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Chizimuzo T.C. Okoli
University of Kentucky, ctokol1@uky.edu

Ellen J. Hahn
University of Kentucky, ejhahn00@email.uky.edu

Lynne A. Hall
University of Kentucky, lynne.hall@uky.edu

Mary Kay Rayens
University of Kentucky, mkrayens@email.uky.edu

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Hair Nicotine as a Biomarker for Exposure to Secondhand Smoke

Chizimuzo T.C. Okoli, MSN, RN,
Ellen J. Hahn, DNS, RN,
Lynne A. Hall, Dr PH, RN,
Mary Kay Rayens, Ph. D.

University of Kentucky
College of Nursing
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- University of Kentucky Prevention Research Center
Purpose

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 correlates 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 - 0.10</td>
<td>A&lt;D</td>
</tr>
<tr>
<td>One Source</td>
<td>47</td>
<td>.16</td>
<td>-0.10 - 0.42</td>
<td>ND</td>
</tr>
<tr>
<td>Two Sources</td>
<td>52</td>
<td>.28</td>
<td>0.01 - 0.55</td>
<td>ND</td>
</tr>
<tr>
<td>Three or More Sources</td>
<td>22</td>
<td>.65</td>
<td>0.12 - 1.18</td>
<td>D&gt;A</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

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>
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</thead>
<tbody>
<tr>
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<td>.39</td>
<td>-.10</td>
<td>-1.89</td>
<td>.061</td>
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<tr>
<td>Gender</td>
<td>-.20</td>
<td>.17</td>
<td>-.10</td>
<td>-1.18</td>
<td>.242</td>
</tr>
<tr>
<td>Number of Sources of Exposure</td>
<td>.22</td>
<td>.09</td>
<td>.21</td>
<td>2.39</td>
<td>.018</td>
</tr>
<tr>
<td>Type of Establishment</td>
<td>.37</td>
<td>.17</td>
<td>.19</td>
<td>2.19</td>
<td>.030</td>
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</table>

<table>
<thead>
<tr>
<th>Model 2</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-.61</td>
<td>.51</td>
<td></td>
<td>-1.20</td>
<td>.233</td>
</tr>
<tr>
<td>Cigarettes smoked per day</td>
<td>.35</td>
<td>.04</td>
<td>.57</td>
<td>8.22</td>
<td>&lt;.0001</td>
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<tr>
<td>Age</td>
<td>.02</td>
<td>.01</td>
<td>.11</td>
<td>1.69</td>
<td>.094</td>
</tr>
<tr>
<td>Gender</td>
<td>-.43</td>
<td>.17</td>
<td>-.16</td>
<td>-2.58</td>
<td>.011</td>
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<tr>
<td>Type of Establishment</td>
<td>.28</td>
<td>.14</td>
<td>.13</td>
<td>2.00</td>
<td>.047</td>
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<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.


