Segal’s law:
"A man with a watch knows what time it is. A man with two watches is never sure."

Prof Andrea Petróczi
Doping prevalence figures

- Adverse Analytical Findings (AAF) ≈ 2%
- Athlete Biological Passport (ABP): IAAF, haematological module (blood doping) ≈ 14% - 20%
- Self-reports: UQM (random response model to provide full protection) ≈ 50%
The tale of two cities

**DAEGU (South Korea)**

- 13th IAAF World Championship
  Aug 27 – Sept 4, 2011

**DOHA (Qatar)**

- 12th quadrennial Pan-Arabic Games
  December 6-23, 2011
Unrelated Question Model (UQM)

• Established but limiting (df = 1)

EXAMPLE: If your birthday falls between 1\textsuperscript{st} and 10\textsuperscript{th} of the month (inclusive), answer Question A; otherwise answer Question B.

• QUESTION A: Is your birthday in the first half of the year? (Yes/No)
• QUESTION B: \textit{Did you do X....?} (Yes/No)

Single Sample Count (SSC)

• Promising (df > 1) but very new (in 2012) and under development

EXAMPLE: How many ‘Yes’ answers do you have in total?

• My birthday is in the first half of the year
• My birthday is in Feb/Apr/Jun/Aug/Oct/Dec
• \textit{I did}........
• My birthday is in the first half of the month
• My birthday is on an even day
Distribution of birthdays

- Odd/Even days: 0.51
- Odd/eEven months: 0.507
- First 15 days vs. First 6 months vs. rest: 0.507
- First 6 months vs. rest: 0.499
- Odd vs. even years: 0.489

### Data collection

<table>
<thead>
<tr>
<th>DAEGU (IAAF WC)</th>
<th>DOHA (Arab Games)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• SSC and UQM in random order</td>
<td>• Randomly allocated to SSC or UQM</td>
</tr>
<tr>
<td>• Identical target Q</td>
<td>• 2 sets</td>
</tr>
<tr>
<td>• 21 languages</td>
<td>• Doping</td>
</tr>
<tr>
<td>• N = 1,203</td>
<td>• Nutritional supplement</td>
</tr>
<tr>
<td></td>
<td>• 3 languages</td>
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<tr>
<td></td>
<td>• N = 965 (UQM), 1,020 (SSC)</td>
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</tbody>
</table>
Results

DAEGU (IAAF WC)

UQM:
• past-year doping was 43.6% (95% confidence interval 39.4-47.9%)
• SSC ≠ UQM

DOHA (Arab Games)

UQM:
• past-year doping use was 57.1% (52.4-61.8%)
• past-year supplement use was 70.1% (65.6-74.7%)
• SSC ≠ UQM
How can we explain the difference...?

Noncompliance

• Proportion of the sample we do not know much about

• Major threat to Random Response / Fuzzy Response techniques
Noncompliance effect in UQM

REMEMBER: If your birthday falls between 1st and 10th of the month (inclusive), answer Question A; otherwise answer Question B.

• QUESTION A: Is your birthday in the first half of the year? (Yes/No) \[p_2 = 50/50 \text{ or } 0.5\]

• QUESTION B: *Have you violated anti-doping in the past 12 months by knowingly using prohibited substance or methods?* (Yes/No) \[\text{[expected } p_1 = 2/3 \text{ or } 0.66\]

IF \( p_1 < 2/3 \) \[= \text{more than the expected 1/3 answers QA}\]
⇒ pulls \( p^\wedge \) toward 50\% (QA)

\[
\hat{p} = \frac{\lambda - p_2(1 - p_1)}{p_1}
\]

IF \( p < 0.5 \) ⇒ inflates estimation
IF \( p > 0.5 \) ⇒ deflates estimation
Detecting noncompliance in the SSC

- Possible with the ‘0 or 5’ response option
- $p$ of 0 is 0.0625 is irrespective of $d$; thus $p$ of ‘0 or 5’ is $1/16$ (6.25%)
- The significant difference between the observed $p$ and the expected $p = 0.0625$ is the evidence for noncompliance
- **DAEGU:** The observed $p$ of ‘0 or 5’ was 0.128 $>>$ 0.0625 ($z = 8.358$, $p < 0.001$) $\Rightarrow$ evidence for noncompliance
- **DOHA:** The observed $p$ of ‘0 or 5’ was 0.087 for doping ($z = 3.1262$, $p = 0.0018$) and 0.0797 for dietary supplements ($z = 2.1947$, $p = 0.0282$) $\Rightarrow$ evidence for noncompliance
"I would cheat the rules (think of a different b-day) to make my answer seem technically 'truthful'".
Lessons & future directions

• "Never go to sea with two chronometers; take one or three."

• Focus on the (long neglected) behavioural side
• Noncompliance must be better understood and handled
• Motivation must be considered
  • *It’s safe, but why should I tell you?*
• Clean athletes’ frustration with the (unnecessary) ‘cloak & dagger stuff’ must be addressed