Insights from time use research and mixed data methods.

A contribution to INSIGHTS: bringing together sensor technology and social research


Research funded by the UK Economic and Social Research Council, the European Research Council, and the US National Institutes of Health National Cancer Institute
In what follows...

- How to measure activities?
- Time diary research.
- Mixed diary and sensor research:
  1. ...to simplify diary data collection
  2. ...to validate and calibrate diaries
  3. ...to amplify the meaning of diary evidence
- An example: daily metabolic activity (METs)
- *Situating* sensors: sampling, representativeness
Measuring time use

• ‘Beeper’ sampling (ESM/EMA) studies:
  – What were you doing when the beeper went?

• Questionnaire ‘stylized’ items:
  – “How much time did you spend ... last week?”
  – “How often do you....? How often ...last month?”
    – respondents don’t know....and will exaggerate!

• Diaries:
  – What were you doing at 4am? Doing anything at the same time? Who were you with? What did you do next? What time did that start? .....
<table>
<thead>
<tr>
<th>Time: 7am - 10am Morning</th>
<th>What were you doing? Please write down one main activity.</th>
<th>If you did something else at the same time, what else did you do?</th>
<th>Did you use a smartphone, tablet, or computer?</th>
<th>Location, or mode of transport</th>
<th>Were you alone or with somebody you know? Mark all relevant boxes.</th>
<th>How much did you enjoy this time? 1 = not at all; 7 = very much</th>
</tr>
</thead>
<tbody>
<tr>
<td>7am-7.10</td>
<td>Woke up the children</td>
<td></td>
<td>An</td>
<td>At home</td>
<td>[ ] Spouse/partner [ ] Mother [ ] Father [ ] Child 0-7 [ ] Other [ ] Others you know</td>
<td>5</td>
</tr>
<tr>
<td>7.10-7.20</td>
<td>Had breakfast</td>
<td>checked emails</td>
<td>Yes</td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>7.20-7.30</td>
<td></td>
<td>Ttalked with my family</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>7.30-7.40</td>
<td>Cleared the table</td>
<td>Listened to the radio</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.40-7.50</td>
<td></td>
<td></td>
<td>Yes</td>
<td>At home</td>
<td>[ ] Spouse/partner [ ] Mother [ ] Father [ ] Child 0-7 [ ] Other [ ] Others you know</td>
<td>4</td>
</tr>
<tr>
<td>7.50-8am</td>
<td>Helped the children dressing</td>
<td>Talked with my children</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8am-8.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.10-8.20</td>
<td>Went to the day care centre</td>
<td></td>
<td></td>
<td>on foot</td>
<td>[ ] Spouse/partner [ ] Mother [ ] Father [ ] Child 0-7 [ ] Other [ ] Others you know</td>
<td>1</td>
</tr>
</tbody>
</table>

Use an arrow or quote marks to record that an activity lasted longer than 10 minutes.
Why diaries are the gold-standard for activity research

Diary methods are essentially preferable to questionnaire:

• “yesterday” format maximises recall accuracy & specificity

• sequential nature of the diary record provides
  – *prompts* (*this* activity followed *that*) and
  – *cues for recall effort* (from gaps in the continuity of reconstructions)

• the neutral nature of the request for diary record gives no idea of researchers’ interests (*versus* directive effect of the particular activities identified by PA questionnaire items)

• the real-time 24-hour constraint of the diary, means that misrepresentation is *more difficult* than truthsaying. It is *simpler* for respondents to provide truthful diary accounts!
Random-day diaries vs “stylised” q’nnaire items: participation estimates

Figure 1. – Reported Monthly Participation Frequencies and Diary Participation Rates (UK HETUS 2000/1, Adult Sample Only)

Brief history of time diary research

History

– Russian peasant studies c. 1900
– M. Pember-Reeves, UK, Fabian Soc., 1911
– I. Strumilin, Russia, NEP 1921
– H. Kneeland, USA, USDA 1925
– A. Szalai, UNESCO 1965
– Harmonised European Time Use Study (HETUS) 1999-2015
– American Time Use Study (ATUS) 2003—
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>1964</td>
<td>1987</td>
<td></td>
<td>2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td>1965</td>
<td>1976-7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>1979</td>
<td>1989</td>
<td></td>
<td>2002-3 (2010-11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slovenia</td>
<td>1965</td>
<td></td>
<td></td>
<td>2001-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Africa</td>
<td></td>
<td></td>
<td></td>
<td>2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Korea</td>
<td></td>
<td></td>
<td></td>
<td>1997</td>
<td>2003, 2008 (2014)</td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td></td>
<td></td>
<td></td>
<td>1992, 1997</td>
<td>2002-3</td>
<td>2010</td>
</tr>
<tr>
<td>Sweden</td>
<td></td>
<td></td>
<td></td>
<td>1990-1</td>
<td>2000-1 (2010-11)</td>
<td></td>
</tr>
</tbody>
</table>
CTUR diary/instrumentation

- 6 towns GPS/GSM, 2012-13
  - With Trajectory Partnership
  - 1300 days multiple activity, copresence, enjoyment

- CAPTURE24, 2015-16
  - With Oxford U. Public Health Dept
  - Diary, camera, accelerometer. 150 days’ data

- Energy-24, 2016-
  - With Oxford Sustainable Energy Institute
  - Diary, camera, accelerometer + energy meter.
**Delivery Day: 23/07/2015**

- Participant receives the data collection ‘survey pack’ from the researcher;
- Researcher introduces the research project and explains step by step the all stages of data collection process from the *Information booklet* and ‘survey pack’;
- Interview *Questionnaire survey* (30 min);
- *Activity watch* worn by the participant (2 Days);
- *Electricity recorder* installed by the participant or researcher (1 Day);

**Study Day: 24/07/2015**

- *Wearable camera* worn by the participant (1 Day);
- *Time Use Diary* self-completion by the participant (1 Day);

**Collection Day: 25/07/2015**

- Researcher collects from the participant data equipment and ‘survey pack’;
- *Re-construction* interview with the researcher involves download and store images onto an encrypted computer and delete any of your images that you don’t wish them to be in the study (50 min);
- *Consent form* signed by the participant;
- *Activity watch* taken off by the participant;
- *Electricity recorder* uninstalled by the researcher or participant;
Helen Pearson “The Time Lab” NATURE, Vol 526, 22 October 2015, pp 492-496
METs & time-use diaries

- **Ainsworth Compendium ➔ Tudor Locke 2009**
  - Attaching METs to ATUS
  - Enables balance between “exercise” & other activities

- **Van der Ploeg *et al* 2010**
  - “TUS used retrospectively ...physical & sedentary activity”

- **Ng and Popkin 2012**
  - Historical change in physical activity
  - Attaching METs to MTUS data (UK and US)
  - .... METs to non-diary data (China, India, Brazil)
  - Uncover dramatic growth in sedentary activity
Two diary-based physical activity measures

1. Aggregate daily metabolic activity (METs)
Mean daily MET per minute score (mdMETs), respondent with N activities during sampled day

\[
mdMETs = \frac{(MET_{activity1} \times Dur_{activity1}) + (MET_{activity2} \times Dur_{activity2}) + \ldots (MET_{activityN} \times Dur_{activityN})}{1440}
\]

2. Metabolic activity by duration.
For public health recommendations of the form:

“…>150 minutes a week moderate intensity PA…..”
reorder each diarist’s daily activities from the highest to lowest intensity level, then calculate threshold proportions.
ATUS/MTUS METs comparison
20% reduction in total variance

Fig 2b: Mean daily METS: ATUS 6-digit categories
Men, by age and educational attainment

- primary
- incomplete high
- high school grad
- incomplete college
- Batchelors degree
- Masters degree
- Doctorate, professional

Age group

15-30  30-45  45-60  60-75  75
## METs and self-reported health

<table>
<thead>
<tr>
<th>Simple OLS, entire good-diarist samples</th>
<th>UK HETUS 2001</th>
<th>ATUS 2006-12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20,107 days</td>
<td>86,196 days</td>
</tr>
<tr>
<td>R Squared</td>
<td>0.135</td>
<td>0.084</td>
</tr>
<tr>
<td>mean daily METs</td>
<td>2.156</td>
<td>1.124</td>
</tr>
<tr>
<td>....squared /1000</td>
<td>-0.531</td>
<td>-0.309</td>
</tr>
<tr>
<td>age</td>
<td>0.123</td>
<td>0.093</td>
</tr>
<tr>
<td>age *daily METs</td>
<td>-0.110</td>
<td>-0.086</td>
</tr>
<tr>
<td>........squared</td>
<td>0.026</td>
<td>0.021</td>
</tr>
<tr>
<td>(Constant)</td>
<td>-0.725</td>
<td>1.102</td>
</tr>
</tbody>
</table>
UK/US METs and Health

One day model UK aged 30
One day model UK aged 70
One day model US aged 30
One day model US aged 70

Mean daily METs

negative-scored subjective health
Exercise: a balanced perspective
Contributions to daily METs, ordered by activity level

Poland sample ages 15+

UK sample ages 15+

US sample ages 15+

- exercise
- travel
- paid work
- unpaid work
- child and adult care
- leisure away from home
- leisure at home
- sleep, personal care
METograms: % of sample with aggregate METs levels for various durations on a diary day

Polish men aged 18-39

UK men aged 18-39

US men aged 18-39
Research Opportunities

• Combine diaries with “physical methods” for validation, calibration and adjustment

• Recruit study participants from large random sample “feeder” surveys, allowing “inverse participation probability weights” producing nationally representative stats.

• Use representative—and comprehensive—time use data to provide a framework for interpreting the accurate but partial views of daily life derived from passive sensors.
References


