# Participation Metrics for Accelerometer-Based Research

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#### **Motivation**

- Accelerometers used by researchers to measure physical activity
  - Common devices: Fitbit, AppleWatch, GENEActiv
- Non-participation is a key challenge
- Occurs at two hierarchical levels:
  - Sample members: missing because they do not participate
  - Measurements: missing due to non-wear (among participants)
- Unlike with surveys, no standards exist for computing participation rates
- Efforts to examine the level of non-participation bias are rare

#### **Our aims**

- Conceptual aim
  - Propose definitions and formulas for calculating participation rates in accelerometer-based studies
  - Propose methods for assessing non-participation bias
- Empirical aim
  - Illustrate these concepts using data from National Health and Nutrition Examination Survey (NHANES) 2011-2012 and 2013-2014

# Basic steps in accelerometer-based studies

- 1. Implement screening
- 2. Invite eligible individuals to participate in study
- 3. Provide accelerometer devices
- 4. Collect devices
- 5. Extract and process data
  - 5a. Measurements aggregated into periods (e.g., 1 minute, 5 minutes)
  - 5b. Classification of wear vs non-wear periods using statistical algorithm

# Sample members

# Complication (1 of 2)

- Sample members that do not participate in screening step
  - Eligibility is unknown
  - Unclear whether they should be included in denominator of participation rate
- Addressing this issue: as in surveys, estimate proportion that are eligible using information from other cases
  - Or present two participation rates: one including all cases of unknown eligibility in the denominator and one excluding these cases

# Complication (2 of 2)

- Individuals do not wear devices for the full study period
  - Unclear what amount of wear-time is sufficient to be deemed a participant
- Addressing this issue: develop a priori definition of what constitutes "sufficient" wear-time in a particular study
  - For example: ≥72 of 168 hours; ≥5 of 7 days with at least 10 hrs/day
  - Participant inclusion criteria vary across studies

# **Participation rate**

Proportion of eligible cases who provided sufficient data

$$\frac{S}{S + IN + T + D + R + e(U)}$$

where

*S* = Sufficient (inferred) wear-time

IN = Insufficient (inferred) wear-time on returned device

T = Technical problem extracting or processing data on returned device

D = Device never returned

*R* = Refusal/Non-consent

*U* = Unknown eligibility (no screener completed)

*e* = Estimated eligibility rate

### **Assessing non-participation bias**

- Compare characteristics of participants and non-participants
  - If sample is recruited from respondents to a previous survey, can use self-report information for both groups
  - Self reports of <u>physical activity</u> capture information directly about the behavior of interest

# Illustration: NHANES 2011-2012 and 2013-2014

- Cross-sectional study of U.S. general population
  - Participants first interviewed in homes, subsequently examined in Mobile Examination Center (MEC), then given accelerometer
- Data source: Actigraph GT3X+ (waterproof) accelerometer
  - 80 Hz raw data aggregated to 1-minute measurement periods
  - Ages 3 yrs + (6+ for 2011)
- Protocol:
  - 24-hour wear requested over 7 complete days
  - Return device by mail (\$40 incentive paid upon receipt)

### **Participation rates**

	2011 NHANES		2013 NHANES	
Step	N	Rate	N	Rate
Study Sample <sup>a</sup>	7,821		8,913	
Returned Device (w/ readable data)	6,917		7,776	
Adherent Participants <sup>b</sup>	6,467		7,114	
Participation rate		83%		80%

<sup>&</sup>lt;sup>a</sup> Responded to household interview; examined in Medical Examination Center; eligible for accelerometer study <sup>b</sup> Algorithm-estimated wear time of at least 10+ hours on 4+ days of the 7-day study period.

#### **Assessment of non-participation bias**

	2011 NHANES		2013 NHANES	
Step	N	Average Weekly PA (METs)	N	Average Weekly PA (METs)
Study Sample - BENCHMARK	6,549	3,097	6,979	3,156
Adherent Participants	5,385	3,060	5,597	3,103
Overall Discrepancy		-37 (-1%)		-53 (-2%)

Analysis restricted to participants aged 12+

MET: Unit of energy expenditure. Computed using NHANES responses as follows: METs = (Mins Moderate PA  $\times$  4.0) + (Mins of Vigorous PA  $\times$  8.0)

# Measurements

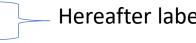
# Within-participant missing data

- Among those deemed to be participants, there may be missing measurements (due to non-wear or technical problems)
- Wear rate: proportion of wear periods of all measurement periods among participants

$$\frac{W}{W + NW + NC}$$

where

W = wear periodsNW = non-wear periodsNC = non-classifiable periods



Hereafter labeled as "non-wear" for simplicity

#### Assessing non-wear bias

- In practice, no information is available about physical activity during non-wear periods
- Addressing this issue:
  - Replace these periods with the average of wear periods from other participants at the same time of day.
  - Then compare characteristics of wear and non-wear periods.

#### Non-wear rates

	2011 NHANES		2013 NHANES	
Step	N	Rate	N	Rate
Total Periods	10,080		10,080	
Classifiable Periods <sup>a</sup>	9,638		9,665	
Wear Periods	9,119		9,071	
Wear Rate		91%		90%

<sup>&</sup>lt;sup>b</sup> Classifiable into wear vs. non-wear categories, as reflected by algorithm-assigned "confidence value".

Future step is to assess non-wear bias: Compute  $\bar{y}$  by replacing non-wear periods with average of wear periods at the same time of day, and compare it to  $\bar{y}_w$ .

#### **Discussion and Conclusion**

- Estimates in accelerometer-based studies are based on data that exclude: (level 1) non-participants and (level 2) non-wear periods among participants
- To compute participation rates, we divided cases into highlevels groups -> more fine-grained categories can be used
- Our indicators of non-participation bias have limitations
  - Self-report data from different reference period; contains some amount of measurement error
  - Actual values of non-wear periods are generally unknowable
- Potential next step is to extend to other data sets

#### **Thank You!**

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