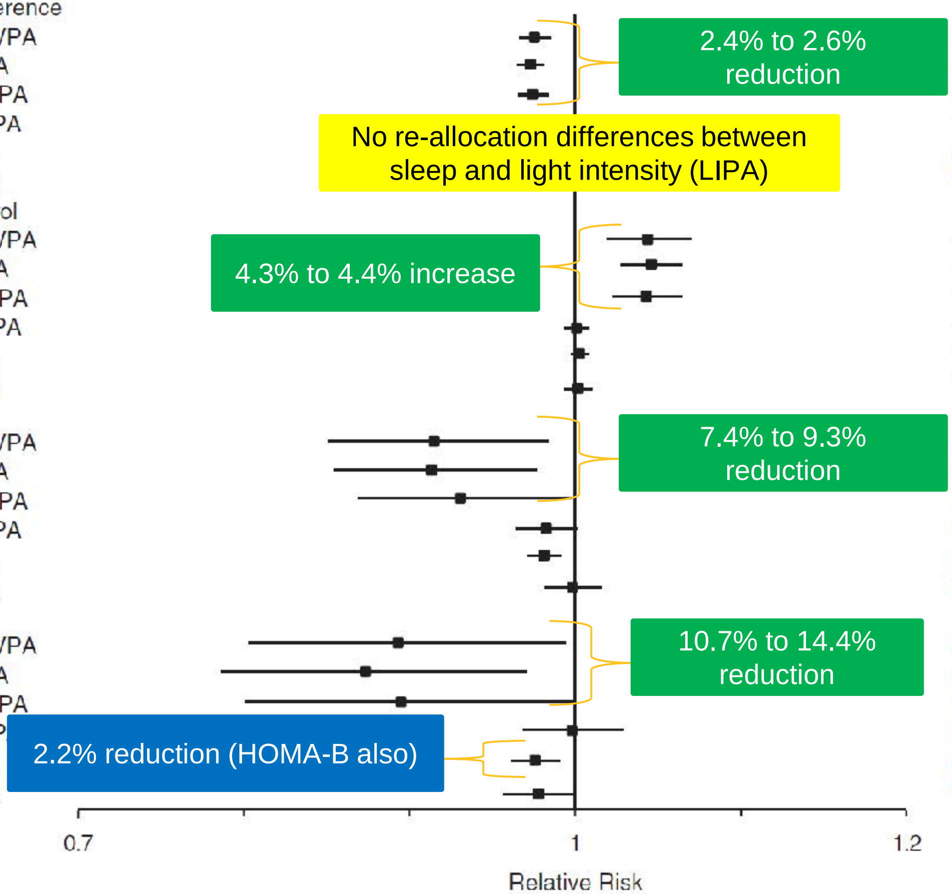
Outcomes: Cardiometabolic risk factors

Sleep	Sedentary	Light	MVPA
Self-reported	<100 cts/min	100-1,951 cts/min	≥1,952 cts/min

Total Activity

Results (per 30min re-allocation)

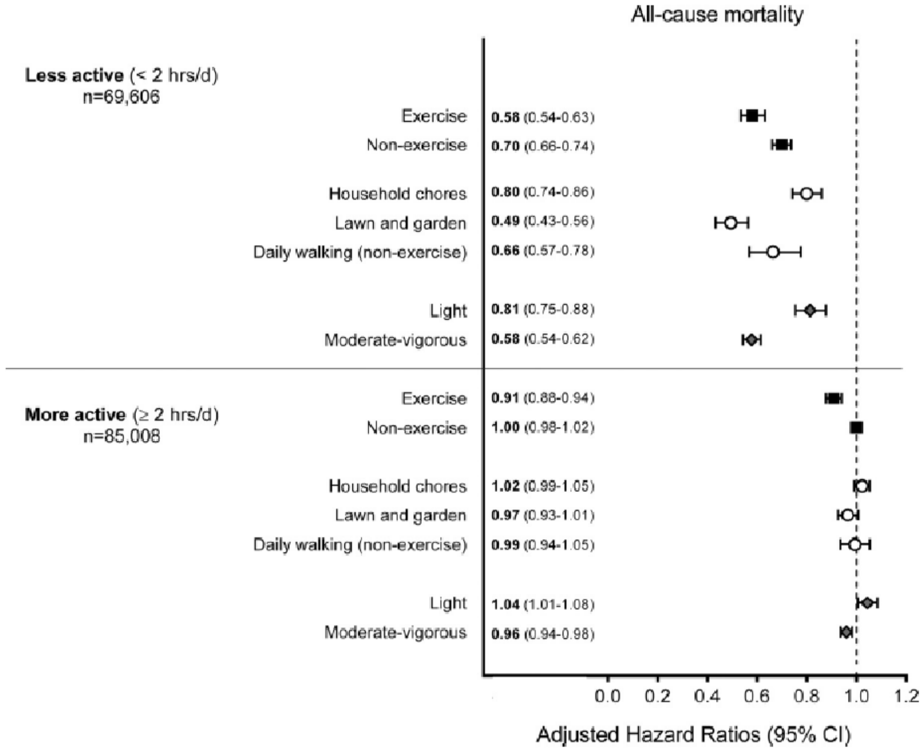
Association	RR (95% CI)
Waist circumference	
Sleep to MVPA	0.976 (0.966, 0.985)
SB to MVPA	0.973 (0.965, 0.981)
LIPA to MVPA	0.974 (0.966, 0.983)
Sleep to LIPA	1.001 (0.998, 1.005)
SB to LIPA	0.999 (0.996, 1.001)
SB to sleep	0.997 (0.993, 1.001)
HDL cholesterol	
Sleep to MVPA	1.044 (1.019, 1.070)
SB to MVPA	1.046 (1.028, 1.065)
LIPA to MVPA	1.043 (1.023, 1.064)
Sleep to LIPA	1.001 (0.994, 1.008)
SB to LIPA	1.003 (0.998, 1.008)
SB to sleep	1.002 (0.994, 1.011)
Triglycerides	
Sleep to MVPA	0.915 (0.851, 0.983)
SB to MVPA	0.914 (0.855, 0.977)
LIPA to MVPA	0.931 (0.869, 0.998)
Sleep to LIPA	0.983 (0.964, 1.002)
SB to LIPA	0.981 (0.972, 0.991)
SB to sleep	0.999 (0.982, 1.016)
Insulin	
Sleep to MVPA	0.893 (0.803, 0.994)
SB to MVPA	0.874 (0.786, 0.970)
LIPA to MVPA	0.895 (0.801, 1.000)
Sleep to LIPA	0.998 (0.969, 1.029)
SB to LIPA	0.976 (0.962, 0.991)
SB to sleep	0.978 (0.957, 1.000)



Mortality Benefits for Replacing Sitting Time with Different Phvsical Activities

ABSTRACT

MATTHEWS, C. E., S. C. MOORE, J. SAMPSON, A. BLAIR, Q. XIAO, S. K. KEADLE, A. HOLLENBECK, and Y. PARK. Mortality Benefits for Replacing Sitting Time with Different Physical Activities. *Med. Sci. Sports Exerc.*, Vol. 47, No. 9, pp. 1833–1840, 2015. **Purpose**: Prolonged sitting has emerged as a risk factor for early mortality, but the extent of benefit realized by replacing sitting



Stamatakis et al. International Journal of Behavioral Nutrition and Physical Activity (2015) 12:121
DOI 10.1186/s12966-015-0280-7

International Journal of Behavioral Nutrition and Physical Activity

RESEARCH Open Access

All-cause mortality effects of replacing sedentary time with physical activity and sleeping using an isotemporal substitution model: a prospective study of 201,129 mid-aged and older adults

Emmanuel Stamatakis[1,2,3*], Kris Rogers[4], Ding Ding[5], David Berrigan[6], Josephine Chau[1,4], Mark Hamer[3,7] and Adrian Bauman[1,4]

Table 3 Independent[a] and isotemporal substitution[b] effects of sleeping, screen time, sitting, walking and non-walking moderate to vigorous physical activity on all-cause mortality risk. Participants who were considered healthy at baseline, defined as those who were never diagnosed with cardiovascular disease, diabetes, or cancer, (Imputed data[c], $n = 143{,}680$; 2690 deaths)

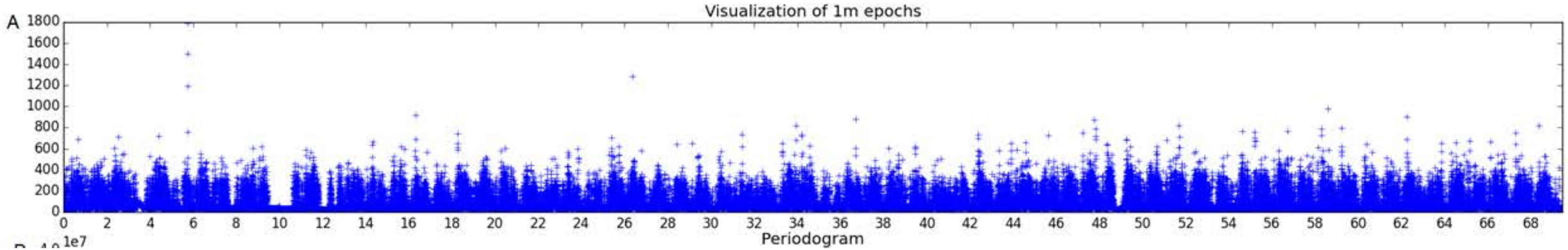
	With 1 hr of:							
1. Isotemporal Substitution Model- *Replace 1 hr of:*	Sleeping (<=7 hrs)	Sleeping (>7 hrs)	Screen-time	Sitting	Standing	Walking	MVPA	Total activity
A. Sleeping (<=7 hrs)	-	-	1.03 (0.97–1.09)	1.05 (0.98–1.11)	1.02 (0.96–1.08)	0.95 (0.81–1.11)	0.95 (0.86–1.04)	0.99 (0.94–1.05)
B. Sleeping (>7 hrs)	-		0.98 (0.94–1.01)	0.98 (0.95–1.02)	0.94 (0.91–0.98)	0.88 (0.79–0.98)	0.89 (0.84–0.95)	1.04 (1.00–1.07)
C. Screen-time	0.89 (0.83–0.95)	1.06 (1.02–1.1)	-	1.01 (0.99–1.04)	0.97 (0.95–0.99)	0.91 (0.84–0.99)	0.92 (0.87–0.96)	1.01 (1.00–1.03)
D. Sitting	0.88 (0.82–0.94)	1.04 (1.00–1.08)	0.99 (0.96–1.01)	-	0.96 (0.94–0.98)	0.90 (0.83–0.98)	0.90 (0.86–0.95)	1.03 (1.01–1.04)
E. Standing	0.91 (0.85–0.97)	1.08 (1.04–1.12)	1.03 (1.01–1.05)	1.04 (1.02–1.06)	-	0.93 (0.86–1.02)	0.94 (0.90–0.98)	0.99 (0.97–1.00)
F. Walking	0.98 (0.88–1.08)	1.18 (1.11–1.26)	1.10 (1.01–1.20)	1.11 (1.02–1.21)	1.07 (0.98–1.16)	-	1.01 (0.91–1.11)	0.92 (0.85–1.00)
G. MVPA	0.97 (0.90–1.05)	1.17 (1.11–1.23)	1.09 (1.04–1.14)	1.11 (1.06–1.16)	1.06 (1.02–1.11)	0.99 (0.90–1.10)	-	0.93 (0.89–0.97)
2. Partition model[b]	0.99 (0.94–1.05)	1.06 (1.03–1.10)	1.02 (1.01–1.04)	1.03 (1.02–1.05)	0.98 (0.97–0.99)	0.89 (0.82–0.97)	0.91 (0.87–0.95)	-

[a]Adjusted for sex, age, educational level, marital status, urban or rural residence, BMI, smoking status, self-rated health, receiving help with daily tasks for a long-term illness or disability, prevalent disease at baseline (cardiovascular disease, diabetes, or cancer), psychological distress, and mutually adjusted for all activity classes
[b]Adjusted for sex, age, educational level, marital status, urban or rural residence, BMI, smoking status, self-rated health, receiving help with daily tasks for a long-term illness or disability, psychological distress, mutually adjusted for all activity classes, and total time in all activity classes
[c]Multiple imputation to replace missing time of the activity classes (based on age, sex, and non-missing other activity classes variables)

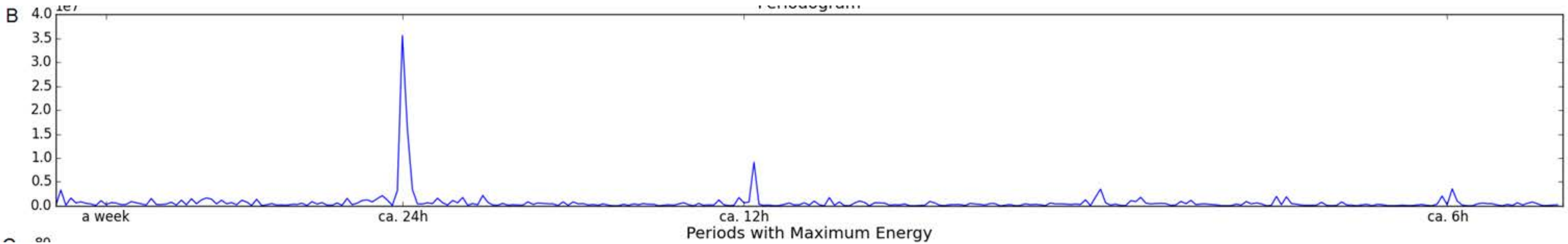
Behavioral periodicities

Continuous raw wrist-worn accelerometry data (40hz – sampled to 1min epoch)

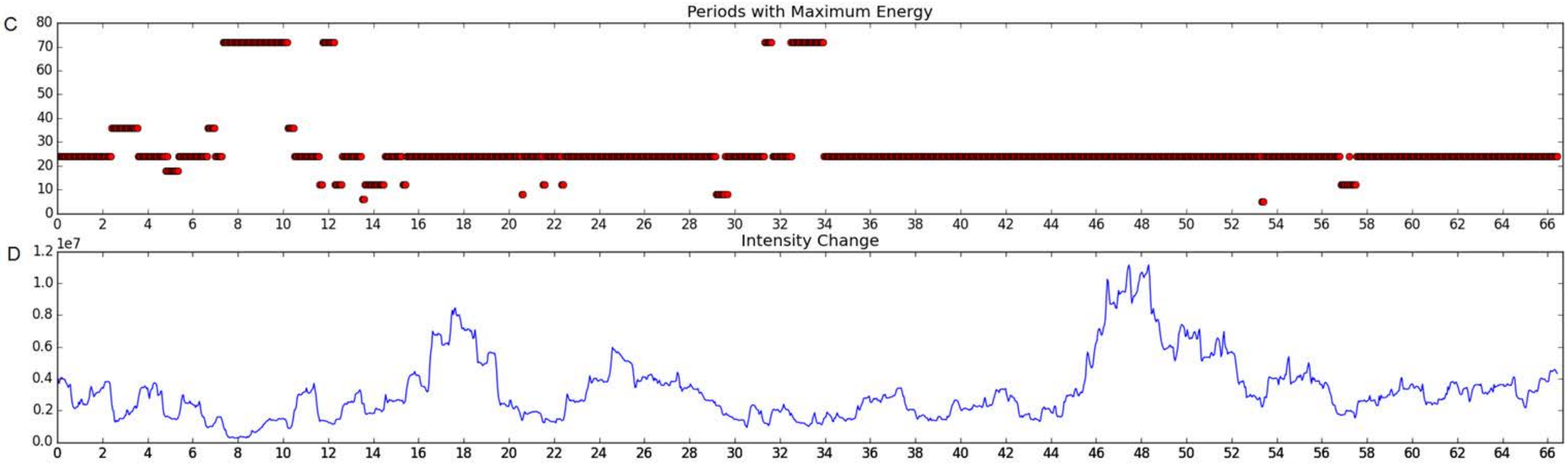
Looking for patterns (e.g., daily, weekly, annual)



Behavioral periodicities are repeating patters



Changes in behavioral periodicity strength over time



Behavioral periodicities and health outcomes

Table 3. Partial correlation coefficients, between cardiometabolic biomarkers and health-related quality of life indices, and periodicity strength metrics (N=20).

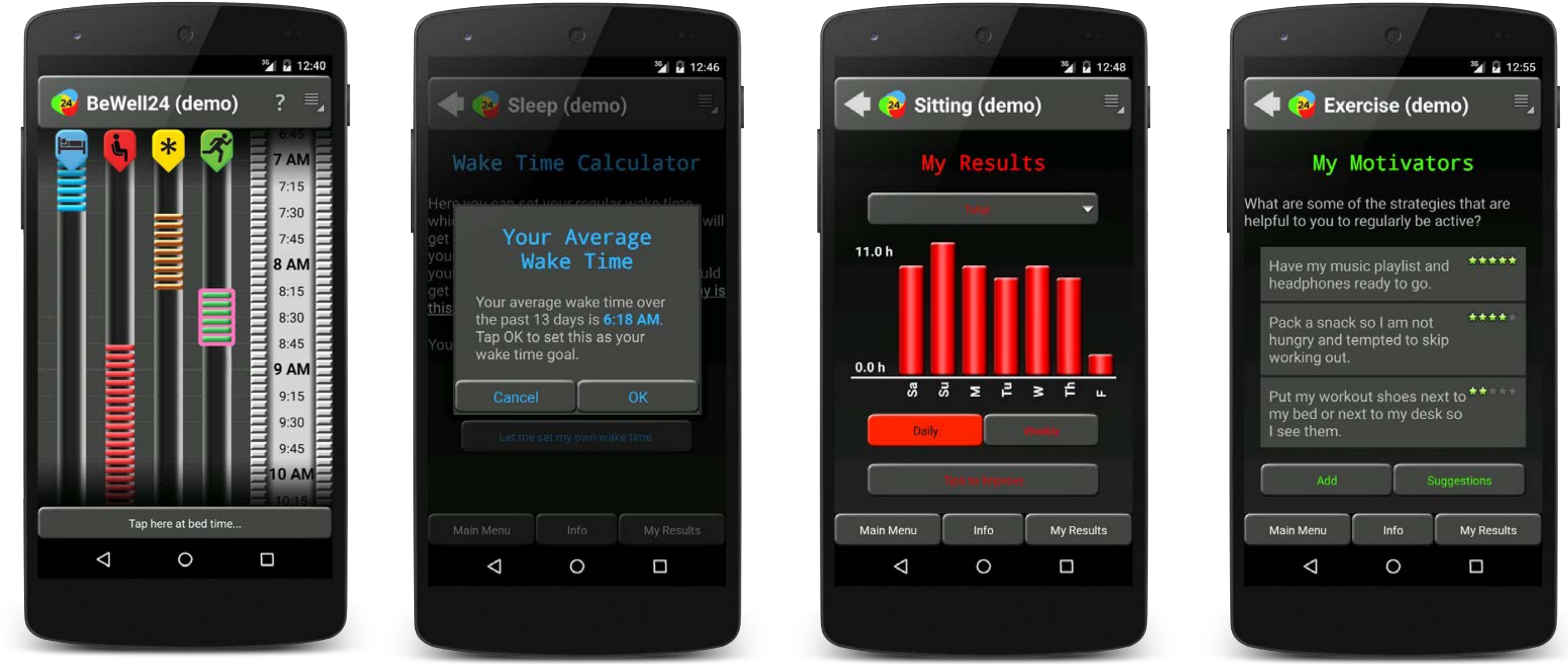
	$M \pm SD$	Periodicity strength metrics				
		Method 1	Method 2	Method 3	Method 4	Method 5
Waist circumference, in	66.82 ± 35.10	0.28	0.27	0.25	0.30	‡
Systolic BP, mm Hg	138.6 ± 17.13	‡	‡	‡	‡	0.57 *
Diastolic BP, mm Hg	89 ± 16.32	‡	‡	‡	‡	‡
Total cholesterol, mg/dL	177.4 ± 50.51	0.52 †	0.68 **	0.57 *	0.46 †	0.47 †
HDL cholesterol, mg/dL	33.9 ± 11.76	‡	‡	‡	‡	0.51 †
LDL cholesterol, mg/dL	109.7 ± 37.64	0.45 †	0.57 *	0.46 †	0.40	0.42
hs-CRP, mg/dL	7.76 ± 5.60	0.47 †	0.38	0.30	0.53 †	‡
Triglycerides, mg/dL	168.7 ± 74.06	0.77 **	0.86 ***	0.81 ***	0.75 **	‡
Plasma glucose, mg/dL	117.2 ± 50.69	‡	‡	‡	‡	‡
Insulin, pmol/L	44.58 ± 73.01	‡	‡	‡	‡	‡
Health-related quality of life	47.25 ± 13.03	0.37	0.54 *	0.55 *	0.37	0.52 †

***$p<0.001$; **$p<0.01$; *$p<0.05$; †$p<0.10$; ‡$r < 0.25$ and $p>0.05$.

All models are adjusted for age, gender, race/ethnicity, leisure-time physical activity, insomnia symptoms, and intervention assignment.

Using wearables to intervene across the 24 hours

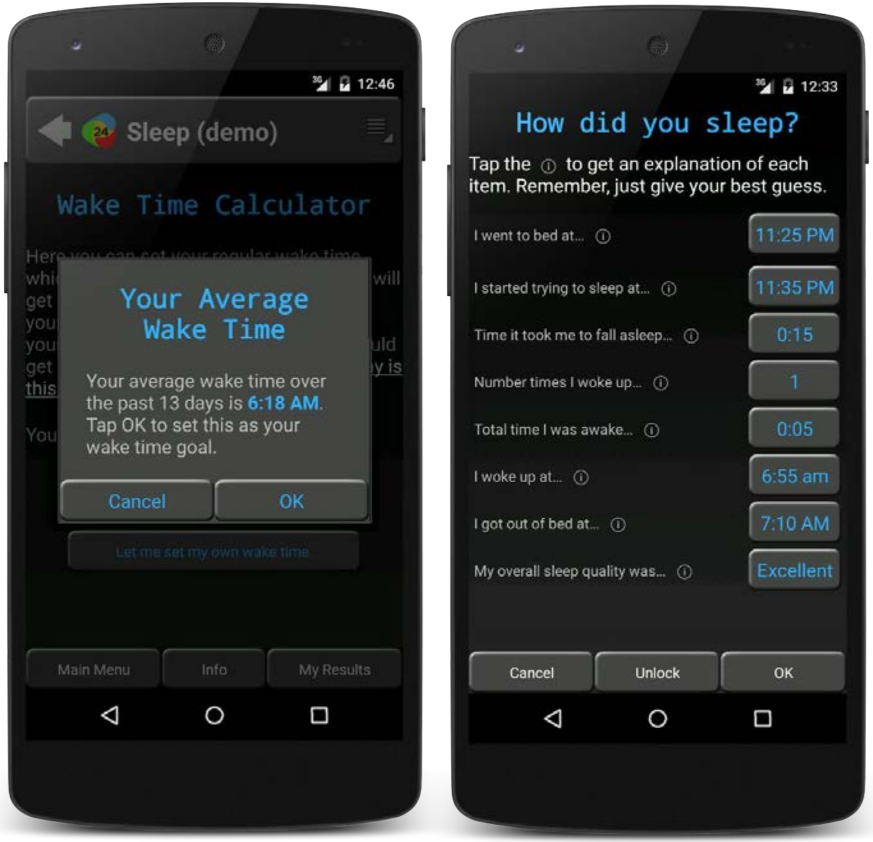
BeWell24 **Smartphone “app” that uses evidence-based behavioral strategies to target the full 24h spectrum of health behaviors**



Activity Monitoring

- Users self-report behaviors across the 24h
- Able to report context of behaviors
  - Sleep quality metrics
  - Domains of sitting (e.g., work, TV, transport)
  - Types of exercise
- Ideally 5min in morning and 5min in evening

Sleep

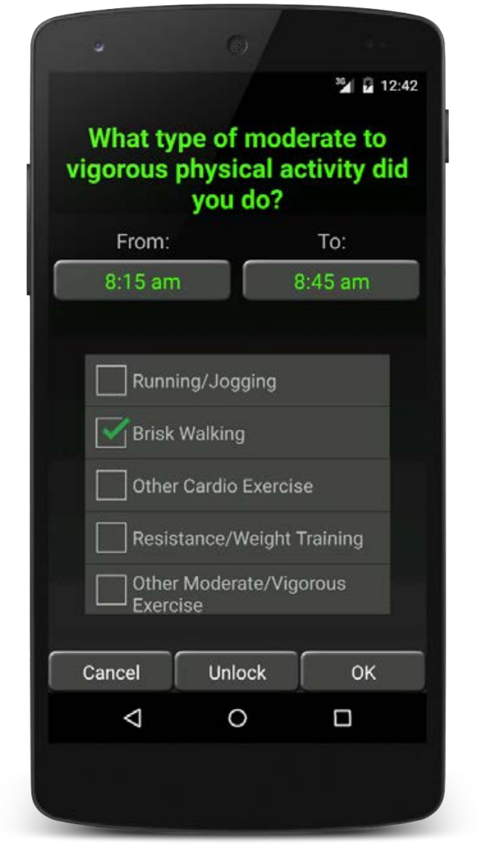


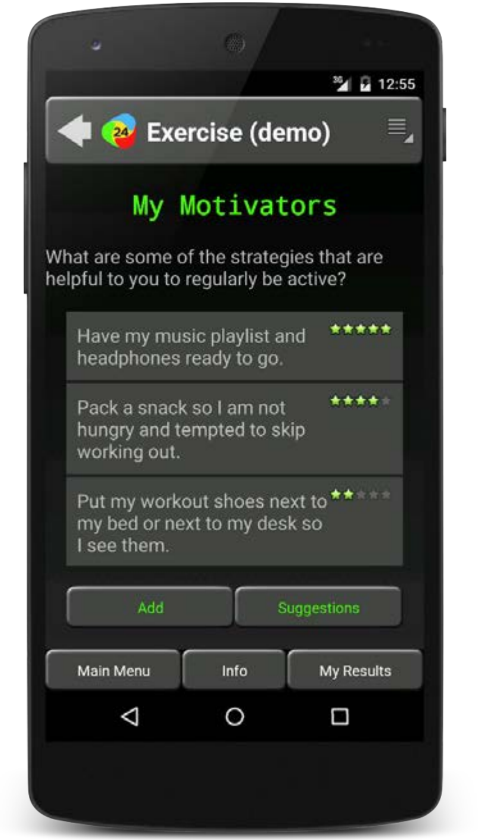
- Evidence-based treatment to re-associate bed with restful sleep
- Personalized wake time calculator with feedback
- Basic sleep hygiene tips

Sedentary

- Focus on reducing time spent <u>sitting</u> by swapping sitting with other activities
- Gives context-specific (i.e., work, TV) feedback and tips

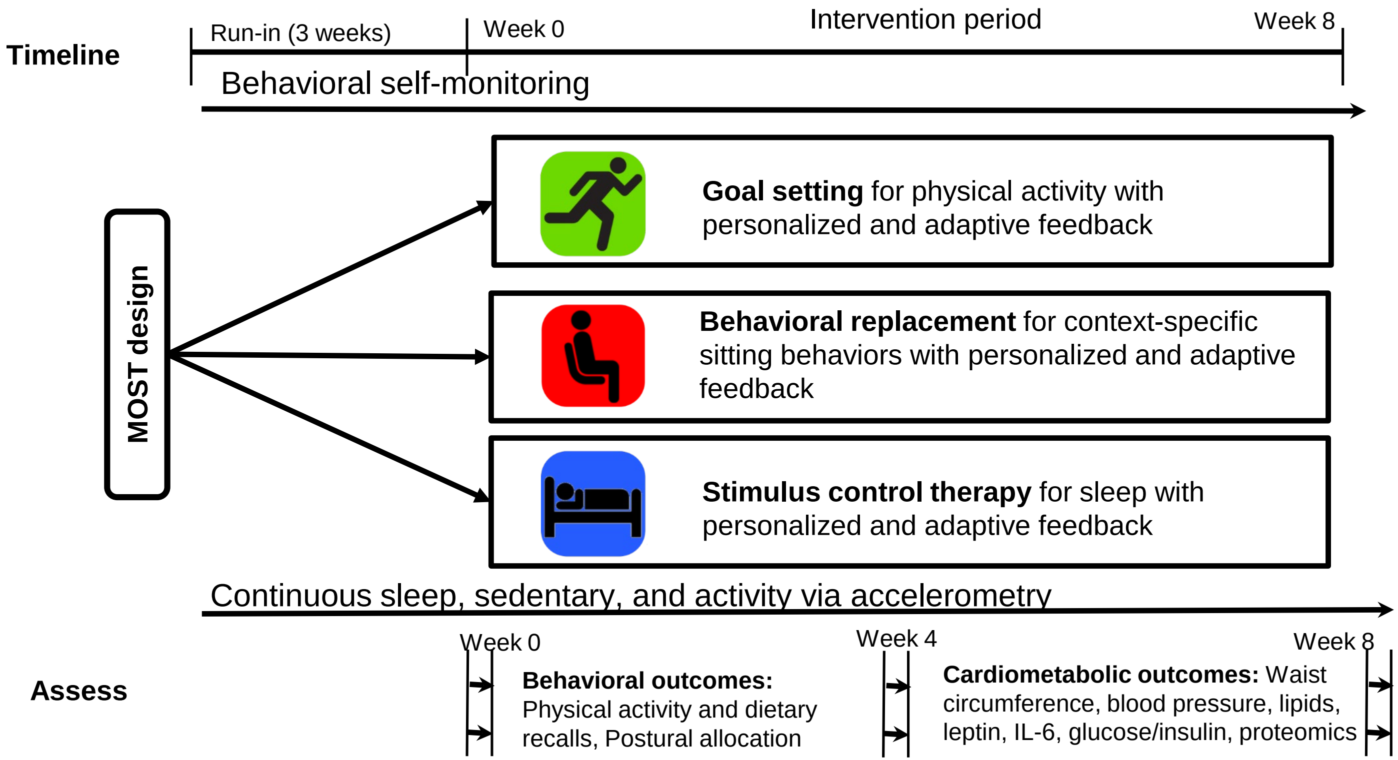
Physical activity





- Provides automated goal suggestions based on previous behavior
- Provides user-generated tips for motivation

BeWell24 Pilot study (N=26)



Participants

- 49 ± 9 years (range: 36-65)
- 85% men
- 73% Caucasian
- BMI = 35.0 ± 8.3 kg/m^2
- 81% retention

Synergistic results

7% increase in
sleep efficiency

12% of 47 min/day
in sitting

105% or 11 min/day of
moderate-vigorous physical activity

12.3% reduction in
fasting glucose

“Smartphone-delivered Diabetes Prevention in the VA” (in progress)

<u>Aim</u>

To test whether *BeWell24* app + FitBit will improve glucose metabolism (**fasting glucose, HbA1c**) over 9 months relative to usual care.

NIH: R18DK109516 (PI: Buman & Reaven)

Fitbit integrated components

Linking wearable data back to providers

LOCAL TITLE: BEWELL24 (LIFESTLYE SMARTPHONE APP) UPDATE
STANDARD TITLE: BEWELL24 UPDATE
DATE OF NOTE: MAY 25, 2017 ENTRY DATE: MAY 25, 2017
AUTHOR: REAVEN, PETER EXP COSIGNER:
URGENCY: STATUS: COMPLETED

SLEEP

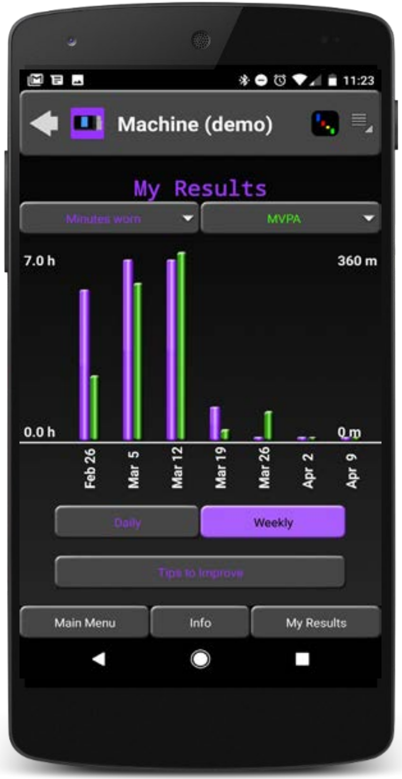
Patient sleep duration: 8 HOURS/NIGHT over the last two weeks; this is up from 7 hours/night
ADVISE: Praise patient for getting adequate sleep.

Patient sleep quality: POOR over the last two weeks; this was GOOD previously
ADVISE: Encourage regular bed and wake times. Avoid alcohol and caffeine before bed.

PHYSICAL ACTIVITY

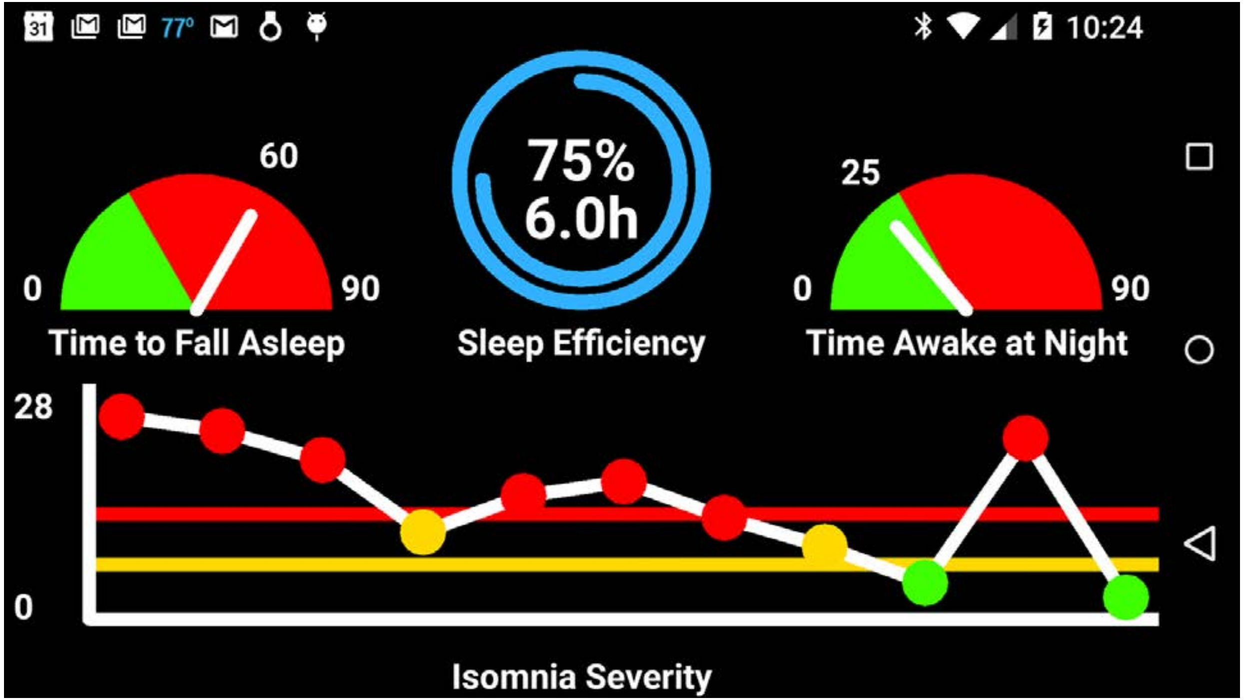
Exercise: 32 MINUTES/DAY over the last two weeks; this is up 20%
Lifestyle movement: 120 MINUTES/DAY over the last two weeks; this is up 20%
ADVISE: Praise patient for regular exercise and incorporating movement into their daily routine.

“SleepWell24: An Innovative Smartphone App to Improve PAP Adherence” (in progress)



NIH: R21NR016046 (PI: Buman & Petrov)

Integration with clinical team: “Show my provider”



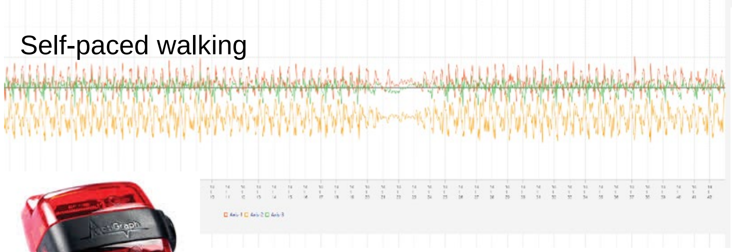
Some final thoughts on wearable technology for 24 hour behaviors

Where are we on activity identification?

- Progress has been slower than expected

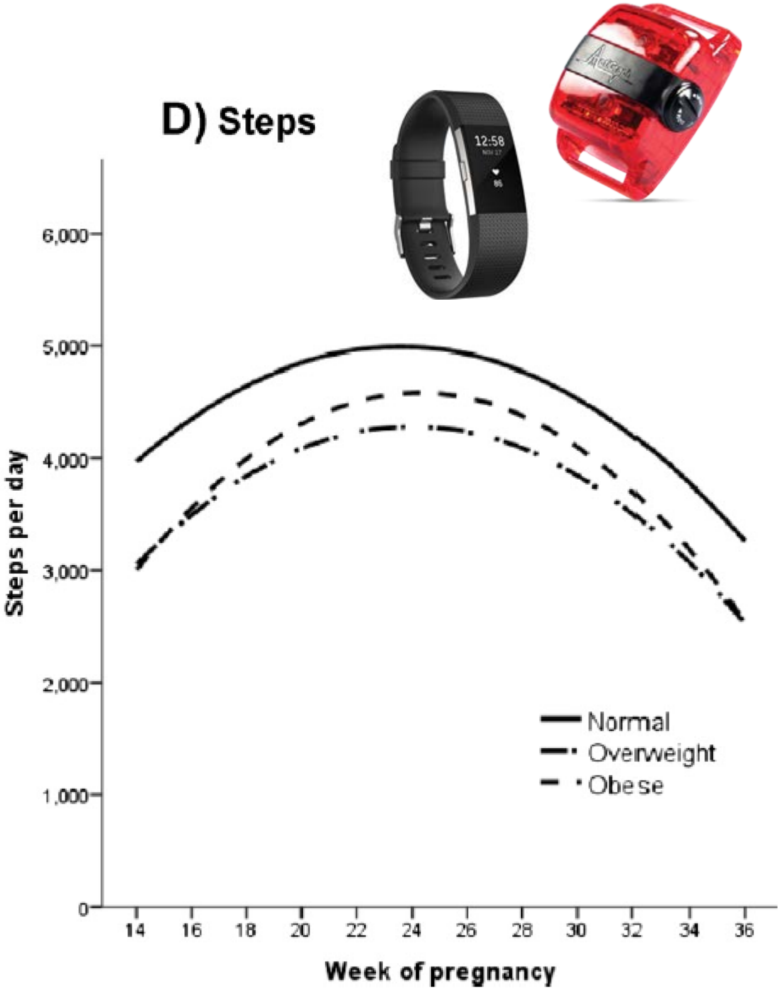
- Few accessible models currently exist

- Industry is much further along than researchers



Pick your sensors carefully

- Be clear about your purpose
- Self-monitoring is a *critical* component of successful behavior change
- Don't be afraid to use both
- Leverage consumer devices for trajectory and process purposes

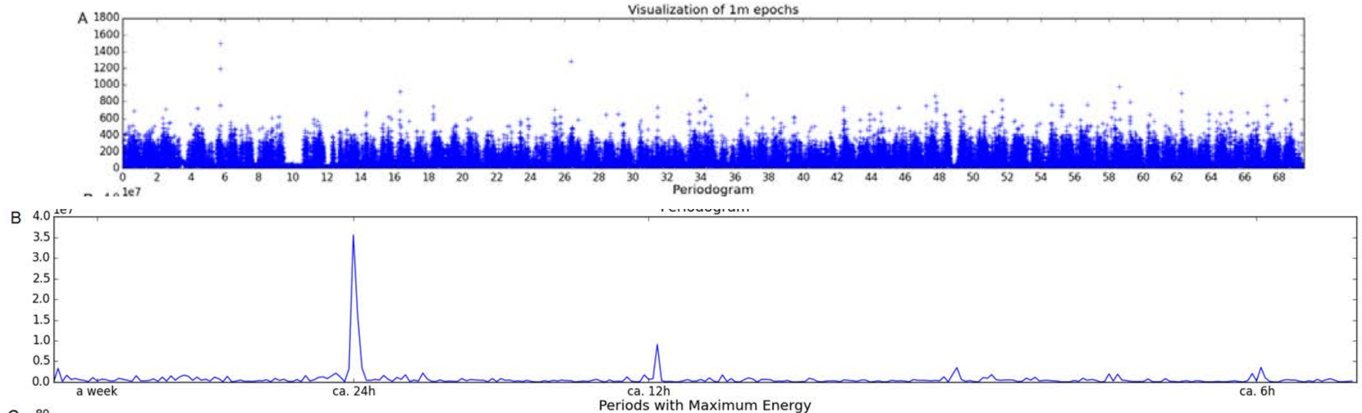


24-hour monitoring brings new challenges

Sedentary time looks a lot like sleep

Recommend using a log (for now)

Also brings new opportunities and metrics



Thank you!

Matthew Buman, PhD, FACSM, FSBM
mbuman@asu.edu

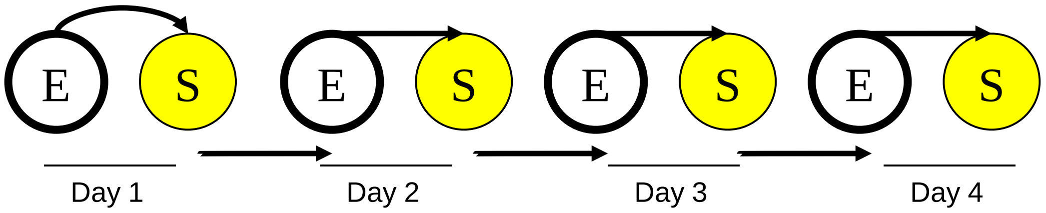
Temporal Association Studies

Between-person – “average effects”

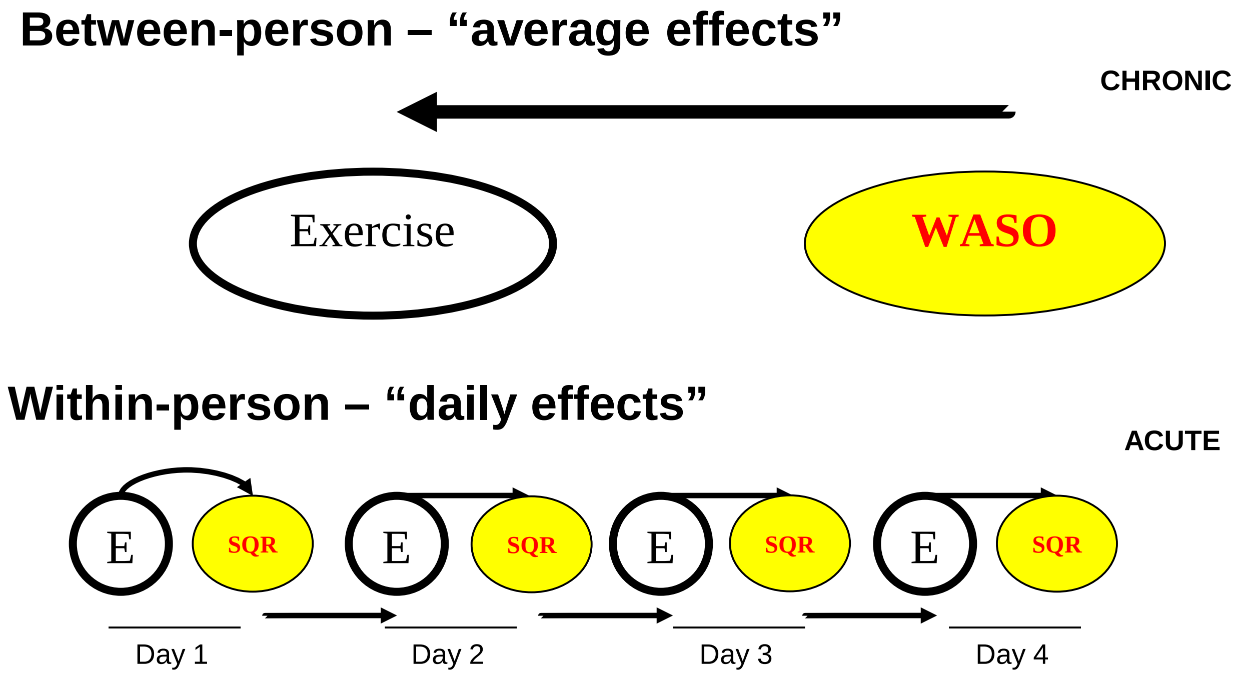
CHRONIC

Within-person – “daily effects”

ACUTE



Subjective PA and sleep (daily diary)
N = 79 older adults x 126 observations

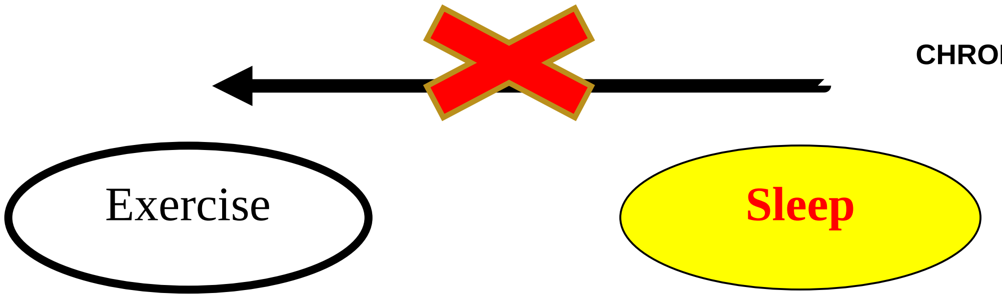


Dzierzewski, Buman, et al., 2014, J Sleep Res

Objective PA and sleep (Actigraph & Actiwatch)
N = 143 older women x 7 observations

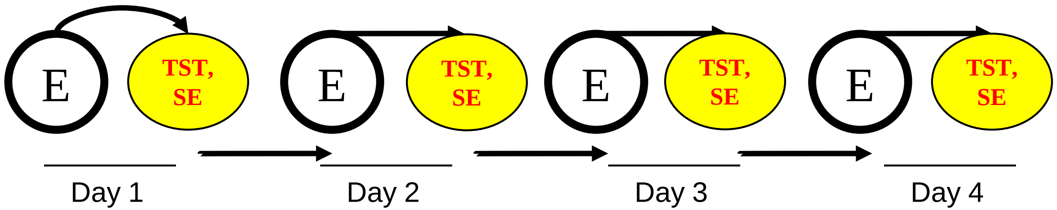
Between-person – "average effects"

CHRONIC

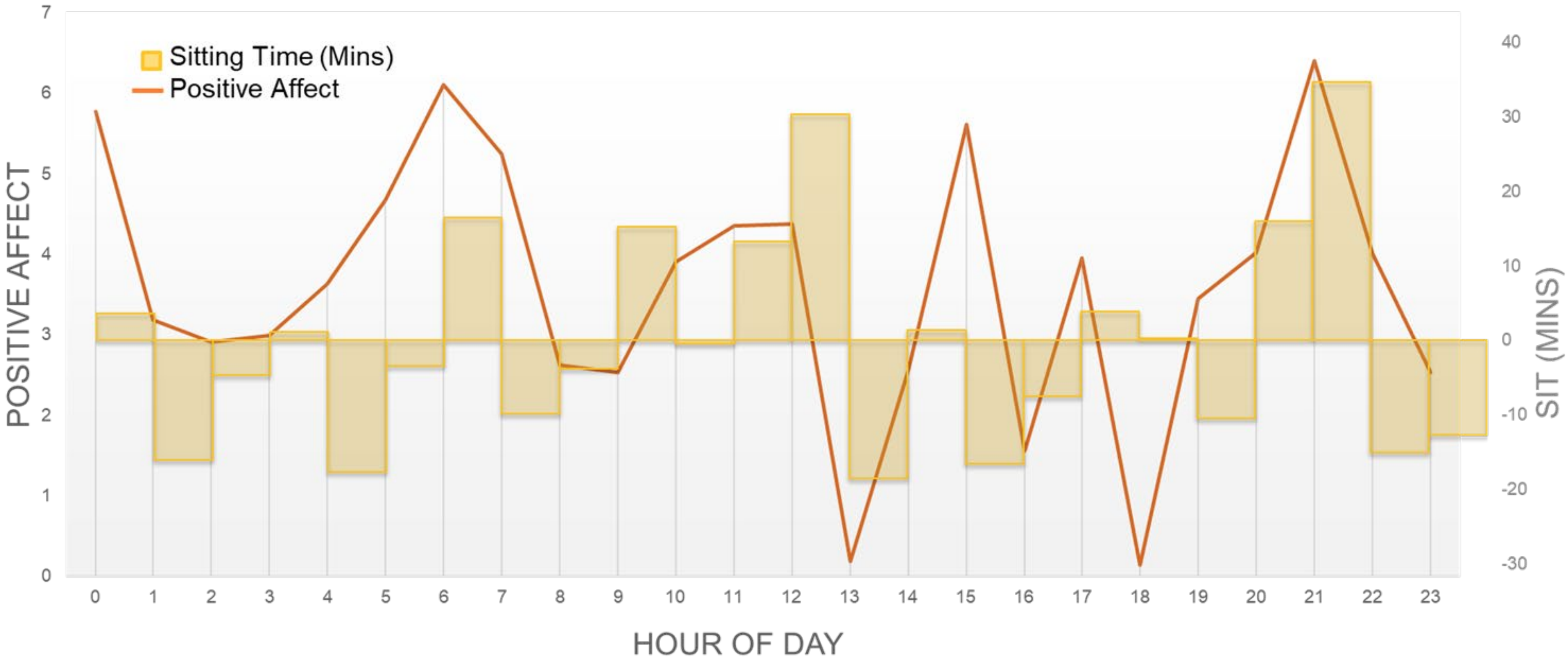


Within-person – "daily effects"

ACUTE

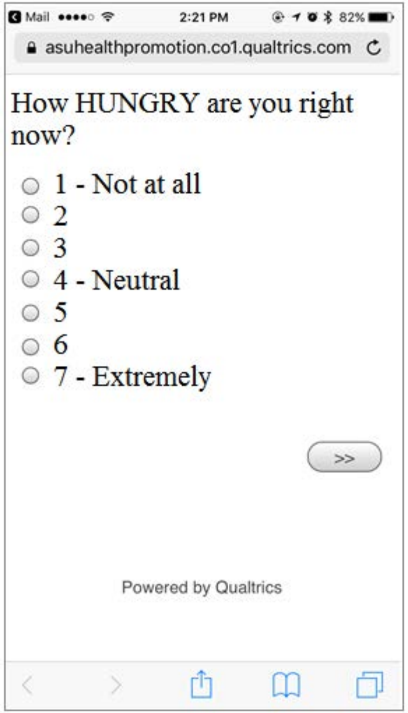


Lambiase, et al., 2014, *Med Sci Sports Exerc*


Sitting Time (Mins)
Positive Affect
POSITIVE AFFECT
SIT (MINS)
HOUR OF DAY
0
1
2
3
4
5
6
7
40
30
20
10
0
-10
-20
-30
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

Intensive measures of sedentary time, affect/mood, and glucose

activPAL micro

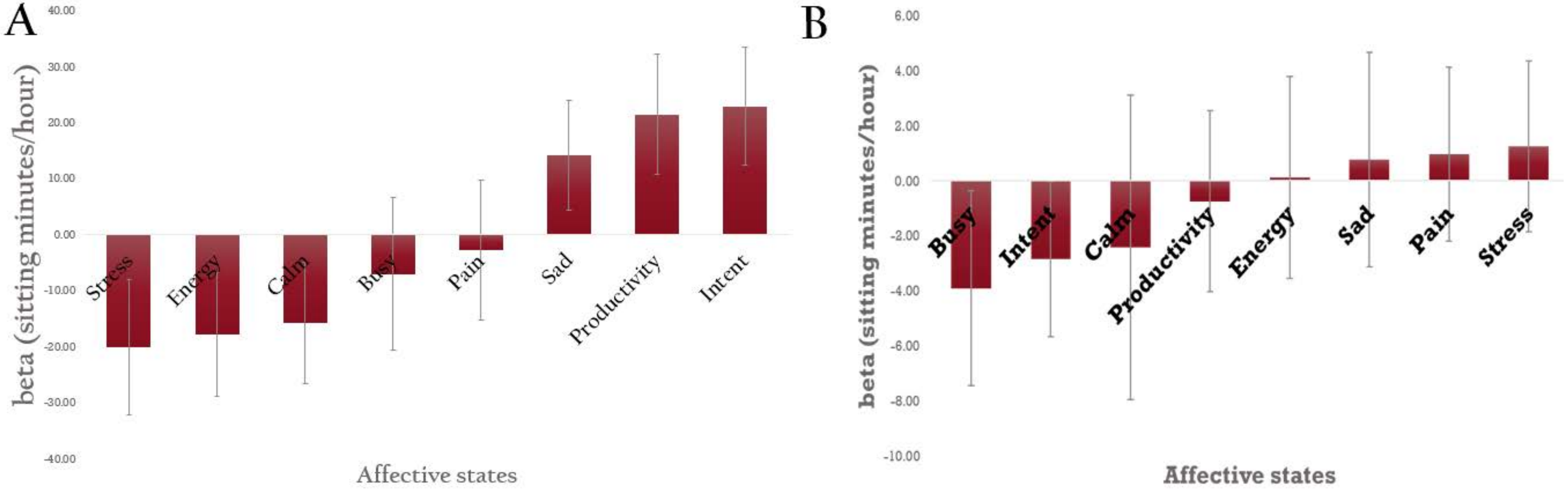


Affective prompts via EMA

Freestyle Libre continuous glucose monitor

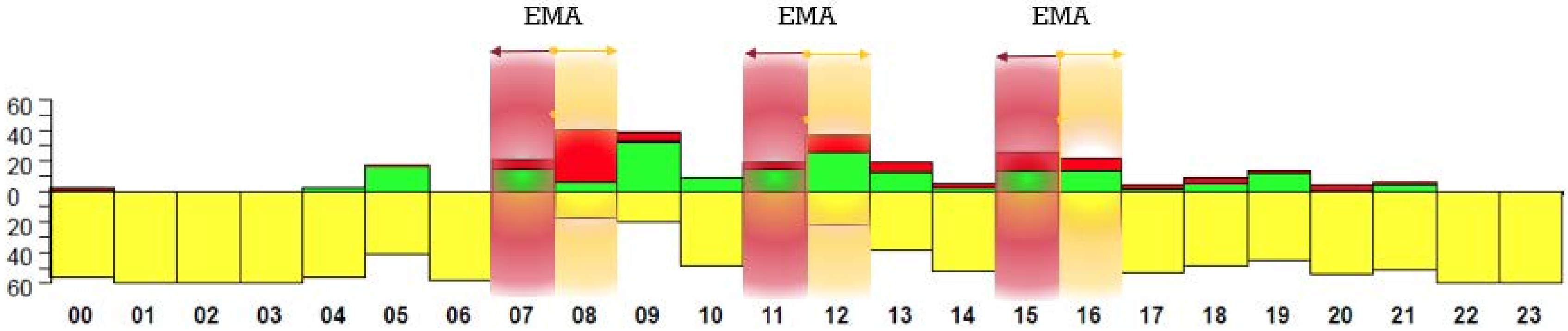
Meynard Toledo

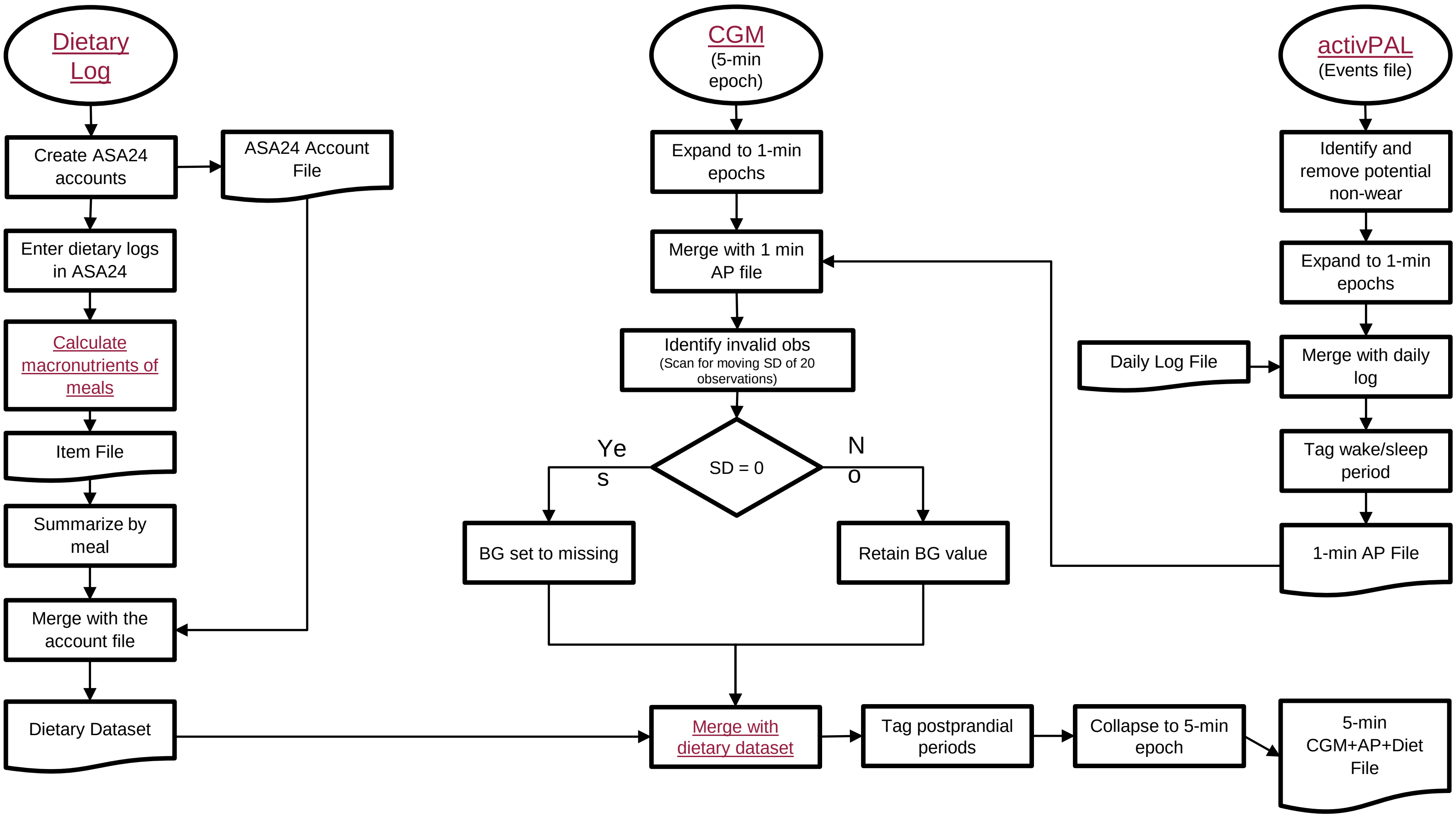
Affective states



Momentary affective states predict engagement in sedentary behavior in both between (A) and within (B) subjects.

EMA and CGM matched with activPAL




Dietary Log
Create ASA24 accounts
ASA24 Account File
Enter dietary logs in ASA24
Calculate macronutrients of meals
Item File
Summarize by meal
Merge with the account file
Dietary Dataset
CGM (5-min epoch)
Expand to 1-min epochs
Merge with 1 min AP file
Identify invalid obs (Scan for moving SD of 20 observations)
SD = 0
Yes
No
BG set to missing
Retain BG value
Merge with dietary dataset
Tag postprandial periods
Collapse to 5-min epoch
5-min CGM+AP+Diet File
activPAL (Events file)
Identify and remove potential non-wear
Expand to 1-min epochs
Daily Log File
Merge with daily log
Tag wake/sleep period
1-min AP File

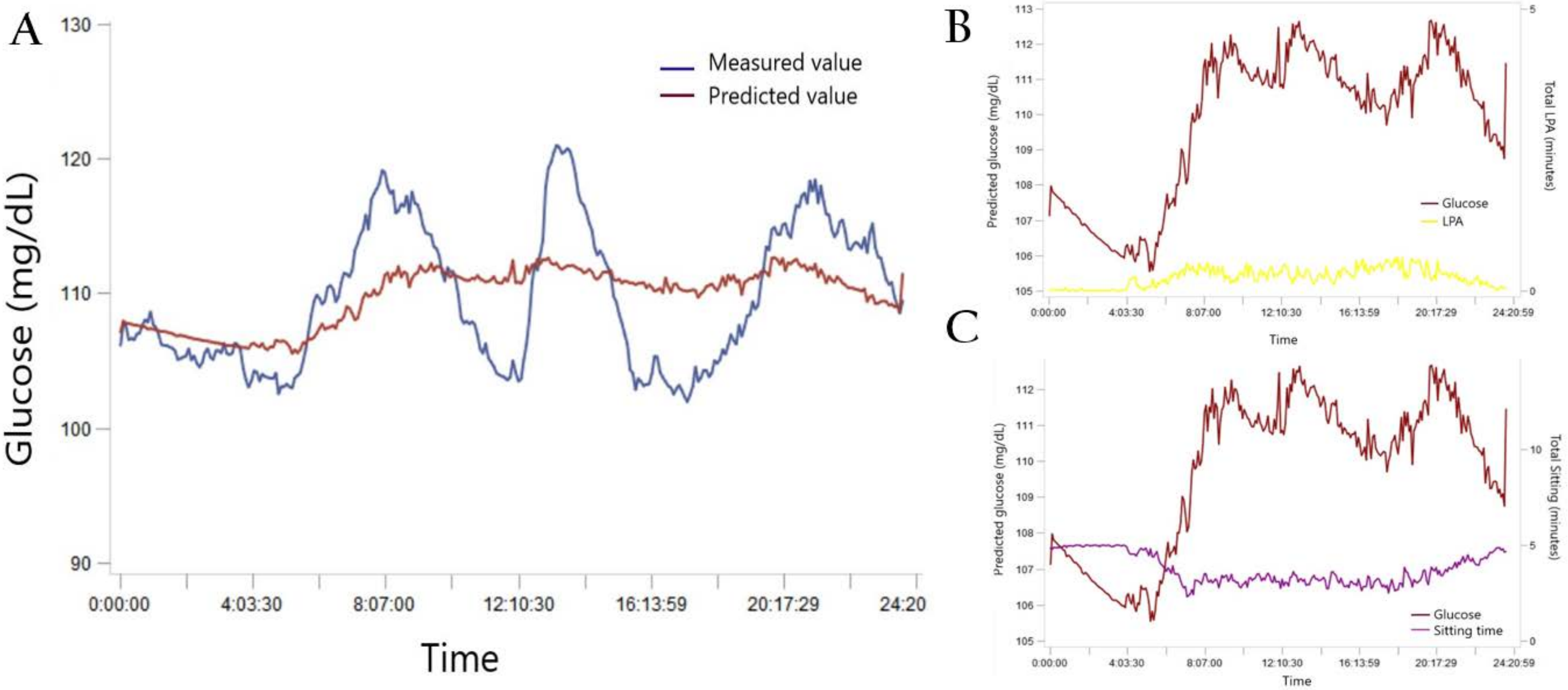
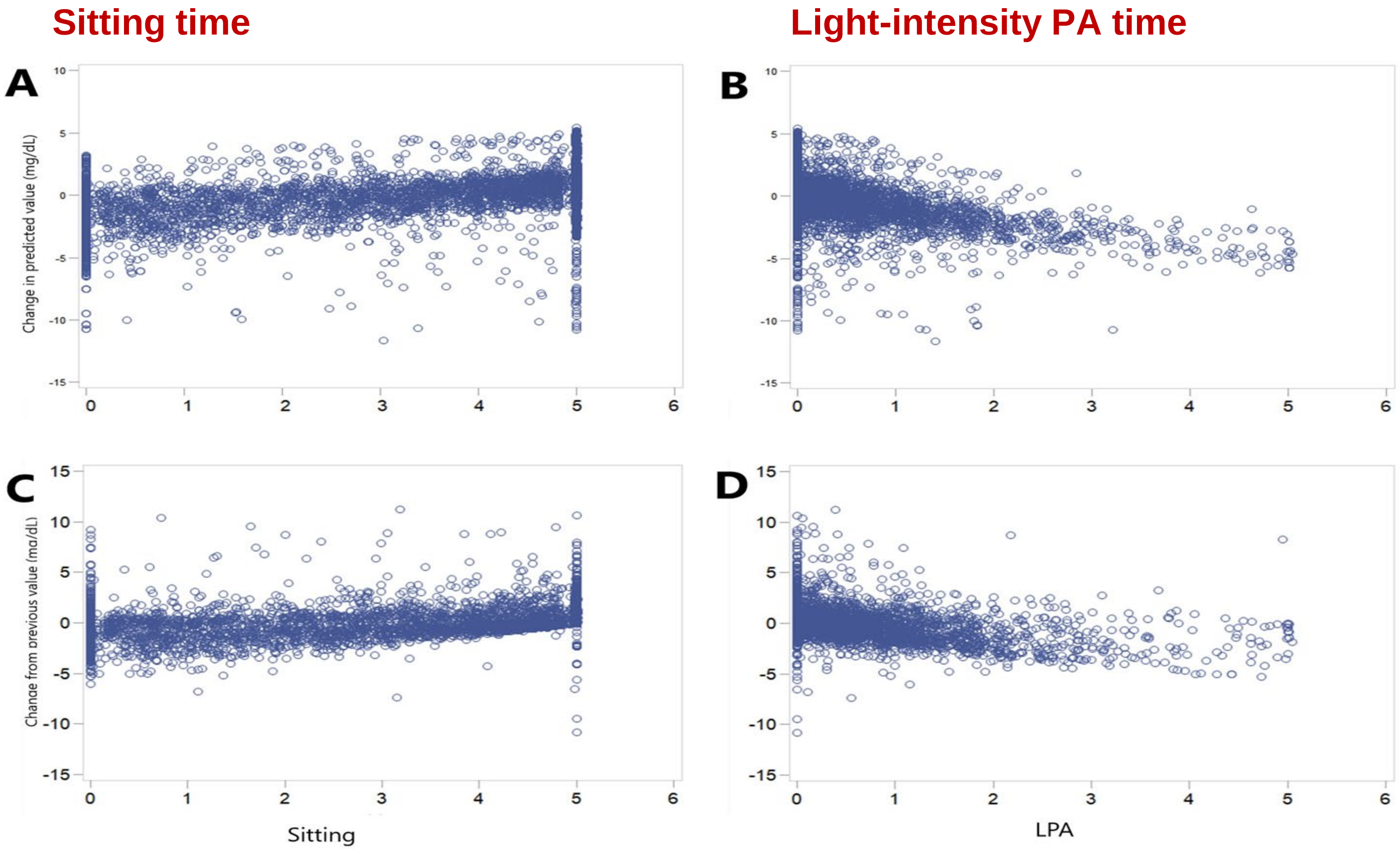


Figure 1. Average glucose level in a 24hr period. Figure 1A shows the predicted glucose level vs. measured glucose, 1B and 1C shows the predicted glucose along with total LPA and sitting time, respectively.



Relationship of glucose with sedentary and more active behaviors. Figures A and B plot the change in predicted glucose values from the models that exclude behaviors in the final model. Figures C and D plot the change in glucose levels (k_t-k_{t-1}) from previous observation against sitting and LPA.

Implications of temporal association studies

- Understanding the contextual circumstances of behaviors

- Intensively-adapting interventions

- Multi-level decision-making framework (system science)
  - just-in-time strategies (e.g., prompts)
  - shaping strategies (e.g., self-monitoring, feedback)

Accelerometer and Direct Observation Assessment of Physical Activity: Application in Children and Adolescents

David Dzewaltowski, Ph.D.

Ann M. Essay, MPH

University of Nebraska Medical Center

COLLEGE OF PUBLIC HEALTH

Disclosures

Buffett Early Childhood Institute
at the University of Nebraska

NIH NATIONAL CANCER INSTITUTE
Division of Cancer Control & Population Sciences

USDA United States Department of Agriculture
National Institute of Food and Agriculture

- Whole-of-Community Systems Intervention for Youth Population Physical Activity
  - R01CA215420-01A1, NIH, National Cancer Institute
- Indigenous Qualitative Inquiry in Implementation Science of Community Hub Coalitions in Whole-of-Community Systems Interventions
  - R01CA215420-02S1
- Dissemination of the Evidence-Based SWITCH® Program for Childhood Obesity Prevention
  - 2015-68001-23242, USDA, National Institute of Food and Agriculture
- Evaluating a Systems-Based Health Intervention for Middle School Wellness
  - R21 HD090513-01A1, NIH, NICHD
- Patient-Clinic-Community Integration to Prevent Obesity among Rural Preschool Children
  - Patient Centered Outcomes Research Institute

"Research reported in this publication was supported by the National Cancer Institute of the National Institutes of Health under Award Number R01CA215420. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health."

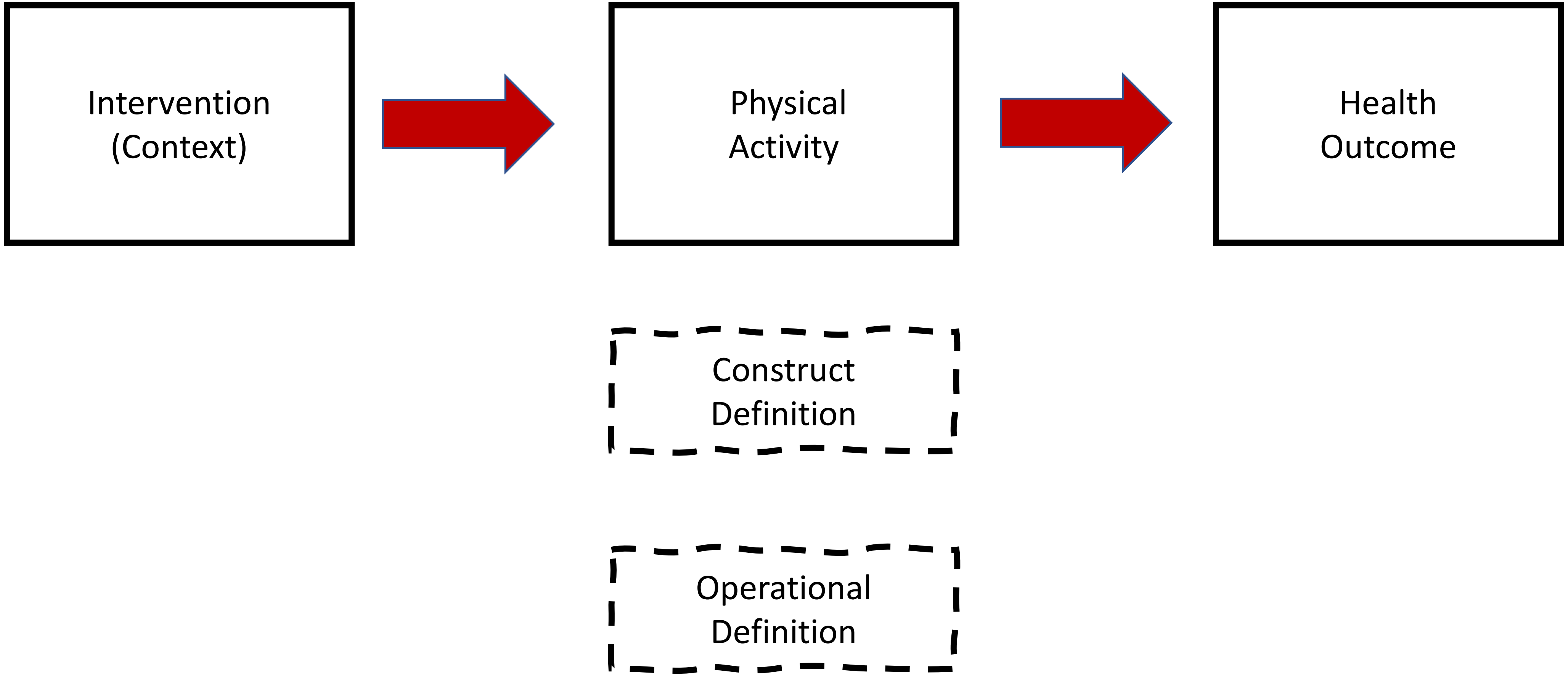
Agenda

- The Phenomenon of Physical Activity
- Assessment Using Accelerometers
- Assessment Using Observation
- Concurrent Use of Accelerometers and Observation
  - Research Question
    - Context-Behavior Relations

What is Physical Activity?

U.S. Department of Health and Human Services. (2018). *Physical Activity Guidelines for Americans, 2nd edition*. Washington, DC: U.S. Department of Health and Human Services.

Research Question Drives PA Definition and Measurement



PA Construct Definition and Measurement

- **Physical activity.** Bodily movement produced by skeletal muscles that results in energy expenditure. The term does not require or imply any specific aspect or quality of movement and encompasses all types, intensities, and domains.

- **Movement Behavior or Energy Expenditure?**
  - **Mode?**
  - **Intensity?**
  - **Duration?**
  - **Frequency?**
  - **Volume?**
  - **Meeting Physical Activity Guidelines?**

2018 Physical Activity Guidelines Advisory Committee. *2018 Physical Activity Guidelines Advisory Committee Scientific Report*. Washington, DC: U.S. Department of Health and Human Services, 2018.

PA Construct Definition and Measurement

- **Absolute intensity.** The rate of energy expenditure required to perform any given physicalactivity. It can be measured in metabolic equivalents, kilocalories, joules, or milliliters of oxygen consumption.
- • **Metabolic equivalent of task (MET).** A unit that represents the metabolic cost of physical activity. One MET is the rate of energy expenditure while sitting at rest, which, for most people approximates an oxygen uptake of 3.5 ml per kg per min. The energy expenditure of other activities is expressed in multiples of METs.For example, for the average adult, sitting and reading requires about 1.3 METs, strolling or walking slowly requires about 2.0 METs, and running at 5 miles per hour requires about 8.3 METS.

Absolute rates of energy expenditure are commonly divided into four categories:

- **Sedentary activity.** Activity requiring 1.0 to 1.5 METs, such as sitting and reading or watching television, or standing quietly.
- **Light intensity.** Activity requiring 1.6 to less than 3.0 METs, such as walking at a slow pace (2 mph or less) or cooking.
- **Moderate intensity.** Activity requiring 3.0 to less than 6.0 METs, such as walking briskly (3 to 4 mph), mopping or vacuuming, or raking a yard.
- **Vigorous intensity.** Activity requiring 6.0 or greater METs, such as walking very fast (4.5 to 5 mph), running, mowing grass with a hand-push mower, or participating in an aerobics class.

2018 Physical Activity Guidelines Advisory Committee. *2018 Physical Activity Guidelines Advisory Committee Scientific Report*. Washington, DC: U.S. Department of Health and Human Services, 2018.

PA Construct Definition and Measurement

Validity

- Interpretation/Use Argument (Kane, 1992, 2002b, 2006, 2013)
  - "Validity is not a property of the test. Rather, it is a property of the proposed inter-pretations and uses of the test scores. Interpretations and uses that make sense and are supported by appropriate evidence are considered to have high validity (or for short, to be valid), and interpretations or uses that are not adequately supported, or worse, are contradicted by the available evidence are taken to have low validity (or for short, to be invalid). (Kane, 2013, p. 3)

Validity for what

- **Movement Behavior or Energy Expenditure?**
  - Mode?
  - Intensity?
  - Duration?
  - Frequency?
  - Volume?
  - Meeting Physical Activity Guidelines?

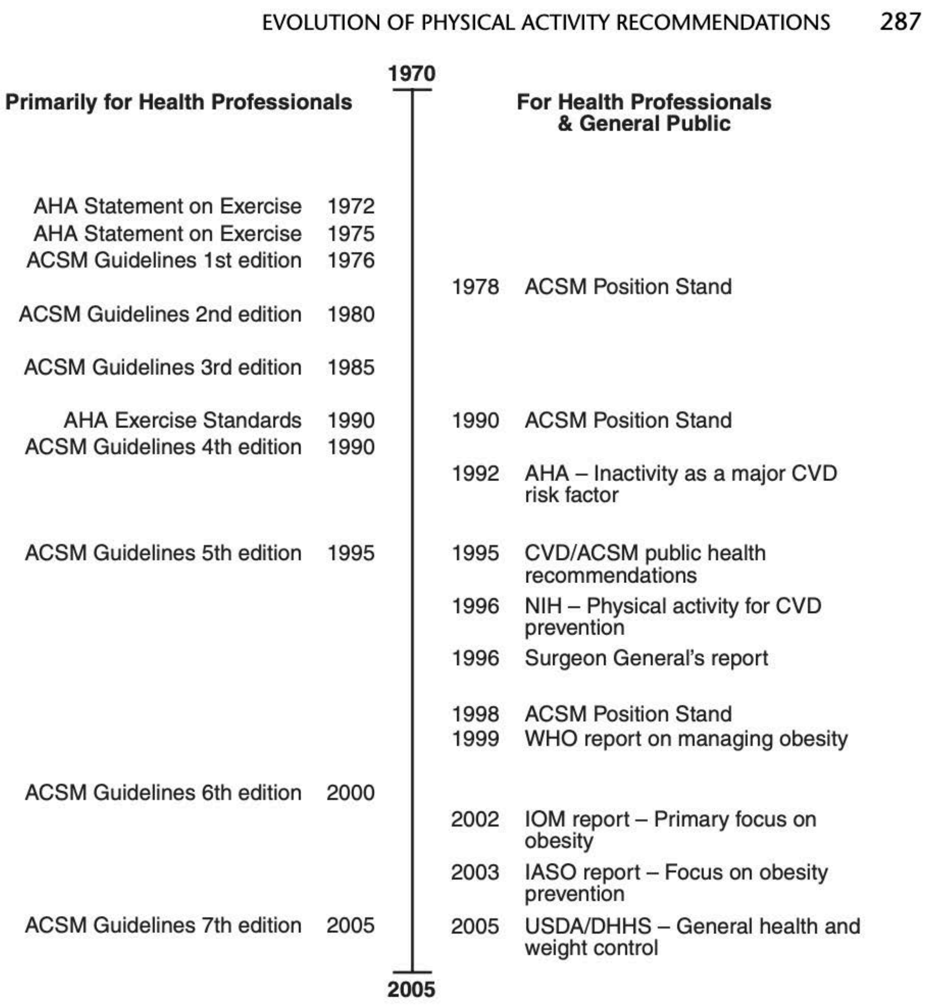
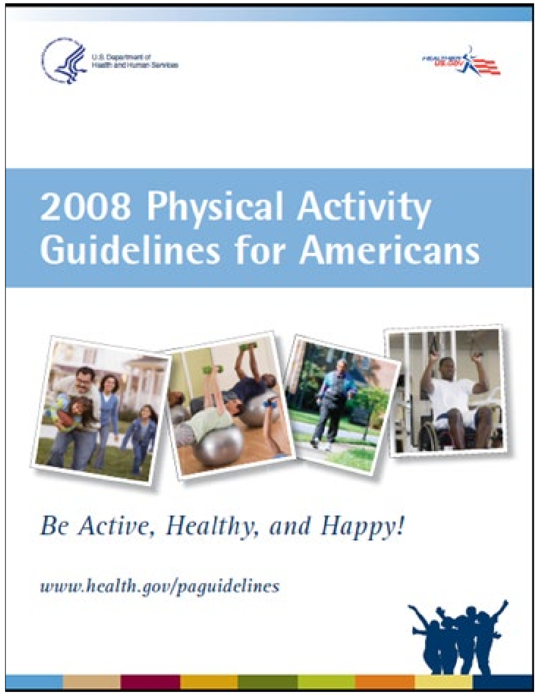


Figure 15.1 Major physical activity guidelines and recommendations for adults in the USA.

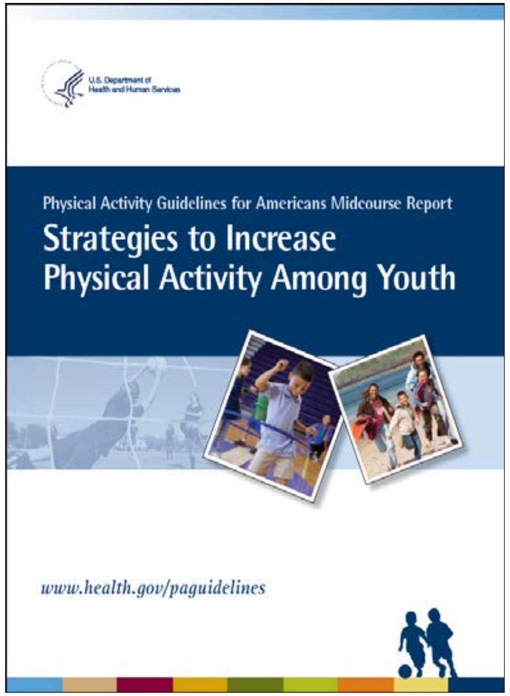
- Exercise Training Paradigm
  - Pre 1995
  - Goal was fitness/performance
- Health Paradigm
  - Goal was health

Haskell, W. L. (2009). Evolution of physical activity recommendations. *Epidemiologic methods in physical activity studies*, *283*, 301.

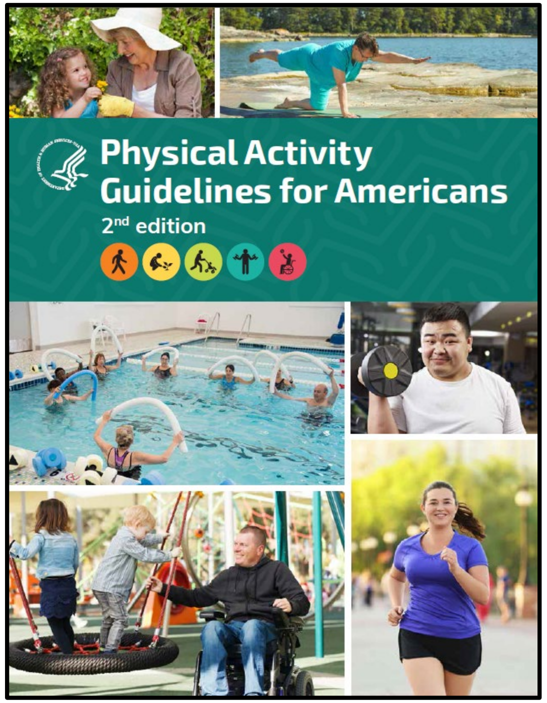
History of the Physical Activity Guidelines



2008



2013



2018

Information adapted from the Physical Activity Guidelines for Americans, 2nd edition. Available at health.gov/PAGuidelines.

Table 15.1 Exercise Dose Recommendations in the ACSM Guidelines for Exercise Testing and Exercise Prescription (Editions 1, 3, 5, 7).

Component	*1975 (1st)*	*1986 (3rd)*	*1995 (5th)*	*2005 (7th)*
Type	Aerobic Endurance	Aerobic Endurance	Aerobic Endurance	Aerobic Endurance
Intensity	60%–90% VO_{2max} 60%–90%	55%–80% VO_{2max} 60%–80%	40%–85% VO_{2max} or HRR HRR	40%–85% VO_{2max} or HRR HRR
Session Duration	20–60 minutes	15–60 minutes	20–60 minutes	20–60 minutes
Session Frequency	3–5 days/week	3–5 days/week	3–5 days/week	3–5 days/week
Total Activity	800–2000 kcal/week		1000–2000 kcal/week	

VO_{2max} = maximal oxygen uptake; HRR = heart rate reserve; kcal/week = kilocalories expended during physical activity per week.

Haskell, W. L. (2009). Evolution of physical activity recommendations. *Epidemiologic methods in physical activity studies*, *283*, 301.

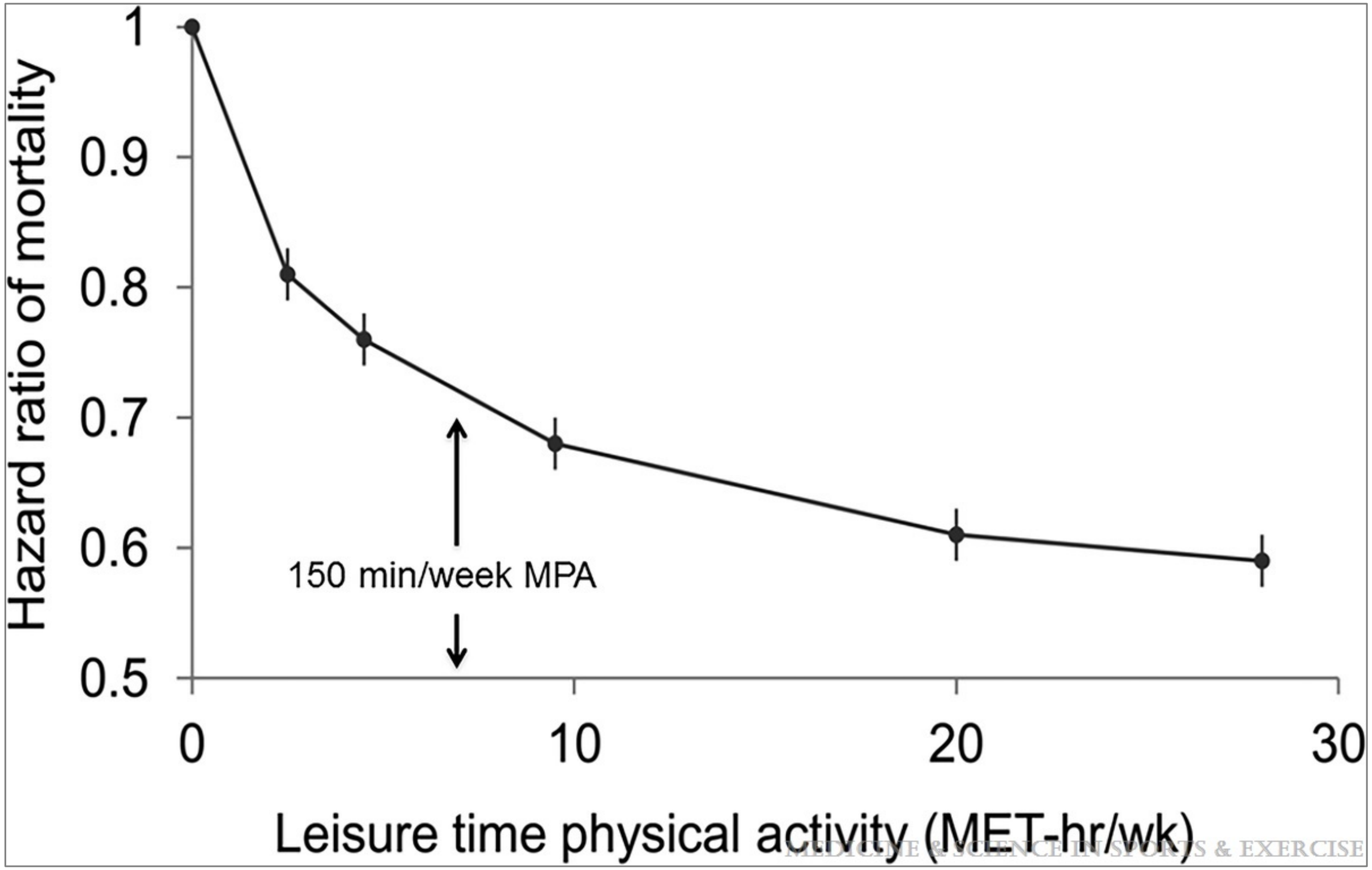
Table 15.2 ACSM Position Stands on Physical Activity and Health

Component	*1978 (1st)*	*1990 (2nd)*	*1998 (3rd)*
Type	Aerobic Endurance	Aerobic Endurance	Aerobic Endurance
Mode	Large muscle, dynamic	Large muscle, dynamic	Large muscle dynamic
Intensity	60%–90% HRR 50%– 85% $V0_2$ max	60%–90% MHR 50%–85% VO_2 max or HRR	55%–90% MHR 40%–80% $V0_2R$ or HRR
Session Duration	15–60 minutes*	20–60 minutes*	20–60 minutes*
Session frequency	3–5 days/week	3–5 days/week	3–5 days/week
Resistance exercise	No specific recommendation	8–10 exer (1 set of 8–12 reps., two times/week)	8–10 exer (1 set of 8–12 reps., two times/week)

MHR = maximum heart rate; HRR = heart rate reserve; $V0_2$ max = maximum oxygen uptake; $V0_2R$ = oxygen uptake reserve; exer = exercises; reps = repetitions.
*Duration inversely related to intensity.

Haskell, W. L. (2009). Evolution of physical activity recommendations. *Epidemiologic methods in physical activity studies*, *283*, 301.

Physical Activity Phenomenon



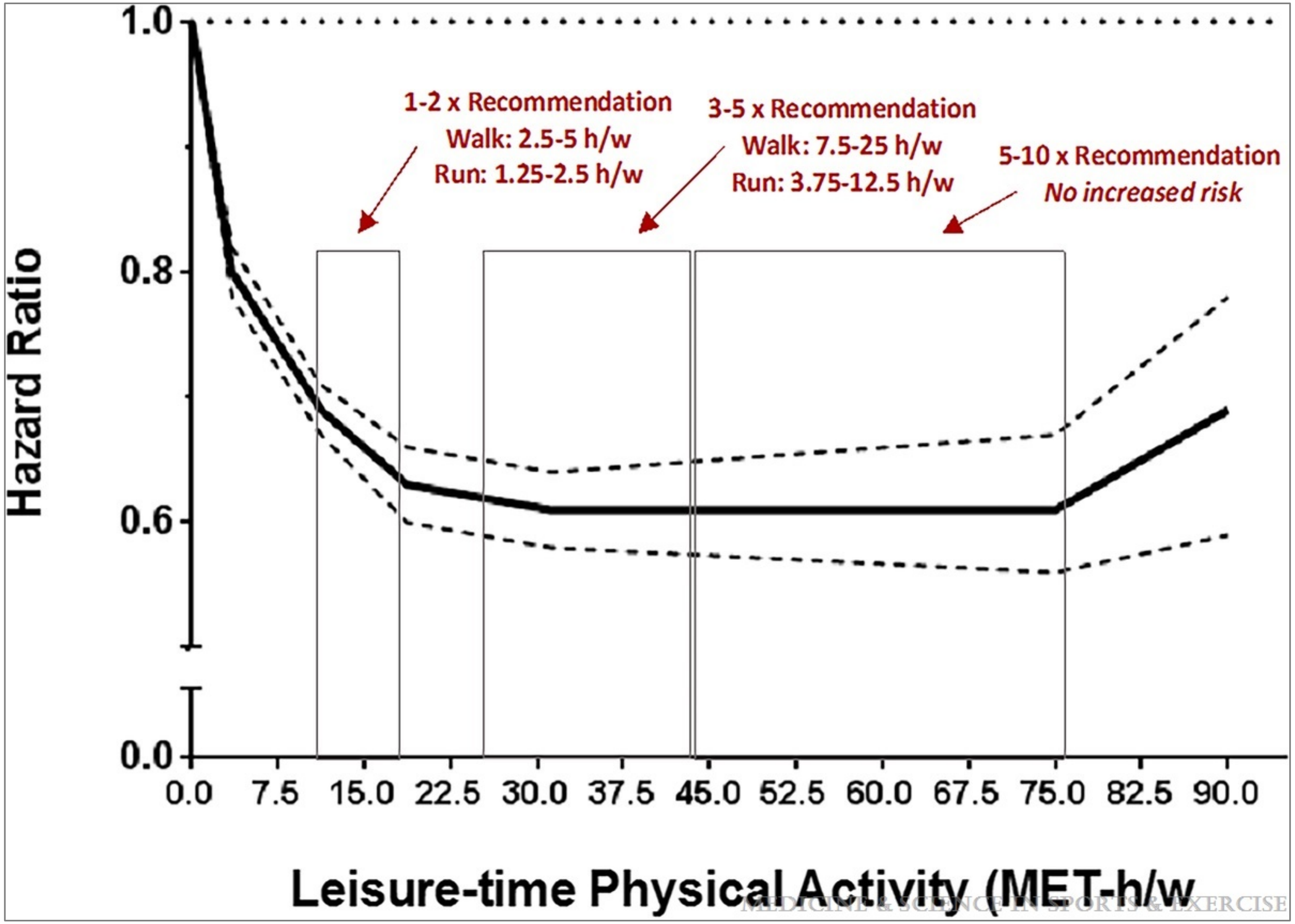
[Physical Activity, All-Cause and Cardiovascular Mortality, and Cardiovascular Disease]

KRAUS, WILLIAM E.; POWELL, KENNETH E.; HASKELL, WILLIAM L.; JANZ, KATHLEEN F.; CAMPBELL, WAYNE W.; JAKICIC, JOHN M.; TROIANO, RICHARD P.; SPROW, KYLE; TORRES, ANDREA; PIERCY, KATRINA L.; FOR THE 2018 PHYSICAL ACTIVITY GUIDELINES ADVISORY COMMITTEE*

Medicine & Science in Sports & Exercise51(6):1270-1281, June 2019.

doi: 10.1249/MSS.0000000000001939

Relationships of MVPA to all-cause mortality, with highlighted characteristics common to studies of this type. Shown is the relation of leisure time physical activity amount and HR for mortality. The points shown represent the mortality HR for each of the physical activity categories; the vertical lines represent the 95% CI for that physical activity category. The reference category no leisure time physical activity. The lines connecting the points help to illustrate the dose–response relationship between physical activity and risk of mortality; the shape of the association shown here is similar to that obtained using spline modeling. As discussed in the text and displayed in this graphic, the characteristics of this curve seems to apply for most studies of the relationships of MVPA with all-cause and CVD mortality, as well as with incident coronary artery disease, ischemic stroke and all-cause heart failure: there is no lower threshold for effect; there is a steep, early slope; about 70% of the benefit obtained by physical activity alone is reached by 8.25 MET·h·wk−1 (150 min of “brisk walking” (3 mph); there is not apparent upper threshold for effect; there is no evidence for increased risk at the greatest amounts of physical activity; and there is not obvious “best amount.” Source: adapted from Moore et al. (17).



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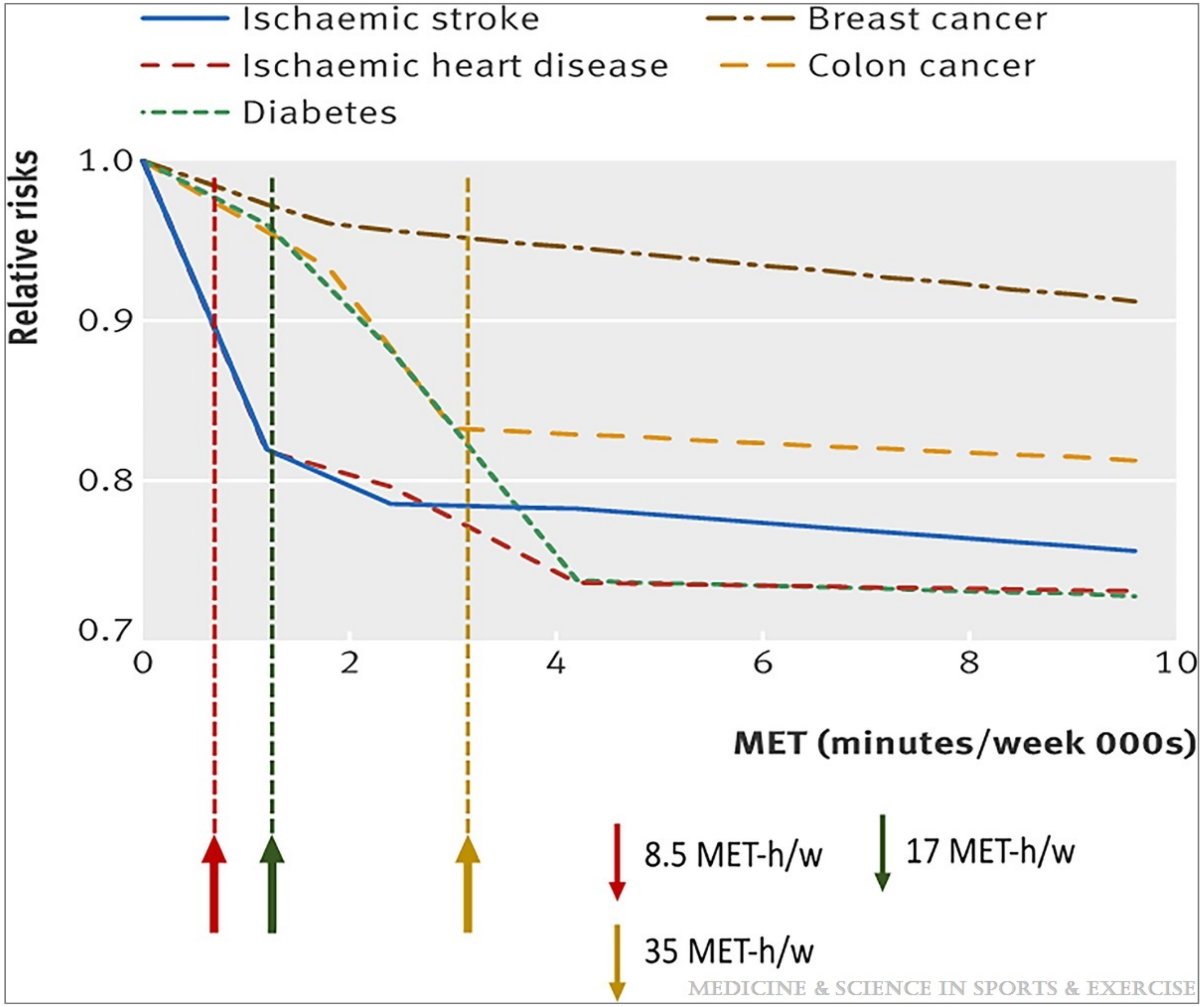
KRAUS, WILLIAM E.; POWELL, KENNETH E.; HASKELL, WILLIAM L.; JANZ, KATHLEEN F.; CAMPBELL, WAYNE W.; JAKICIC, JOHN M.; TROIANO, RICHARD P.; SPROW, KYLE; TORRES, ANDREA; PIERCY, KATRINA L.; FOR THE 2018 PHYSICAL ACTIVITY GUIDELINES ADVISORY COMMITTEE*

Medicine & Science in Sports & Exercise51(6):1270-1281, June 2019.

doi: 10.1249/MSS.0000000000001939

Relationships of MVPA to all-cause mortality, with highlighted characteristics common to studies of this type. The ranges of physical activity relative to 2008 US Physical Activity Guidelines for aerobic activity are shown as ranges. There is no increase in risk noted up to 10 times the current guidelines PA amounts. Source: adapted from Arem et al. (15).

Physical Activity Phenomenon



[Physical Activity, All-Cause and Cardiovascular Mortality, and Cardiovascular Disease]

KRAUS, WILLIAM E.; POWELL, KENNETH E.; HASKELL, WILLIAM L.; JANZ, KATHLEEN F.; CAMPBELL, WAYNE W.; JAKICIC, JOHN M.; TROIANO, RICHARD P.; SPROW, KYLE; TORRES, ANDREA; PIERCY, KATRINA L.; FOR THE 2018 PHYSICAL ACTIVITY GUIDELINES ADVISORY COMMITTEE*

Medicine & Science in Sports & Exercise51(6):1270-1281, June 2019.

doi: 10.1249/MSS.0000000000001939

Dose–response relationships between total physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events using 174 studies (43 for ischemic heart disease, and 26 for ischemic stroke). For reference, shown are the lower end (red arrows and dotted line) and upper bounds (green arrows and dotted line) of the 2008 guidelines for MVPA. Also indicated is the MVPA amount associated with normalization of the risk from >8 h·d−1 of sedentary activity from Ekelund, 2016 (8) (gold arrows and dotted line). The latter would represent the amount of physical activity required to compensate for an entirely sedentary lifestyle. The risk for ischemic heart disease and ischemic stroke are reminiscent of the characteristic dose–response relationships established for all-cause and cardiovascular mortality noted previously and in Figure 2. The universality of the dose–response relationships described in the caption of Figure 2 to other outcomes—such as type 2 diabetes and some cancers—are shown in this figure. Reproduced with permission from Kyu HH, Bachman VF, Alexander LT, et al. Physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events: systematic review and dose–response meta-analysis for the global burden of disease study 2013. BMJ. 2016;354:i3857. Copyright © 2013 BMJ Publishing Group Ltd.

Research Question Drives Definition

Definition

- Physical activity is?

Outcome Measure

- MET-h/w
- % time in moderate-to-vigorous physical activity
- Min of MVPA per day or per week
- Meeting physical activity guidelines?

Summary -Research Question Drives Definition

- **Begin with research question and basic assumptions**

- **Our Work**
  - Physical activity is a word that defines a classification of high frequency movement behavior

- **Research Questions**
  - What drives PA (PA)?
  - What interventions impact drivers impact population health PA?

Physical Activity Phenomenon

ISMPB
International Society *for the* Measurement *of* Physical Behaviour

HOME ABOUT MEMBERSHIP ICAMPAM ISMPB WORKSHOP JOURNAL RESOURCES JOB BOARD ISMPB NEWSLETTER CONTACT US

Physical activity assessment

Welcome

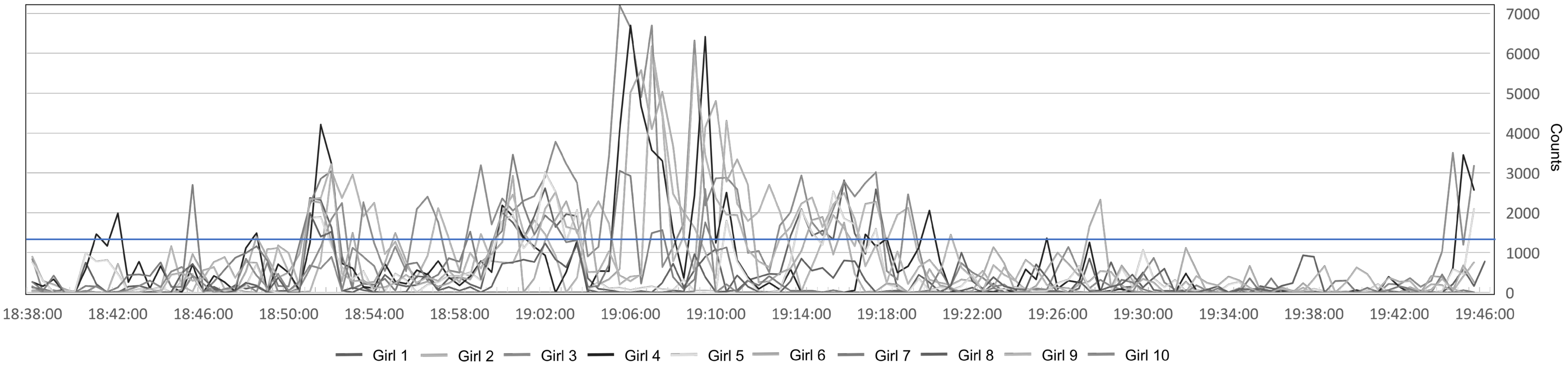
Welcome to the **Physical Activity Assessment** component of the toolkit.

There are five sections of pages which are accessible using the menu to the left:

- **Introduction**: pages explaining key concepts and background information relating to physical activity assessment
- **Subjective methods**: pages outlining the use of different types of subjective methods of physical activity assessment
- **Objective methods**: pages outlining the use of different types of objective methods physical activity assessment
- **Method selector**: A decision matrix summarising the assessment capabilities and practical considerations of physical activity assessment methods. Also see the related instrument library for examples of the instruments used as part of these methods.
- **Harmonisation**: Case studies detailing how physical activity data have been harmonised. Also see the introduction to data harmonisation in the concepts section.

Accelerometry

- Intensity
  - Cut points for behavior frequency
- Duration
  - 15 sec or 30 sec bouts
- Frequency
- Volume
  - Time spent in sedentary, light, moderate, and vigorous intensity physical activity (PA) can be quantified
- Mode
  - ?



Physical Activity Measurement

Data collection decisions

- Device placement
  - Hip (Wrist challenges)
- Wear time
  - 7-days
  - Time Segment
- Data collection sampling frequency
  - Smallest possible - Leave to data processing
  - Epoch length

Physical Activity Measurement

Data processing decisions

- Cut point
- Time segment

Physical Activity Measurement

Youth-Specific Cut Points

Author	Sedentary	Light	Moderate	Vigorous
Evenson et al.	≤100	>100	≥2296	≥4012
Freedson et al.	≤100	>100	≥2200	≥4136
Mattocks et al.	≤100	>100	≥3581	≥6130
Pate et al.	≤148	>148	≥1680	≥3368
Puyau et al.	<800	≥800	≥3200	≥8200
Treuth et al.	≤100	>100	≥3000	≥5200

Counts per minute

Norm Standard

SPECIAL COMMUNICATIONS

Rapid Communications

Physical Activity in the United States Measured by Accelerometer

RICHARD P. TROIANO[1], DAVID BERRIGAN[1], KEVIN W. DODD[1], LOUISE C. MÂSSE[1], TIMOTHY TILERT[2], and MARGARET MCDOWELL[2]

[1]*National Cancer Institute, National Institutes of Health, Bethesda, MD, and* [2]*National Center for Health Statistics, Centers for Disease Control and Prevention, Hyattsville, MD*

ABSTRACT

TROIANO, R. P., D. BERRIGAN, K. W. DODD, L. C. MÂSSE, T. TILERT, and M. MCDOWELL. Physical Activity in the United States Measured by Accelerometer. *Med. Sci. Sports Exerc.*, Vol. 40, No. 1, pp. 181–188, 2008. **Purpose:** To describe physical activity levels of children (6–11 yr), adolescents (12–19 yr), and adults (20+ yr), using objective data obtained with accelerometers from a representative sample of the U.S. population. **Methods:** These results were obtained from the 2003–2004 National Health and Nutritional Examination Survey (NHANES), a cross-sectional study of a complex, multistage probability sample of the civilian, noninstitutionalized U.S. population in the United States. Data are described from 6329 participants who provided at least 1 d of accelerometer data and from 4867 participants who provided four or more days of accelerometer data. **Results:** Males are more physically active than females. Physical activity declines dramatically across age groups between childhood and adolescence and continues to decline with age. For example, 42% of children ages 6–11 yr obtain the recommended 60 $\text{min}\cdot\text{d}^{-1}$ of physical activity, whereas only 8% of adolescents achieve this goal. Among adults, adherence to the recommendation to obtain 30 $\text{min}\cdot\text{d}^{-1}$ of physical activity is less than 5%. **Conclusions:** Objective and subjective measures of physical activity give qualitatively similar results regarding gender and age patterns of activity. However, adherence to physical activity recommendations according to accelerometer-measured activity is substantially lower than according to self-report. Great care must be taken when interpreting self-reported physical activity in clinical practice, public health program design and evaluation, and epidemiological research. **Key Words:** NHANES, MODERATE, VIGOROUS, BOUTS, YOUTH, ADULTS

Recommended

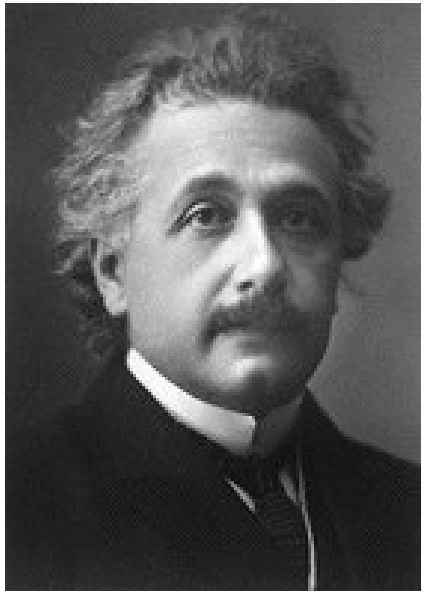
- Hip-worn
- 7-day monitoring period

Challenges

- Compliance
- Valid day, valid week
- Cut points

Naturalistic Observation

"It is the theory that describes what we can observe"



Albert Einstein (1879 - 1955)
Physicist & Nobel Laureate

Observation of behavior in the natural environment

Jane Goodall (1934 –)

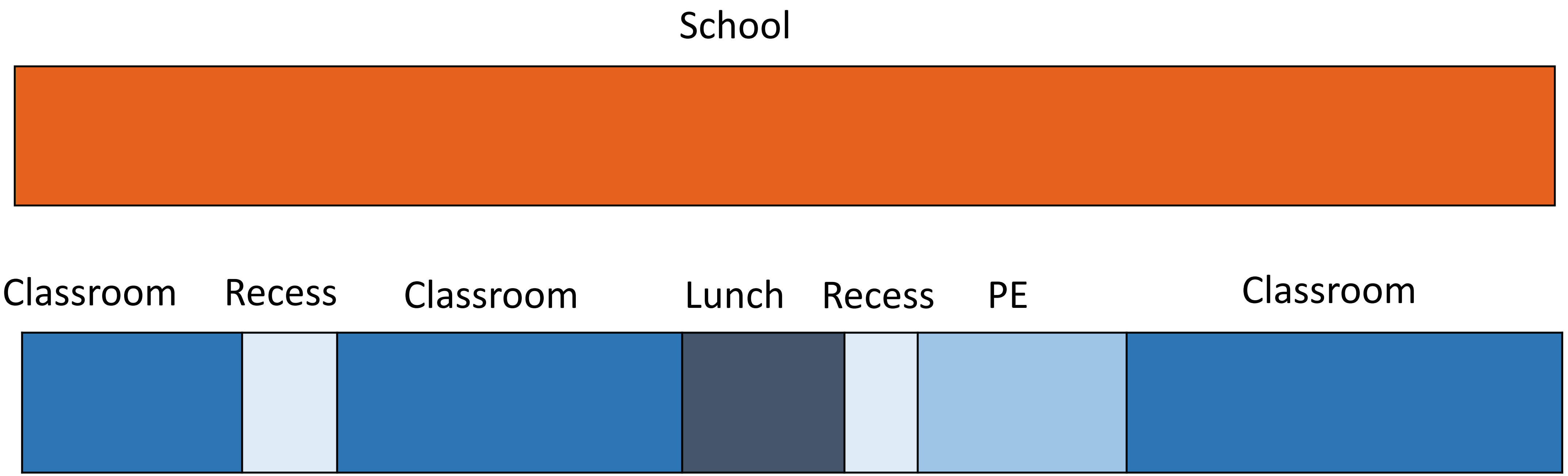
Event – Unit of observation

Individual

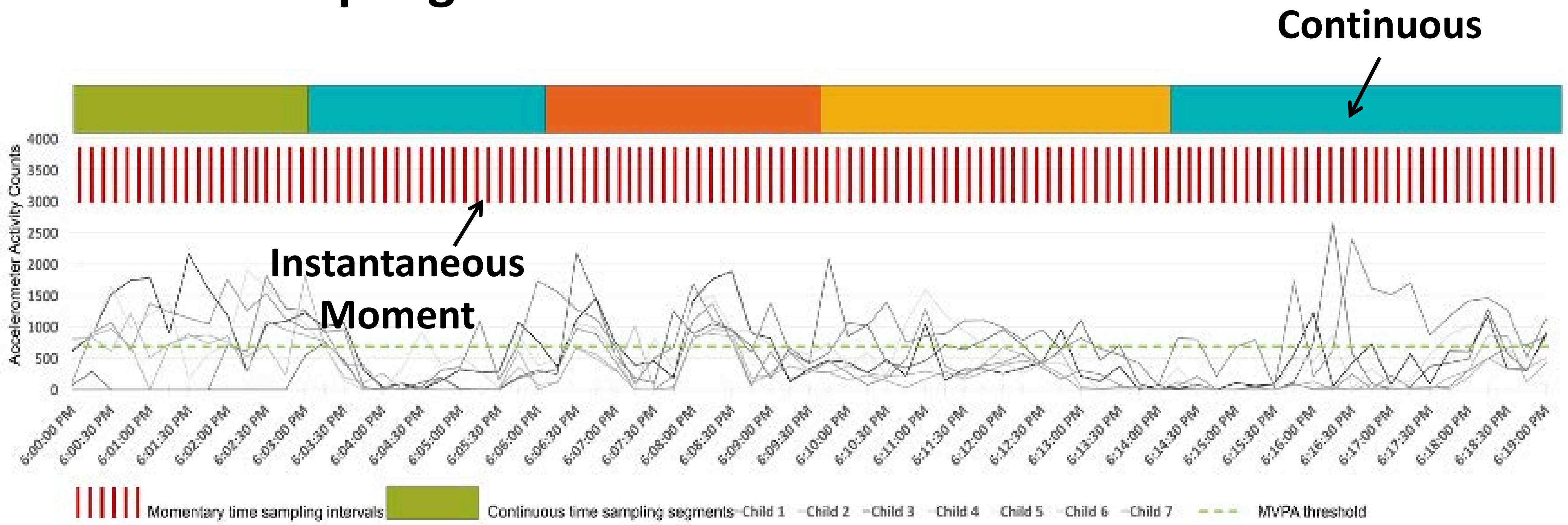
Group

Place

Event - Spatial and Temporal Boundaries



Event – Sampling Time



Direct Observation Systems

Original Article

Development of the System for Observing Student Movement in Academic Routines and Transitions (SOSMART)

Laura B. Russ,
Michael W. Be
Robert Glenn V
and David S. P

HEALTH
Health
2017,
© 2016
Health
Reprin
sagepu
DOI:
journal

JOURNAL OF
Physical Activity & Health
Official Journal of ISPAH
www.JPAH-Journal.com
ORIGINAL RESEARCH

Journal of Physical Activity and Health, 2014, 11, 173-185
http://dx.doi.org/10.1123/jpah.2012-0007

System for Observing Staff Promotion of Activity and Nutrition (SOSPAN)

r Huberty

Preventive Medicine 30, 70–77 (2000)
doi:10.1006/pmed.1999.0591, available online at http://www.idealibrary.com on IDEAL®

Leisure-Time Physical Activity in School Environments: An Observational Study Using SOPLAY

Research Quarterly for Exercise and Sport
©2000 by the American Alliance for Health, Physical Education, Recreation and Dance
Vol. 71, No. 3, pp. 249–259

Student Activity Levels, Lesson Context, and Teacher Behavior During Middle School Physical Education

Thomas L. McKenzie, Simon J. Marshall, James F. Sallis, and Terry L. Conway

Journal of Physical Activity and Health 2006, 3, Suppl 1, S208-S222

System for Observing Play and Recreation in Communities (SOPARC): Reliability and Feasibility Measures

Thomas L. McKenzie, Deborah A. Cohen, Amber Sehgal, Stephanie Williamson, and Daniela Golinelli

SOPARC and SOPLAY

Observation Unit – Place Assessment of Target Areas

DATE __________PARK NAME ___________OBSERVER Init. _______PERIOD: ? 2:00 ? 2:30 ? 3:00 ? 3:30 ? 4:00 ? 4:30 ? 5:00 ? 5:30

TARGET AREA ____________________ ____ START TIME ________________

Target Area # Subtarget Area # of Total Subtarget areas

CONDITIONS OF TARGET AREA

Accessible (e.g., not locked or rented to others) ? Yes ? No

Usable (e.g., is not excessively wet or windy) ? Yes ? No

Equipped (e.g., removable balls available) ? Yes ? No

Supervised (e.g., not locked or rented to others) ? Yes ? No

Organized (e.g., team sporting event) ? Yes ? No

Dark (e.g., insufficiently lit) ? Yes ? No

Empty (i.e., scan area is empty) ? Yes ? No

Comments:

PEOPLE	ACTIVITY	AGE GROUP				ETHNICITY				ACTIVITY LEVEL		
		Child	Teen	Adult	Senior	B	W	H	O	S	W	V
Participants	**Primary Activity**											
Female												
Male												
Participants	**Secondary Activity**											
Female												
Male												
Spectators	**Organized Activity**											
Female												
Male												

Fitness Related Codes:
aerobics (dance/step aerobics)
fitness stations
jogging/running
strengthening exercises (pull ups)

Sport Related Codes:
baseball
basketball
cheer leading
dance
handball
horseshoes
soccer
tennis/racquet

Active Game Related Codes:
climbing/sliding
jumping (rope, hop scotch)
manipulatives/racquet
tag/chasing games

Sedentary Related Codes:
chess/checkers/cards
lying down
picnic (food involved)
reading

Write in the most prominent (primary) physical activity that females and males are doing in the area. If applicable, write in the second most prominent physical activity (secondary) that females and males are doing. A space is also provided to write in the most prominent activity attracting female and male onlookers/spectators to the area (this only applies to organized activities).

McKenzie, T. L., Marshall, S. J., Sallis, J. F., & Conway, T. L. (2000). Leisure-time physical activity in school environments: an observational study using SOPLAY. Preventive medicine, 30(1), 70-77.
McKenzie, T. L., Cohen, D. A., Sehgal, A., Williamson, S., & Golinelli, D. (2006). System for Observing Play and Recreation in Communities (SOPARC): reliability and feasibility measures. Journal of Physical Activity and Health, 3(s1), S208-S222.

OSRAC-P

Observational System for Recording Physical Activity of Children

Sampling Method

- Focal Sampling
  - One focal child
- Temporal Sampling
  - Momentary time sampling
  - 5 second observe, 25 second record
  - Highest level of PA exhibited during observation window

Unit of Observation

- Individual

Time Boundary

- 30-minute observation block

Brown, W. H., Pfeiffer, K. A., McIver, K. L., Dowda, M., Almeida, J. M., & Pate, R. R. (2006). Assessing preschool children's physical activity: the Observational System for Recording Physical Activity in children-preschool version. *Research quarterly for exercise and sport*, *77*(2), 167-176.

Observation

OSRAC-P

Table 1
Children's Activity Rating Scale (CARS)

Level/Description	Expected Heart Rate ($b \cdot min^{-1}$)	Representative Activities
1 Stationary-no movement	<100	lying sitting
2 Stationary-with movement	100 – 119	standing/coloring standing/ball activity
3 Translocation-slow/easy	120 – 139	walk 2.5 mph, 0% grade
4 Translocation-medium/moderate	140 – 160	walk 2.5 mph, 5% grade walk 2.5 mph, 10% grade
5 Translocation-fast, very fast/strenuous	>160	walk 2.5 mph, 15% grade

Energy Expenditure for CARS

Level	Activity		Oxygen Uptake $l \cdot min^{-1}$ M	SD	Oxygen Uptake $ml \cdot kg^{-1} \cdot min^{-1}$ M	SD	METS M	SD	%Max VO_2*	Heart Rate ($b \cdot min^{-1}$) M	SD	%Max Heart Rate*
1	lying	a	0.146	0.023	7.05	1.00	1.01	0.07	14.6	89	5.5	42.7
1	sitting	a	0.144	0.180	6.98	0.82	1.00	—	14.5	94	6.9	45.0
2	stand/color	b	0.211	0.042	#10.06	1.49	1.44	0.20	21.2	116	7.8	55.8
2	stand/ball	b	0.228	0.049	#10.78	2.02	1.55	0.24	23.0	112	8.5	53.6
3	walk-0%	c	0.395	0.069	†18.70	2.34	2.69	0.25	39.8	126	8.7	60.4
4	walk-5%	d	0.510	0.083	†23.93	2.25	3.45	0.47	51.4	141	9.5	67.8
4	walk-10%	e	0.641	0.094	†30.01	2.59	4.34	0.37	64.8	162	10.8	77.5
5	walk-15%	f	0.804	0.119	†37.49	2.91	5.42	0.54	80.6	183	10.1	87.8
	Maximal	g	0.993	0.146	46.52	5.94	6.70	0.76	—	208	8.0	—

a-g = Significantly different ($p < .05$) from other activities
† = Significant gender differences ($p < .05$)
# = No difference between activities in this level for girls, but significant difference between activities in this level for boys
* = Calculated from group means; not statistically analyzed

Brown, W. H., Pfeiffer, K. A., McIver, K. L., Dowda, M., Almeida, J. M., & Pate, R. R. (2006). Assessing preschool children's physical activity: the Observational System for Recording Physical Activity in children-preschool version. *Research quarterly for exercise and sport*, *77*(2), 167-176.
Puhl, J., Greaves, K., Hoyt, M., & Baranowski, T. (1990). Children's Activity Rating Scale (CARS): description and calibration. Research Quarterly for Exercise and Sport, 61(1), 26-36.

OSRAC-P

Category/code	Intervals (n)	Time (%)	LMVPA (%)	MVPA (%)
ASD				
Group composition				
Solitary	91	12.6	70.3	24.2
1:1 Adult	137	19.0	37.2	12.4
1:1 Peer	63	8.8	33.3	4.8
Group (adult present)	326	45.3	34.7	9.8
Group (peers)	103	14.3	19.4	8.7
Total	719		37.4	11.5
NT				
Group composition				
Solitary	64	9.0	70.3	18.8
1:1 Adult	125	17.6	44.8	18.4
1:1 Peer	94	13.2	39.4	10.6
Group (adult present)	356	50.1	39.0	14.0
Group (peers)	71	10.0	39.4	14.1
Total	710		43.0	14.8

- Influences on PA of children with Autism Spectrum Disorders (ASD) during summer camp
- 6 ASD and 6 neurotypical (NT) boys (5 to 6 years of age)
- PA codes aggregated to create variable for sedentary, light and MVPA, and MVPA

Schenkelberg, M. A., Rosenkranz, R. R., Milliken, G. A., & Dzewaltowski, D. A. (2015). Social environmental influences on physical activity of children with autism spectrum disorders. *Journal of Physical Activity and Health*, *12*(5), 636-641.

SOFIT

System for Observing Fitness Instruction Time (SOFIT)

Sampling Method

- Focal Sampling
  - Choose 4 children and 1 alternate
  - Follow each child for 4 minutes then rotate
- Temporal Sampling
  - Interval (teacher behavior)
  - Momentary time sampling (context, PA)
  - 10 second observe, 10 second record
  - Point estimate

Unt of Observation

- Group

Time Boundary

- Total setting time (e.g. total PE class)

McKenzie, T. L., Sallis, J. F., & Nader, P. R. (1992). SOFIT: System for observing fitness instruction time. Journal of teaching in physical Education, 11(2), 195-205.

Observation

SOFIT

Table 1

Estimated Energy Cost Values for Student Activity Codes

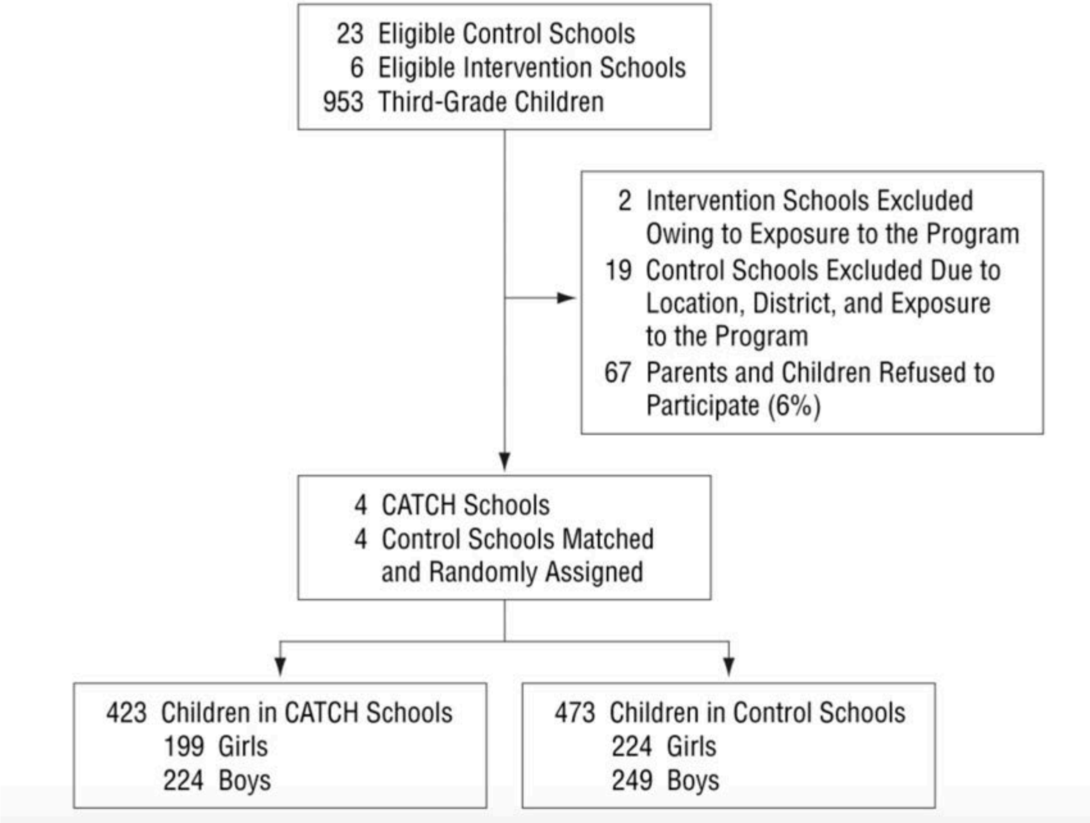
Activity category	Heart rate *M*	Heart rate *SD*	Energy cost (kcal/kg/min) *M*	Energy cost (kcal/kg/min) *SD*
Lying down	99	9.9	.029	.013
Sitting	107	9.8	.047	.018
Standing	110	8.8	.051	.021
Walking	130	6.5	.096	.015
Very active	153	12.6	.144	.026

Note. Adapted from McKenzie et al. (1991).

McKenzie, T. L., Sallis, J. F., & Nader, P. R. (1992). SOFIT: System for observing fitness instruction time. Journal of teaching in physical Education, 11(2), 195-205.

SOFIT

The El Paso Coordinated Approach to Child Health



Coleman, K. J., Tiller, C. L., Sanchez, J., Heath, E. M., Sy, O., Milliken, G., & Dzewaltowski, D. A. (2005). Prevention of the epidemic increase in child risk of overweight in low-income schools: the El Paso coordinated approach to child health. *Archives of pediatrics & adolescent medicine*, *159*(3), 217-224.

SOFIT

- Physical activity during PE class was assessed
- Each school was observed for grades 3, 4, 5, for 8 observation periods per year

Table 3. School Health Outcomes for the El Paso Coordinated Approach to Child Health (CATCH) Program

Outcome	Third Grade		Fourth Grade		Fifth Grade	
	Fall	Spring	Fall	Spring	Fall	Spring
Time spent in moderate to vigorous physical activity (goal ≥50%), %						
Control	38	43	53*	54*	44	63*
El Paso CATCH	30	52	56†	57*	55†	60*
Time spent in vigorous physical activity (goal ≥20%), %						
Control	11	15*	13	12	6*	10
El Paso CATCH	10	16*	16†	13*	12†	12†
Fat in school lunches (goal ≤30%), %						
Control	36	36	31*	36	33*	32*
El Paso CATCH	34	35	28†	30†	32*	31*
Sodium in school lunches (goal 600-1000 mg), mg						
Control	1082	1195	1294	1242	1332	1258
El Paso CATCH	1128	1125	1028	1132	1182	1382

*Significant changes from fall semester of third grade.
†Significant changes from fall semester of third grade and El Paso CATCH schools significantly different from control schools.

Coleman, K. J., Tiller, C. L., Sanchez, J., Heath, E. M., Sy, O., Milliken, G., & Dzewaltowski, D. A. (2005). Prevention of the epidemic increase in child risk of overweight in low-income schools: the El Paso coordinated approach to child health. *Archives of pediatrics & adolescent medicine*, *159*(3), 217-224.

Comparison of Two Systems

Observation Method	OSRAC	SOFIT
Level of Observation	Individual	Group
Focal Sampling	1 focal child	4 children and an alternate, follow each for 4 minutes
Temporal Sampling	Momentary time sampling	Momentary time sampling
Boundary	30-minute block	Total setting time

Comparison of Two Systems

Observation Method	OSRAC	SOFIT
Physical Activity Measures	1 – Stationary or motionless 2 – Stationary w/ limb or trunk movements 3 – Slow-easy movements 4 – Moderate movements 5 – Fast movements	1 – Lying 2 – Sitting 3 – Standing 4 – Walking 5 – Vigorous
Physical Activity Outcome	Outcome of Individual	Outcome of a Group

Key Considerations

Sampling Methods

- Instantaneous / continuous
- Individual / group/place
- Boundaries

Frequency and Length of Observations

- Number of measurements to correctly classify PA
- Depends on research question and setting

Key Considerations

Observer Training and Maintenance

- Study and memorization of protocols
- Practice videos
- Field practice

Observer Reliability

$$\frac{\text{Agreements}}{\text{Agreements + Disagreements}} * 100 = \text{IOA Percentage}$$

Other

- Time investment
- Access to settings

Observing Context-Behavior Relations

Ecological Momentary Assessment

- Methods to collect data in real-time
  - Electronic surveys through mobile phones
- Information about where and what type of activity
- Locations of PA
  - Combine accelerometer, GPS, GIS
- Challenge to measure context

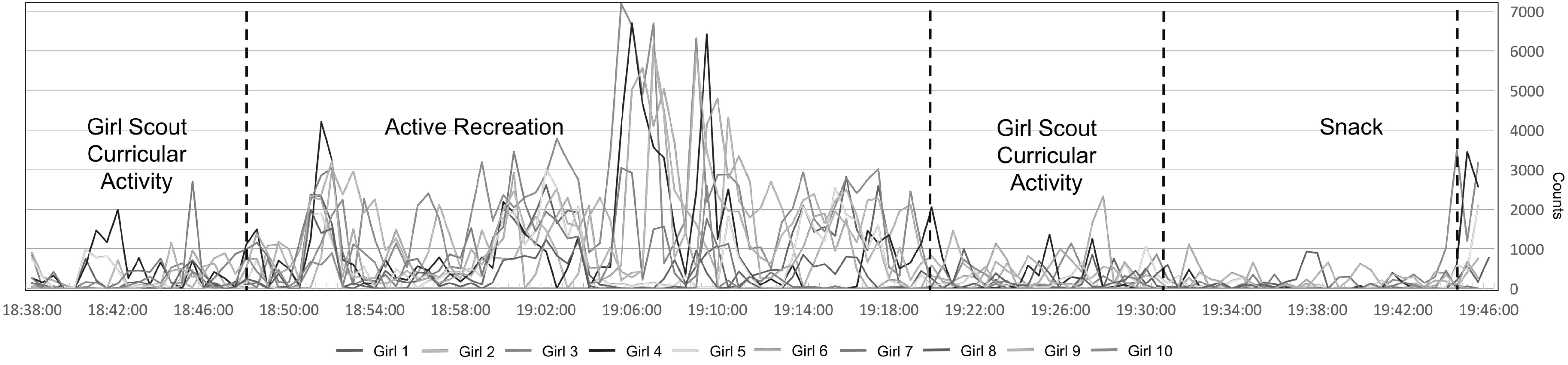
(Carlson et al., 2016; Dunton, 2017; Lee et al., 2016; Romanzini et al, 2019; Zenk et al., 2011)

Context

	OSRAC-P	SOFIT
Contexts	Activity Type Location Indoor Activity Codes Outdoor Activity Codes Activity Initiator Group Composition Prompts	Lesson Context Teacher Behavior

Observing Drivers of PA

- Continuous sampling to divide time into segments based on context characteristics
- Captures natural changes



Schlechter, C. R., Rosenkranz, R. R., & Dzewaltowski, D. A. (2017). Girl Scout Troop Meeting Time-segmented Patterns Of Physical Activity Driven By Task.: 3145 Board# 50 June 2 3. *Medicine & Science in Sports & Exercise*, *49*(5S), 888.

Concurrent Observation and accelerometry

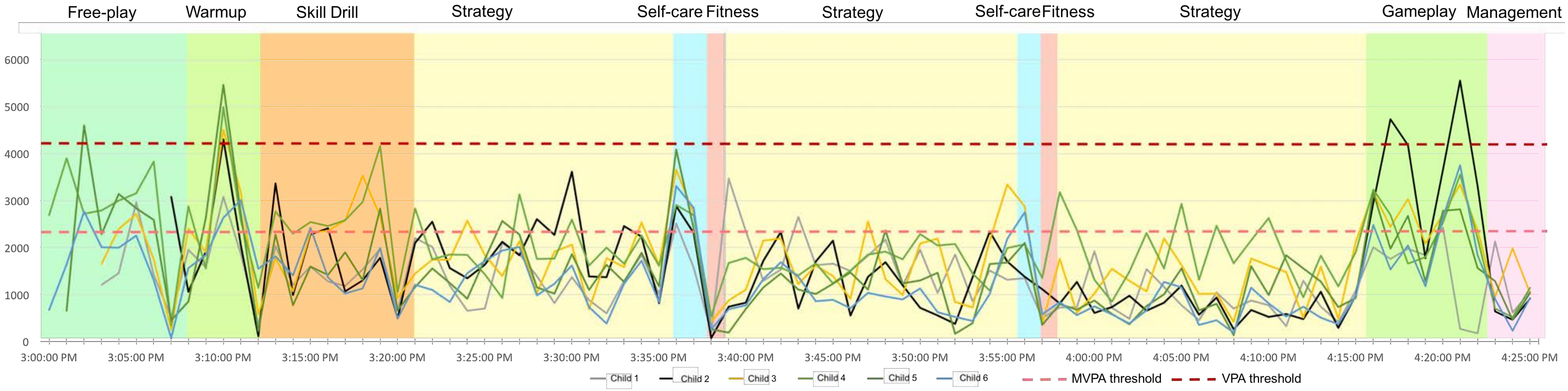
Table 1 Coding scheme, definitions, and examples for each contextual variable

Code	Definition	Example
Task	The purpose of the time segment.	
Warm-up	Time devoted to a routine execution of physical activity with a purpose to prepare the individual for engaging in further activity, but not designed to alter the skill or fitness of the individual on a long-term basis. Usually occurs in the beginning of practice [29]	At the beginning of practice the coach has kids do a serious of dynamic warm-ups and stretches as a group (high knees, lunges, butt kicks, etc.)
Free play	Time during which adult influence of task choice is not intended [29].	The coach has footballs for the kids to play with at the beginning of practice but does not tell the kids what activities to do or not to do.
Fitness	Time where major purpose is to alter the physical state in terms of cardiovascular endurance, strength or flexibility [29, 29].	Running sprints
Sport Skill	Adult-led activity time devoted to practice of skills with the primary goal of skill development [9, 29, 31].	Passing drills, flag grabbing drills
Game play	Adult-led time devoted to playground games where skills are not directly applicable to a competitive sport game and there is little to no adult instruction or feedback [9, 29, 31].	Tag, sharks and minnows
Scrimmage	Adult-led activity time devoted to the refinement and extension of skills in a sport game where two opposing teams are created within a team. Minimal interference from the coach [9, 29, 31].	Within a team, the kids are playing a mock football game
Strategy	Time devoted to transmitting information related to rules and strategy of the sport [29, 31].	Putting in or practicing an offensive play, defensive system, etc.
Management	Time allocated to managerial and organization activities, time devoted to team business that is unrelated to instructional activity [29, 31].	Time out, opening huddle, closing huddle
Self-care	Time devoted to washing, using the rest room, or drinking water.	Water break
Member Arrangement	The arrangement of the setting members within an segment.	
Solitary	Child is doing activity alone [9, 29, 31].	During a dribbling drill, the child is practice by him or herself.
One v One	Child is doing activity with only one additional participant [9].	During a blocking drill, each child has a partner and they take turn blocking.
Small group	Child is performing an activity with greater than one other child, but less than the full team [9].	During a receiving drill, the full team is split into two groups. Each group has their own drill to complete, and the groups are not working together.
Whole group	All children are participating in an activity [9, 29, 31].	All kids go to water break at the same time.
Setting Demand	Population distribution that influences the system	
Optimal	Time period when there are an equal number of opportunities to participate as children to participate (i.e., fosters participation) [20].	During tag all 7 kids are playing at the same time, during warm-up all the kids are on the line at the same time
Disadvantaged	Time period when there are a fewer number of opportunities to participate than children available to participate (i.e., fosters exclusion) [20].	During tag, if you get tagged you have to sit on the sideline until all of the children are out. During a passing drill, only 1 child is receiving the pass at a time, the rest are waiting in line behind him.

Schlechter, C. R., Guagliano, J. M., Rosenkranz, R. R., Milliken, G. A., & Dzewaltowski, D. A. (2018). Physical activity patterns across time-segmented youth sport flag football practice. *BMC public health*, *18*(1), 226.

Concurrent Observation and accelerometry

Observing Drivers of PA



Schlechter, C. R., Guagliano, J. M., Rosenkranz, R. R., Milliken, G. A., & Dzewaltowski, D. A. (2018). Physical activity patterns across time-segmented youth sport flag football practice. *BMC public health*, *18*(1), 226.

Concurrent Observation and accelerometry

Table 3 Physical activity intensity by segment type

Percentage of time, adjusted mean (95% CI)	Low-energy stationary behavior	Differences[a] ($p < .05$)	VPA	Differences[a] ($p < .05$)	MVPA	Differences[a] ($p < .05$)
Task						
a. Warm-up	10.63 (4.79–16.06)	d, e, h	23.40 (19.68–27.12)	e, f, g, h	53.92 (46.84–60.96)	b, e, f, g, h, i
b. Fitness	15.73 (8.84–22.56)	d	20.08 (15.00–25.20)	e, f, g, h, i	36.75 (27.73–45.82)	a, c, d, e
c. Free-play	8.16 (0.00–16.43)	e, h	17.97 (11.53–24.47)	e, h, i,	51.51 (40.72–62.28)	b, e, f, g, h, i
d. Game-play	4.03 (0.00–9.88)	a, b, e, g, h, i,	23.84 (19.49–28.11)	e, f, h, i,	53.56 (46.35–60.85)	b, e, f, g, h, i
e. Management	21.86 (17.59–26.21)	a, c, d, f, g, h, i	10.01 (7.16–13.04)	a, b, c, d, g,	27.81 (23.70–33.90)	a, b, c, d, g,
f. Scrimmage	11.20 (4.54–17.86)	e, h	11.12 (5.81–16.39)	a, b, d,	30.20 (21.19–39.22)	a, c, d
g. Self-care	14.26 (9.79–18.81)	d, e, h	13.08 (9.96–16.24)	a, b, e, i	37.73 (31.23–44.17)	a, c, d, e, h
h. Sport-skill	17.58 (13.29–21.91)	a, c, d, e, f, g, i	10.73 (7.76–13.64)	a, b, c, d,	31.56 (25.52–37.68)	a, c, d, g
i. Strategy	12.58 (8.29–16.91)	d, e, h	8.48 (5.56–11.44)	b, c, d, g	30.62 (24.33–36.87)	a, c, d
	Low-energy stationary behavior	Differences[b] ($p < .05$)	VPA	Differences[b] ($p < .05$)	MVPA	Differences[b] ($p < .05$)
Member Arrangement						
a. One v One	12.53 (4.46–20.54)	None	16.09 (9.63–22.57)	None	35.29 (24.72–45.88)	None
b. Small group	13.27 (7.12–19.28)	None	10.06 (5.20–15.00)	None	35.55 (27.37–43.83)	None
c. Whole group	15.52 (11.97–19.03)	None	12.47 (9.76–15.24)	None	34.53 (29.21–39.79)	None
	Low-energy stationary behavior	Differences[c] ($p < .05$)	VPA	Differences[c] ($p < .05$)	MVPA	Differences[c] ($p < .05$)
Setting Demand						
a. Disadvantaged	18.76 (14.68–22.92)	b	10.30 (7.16–13.44)	b	29.07 (23.22–34.98)	b
b. Optimal	14.21 (10.67–17.73)	a	13.21 (10.65–15.75)	a	36.06 (30.81–41.39)	a

[a]Significance from mixed effects model (e.g.,'a' denotes difference from warm-up)
[b]Significance from mixed effects model (no significant differences found)
[c]Significance from mixed effects model (e.g.,'a' denotes difference from disadvantaged)

Schlechter, C. R., Guagliano, J. M., Rosenkranz, R. R., Milliken, G. A., & Dzewaltowski, D. A. (2018). Physical activity patterns across time-segmented youth sport flag football practice. *BMC public health*, *18*(1), 226.

Summary

- Accelerometry provides data for many different types of outcome measures
- Direct observation can provide contextually rich data on the influences of PA in real-world settings
- Methods provide distinct types of data – choose method based on research question of interest
- Limited assessment of real-time activity and context, temporal components, or questions about the distribution of PA within settings

Resources

Accelerometry

Kim, Y., Beets, M. W., & Welk, G. J. (2012). Everything you wanted to know about selecting the “right” Actigraph accelerometer cut-points for youth, but…: a systematic review. Journal of Science and Medicine in Sport, 15(4), 311-321.

Migueles, J. H., Cadenas-Sanchez, C., Ekelund, U., Nyström, C. D., Mora-Gonzalez, J., Löf, M., ... & Ortega, F. B. (2017). Accelerometer data collection and processing criteria to assess physical activity and other outcomes: a systematic review and practical considerations. Sports medicine, 47(9), 1821-1845.

Trost, S. G., Mciver, K. L., & Pate, R. R. (2005). Conducting accelerometer-based activity assessments in field-based research. Medicine & Science in Sports & Exercise, 37(11), S531-S543.

Direct Observation

Protocols for direct observation systems available from Active Living Research (http://activelivingresearch.org/)

McKenzie, T. L. (2002). The use of direct observation to assess physical activity. In G. Welk (Ed.), Physical activity assessments for health-related research (pp. 179-195). Champaign, IL: Human Kinetics.

McKenzie, T. L. (2010). 2009 C. H. McCloy Lecture: Seeing is believing: Observing physical activity and its contexts. Research Quarterly for Exercise and Sport. 81(2), 113-122.

UNMC℠

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University of Nebraska Medical Center

UNIVERSITY OF NEBRASKA AT OMAHA

Use of Surveillance in Assessing Physical Activity Across the Lifespan

Michaela Schenkelberg, PhD, MPH
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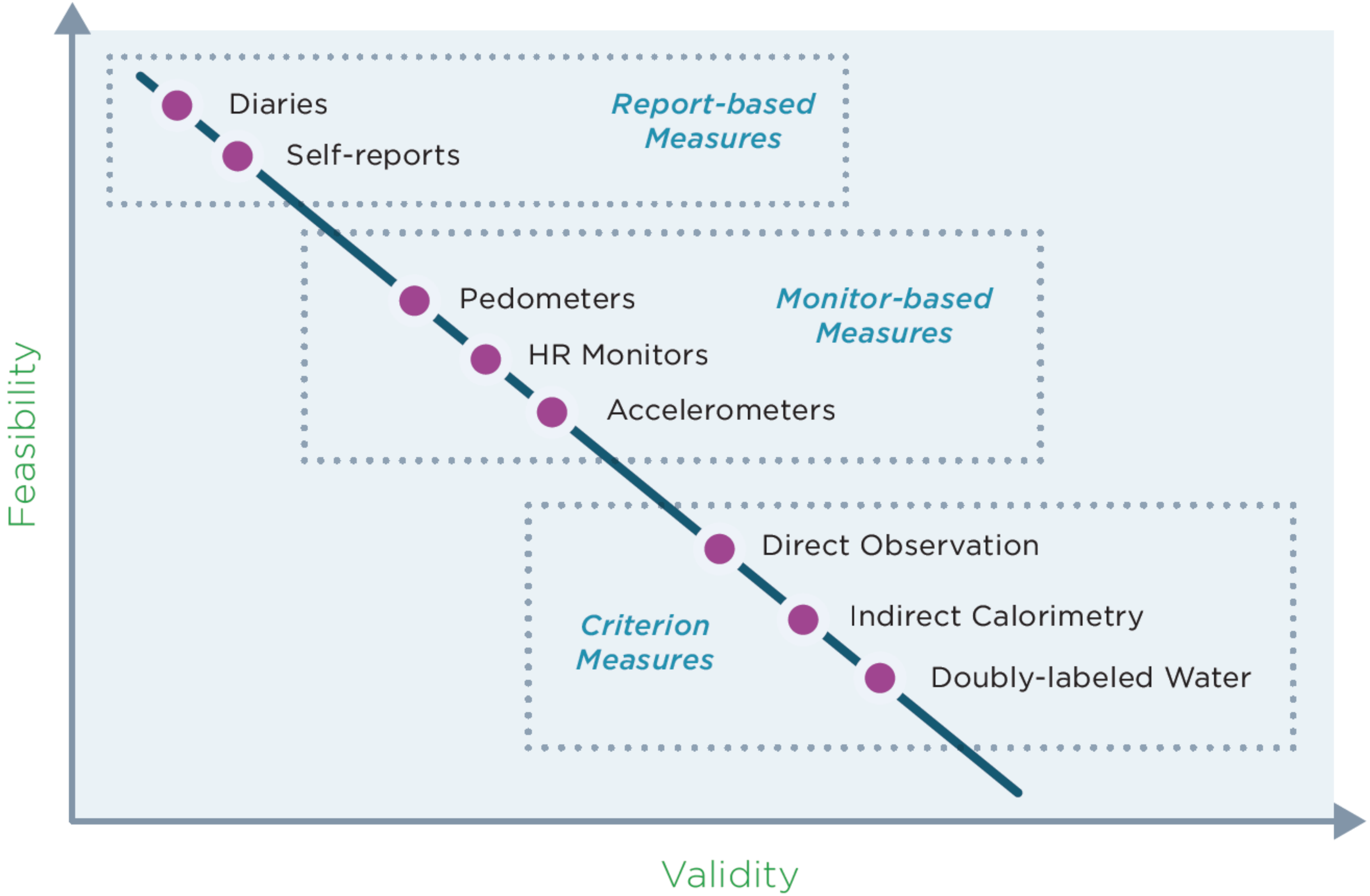
UNMC Centric and GP IDeA-CTR Physical Activity Workshop
March 5th, 2020

Overview

- Use of surveillance
- Physical activity surveillance – children & adults
- System-level physical activity surveillance
- Considerations
- Resources



From: National Collaborative on Childhood Obesity Research (NCCOR)

Surveillance

"**ongoing**, **systematic** collection, analysis, and interpretation of **outcome-specific** data for *use in the planning, implementation, and evaluation of public health practice*"

Thacker, S. B., & Berkelman, R. L. (1988). Public health surveillance in the United States. *Epidemiologic reviews*, *10*(1), 164-190.

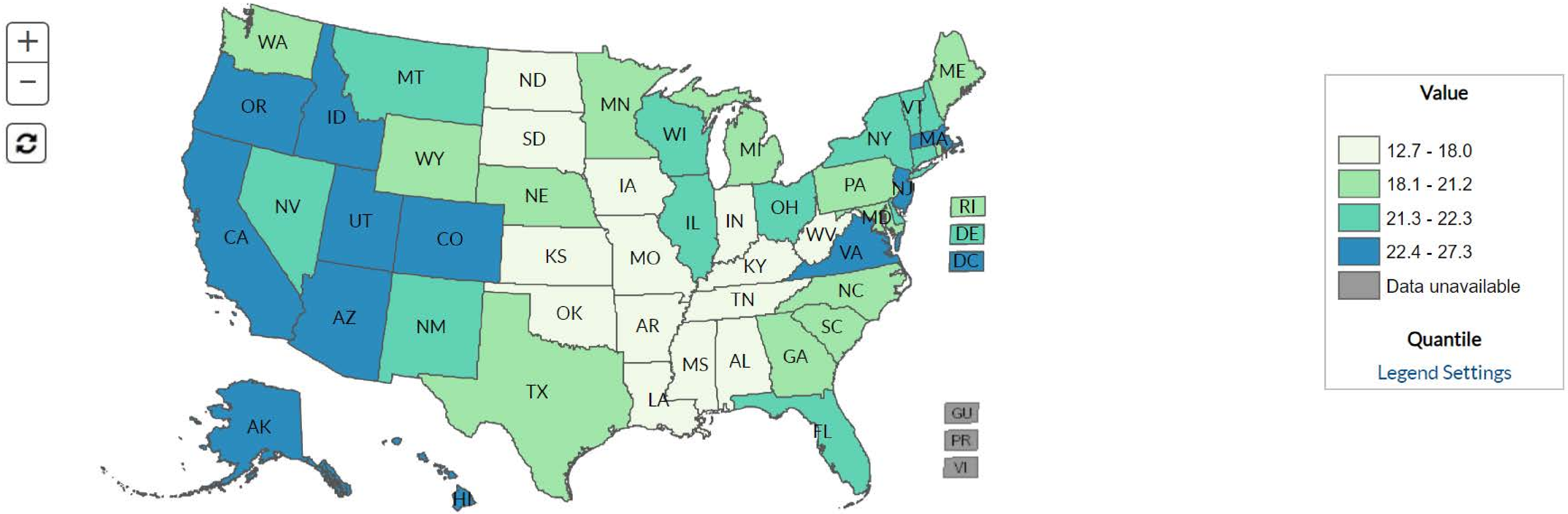
- **Use of surveillance**:
  - Understand prevalence and trends
    - Extent of disease and behavior
  - Inform public health interventions
    - Timely, effective decisions
    - Monitor progress of efforts
  - Resource allocation
  - Data have been used to develop the CDC growth charts

- Data collected at an individual level → aggregated
  - Age
  - Race/ethnicity
  - Region
- Physical activity surveillance
  - Most are self-report
    - Some use of devices
  - Domains of physical activity
  - Outcomes vary

2011

Percent of adults who achieve at least 150 minutes a week of moderate-intensity aerobic physical activity or 75 minutes a week of vigorous-intensity aerobic physical activity and engage in muscle-strengthening activities on 2 or more days a week †

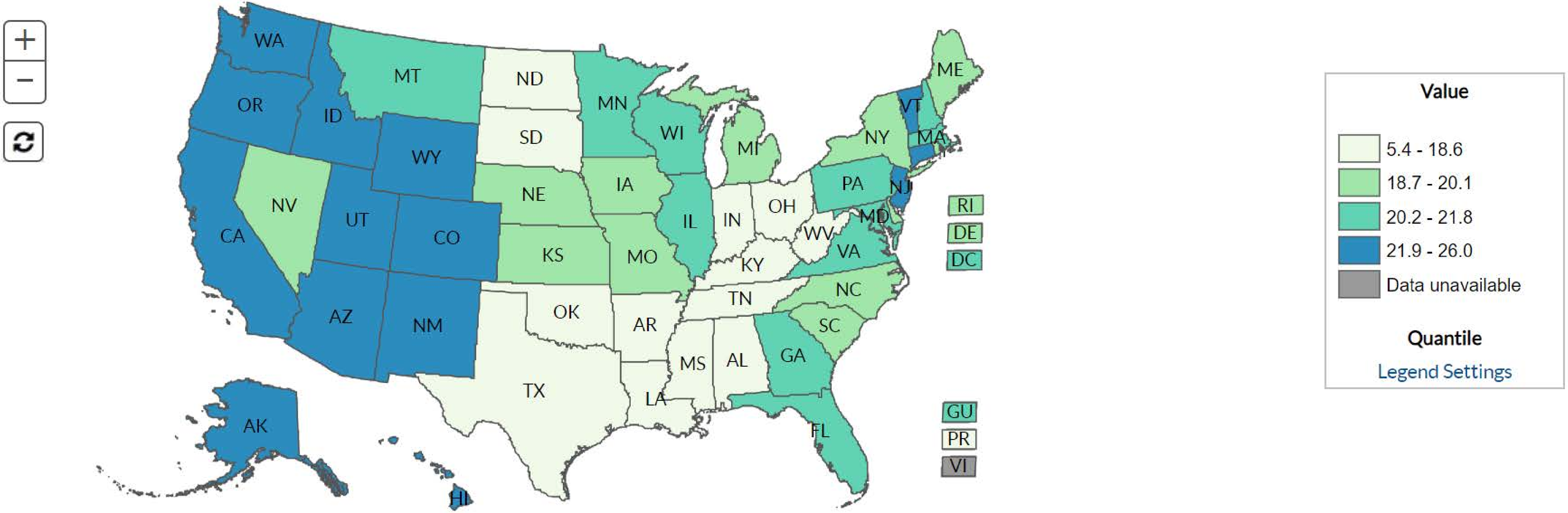
View by: Total

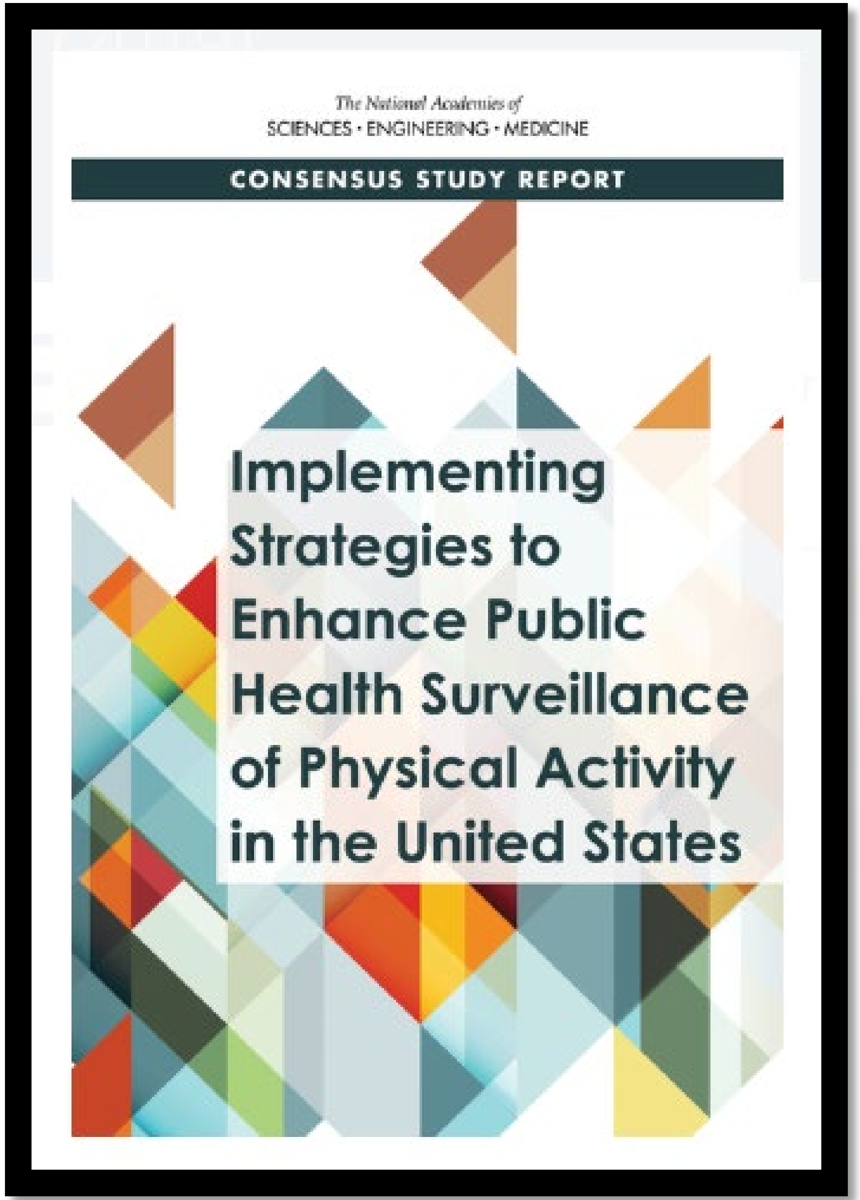


2017

Percent of adults who achieve at least 150 minutes a week of moderate-intensity aerobic physical activity or 75 minutes a week of vigorous-intensity aerobic physical activity and engage in muscle-strengthening activities on 2 or more days a week †

View by: Total





RECOMMENDED STRATEGIES AND ACTIONS TO IMPROVE NATIONAL PHYSICAL ACTIVITY SURVEILLANCE

The committee presents 22 strategies for improving national physical activity surveillance: 6 for children, 6 for health care, 4 for workplaces, and 6 for community supports for physical activity. The committee also recommended specific actions to support implementation of each strategy. A total of 59 implementation actions were identified: 16 for children, 16 for health care, 12 for workplaces, and 15 for community supports for physical activity. The full list of strategies and supporting actions for implementation is provided below.

Children

- Variable physical activity patterns
- Fewer bouts of continuous movement compared with adults
- Difficult to recall physical activity
- Parent proxy – decent, but do parents know what their kids are doing at all times?

- National surveillance systems for youth

- 1960s– National Health and Nutrition Examination Survey (NHANES)
  - 2012 – National Youth Fitness Survey

- 1991 - Youth Risk Behavior Survey (YRBS)
  - High school students
  - No national middle school survey

Measure	Age	Purpose	Setting	Aim of PA Questions	# of Questions	Question format	Validation
YRBS	Grades 9 - 12	To determine prevalence of health behaviors, how they change over time, co-occurrence of health behaviors, provide national-, state-, and local-level comparable data, monitor progress.	School-Based	To determine frequency and intensity of PA in the past week and a typical week (includes PE / sports teams / screen time)	5	Child-report # of days of PA (past week, typical week) at: 1) 20-m of vigorous, 2) 30-m moderate, 3) 60-m mod	**Troped et al., 2007**: Test-retest reliability: 0.51 (MPA), 0.46 (VPA); Underestimates MPA, overestimates VPA. **Prochaska et al., 2001:** Criterion validity w/ CSA monitor, *r*=0.31-0.46; Correct classification=63%.
NHANES	2-11 years; 16+	To assess the health of US children and adults.	Phone Interview	To determine specific kinds of vigorous/moderate activities done at work, active transportation, vigorous/moderate sports, fitness, recreational activities, and sedentary behavior.	23	Parent- and child-reported frequency (# of days) & duration (min or hours) of moderate-vigorous intensity work activities, active transportation, moderate-vigorous recreational activities	
NNYFS	3 – 15 years	Evaluate health and fitness of U.S. children and adolescents, particularly PA and fitness data	Fitness tests (in addition to NHANES survey)	To determine physical activity (via self-report and wrist-worn monitors) level, body measures, fitness (cardiovascular and muscular)			

NHANES

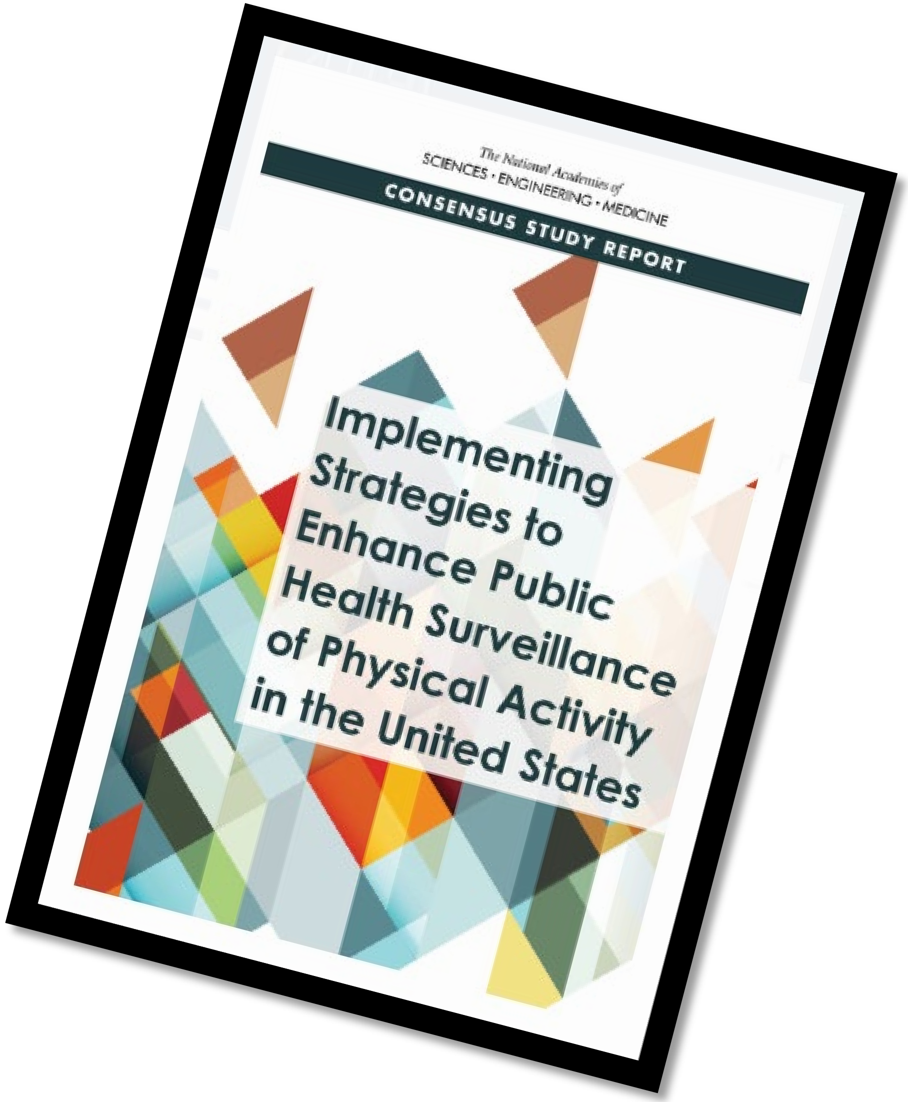
- Accelerometers
  - 2003-2004, 2005-2006 cycles
  - 7-days, waist-worn
  - Poor compliance – 25%

  - 2011-2012, 2013-2014 cycles
  - 7-days, wrist-worn (non-dominant wrist)
  - Improved compliance – 70-80% compliance (6 days/wk)

(Troiano et al., 2014)

What’s Missing?

- Limited surveillance for 2-14 years
- Limited in monitoring where and when children are active
- Limited in monitoring forms, or types, of activity



Youth Activity Profile (YAP)

- Developed for calibration
- Assessment and promotion
- When are children active?
  - School physical activity
  - Out-of-school physical activity
  - Sedentary time

School Items (5)

PA to School
PE
Recess
Lunch
PA from School

Out-of-School Items (5)

Before School
After School
Evening
Saturday
Sunday

Sedentary Items (5)

Computer Time
TV time
Video Games
Cell Phone
Sedentary

JOURNAL OF MEDICAL INTERNET RESEARCH — Saint-Maurice & Welk

Tutorial

Web-Based Assessments of Physical Activity in Youth: Considerations for Design and Scale Calibration

Pedro F Saint-Maurice[1,2], PhD; Gregory J Welk[1], PhD

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RESEARCH ARTICLE

Validity and Calibration of the Youth Activity Profile

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These authors contributed equally to this work.
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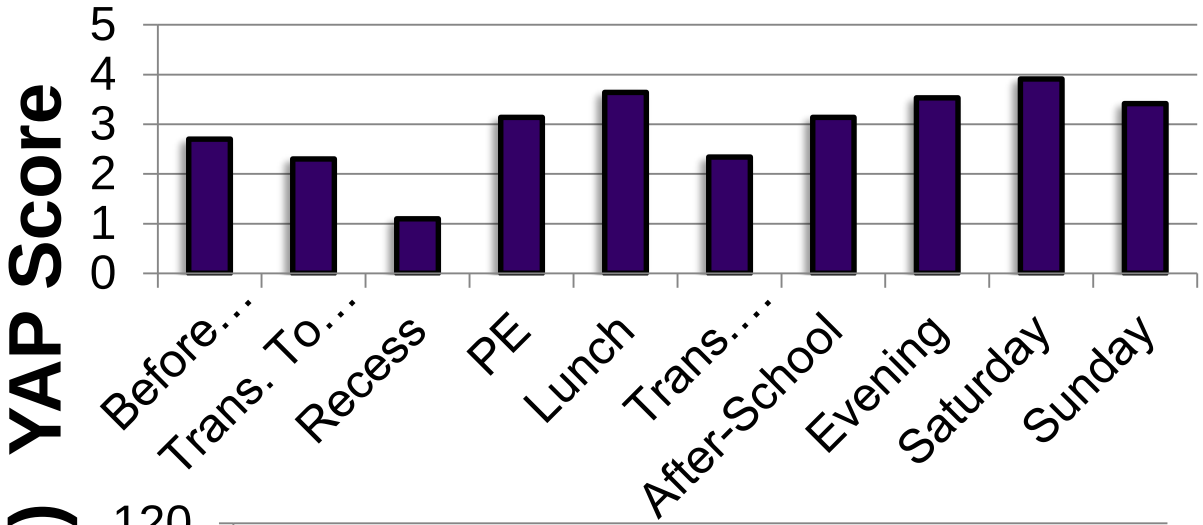
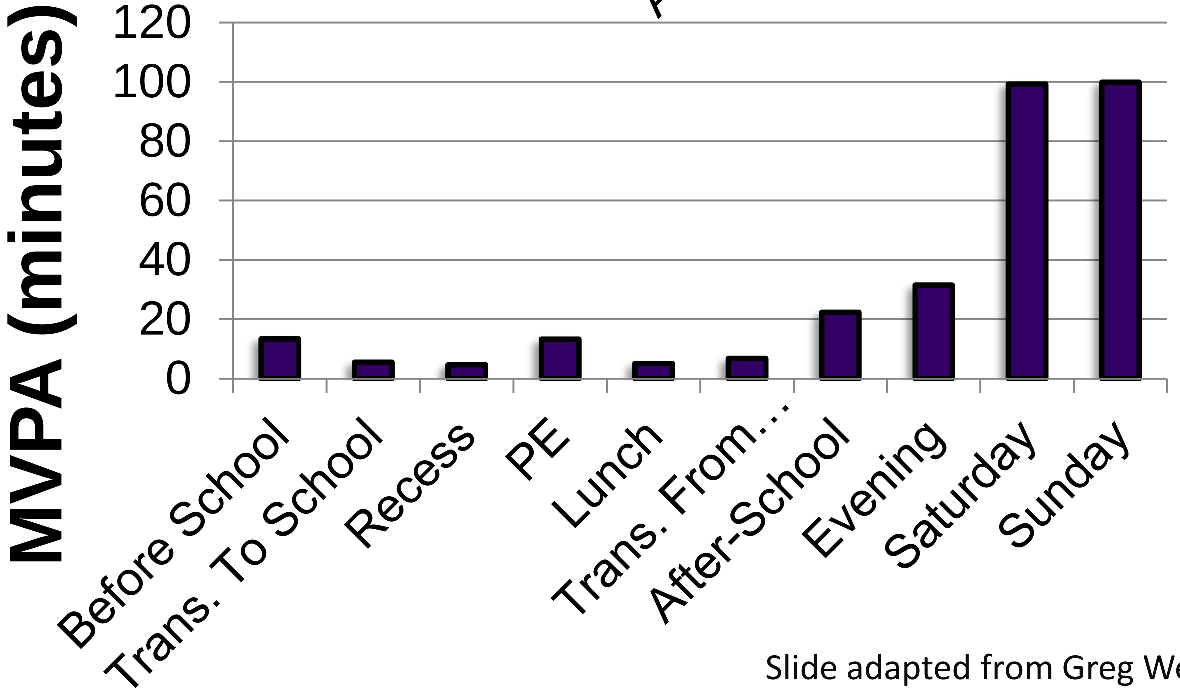


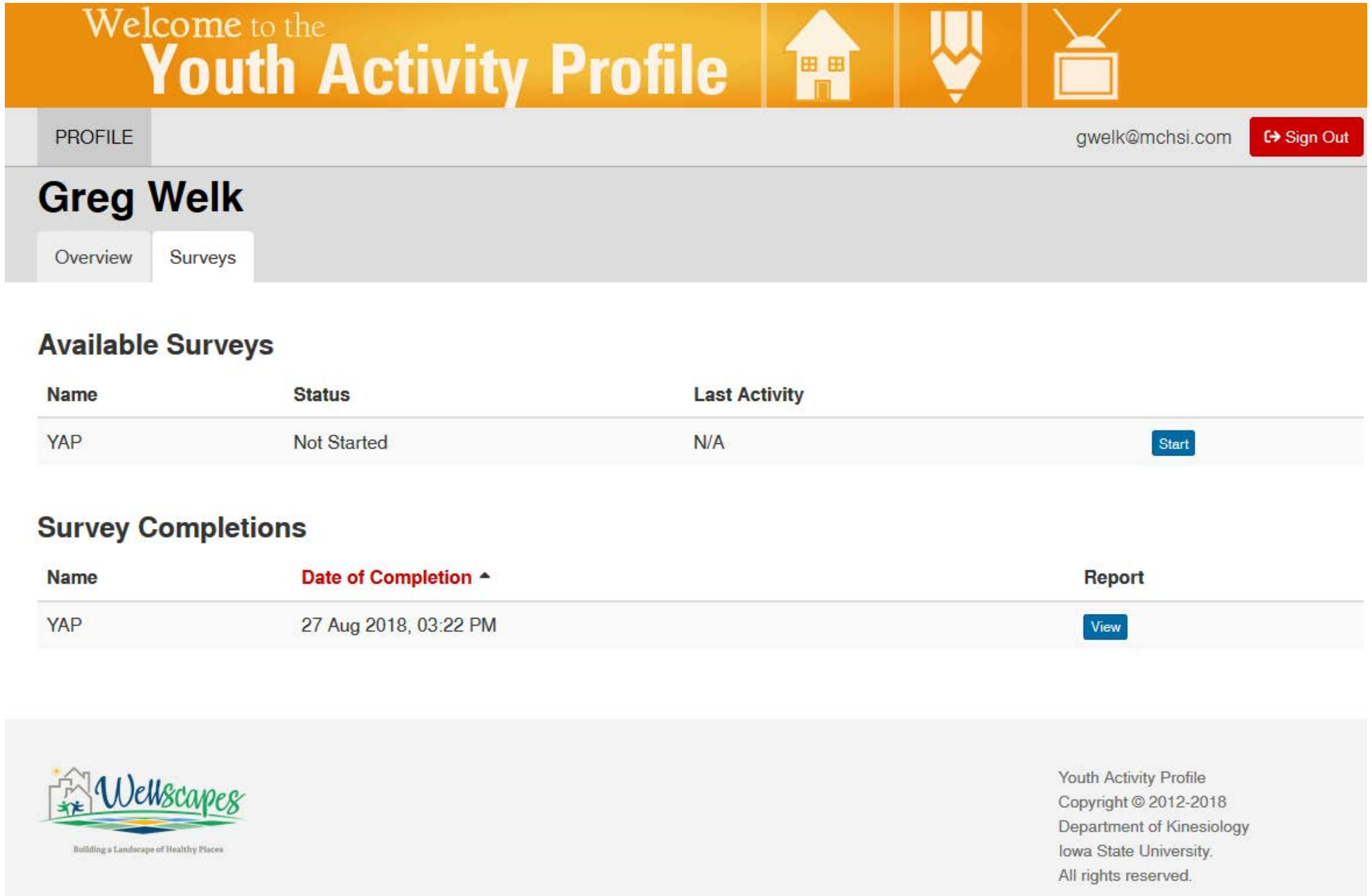


Slide adapted from Greg Welk

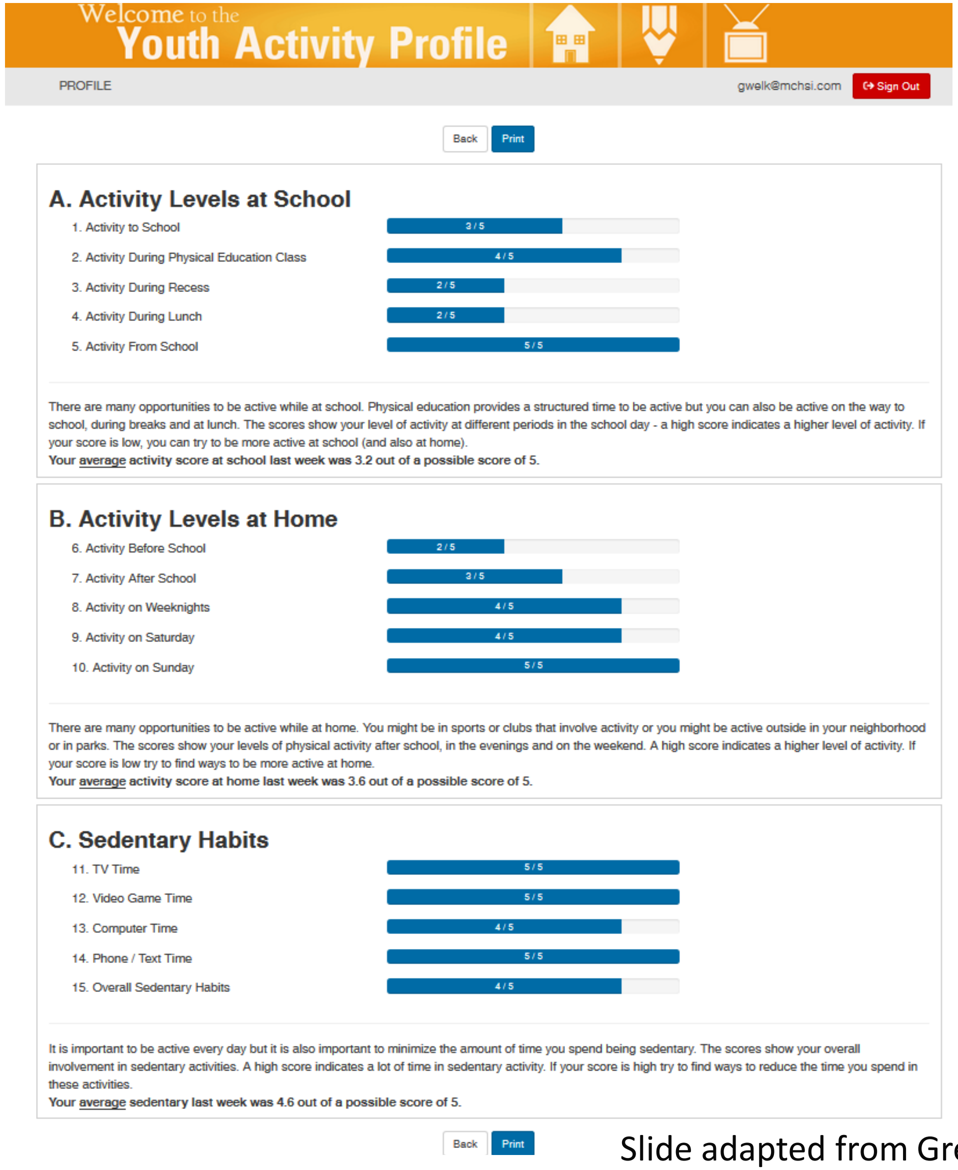
- Multiple Levels
  - Coordinator
  - School
  - Student

- Full administrative controls

- Auto-generated reports



- Multiple Advantages
  - Youth can learn about their behaviors
  - Teachers can reinforce physical activity
  - Schools gets summary report of outcomes
  - Project leaders get aggregated data



Slide adapted from Greg Welk

EASY

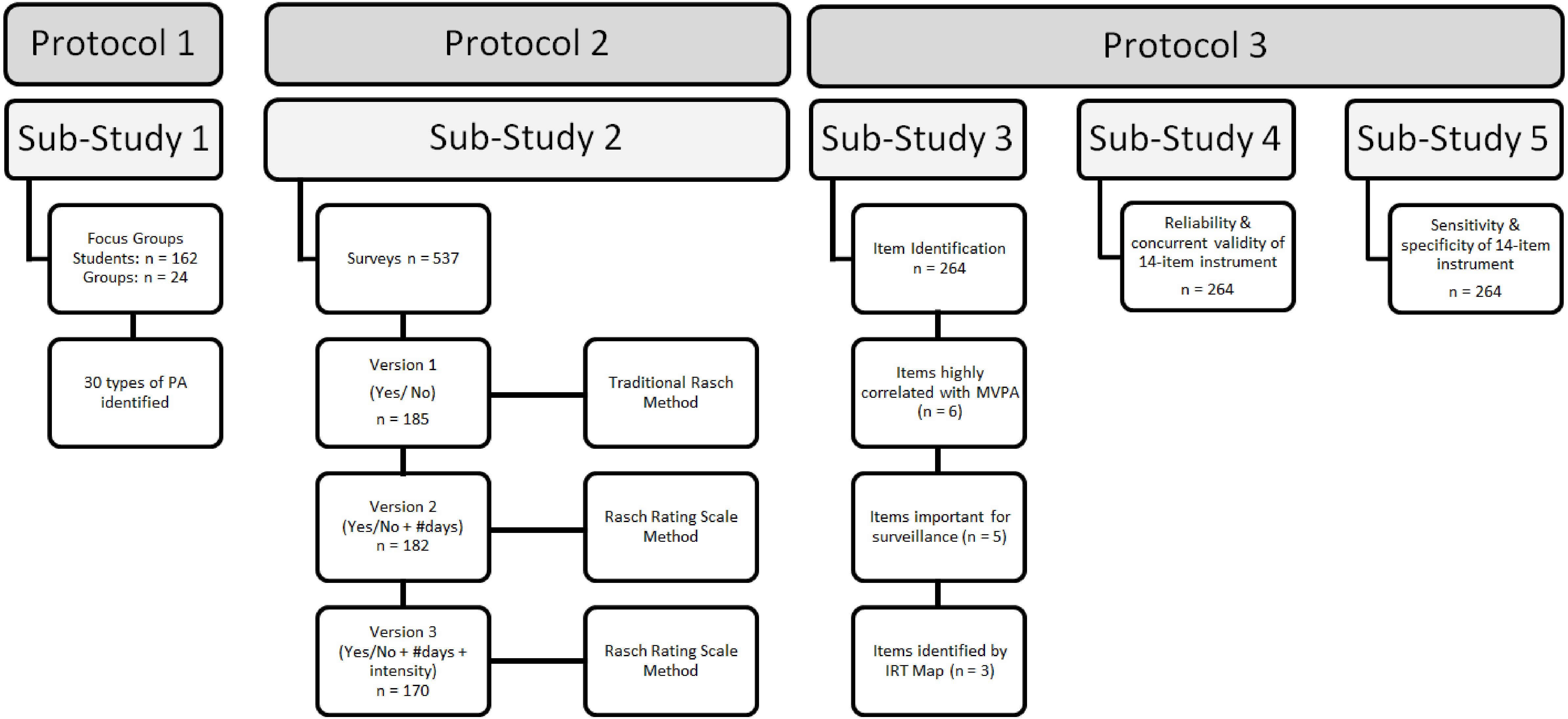
EVALUATION OF ACTIVITY SURVEYS FOR YOUTH

An Instrument for Surveillance of Physical Activity in Youth.

Russell R. Pate, PhD, Kerry McIver, PhD, Marsha Dowda, PhD, Michaela A. Schenkelberg, MPH, Michael Beets, PhD, Christine DiStefano, PhD

Medicine & Science in Sports & Exercise, 2018

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.



(Pate et al., 2018)

TABLE 1. Associations between accelerometer-derived MVPA and item responses ($n = 264$) and test–retest reliability ($n = 342$) of the items.

	MVPA → Item Associations		Test–Retest Reliability					
			Administration 1		Administration 2			
	Yes/No[a]	Days (0–7)[b]	% Yes	Mean Days (1–7) ± SD	% Yes	Mean Days (1–7) ± SD	Kappa (95% CI)	Interclass Correlation Coefficient
In the past week (7 d), did you…								
1. Have PE/gym classes?	−0.03	0.07	93.9	4.29 ± 1.99	93.3	4.25 ± 1.95	0.90 (0.80–0.99)	0.89
2. Play an organized school sports team?	−0.02	−0.02	13.5	0.54 ± 1.50	14.7	0.63 ± 1.62	0.80 (0.70–0.89)	0.84
3. Walk or bike to or from school?	0.12*	0.13*	29.7	1.40 ± 2.35	27.8	1.33 ± 2.30	0.91 (0.86–0.96)	0.94
4. Play actively during recess or other free time at school?	0.25*	0.31**	60.5	2.82 ± 2.66	55.6	2.42 ± 2.51	0.79 (0.72–0.85)	0.82
5. Participate in physical activity in an after-school program?	0.12	0.11	28	1.12 ± 2.05	23.1	0.95 ± 1.90	0.73 (0.64–0.81)	0.86
6. Play on an organized, non–school sports team?	0.34**	0.34**	43	1.54 ± 2.17	39.3	1.40 ± 2.06	0.85 (0.79–0.91)	0.85
7. Participate in physically active classes or lessons?	0.02	0.03	36.4	1.40 ± 2.19	30.8	1.12 ± 1.99	0.83 (0.77–0.90)	0.86
8. Participate in adventure/outdoor activities?	0.23	0.23**	44.5	1.59 ± 2.30	38.6	1.29 ± 2.01	0.81 (0.75–0.88)	0.82
9. Participate in water (pool, lake, or ocean) games or activities, surfing, skiing/wakeboarding, rafting, kayaking/canoeing, etc?	0.05	0.04	18.3	0.51 ± 1.35	15.6	0.43 ± 1.24	0.79 (0.71–0.88)	0.85
10. Play playground games?	0.14*	0.15*	76.6	2.46 ± 2.17	70.2	2.45 ± 2.28	0.69 (0.61–0.78)	0.83
11. Play nonorganized sports?	0.29**	0.31**	56.3	1.93 ± 2.32	50.8	1.78 ± 2.24	0.76 (0.69–0.83)	0.86
12. Take fitness classes at a gym, church, or other facility?	0.05	0.05	20.1	0.76 ± 1.74	18.3	0.65 ± 1.60	0.74 (0.65–0.83)	0.87
13. Workout at videos at home?	−0.02	−0.01	17.6	0.61 ± 1.53	17.3	0.61 ± 1.59	0.84 (0.76–0.92)	0.79
14. Do weight training?	0.22**	0.23**	22.2	0.78 ± 1.73	20.4	0.73 ± 1.67	0.87 (0.81–0.94)	0.89
15. Do any cardio training or conditioning at a gym?	0.11	0.11	26.7	0.89 ± 1.72	21.5	0.71 ± 1.54	0.76 (0.67–0.84)	0.82
16. Play physically active video games?	−0.03	−0.04	53.2	1.81 ± 2.31	51.7	1.70 ± 2.20	0.93 (0.89–0.97)	0.92
17. Ride your bike or other wheeled toys for fun or exercise?	0.21**	0.23**	52.5	1.83 ± 2.30	48.1	1.71 ± 2.26	0.88 (0.82–0.93)	0.89
18. Run or jog for fun or exercise?	0.04	0.13*	78.3	2.91 ± 2.39	70.1	2.55 ± 2.38	0.77 (0.69–0.85)	0.86
19. Walk for fun or exercise?	−0.05	0.03	73.8	2.85 ± 2.57	69.5	2.73 ± 2.48	0.72 (0.64–0.81)	0.84
20. Walk or bike to a store, a friend's house, or to get somewhere else?	0.13*	0.12	61.2	2.22 ± 2.43	56.8	2.06 ± 2.37	0.80 (0.73–0.86)	0.84
21. Do active household chores?	0.13*	−0.18**	86.3	3.79 ± 2.54	83.8	3.63 ± 2.55	0.88 (0.80–0.95)	0.93
22. Do yard work?	0.18**	0.17**	30.4	0.80 ± 1.60	28.6	0.77 ± 1.58	0.91 (0.86–0.96)	0.90
23. Walk your dog?	0.05	0.06	26.8	1.06 ± 2.09	25.5	1.01 ± 2.04	0.94 (0.89–0.98)	0.96
24. Play actively at home?	0.12*	0.14*	80.6	3.48 ± 2.59	76.5	3.09 ± 2.52	0.66 (0.56–0.76)	0.82
25. Play actively at a friend's house?	0.12	0.15*	48.2	1.59 ± 2.20	48.8	1.65 ± 2.17	0.89 (0.84–0.94)	0.90
26. Play actively at school?	0.05	0.07	65	2.90 ± 2.52	56.3	2.55 ± 2.55	0.58 (0.49–0.66)	0.79
27. Play actively at a church?	0.08	0.08	17.7	0.41 ± 1.14	17.1	0.42 ± 1.16	0.87 (0.80–0.94)	0.83
28. Play actively at a gym?	0.16*	0.15*	30.9	1.17 ± 2.02	28.2	1.08 ± 1.99	0.82 (0.75–0.89)	0.87
29. Play actively in your neighborhood?	0.29**	0.30**	53.4	2.17 ± 2.58	50.1	2.03 ± 2.51	0.85 (0.79–0.91)	0.92
30. Play actively at a park or playground?	0.06	0.08	41.2	1.27 ± 1.98	38.4	1.25 ± 2.04	0.80 (0.73–0.87)	0.89

Items in bold were selected to be included in instrument.

[a]Biserial correlations.

[b]Spearman correlations.

*$P < 0.05$.

**$P < 0.001$.

(Pate et al., 2018)

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

(Pate et al., 2018)

- Percentage of students who met MVPA guidelines:
  - 23.1% of boys, 5.4% of girls
- Receiver operator characteristics (ROC)
  - To determine optimal score to determine ≥60 min MVPA
- Sensitivity (Se), specificity (Sp), and area under the curve (AUC)
- Optimal score for detecting compliance: 22
  - Se = 0.90, Sp = 0.44, AUC = 0.68

(Pate et al., 2018)

- Multiple Advantages

  - Items were identified and considered important by youth
    - Identified response format
    - Selected the items

  - Detects compliance with youth PA guidelines
  - Detects forms, or types, of physical activity
    - Inform public health interventions

  - Supports both public health surveillance and interventions

(Pate et al., 2018)

Adults

- Behavioral Risk Factor Surveillance System (BRFSS)
- National Health and Nutrition Examination Survey (NHANES)
- National Health Interview Survey (NHIS)

	BRFSS	NHANES	NHIS
Established	1984; annual	1960s, continuous from 1999	1975, annual since 1990
Topics	Health-related risk behaviors, chronic health conditions, preventive services	Health and nutrition status of adults and children (interviews and physical exams)	Vigorous, light-moderate leisure physical activity, strengthening exercises, occasionally walking
Purpose	Track state/local health objectives, public health planning, disease prevention and health-promotion activities	Vital and health statistics; prevalence of major diseases, relationship between nutrition and health outcomes, standards for height, weight, blood pressure	Monitor health; national-level estimates, track Healthy People 2020 Progress

- During the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise?

- What type of physical activity or exercise did you spend the most time doing during the past month? **(Coding List of PAs)**

- How many times per week or per month did you take part in this activity during the past month? How many minutes or hours did you usually keep at it? **(Repeat)**

- During the past month, how many times per week or per month did you do physical activities or exercises to strengthen your muscles?

- Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like carrying or lifting heavy loads, digging or construction work for at least 10 minutes continuously? **(Repeat – moderate)**
  - In a typical week, on how many days **[how much time]** do you do vigorous-intensity activities as part of your work? **(Repeat – moderate)**

- **Repeat for:**
  - Walking/using a bicycle for at least 10min to get to and from places
  - Vigorous-intensity sports, fitness, or recreational activities
  - Moderate-intensity sports, fitness, or recreational activities
  - Sitting at work, home, getting to and from places, with friends, etc.

- **Past 7 days, how many days were you active at least 60min per day?**

Redesigned items (2020, 2022, 2024, 2026):

- Frequency of moderate-intensity leisure-time activities (# times per day/week/month/year) If at least once per year (Number of hours/minutes each time) **[repeat for vigorous]**

- Frequency of leisure-time muscle-strengthening activities (# times per day/week/month/year)

- Walked at least 10min to get someplace (number of times, average length, number of days) **[repeat for walking for fun/leisure]**

- In the past 12 months, did your doctor advise you to exercise more?

- Several assessments that have been used for decades
    - Opportunity for examining patterns and trends
    - Exercise caution – different items, methodologies

- Prevalence estimates vary (Carlson et al., 2009)
    - NHIS 2005: active = 30.2%, inactive = 40.7%
    - NHANES 2005-2006: active = 33.5%, inactive = 32.4%
    - BRFSS 2005: active = 48.3%, inactive = 13.9%

Systems

- **Schools**
- **Healthcare**
- **Workplace**

Schools

- School Health Polices and Practices Study (SHPPS)
- Established in 1994, every 2yrs since 2012
- State, district, school, classroom levels

- Topics:
    - Health education
    - Health services
    - Health and safe school environment
    - Nutrition services
    - Physical education and activity

Wellscapes

Building a Landscape of Healthy Places

Feasibility of engaging rural communities in implementing whole-of-community youth physical activity surveillance through school systems.

Bavari, AE, Schenkelberg, MA, Essay, A, Norgelas, SJ, Rosenkranz, RR, Welk, GJ, Dzewaltowski, DA (2020). Abstract submitted to Interdisciplinary Association for Population Health Sciences.

Purpose: Engage community partners to implement a population-level online PA surveillance tool.

- System-wide implementation to enhance reach

- Coordinated with local health departments
  - Data-sharing agreement with the schools
  - Delivered in-person training sessions
    - YAP and how to use data

- Implementation
  - School administrators coordinated with teachers
  - All 3rd through 6th grade students (2x per year)
  - Individualized and school-level reports

- 23 teachers and administrators attended the meetings
- Contacts at schools managed their school's YAP platform
  - UNMC team provided technical support, if needed

- Year 1:
  - 465 3rd - 6th graders enrolled
  - Response rates: 86.1% - 95.4%
    - Varied by community and semester

- Year 2:
  - 501 3rd - 6th graders enrolled
  - Completing YAP in April 2020

Healthcare

- PA advisement from healthcare provider in the past year
  - 32.4% (Barnes & Schoenborn, 2012)
  - Limited time with patients (~7.6min per visit) (Nathan et al., 2017)

> Develop surveillance systems to monitor the prevalence of physical activity assessment in adults through expanded integration of a standard physical activity vital sign (PAVS) in health care delivery.

NASEM 2019

- **98% of physicians assess physical activity in youth**
  - 66% ask about duration, intensity, type
  - 7% use a standardized questionnaire
  - 6% use another written type of assessment

- **Systematic physical activity assessment in adults**
  - Physical activity vital sign (PAVS) – electronic health records (EHR)
    - Promoted through ACSM's Exercise is Medicine
    - Recommendation of NASEM Surveillance Report

Huang et al., 2011; Joy & Lobelo, 2017; Lobelo et al., 2020

- BRFSS Items (n=2)
- Screens for inactivity in clinical settings
- Increased physical activity counseling
  - Adults with obesity, diabetes (Grant et al., 2014; Mann et al., 2016)

a. ACSM Exercise is Medicine PAVS (minutes per week of MVPA)

Question 1. On average, how many days per week do you engage in moderate-to-strenous exercise (like a brisk walk)?

________days

Question 2. On average, how many minutes do you engage in exercise at this level?

________minutes

PAVS (minutes per week) = ______ days × ________ minutes

Joy & Lobelo, 2017; Lobelo et al., 2020

- Pediatric PAVS (5-18yrs)
  - Kaiser Permanente Health System
  - Modeled off YRBS (not yet validated)
  - Integrated with health visit and HER (McGlynn et al., 2014)

b. YRBS physical activity question (days per week of ≥60 minutes of MVPA)

During the past 7 days, on how many days were you physically active for a total of ≥60 minutes/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)?

________days

Joy & Lobelo, 2017; Lobelo et al., 2020

Expand the use of data from wearable devices for monitoring physical activity in at-risk patients.

- **Surveillance via wearable devices?**
- ~22% adults use wearable devices (Hyde et al., 2020)
  - 76.3% were willing to share with healthcare provider
- Integrate with EHRs and use as PAVS

- **Issues**:
  - Vary in validity, reliability - difficulty comparing across devices
  - Privacy concerns
  - Data need to be interpreted (raw scores → PA guidelines?)

- **Implementing surveillance in healthcare settings**
  - Not currently part of national surveillance – but could be!

- **Strengths**
  - Potentially greater reach – efficient
  - Personal, local, and national data
    - Tailored physical activity advice/counseling/referrals
    - Disease and behavior trends in local population
    - National surveillance of patterns of behavior
  - Wearables are promising – need some work

Considerations

- Trade-offs associated with self-report
- Comparisons across instruments, years, methods, etc.
- Enhance existing national systems
- Explore novel approaches / technological developments
- System-wide surveillance
    - Population-level
    - Environmental factors (i.e., policies and practices)

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Resources

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