Physical Activity

Soren Brage & Aiden Doherty

on behalf of the Biobank Accelerometry Working Group
Physical Activity and all-cause mortality

EPIC-Europe; n=500,000, >20,000 deaths

Calibration study; n=2000

Ekelund et al, AJCN 2015

“20 min/day brisk walking lowers mortality by 25%”
A new era for Physical Activity Epidemiology

<table>
<thead>
<tr>
<th>Year</th>
<th>Ecological studies</th>
<th>Moderate sized prospective cohort studies establishing association with major disease outcomes</th>
<th>Large prospective cohort studies establishing association with rarer disease outcomes using simple global indices of PA</th>
<th>Smaller studies with detailed measures establishing dose-response relationships with quantitative traits</th>
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Biobank physical activity data processing

Define scientific need for measurement → Determine approach to measurement → Undertake measurement → Process and store source data → Derive summary information from source data → Release summary information alongside other data releases for epidemiological analysis

3 axes and 3 components
- Activity
- Gravity
- Noise
Response rate

- 240,000 invited
- 106,053 consented (44.2%)
- 103,720 datasets received (97.8%)

Wear time analysis

- 103,586 for wear time analysis (99.9%)

Physical activity analysis

- 96,608 for physical activity analysis (93.3%)

Reasons for data loss

- 1,350 declined
- 132,597 no response
- 2,333 datasets lost
  - 87 subsequent participant withdrawals
  - 1,316 devices not returned
  - 930 datasets unreadable
- 123 aged <45yrs at time of wear
- 11 datasets not calibrated
  - 8 with no other successful uses of device
  - 3 with >1% of values 'clipped' before/after calibration
  - 3,049 participants with insufficient stationary data
  - 2,887 re-calibrated using previous device use
  - 154 re-calibrated using next device use
- 6,978 insufficient wear time
  - < 72hrs wear
  - data missing in at least one-hour period of the 24-hour cycle
I. Raw measurement and data storage

Triaxial acceleration waveform (~100Hz)
- Uncalibrated signal
- Variable sampling frequency
- Potentially interrupted signal
- Page level: Clock, temperature, interrupts

II. Post-processing
- Sensor calibration to local gravity
  - within-record (or closest)
- Time-stamping and resampling
- Filtering of machine noise (>20Hz)
- Identification of non-worn time

III. Feature extraction
- e.g. mean magnitude, standard deviation, pitch, roll
- power spectra, wavelets, pattern matching

IV. Prediction
- e.g. whole-body movement intensity, activity type, PAEE
Accelerometer calibration to local gravity

Table 4. Impact of autocalibration on daily wrist acceleration calculated with metric ENMO

<table>
<thead>
<tr>
<th>Cohort/Metric</th>
<th>C₀</th>
<th>C₁</th>
<th>C₂</th>
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Van Hees et al, JAP 2014
# Accelerometer calibration to local gravity

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<tr>
<th>Country</th>
<th>Un-calibrated Mean (sd)</th>
<th>Gravity-calibrated Mean (sd)</th>
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*Van Hees et al, JAP 2014*
Non-wear detection: 10-sec SD of all 3 axes
Wear compliance by age, sex and hour of day

Doherty et al., in review
Diurnal information bias: Missingness simulation
Comparison with other measures of activity

Validity
Vector magnitude $\sim AEE_{DLW}$ (n=63 Swedish women, left or right wrist) : $r=0.61$
Vector magnitude $\sim AEE_{Acc+Hr}$ (n=2000 UK adults, non-dominant wrist) : $r=0.66$

Van Hees et al 2013, 2014; White et al (in prep)
Further UK validation work (preliminary results)

Non-dominant vs dominant wrist acceleration

Wrist acc vs PAEE (dlw, n=16)

\[ R^2 \sim 80\% \]

White et al (in preparation)
Average vector magnitude by age and sex

![Bar chart showing mean acceleration (mg) by age group and sex, with error bars. The chart includes data for age groups 45-54, 55-64, 65-74, and 75-79 years, distinguishing between female and male outcomes.]
Average vector magnitude by age, sex and hour of day

**Female**

- 4am: 10 mg
- 8am: 15 mg
- 12pm: 20 mg
- 4pm: 25 mg
- 8pm: 30 mg

**Male**

- 4am: 10 mg
- 8am: 15 mg
- 12pm: 20 mg
- 4pm: 25 mg
- 8pm: 30 mg

**Age Groups**

- 45-54 yrs: 20 mg
- 55-64 yrs: 25 mg
- 65-74 yrs: 30 mg
- 75-79 yrs: 35 mg

Doherty et al, in review
Movement intensity distribution by age and sex

Doherty et al, in review
Associations with weight status

Kim et al, in prep
Summary

- Consensus summary variables available in the data showcase
  - Use as
    - *exposures*
    - *confounding control*
    - *mediators*
    - *outcomes*
  - Post-processed signal data also available (as bulk)
    - e.g. for further inference work
  - Raw binary data also available (as bulk)
Biobank Accelerometry Working Group

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Soren Brage