Urinary metabolites of 1–nitropyrene in U.S.–Mexico border residents who frequently cross the San Ysidro Port of Entry
U.S. EPA defines the U.S. Mexico Border Region as 62 miles north and south of the U.S.-Mexico Border and extends into the sea boundaries to the east and west.
California-Baja California Land Ports of Entry

San Ysidro Port of Entry
San Ysidro Port of Entry

- Busiest land border crossing in the western hemisphere, according to U.S. General Services Administration\(^1\).

<table>
<thead>
<tr>
<th>Year/Direction</th>
<th>Personal Vehicles</th>
<th>Personal Vehicle Passengers</th>
<th>Pedestrians</th>
<th>Buses</th>
<th>Bus Passengers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010 northbound(^2)</td>
<td>13,348,364</td>
<td>23,600,605</td>
<td>6,439,952</td>
<td>70,548</td>
<td>550,301</td>
</tr>
</tbody>
</table>

\(^1\)http://www.gsa.gov/portal/content/104872
\(^2\)http://transborder.bts.gov/programs/international/transborder/TBDR_BC/TBDR_BC_Index.htm
San Ysidro Port of Entry Pedestrian Pathway
Previous work

- Occupational studies have shown differences in DPM exposure between high exposure groups and low exposure groups using 1-NP and/or its urinary metabolites.¹-³
- Human studies have shown urinary metabolites of 1-NP are higher in participants with exposure to elevated levels of DPM.³,⁴-⁷

Data Gap

To date there has been no community study that has detected differences in 1-NP and its urinary metabolites in a lower exposure range.

**Study Purpose and Specific Aims**

Compare 1-NP in personal air samples with its urinary metabolites in same individual and assess ability to detect non-occupational diesel exposure concentrations at the US-Mexico border.

1) Comparison of urinary concentrations between border commuters and non-border commuters

2) Multilevel linear regression model to assess association between personal exposure to 1-NP and urinary metabolites
Eligibility Criteria

- ≥ 18 yrs of age
- Non-smokers in a non-smoking home
- Free of any chronic conditions
- Not occupationally exposed to DE
- IRB consent

- Border Commuters: Cross the border 2x a week or more as a pedestrian
- Non-Border Commuters: Did not cross any border crossings in the prior 4 months
## Samples Collected

<table>
<thead>
<tr>
<th>24-hr personal samples</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1-NP on a PM$_{2.5}$ filter and RH/Temp</td>
<td>Subset</td>
</tr>
<tr>
<td>Questionnaire</td>
<td>All</td>
</tr>
<tr>
<td>24-hr Time Activity Diary</td>
<td>All</td>
</tr>
<tr>
<td>Spot Urine Sample</td>
<td>All</td>
</tr>
</tbody>
</table>
Challenges

- High Security Area
- International Border
- Concerns for Participant Safety
- Timing of getting urine samples
Participants and Sampling Events

- Repeat participations, 73 border commuter sampling events and 18 non-border commuter sampling events
- Criterion that three weeks had passed from their last participation
- 27 border commuters and 17 non-border commuters total
- All border commuters who participated lived in Tijuana
- All non-commuters who participated lived in South San Diego
- All participants self-classified as Hispanic
- Reported mean northbound vehicle delay time (an indicator of the amount of idling traffic near pedestrian pathway) was 83min (range 32-137min)
- Border Commuters spent an average of 60min waiting in the northbound pedestrian lane (range 20-200min)
Extracts quantified using 2D-HPLC MS/MS

LOQ: \((\text{blank}+2\text{SD})/\sqrt{2}\)

Urine: creatinine measured to adjust for excretion rate
- in a subset of participants
- not known if needed for these metabolites
- measured by the University of Washington Hospital’s clinical laboratory using a colorimetric assay
## Results: Comparison of urinary concentrations between border commuters and non-border commuters

<table>
<thead>
<tr>
<th></th>
<th>n(^a)</th>
<th>GM (GSD)</th>
<th>Range</th>
<th>P-value(^b)</th>
<th>n (% &lt; LOQ)(^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>8-OHNP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unadjusted (pg/mL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Border commuter events</td>
<td>68</td>
<td>0.058 (0.059)</td>
<td>0.011 – 0.37</td>
<td>&lt; 0.01</td>
<td>1 (1.5)</td>
</tr>
<tr>
<td>Non-border commuter events</td>
<td>18</td>
<td>0.027 (0.020)</td>
<td>0.011 – 0.088</td>
<td>0.07</td>
<td>2 (11)</td>
</tr>
<tr>
<td>Creatinine Adjusted (pg/mg creatinine)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Border commuter events</td>
<td>50</td>
<td>0.057 (0.098)</td>
<td>0.010 – 0.71</td>
<td>0.07</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Non-border commuter events</td>
<td>17</td>
<td>0.035 (0.029)</td>
<td>0.016 – 0.13</td>
<td>2 (12)</td>
<td></td>
</tr>
<tr>
<td><strong>8-OHNAAP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unadjusted (pg/mL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Border commuter events</td>
<td>68</td>
<td>0.032 (0.095)</td>
<td>0.014 – 0.56</td>
<td>0.07</td>
<td>37 (54)</td>
</tr>
<tr>
<td>Non-border commuter events</td>
<td>18</td>
<td>0.019 (0.013)</td>
<td>0.014 – 0.060</td>
<td>12 (66)</td>
<td></td>
</tr>
<tr>
<td>Creatinine Adjusted (pg/mg creatinine)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Border commuter events</td>
<td>50</td>
<td>0.035 (0.078)</td>
<td>0.0047 – 0.57</td>
<td>0.15</td>
<td>26 (52)</td>
</tr>
<tr>
<td>Non-border commuter events</td>
<td>17</td>
<td>0.026 (0.024)</td>
<td>0.087 – 0.10</td>
<td>11 (67)</td>
<td></td>
</tr>
<tr>
<td><strong>8-OHNP + 8-OHNAAP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unadjusted (pg/mL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Border commuter events</td>
<td>68</td>
<td>0.11 (0.11)</td>
<td>0.025 – 0.66</td>
<td>&lt; 0.01</td>
<td>1 (1.5)</td>
</tr>
<tr>
<td>Non-border commuter events</td>
<td>18</td>
<td>0.048 (0.025)</td>
<td>0.025 – 0.10</td>
<td>2 (11)</td>
<td></td>
</tr>
<tr>
<td>Creatinine Adjusted (pg/mg creatinine)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Border commuter events</td>
<td>50</td>
<td>0.11 (0.12)</td>
<td>0.024 – 0.76</td>
<td>0.024</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Non-border commuter events</td>
<td>17</td>
<td>0.063 (0.047)</td>
<td>0.031 – 0.23</td>
<td>2 (12)</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: GM, geometric mean; GSD, geometric standard deviation; LOQ, limit of quantification; 8-OHNP, 8-hydroxy-1-nitropyrene; 8-OHNAAP, 8-hydroxy-N-acetyl-1-aminopyrene. \(^a\)Number of participant events. \(^b\)Bold indicates value was P<0.05. \(^c\)n<LOQ, number of urine samples below LOQ of 0.011 pg/mL for 8-OHNP and 0.014 pg/mL for 8-OHNAAP. Samples below and above LOQ were included in the analysis.
Results: Multilevel linear regression model to assess association between personal exposure to 1-NP and urinary metabolites

\[ \text{Ln(Personal 1-NP)}_{ij} = \beta_0 + \beta_1 \text{Ln(metabolite)}_{ij} + \mu_i + e_{ij} \]

Where:
- \( i \) represents border commuters and non-border commuters
- \( j \) represents a specific urine and filter sample pair
- \( \beta_0 \) is the intercept parameter
- \( \beta_1 \) is the slope estimate for the corresponding predictor variable (8-OHNP, 8-OHNAAP or 8-OHNP+8-OHNAAP)
- \( \mu_i + e_{ij} \) is the random part of the model with the following distributions: \( \mu_i \sim N(0,\gamma^2) \), \( e_{ij} \sim N(0,\sigma^2) \)

Results for unadjusted metabolites above and below LOQ

- 14% increase in 1-NP for each 10% increase in 8-OHNP (P=0.3)
- 20% increase in 1-NP for each 10% increase in 8-OHNAAP (P=0.02)
- 16% increase in 1*NP for each 10% increase in summed metabolites (P=0.01)
- Effect estimates similar for creatinine-adjusted models
- Effect estimates were modestly attenuated when data below LOQ were excluded
Conclusions

- Border Commuters had higher urinary concentrations of 1-NP metabolites as compared to Non-border commuters.
- Detect differences in 1-NP and its urinary metabolites in a lower exposure range than has been previously demonstrated (sum of metabolites most robust).
- Higher urinary 1-NP metabolite concentrations were associated with higher personal 1-NP exposures. However, the regression models explained only a small proportion of the variability between 1-NP measured in the prior 24-hours and the urinary metabolites.

Questions?
¿Preguntas?