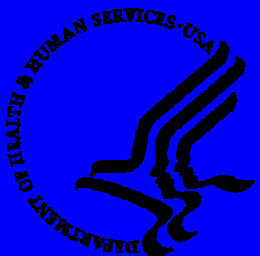# Using Accelerometry: Methods Employed in NHANES

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Overview

- NHANES
- Accelerometry
- Accelerometry Analytic Issues
  - Decisions and data cleaning
- The BIG NHANES Data Set
- Results from NHANES 2003-2004

NHANES

➤ Nationally representative sample
  – Household interview
  – Biomedical examination
➤ Oversamples for NHANES 2003-2004
  – Low income
  – Ages 12-19 y, 60+
  – Non-Hispanic Black, Mexican-American
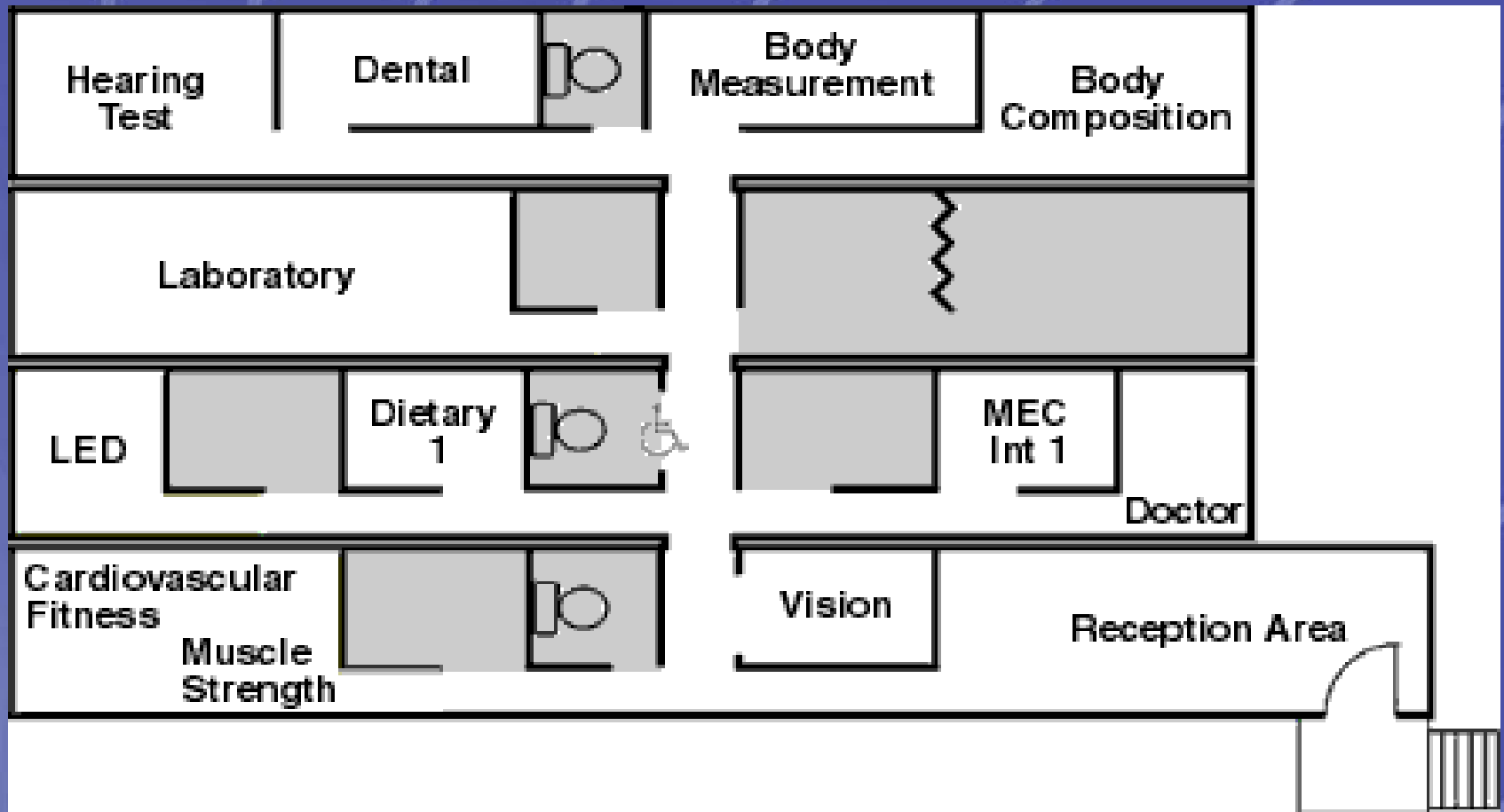➤ Response rates >70%

NHANES Mobile Exam Center

National Health and Nutrition Examination Survey

...monitoring the nation's health

NHANES

Floor plan showing: Hearing Test, Dental, Body Measurement, Body Composition, Laboratory, LED, Dietary 1, MEC Int 1, Doctor, Cardiovascular Fitness, Muscle Strength, Vision, Reception Area

Why Consider Accelerometers?

- Activities we are interested in may be routine and occur throughout the day
  - transportation, including short trips
  - walks for pleasure
- This type of behavior is difficult to report – frequency/intensity/duration
  - not discrete units, e.g. packs of cigarettes
- Reporting is subject to "desirability" - bias
- Qx. have limited reliability/validity
- Diaries have fairly high subject burden

Benefits of Accelerometers

➢ Remove cognitive aspect of data collection

  – provide objective data

➢ Can monitor multiple days with low burden

➢ Captures "real-time" intensity, duration, and can derive frequency of bouts

➢ Non-reactive measurement possible

Accelerometer Caveats

- Does not provide context of activity
- Primarily measures locomotor activity
  - not total activity or energy expenditure
  - misses upper body movement with usual placement
  - cannot distinguish load-carrying vs. not
- BUT walking/running is a primary source of activity, and may be your focus

How Accelerometers Work

Accelerometer Methods

➢ Measures body movement in terms of acceleration

 – related to intensity of physical activity
 – measured in 1 to 3 orthogonal planes
 » anterior-posterior
 » medial-lateral
 » vertical
 – Data stored for later download/analysis
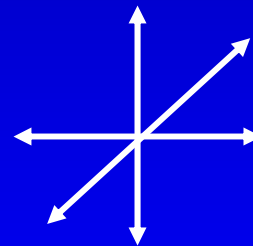
Accelerometer Output

➤ Counts

  – generated based on sampling frequency

  » range of 1-64 Hz

  – usually summed up over epoch period – often 1 min, may be user-defined

  – NOT comparable across devices

  » different sensors,
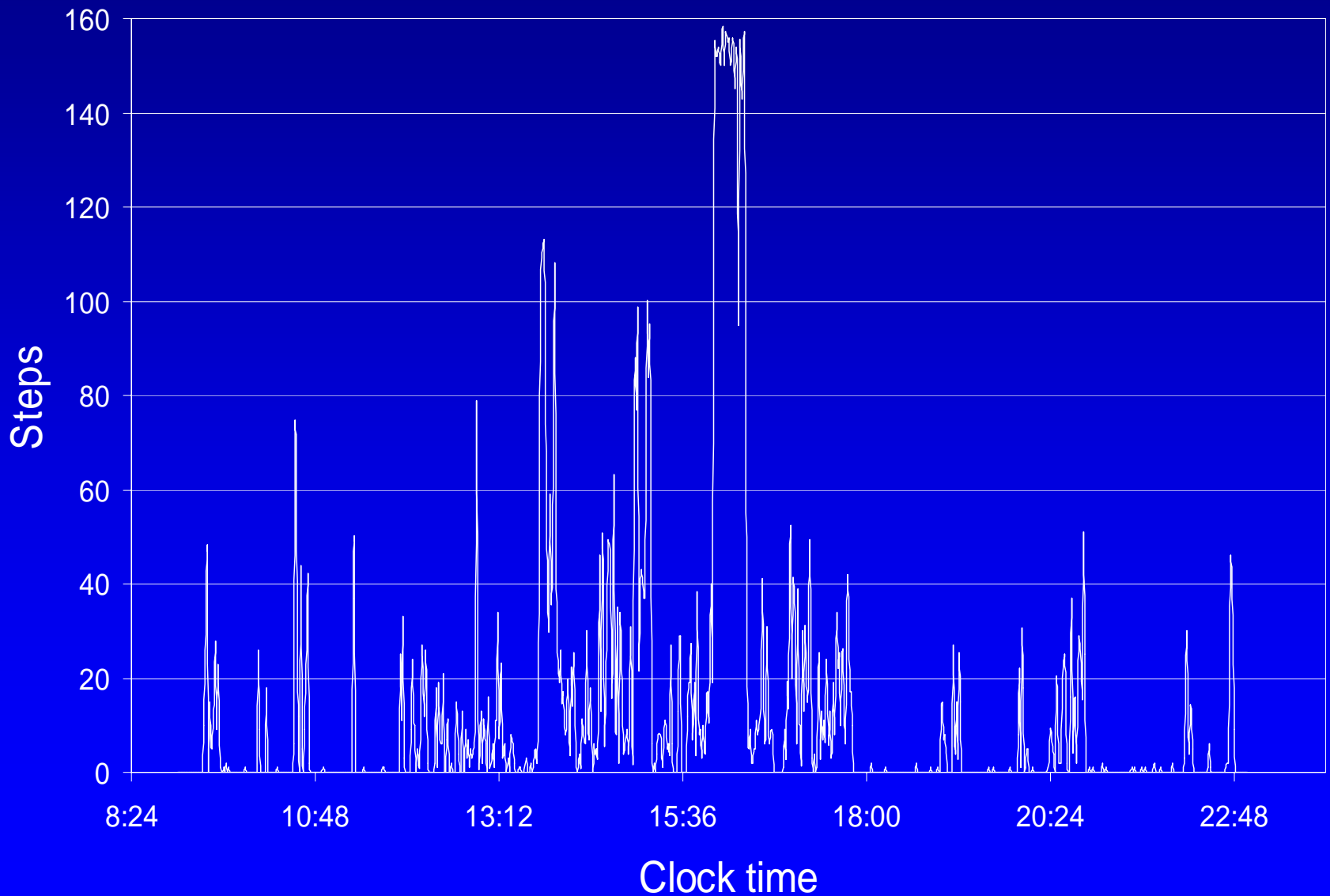
  » conversion parameters,

  » amplification

Data Obtained

- Pattern of counts over time
  - cumulative counts
  - average counts/min
  - time spent within given count criteria
    - sedentary, light, moderate, vigorous, etc.
- Pattern of steps over time (some devices)

Activity counts
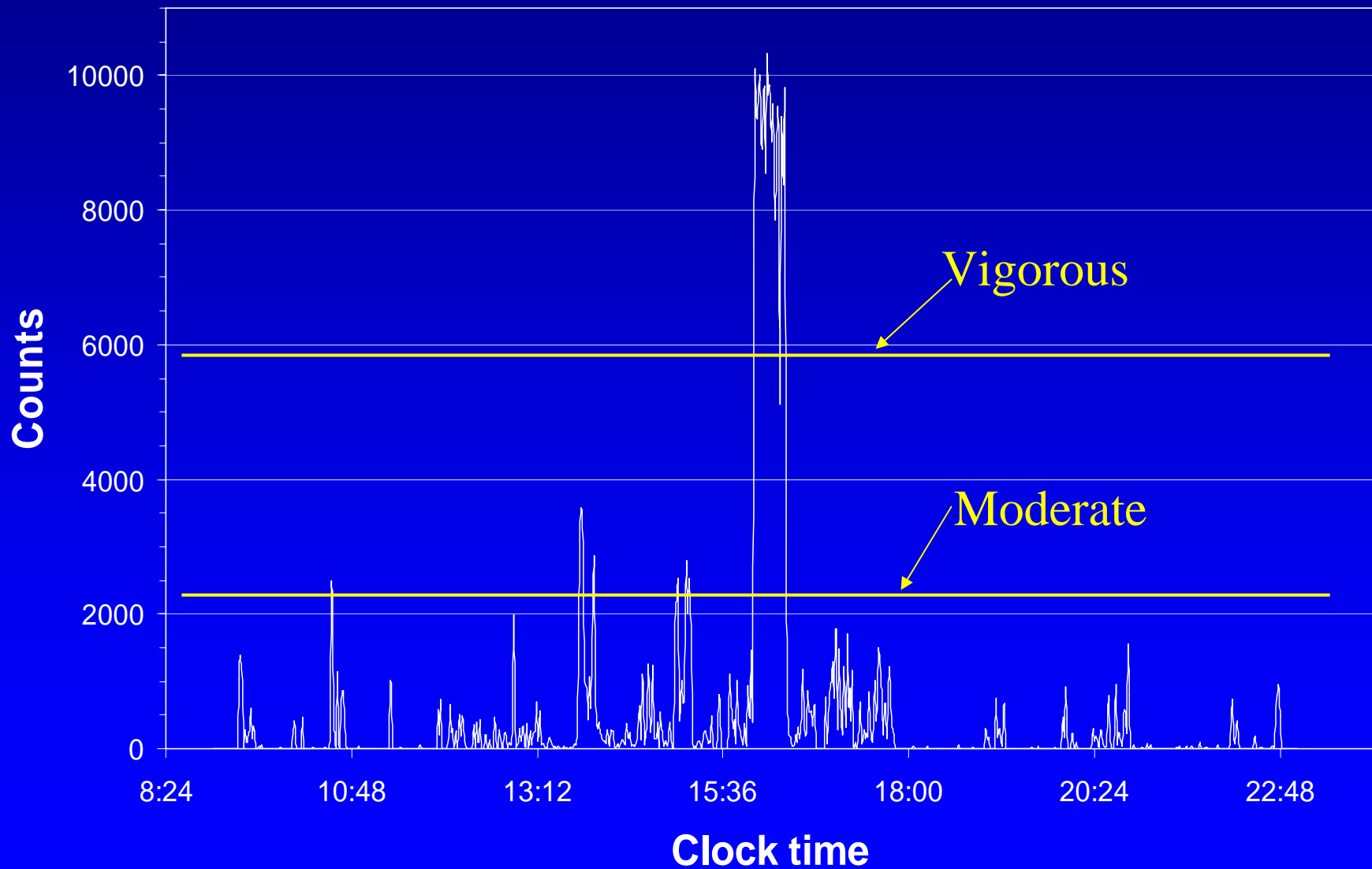
Weekend Steps (total=10,700)

NHANES Physical Activity Monitor Component

PA Monitors in NHANES

- Ages 6 y +
  - Wheelchair-bound/non-ambulatory excluded
- Ask for 7 d of wear while awake
  - Take off for water activities (swim, bathe)
- Mail back monitor

- Recruitment rate ~93%
- Monitor return rate ~97%

Component Response Rates

- Number examined 7943
- Data available 7176

- Agreed to component 95%
- Returned device 97%
- Retrievable data 98%

- Data/Eligible 90%

Analytic Issues

Exploratory Analyses

- Pilot data set
  - 243 persons
- Used to explore decision options
- Need to determine:
  - Non-wear vs. wear
  - "Valid" day of data
  - Number of valid days needed
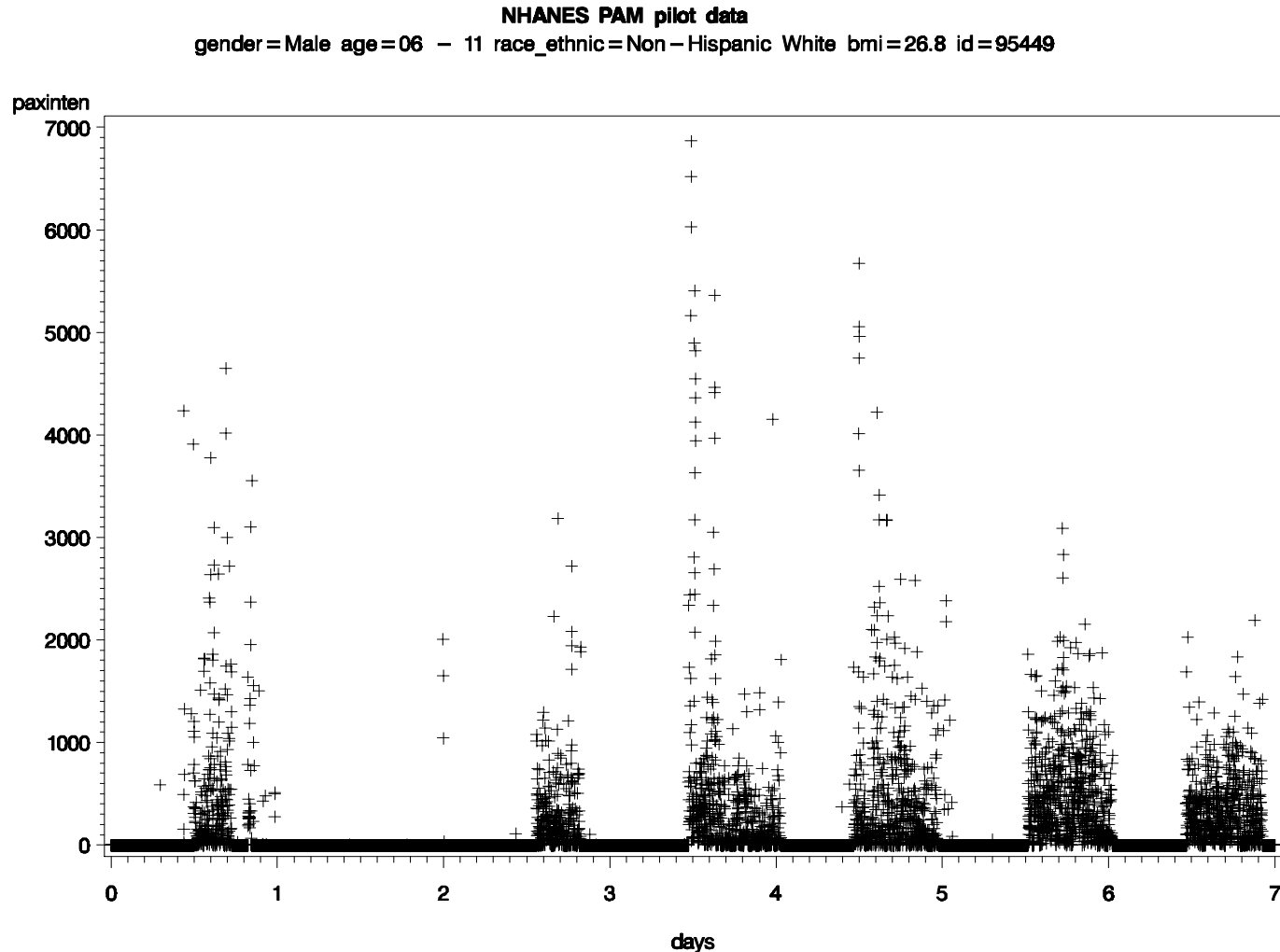 - Activity bout definitions

Defining Non-wear I

- Need to decide when someone has taken off the monitor
- Considered 20 and 60 minute intervals of zero counts
- 20 minute criteria too conservative:
  - Too many bouts of non wear (21% >5/d)
  - Elderly respondents (50% >5/d)
- Inspection of these records suggested periods of sedentary behavior, perhaps television
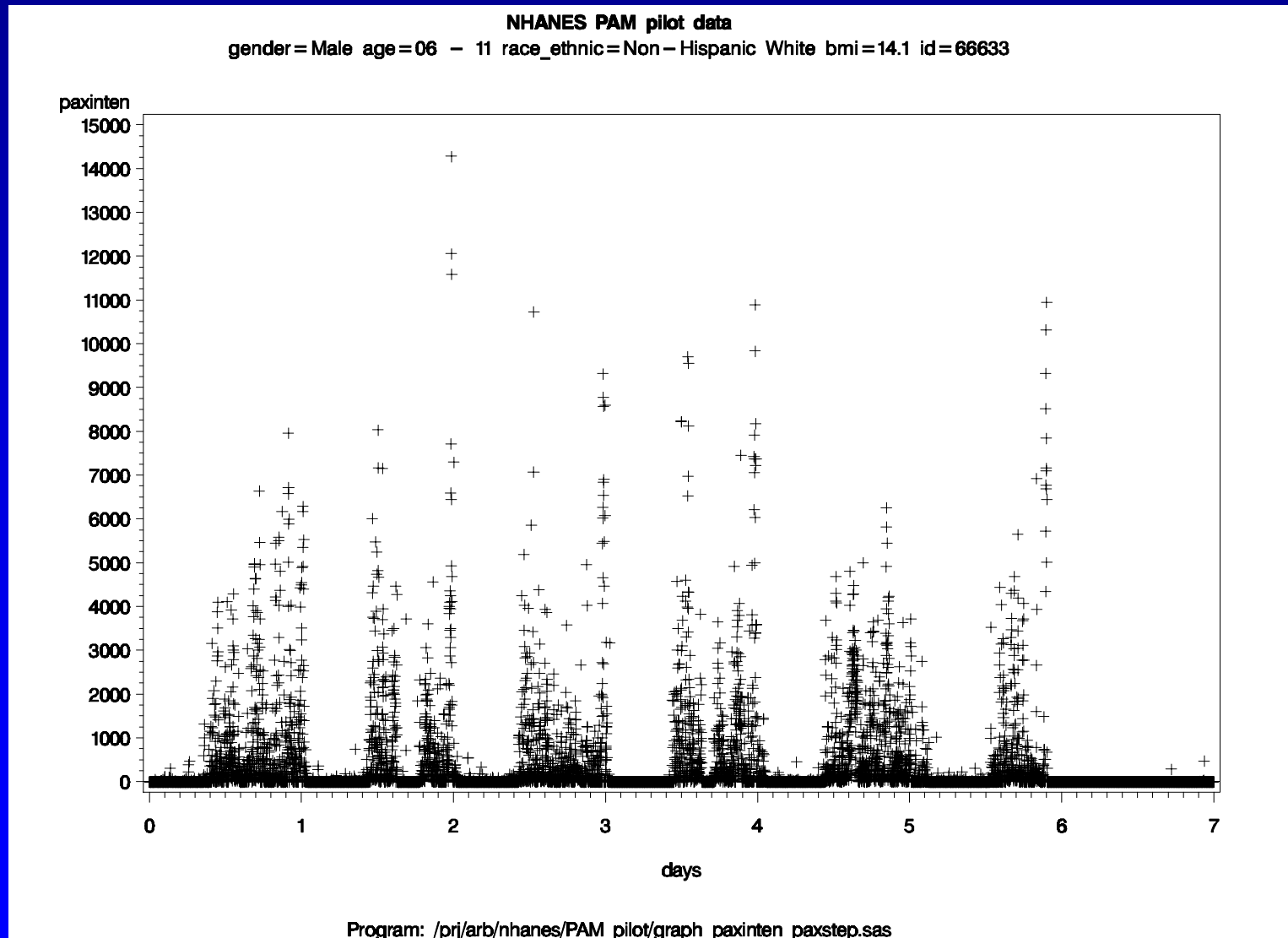
Defining Non-wear II

- Selected 60 minute criterion
  - Individuals with zero non-wear
- Device worn all 24 h
  - Slight activity during sleep
- Relaxed criteria to allow 1-2 min interruptions of counts <100

Normal Trace

NHANES PAM pilot data
gender=Male age=06 − 11 race_ethnic=Non−Hispanic White bmi=26.8 id=95449

Program: /prj/arb/nhanes/PAM_pilot/graph_paxinten_paxstep.sas

Trace with Sleep-Wear

NHANES PAM pilot data
gender = Male age = 06 – 11 race_ethnic = Non – Hispanic White bmi = 14.1 id = 66633

Program: /prj/arb/nhanes/PAM_pilot/graph_paxinten_paxstep.sas

Valid Day and Valid Record

- Valid day: At least ten hours of wear time
- Valid record: Any four days
  - Choice based on expert opinion
  - Activity and frequency of wear vary by day of the week, future studies will investigate this

- Note: We identified some 85 recording with anomalous records e.g. multiple peak values in a row. We identified these visually and flagged the values as erroneous.

Data Cleaning I
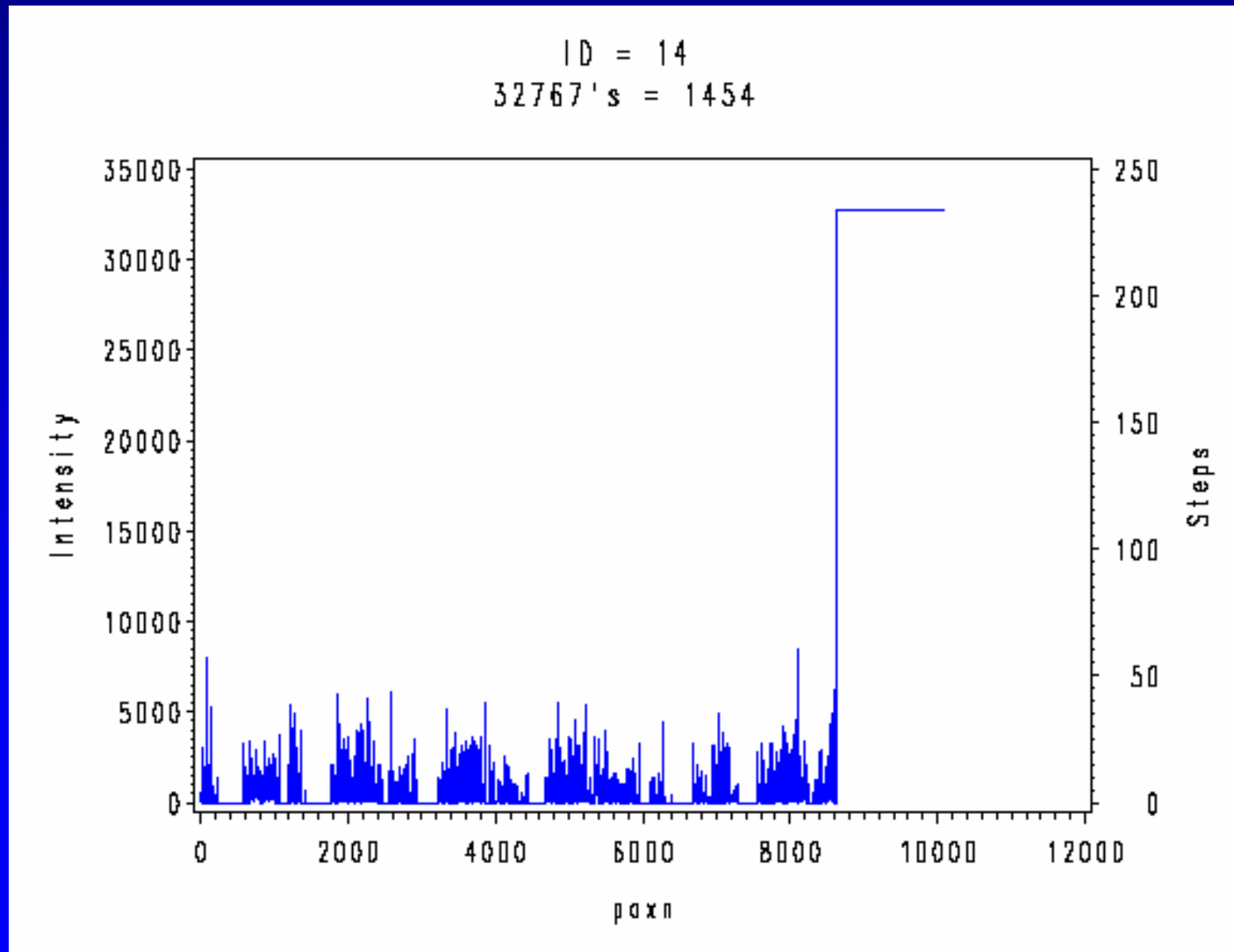
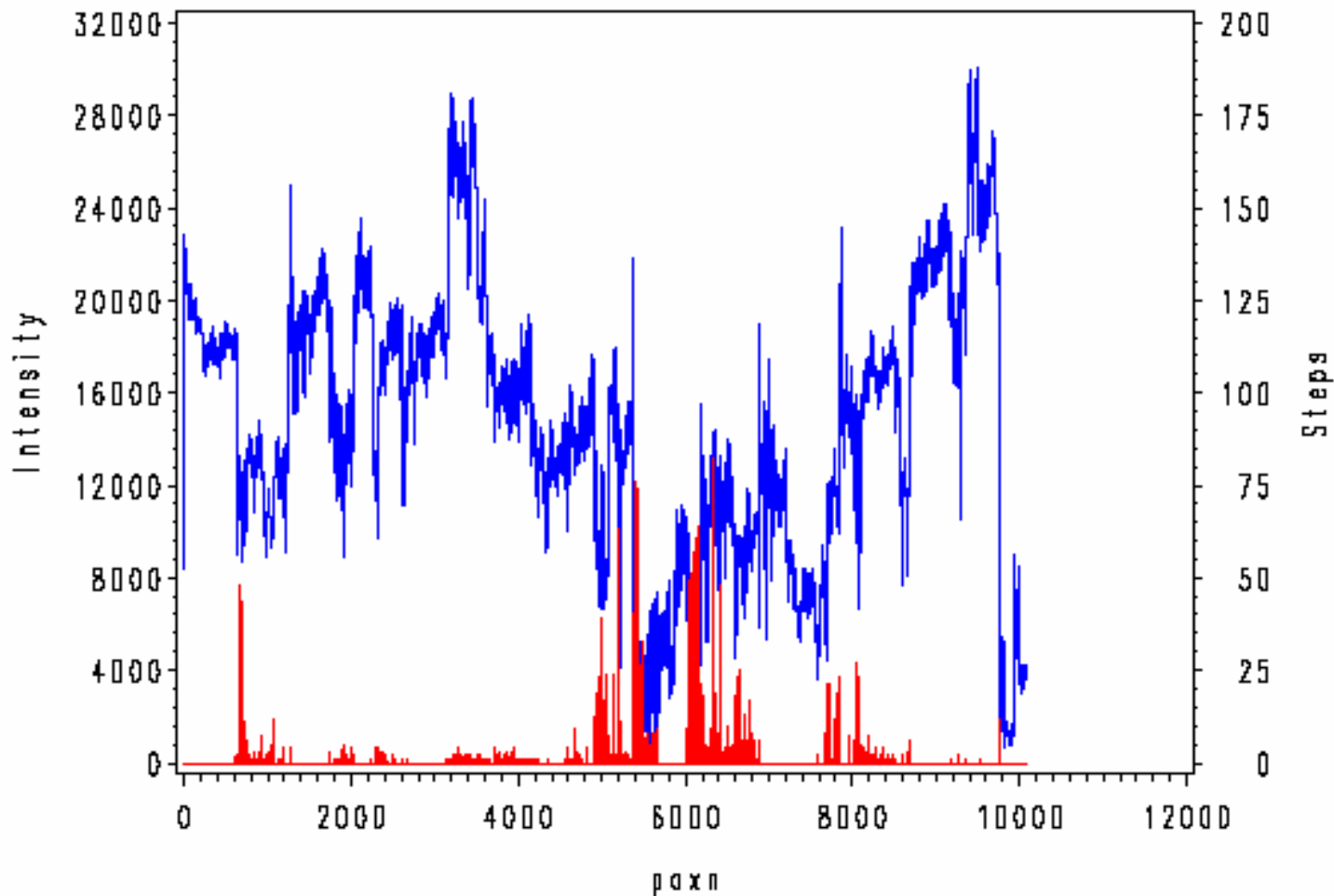# Data Cleaning II
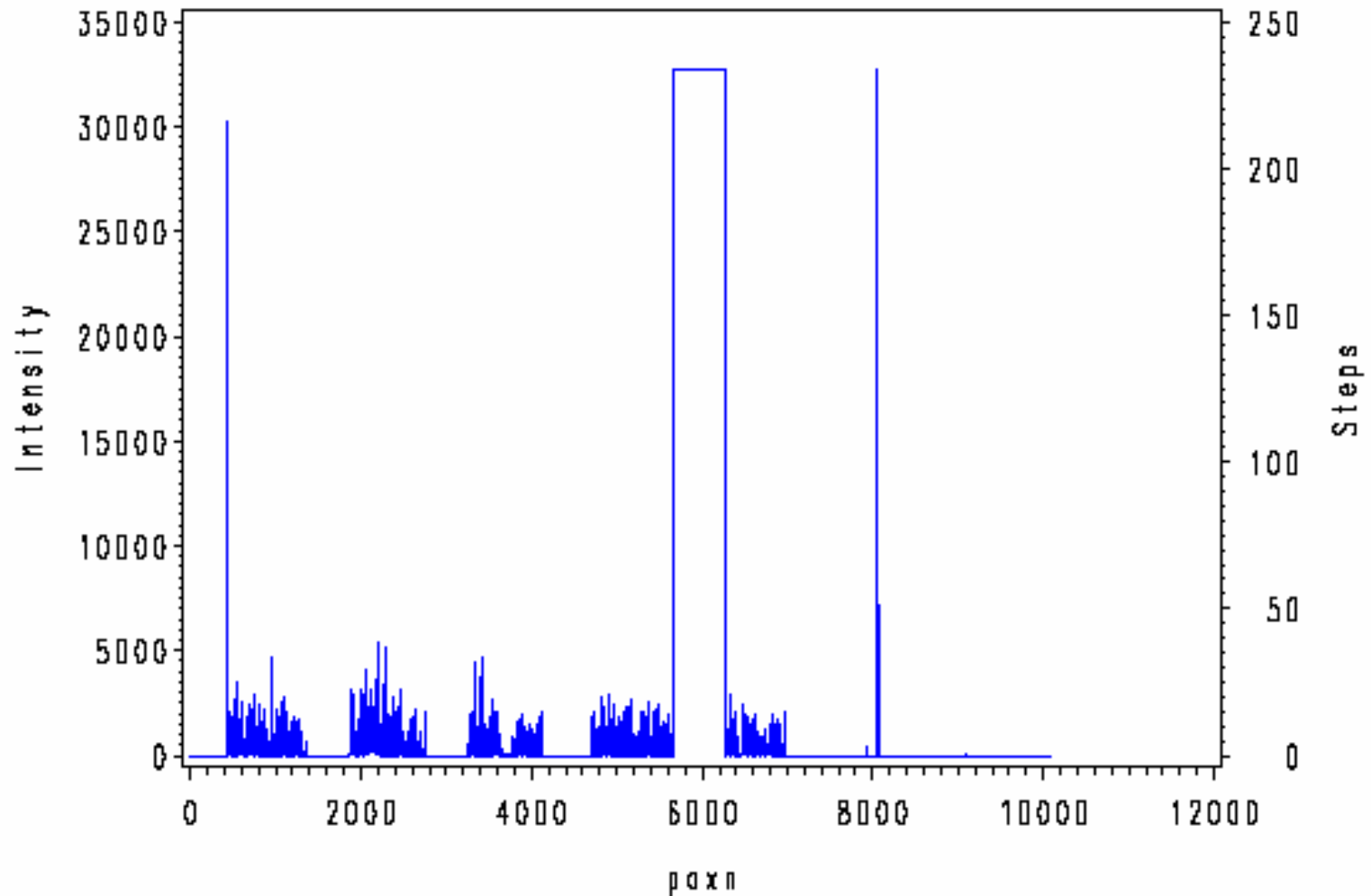
Funky Looking Traces

9013 Intensities Greater Than 100 With Zero Steps

Cutpoints for Moderate and Vigorous PA

- ➢ Required to assess adherence to PA recommendations
- ➢ Comparison to past studies using other instruments
- ➢ Problems
  - – Few studies
  - – Inadequate age range
  - – Seldom done with free living people

What Are Moderate and Vigorous PA?

- Light (<3.0 MET) – office work, sitting, cooking, cleaning -almost everything we do

- Moderate (>3.0 MET) - Walk 2.5-3 mph

- Vigorous (>6.0 MET) – jogging, doubles tennis

Cutpoints for Moderate and Vigorous PA-Adults

Author		Moderate	n		Vigorous	n	
Freedson	Treadmill	1952	50	668.4932	5725	50	1960.616
Yngve	Track	2743	28	526.0548	6403	28	1227.973
	Treadmill	2260	28	433.4247	5896	28	1130.74
Brage	Treadmill	1810	12	148.7671	5850	12	480.8219
Leenders	Treadmill	1267	28	242.9863	6251	28	1198.822
				2019.726			**5998.973**

Note heterogeneity among studies in cutpoints, especially for moderate activities.

Decision: weighted average of these studies.

Cutpoints for Youth

Age	Moderate	Vigorous
6-11	1703	4252
12-19	2888	6182

Comment: We calculated age-specific estimates of met scores during treadmill walking and jogging from a single study. These are the age-group averages.

Bout Definition

- ➢ Based on public health recommendations
  - – 10 minute accumulations
- ➢ Defined similar to non-wear
- ➢ Looked at various lengths
- ➢ Allowed break of 1-2 min below threshold in 10 minute bout

The BIG Data Set

How Big Is It?

- File is 2.3 GB
- More than 70 million records
  - 7d x 1440 min per person
  - Minute #, counts for each
- SAS file sort takes 1-2 h on PC
- Correlation takes approx. 2 h

Analytic Sample - 4+ Valid days

Age	**n**	**Group %**
Total	4867	71
6-11	597	70
12-19	1181	62
20-39	888	63
40-59	941	79
60+	1260	85

Effect of Sample Restriction

- Compared all eligible respondents to those with 4+ valid days

- Examined gender, age, racial/ethnic composition, and weight status

- No significant differences observed within 3 age strata

Results

- Mean counts/min during wear time
  - By gender, age, and race-ethnicity
- Minutes above threshold
  - Effect of choice of bout length
  - By gender, age, and race-ethnicity
- Adherence to recommendations of 30+ min moderate intensity on 5 or more days

Detailed Results Forthcoming

➢ The results from this presentation are being submitted to a peer-reviewed journal and will be posted as soon as the publication status is determined.

➢ Thank you for your patience!

Further Steps

➢ Sensitivity analyses
- Cutoff selection
- Inclusion/exclusion of weekend days
- Varying required number of hours for a valid day
- Imputation of missing days
- Combos of above

Thank you – Questions?

http://riskfactor.cancer.gov

Risk Factor Monitoring and Methods Branch, Division of Cancer Control and Population Sciences, NCI