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Hair Nicotine as a Biomarker for Exposure to Secondhand Smoke

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- University of Kentucky Prevention Research Center
To assess the validity of hair nicotine as a biomarker of tobacco smoke exposure, particularly Secondhand Smoke (SHS), among a sample of bar and restaurant workers, using a self-reported questionnaire.
Specific Aims

- To assess the ability of hair nicotine to distinguish between smoking status of participants

- Assess the convergent validity of hair nicotine as a measure of SHS exposure
  - How well hair nicotine levels correlate to SHS items
  - How well hair nicotine levels are representative of number of sources of SHS exposure
Advantages of Hair Nicotine

- Objective measure
- Relatively inexpensive
- Captures chronic SHS exposure
- High specificity and sensitivity to tobacco smoke
- Non-invasive
- Can be stored for a long time with minimal care requirements
Disadvantages of Hair Nicotine

- Inter-individual variability in hair growth and nicotine metabolism
- Hair nicotine may yield false positives results if used as a measure of acute exposure
- Cannot distinguish between active and passive smoking exposure in same individual
Methods

Non-experimental design with convenience sampling
\(N = 207\) workers from Kentucky and West Virginia

Eligibility criteria:
- Work in a bar or restaurant
- 18 years of age or older
- Work a minimum of 10 hours per week
- Have worked for a minimum of one month in work establishments.
Measures of Self-reported SHS Exposure

Work exposure

- “Thinking about the past 7 days altogether, about how many days or hours were you exposed to other people’s tobacco smoke indoors at work”
- “Do you have a second indoor job where smoking is permitted”

Home and Car exposure

- “Including yourself, how many adults living in your household have smoked inside for more than one month”
- “Thinking about the past 7 days altogether, about how many days or hours were you exposed to other people’s tobacco smoke indoors at home”
- “Thinking about the past 7 days altogether, about how many days or hours were you exposed to other people’s tobacco smoke in your car or truck?”
**Procedure**

- 10-15 mg of hair cut from back of scalp.

- Participants reported to health department to complete a 10 minute questionnaire and then gave hair samples, or completed phone interview and gave hair samples at convenient location.

- Hair samples sent to New Zealand for analysis using reversed-phase high performance liquid chromatography with electrochemical detection (HPLC-ECD) (Mahoney & Al-Delaimy, 2001)
Results

- Sample Description
  - Female = 62%, Caucasian = 90%
  - Mean age = 26.2 (SD = 8.9) years
  - Work history = 28.5 (SD = 38.4) months
  - Restaurant workers = 86%
    - Non alcohol = 16%
    - Alcohol = 71%
  - Bar workers = 14%

- Log transformed values for hair nicotine (mean = 0.87, SD = 1.3)

- Smokers had more sources of exposure than nonsmokers ($\chi^2 = 40.15, \ p < .0001$).
Table 1. Differences in Hair Nicotine Levels by Number of Sources of SHS exposure Among Nonsmokers

<table>
<thead>
<tr>
<th>Sources of SHS exposure</th>
<th>N</th>
<th>Mean</th>
<th>95% CI</th>
<th>Posthoc Fisher’s LSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>No source</td>
<td>4</td>
<td>-.46</td>
<td>-1.02</td>
<td>0.10</td>
</tr>
<tr>
<td>One Source</td>
<td>47</td>
<td>.16</td>
<td>-0.10</td>
<td>0.42</td>
</tr>
<tr>
<td>Two Sources</td>
<td>52</td>
<td>.28</td>
<td>0.01</td>
<td>0.55</td>
</tr>
<tr>
<td>Three or More Sources</td>
<td>22</td>
<td>.65</td>
<td>0.12</td>
<td>1.18</td>
</tr>
</tbody>
</table>

Note: ANOVA ($F = 2.06$, $p = .109$); Kruskall-Wallis ($\chi^2 = 4.49$, $p < .213$)

A = No source
D = Three or More Sources
ND = No Difference
Figure 1. Hair Nicotine Levels of Nonsmokers by Number of Sources of Exposure

<table>
<thead>
<tr>
<th>Number of Sources of SHS exposure</th>
<th>Log transformed hair nicotine levels ng/mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>No source</td>
<td>-0.46</td>
</tr>
<tr>
<td>One source</td>
<td>0.16</td>
</tr>
<tr>
<td>Two Sources</td>
<td>0.28</td>
</tr>
<tr>
<td>Three or more sources</td>
<td>0.65</td>
</tr>
</tbody>
</table>

Trend Analysis (F = 4.68, p = .032)
Table 2. Models Predictive of Hair Nicotine Levels using Step-Wise Multiple Regression

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>Adjusted R Square</th>
<th>Std Error of Estimate</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.31</td>
<td>.07</td>
<td>.94</td>
<td>4.32</td>
<td>.006</td>
</tr>
<tr>
<td>2</td>
<td>.69</td>
<td>.46</td>
<td>.94</td>
<td>24.19</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

Model 1 = Nonsmokers
Model 2 = Total Sample
Table 3. Models Predicting Nicotine Dependence

<table>
<thead>
<tr>
<th>Model 1</th>
<th>B</th>
<th>Std err</th>
<th>Beta</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-.73</td>
<td>.39</td>
<td></td>
<td>-1.89</td>
<td>.061</td>
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<tr>
<td>Gender</td>
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<td>.17</td>
<td>-.10</td>
<td>-1.18</td>
<td>.242</td>
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<tr>
<td>Number of Sources of Exposure</td>
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<td>.09</td>
<td>.21</td>
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<tr>
<td>Type of Establishment</td>
<td>.37</td>
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<td>.19</td>
<td>2.19</td>
<td>.030</td>
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</table>

<table>
<thead>
<tr>
<th>Model 2</th>
<th>B</th>
<th>Std err</th>
<th>Beta</th>
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<th>p</th>
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<tr>
<td>Constant</td>
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<td></td>
<td>-1.20</td>
<td>.233</td>
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<td>Cigarettes smoked per day</td>
<td>.35</td>
<td>.04</td>
<td>.57</td>
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<td>&lt;.0001</td>
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<td>.11</td>
<td>1.69</td>
<td>.094</td>
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<td>-.16</td>
<td>-2.58</td>
<td>.011</td>
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<tr>
<td>Type of Establishment</td>
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<td>.14</td>
<td>.13</td>
<td>2.00</td>
<td>.047</td>
</tr>
<tr>
<td>Number of Sources of Exposure</td>
<td>.19</td>
<td>.09</td>
<td>.16</td>
<td>2.17</td>
<td>.032</td>
</tr>
</tbody>
</table>
Summary of Findings

- Hair nicotine clearly distinguished between smokers and nonsmokers \((t = 9.89, \ p <.0001)\).

- Among smokers, hair nicotine distinguished between light, moderate and heavy smokers \((\chi^2 = 9.57, \ p = .008)\).

- As the number of sources of exposure increases, hair nicotine levels increase \((F= 4.68, \ p=.032)\).

- The best predictors of hair nicotine levels were the number of cigarettes smoked per day \((\beta = .57)\), Gender \((\beta = -.16)\) and number of Sources of SHS exposure \((\beta = .16)\).
Limitations

- Small sub-sample sizes for assessing hair nicotine based on sources of SHS exposure among nonsmokers.

- Homogenous sample
  (Restaurants workers = 86%, bars workers = 14%).

- No alternative measure of SHS such as a passive air nicotine monitor.
Implications

- Important to incorporate valid objective measures of SHS exposure in future research.

- Objective measures are necessary counterparts to questionnaires in assessing SHS exposure.

- Hair nicotine is a non-invasive, relatively inexpensive and easily accessible means of determining tobacco smoke exposure in both smokers and nonsmokers.
References


References

