E-cigarette consumption and puffing topography data
Outline

- Nicoventures Introduction
- Topography and use patterns to inform product stewardship
- Developing an e-cigarette specific topography device
- Mapping vapers' topography for our Vype products
- Understanding use patterns through consumption surveys
- Summary and next steps
Nicoventures

• Our aim is to provide adult smokers who want to reduce, replace or stop smoking with a range of high quality alternative products, delivering much of the experience they expect from a cigarette, but without the serious health risk of smoking.

• Our focus is the development and production of innovative, high quality inhaled nicotine products that meet relevant regulatory requirements.

• Nicoventures is part of the BAT Group but is separate from the tobacco business.
Data gaps in informing responsible product stewardship

- Estimating exposure for product stewardship assessments:
  
  \[(\text{# of puffs/session}) \times (\text{# of sessions/day}) \times (\text{constituent concentration /puff}) = \text{daily exposure}\]

- Need to understand how e-cigarettes are used by consumers and estimate exposure to e-cigarette aerosol to inform responsible product stewardship

- Existing topography equipment produced variable and often inaccurate puff volumes with e-cigarettes

- Published data on users’ puffing topography shows considerable variation

- Also, there is limited data on the consumption patterns of various e-cigarette products in the marketplace
E-cigarette specific topography device development and validation

The original SA-7 device

Adaptations made to the original SA-7 for testing e-cigarettes

Spigot adapter to attach e-cigarettes to modified topography holder. Spigot removes jetting through orifice, which results in inaccurate puff volumes

Pressure ports on top to reduce excipients from blocking tubes

Bracket to support larger e-cigarette modular devices

Removable cap allows access to orifice plate for cleaning

Device validated for accuracy of:
- Puff volumes
- Puff duration

Using disposable, rechargeable cartridge and modular devices

- Puff volumes: ±1.0 mL across a 20 – 120 mL range
- Puff durations: ±0.1 s across a 1.5 – 3.0 s range

Patent pending (UK application number 1420649.4 – unpublished)
Puffing topography study on Vype Reload and the Vype ePen

Study Objective
- To determine the puffing topography of regular users of e-cigarettes using either Vype Reload or ePen, to provide data to support product stewardship assessments

Subject recruitment
- Age ranging between 21 – 64 years
- Male / female equal gender split
- Use e-cigarettes at least 2 or more days per week – ideally daily e-cigarette usage
- Could be dual users of e-cigarettes and tobacco products

- 32 users of rechargeable, cartomiser e-cigarette products
  - 16 males:16 females
- 28 users of rechargeable, modular e-cigarette products
  - 16 males:12 females
Product
- Users of cartomiser products provided with Vype Reload
- Users of modular products provided with Vype ePen (a closed-modular device)

Number of replicates
- Volunteers vaped the assigned product through the topography head on two separate occasions on different days
- Volunteers who used the closed-modular product used the product at high and low power settings (randomised and blinded to volunteer)

Vype Reload
Rechargeable, cartomiser product

Vype e-Pen
Rechargeable, closed modular product
## Users’ puffing topography data

### Vype Reload (rechargeable, cartomiser)

<table>
<thead>
<tr>
<th>Puffing Behaviour</th>
<th>Length of Session (Min:Sec)</th>
<th>Number of Puffs (#)</th>
<th>Mean Puff Volume (mL)</th>
<th>Mean Puff Duration (s)</th>
<th>Mean Puff Interval (s)</th>
<th>Mean Peak Flow Rate (mL/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rep. 1 (n=32)</td>
<td>7:10 (4:12)</td>
<td>22.0 (16.3)</td>
<td>50.4 (21.0)</td>
<td>2.0 (0.6)</td>
<td>22.8 (10.8)</td>
<td>38.0 (10.2)</td>
</tr>
<tr>
<td>Rep. 2 (n=32)</td>
<td>6:38 (3:13)</td>
<td>20.3 (13.6)</td>
<td>54.0 (22.4)</td>
<td>2.1 (0.7)</td>
<td>23.6 (10.7)</td>
<td>39.9 (10.4)</td>
</tr>
<tr>
<td>Total Replicates</td>
<td>6:54 (3:43)</td>
<td>21.1 (14.9)</td>
<td>52.2 (21.6)</td>
<td>2.0 (0.7)</td>
<td>23.2 (10.6)</td>
<td>39.0 (10.3)</td>
</tr>
</tbody>
</table>

*a Presented as Mean values (Standard Deviation)*

### Paired Comparison (n=32)

<table>
<thead>
<tr>
<th>Puffing Behaviour</th>
<th>Length of Session</th>
<th>Number of Puffs</th>
<th>Mean Puff Volume</th>
<th>Mean Puff Duration</th>
<th>Mean Puff Interval</th>
<th>Mean Peak Flow Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rep. 1 (n=32)</td>
<td>0.372</td>
<td>0.588</td>
<td>0.079</td>
<td>0.393</td>
<td>0.717</td>
<td>0.144</td>
</tr>
<tr>
<td>Rep. 2 (n=32)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Replicates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*b Paired t-test, α 0.05*  

**No statistical difference in replicate data**
### Vype ePen (rechargeable, closed-modular)

<table>
<thead>
<tr>
<th>Puffing Behaviour</th>
<th>Length of Session (Min:Sec)</th>
<th>Number of Puffs (#)</th>
<th>Mean Puff Volume (mL)</th>
<th>Mean Puff Duration (s)</th>
<th>Mean Puff Interval (s)</th>
<th>Mean Peak Flow Rate (mL/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Power (n=28)</td>
<td>7:05 (5:33)</td>
<td>14.3 (6.0)</td>
<td>83.8 (42.5)</td>
<td>2.2 (0.9)</td>
<td>30.1 (19.6)</td>
<td>60.5 (21.1)</td>
</tr>
<tr>
<td>Low Power (n=27)</td>
<td>8:19 (7.00)</td>
<td>18.1 (9.3)</td>
<td>82.1 (46.9)</td>
<td>2.1 (0.9)</td>
<td>28.5 (19.0)</td>
<td>60.7 (18.8)</td>
</tr>
<tr>
<td>Total Replicates (n=55)</td>
<td>7:41 (6:17)</td>
<td>16.1 (8.0)</td>
<td>83.0 (44.3)</td>
<td>2.2 (0.9)</td>
<td>29.3 (19.2)</td>
<td>60.6 (19.8)</td>
</tr>
</tbody>
</table>

*a Presented as Mean values (Standard Deviation)*

### Paired Comparison (n=27)

<table>
<thead>
<tr>
<th>p value</th>
<th>Length of Session</th>
<th>Number of Puffs</th>
<th>Mean Puff Volume</th>
<th>Mean Puff Duration</th>
<th>Mean Puff Interval</th>
<th>Mean Peak Flow Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.409</td>
<td>0.067</td>
<td>0.908</td>
<td>0.364</td>
<td>0.596</td>
<td>0.757</td>
<td></td>
</tr>
</tbody>
</table>

*b Paired t-test, α 0.05*

**No statistical difference between power settings**
## Users’ puffing topography data

### Comparison between user groups (devices)

<table>
<thead>
<tr>
<th>User Group</th>
<th>Length of Session (Min:Sec)</th>
<th>Number of Puffs (#)</th>
<th>Mean Puff Volume (mL)</th>
<th>Mean Puff Duration (s)</th>
<th>Mean Puff Interval (s)</th>
<th>Mean Peak Flow Rate (mL/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reload (n=64)</td>
<td>6:54</td>
<td>21.1</td>
<td>52.2</td>
<td>2.0</td>
<td>23.2</td>
<td>39.0</td>
</tr>
<tr>
<td>ePen (n=55)</td>
<td>7:41</td>
<td>16.1</td>
<td>83.0</td>
<td>2.2</td>
<td>29.3</td>
<td>60.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>p value</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.417</td>
<td><strong>0.022</strong></td>
<td><strong>0.000</strong></td>
<td>0.382</td>
<td><strong>0.039</strong></td>
<td><strong>0.000</strong></td>
</tr>
</tbody>
</table>

*a 2 sample t-test, α 0.05

### Statistical differences observed between users of two study products

- Closed-modular users took fewer but larger puff volumes, with longer inter-puff interval
- Data show that users’ topography varies according to product used
- Implication for laboratory product testing and stewardship
Demographic and use behaviour effects

For each user group we consider the effect of the following variables on the topography measures:
- Gender
- Age category (18-24, 25-34, 35-44, 45+)
- Length of use of e-cigarettes (1-2 months, 3-6 months, 6 months+)
- Frequency of e-cigarette use per day (once, 2-3 times, 4 or more times)

Data were analysed using a General Linear Mixed model ANOVA.

Where a factor was statistically significant, Tukey’s comparison was used to identify differences.

Data with statistical differences shown as boxplots, highlighting differences.
Demographic and use behaviour effects

Closed-modular

Puff duration is statistically lower for those users who have been using e-cigarettes for 1-2 months compared with more experienced users.

Rechargeable, cartomiser

Boxplot of Mean Puff Duration (s)

Boxplot of Mean Puff Volume (mL)

Boxplot of Mean Puff Duration (s)
Objective
- To determine the consumption of e-cigarettes across a broad range of e-cigarette users, to provide data to support product stewardship assessments

1200 e-cigarette users in U.K.
- 400 users each of disposable, rechargeable (cartomiser) and rechargeable modular devices
- On-line survey

Data collected include
- Session length
- Number of puffs per session
- Number of sessions per day
- Units or e-liquid volume consumed per week
### Consumption Survey Data

<table>
<thead>
<tr>
<th></th>
<th>Disposable</th>
<th>Cartomiser</th>
<th>Modular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session length (min:s)</td>
<td>10:24</td>
<td>8:54</td>
<td>9:36</td>
</tr>
<tr>
<td>Puffs/session (#)</td>
<td>11-20*</td>
<td>11-20*</td>
<td>1-10*</td>
</tr>
<tr>
<td>Sessions/day (#)</td>
<td>4.2</td>
<td>6.0</td>
<td>7.2</td>
</tr>
<tr>
<td>Units/week (#)</td>
<td>4.2</td>
<td>2.1</td>
<td>10.1**</td>
</tr>
</tbody>
</table>

* Mode
** mL consumed per week

When combined with aerosol constituent concentration data, allows calculation of daily exposure
Summary

- Validated topography device for use with e-cigarettes
  - Important to ensure accurate puff volumes
  - To inform chemical and biological testing regimes representative of users’ behaviour

- Statistical differences observed between users of cartomiser and closed-modular devices for:
  - Puff number
  - Mean puff volume
  - Mean puff interval
  - Mean peak flow rate

<table>
<thead>
<tr>
<th>User Group Comparison</th>
<th>Number of Puffs/session (#)</th>
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- Age, gender and usage patterns affect some topography measures, no clear trends identified across user groups

- Combining topography and frequency of use data provide a means to estimate daily exposure to e-cigarette aerosol constituents
  - Combined data informs our approach to responsible product stewardship
Thank you!