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# Accuracy of parental and youth reporting of secondhand smoke exposure: The Florida youth cohort study

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**Abstract**

The accuracy of adolescent and parental reports of youth secondhand smoke exposure has received limited attention in the research literature. Florida Youth Cohort Study participants provided saliva samples during the fifth round of interviews for determination of cotinine levels. After exclusion of admitted or likely youth smokers with cotinine levels > 14.7 ng/ml, there were 341 youth ages 13–17 who completed a telephone interview; 304 parents of these participants completed a similar secondhand smoke exposure interview. Adolescents with cotinine levels above the threshold of detection (> 0.10 ng/ml) were considered exposed. Specificity ranged from 87.1–97.8. Positive predictive value, negative predictive value, sensitivity, and kappa values varied considerably by the reporting source (e.g., youth, parent, or a combination of responses), and the age and gender of the youth respondent. Agreement between youth and parent that at least one parent smoked inside the home yielded the best combination of sensitivity (85.0) and specificity (89.8) and was least affected by the age and gender of the youth respondent.


*Keywords:* Secondhand smoke exposure; Cotinine; Reporting accuracy

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## 1. Introduction

Biological confirmation of exposure to secondhand smoke (e.g., cotinine) has become the gold standard (Benowitz, 1999), yet such an approach is often not possible due to cost constraints or the feasibility of collecting biological samples such as serum, urine, saliva, or hair. Unfortunately, the accuracy of self-reported secondhand smoke exposure has not been adequately examined in adolescents. Many of the available studies were conducted in clinical pediatric populations (Callais et al., 2003; Emerson et al., 1995; Knight et al., 1996; Oddoze et al., 1999; Willers et al., 2000), and among the limited community-based studies, there was no attempt to determine if reporting accuracy could be enhanced by combining information from parents and children (Forastiere et al., 1993; Fried et al., 1995; Jarvis et al., 1992; Woodruff et al., 2003). This study evaluates the accuracy of secondhand smoke exposure as reported by youth and their parents, using salivary cotinine levels to determine objective verification of exposure.

## 2. Methods

A stratified random sample of 13,000 households was drawn from a list of 292,000 Florida households maintained by a local firm (Dunhill Associates). This list was estimated to include 40% of Florida families with children in grades 4–7. Households were stratified by seven regions in the State of Florida. In 1999, oversampling of households with children in the earlier grades, and in one region with a more transient population was undertaken, given concerns that response rates would be lower in these subgroups. Sampling from the stratified list ceased when a pre-determined number of parents and their child agreed to participate under each stratification category (i.e., region and grade). This procedure yielded an ethnic/racial distribution similar to that of the Florida youth population, although the educational attainment of parents was higher than State averages (Lee et al., 2003).

Four follow-up rounds of interviews were completed on this cohort, with the most recent round of interviews completed in 2004 ($n=617/1219$; 51% of the baseline sample). At each round, attempts were made to reinterview all baseline participants. During the last interview round, one parent, typically the mother was also invited to complete an interview ($n=306$). Two parents without matching youth data were excluded from the analysis.

### *2.1. Self-reported secondhand smoke exposure*

A short interview enquiring about household smoking exposures (e.g., cigarettes, cigars, pipe tobacco) was administered to the youths and parents (Appendix A). Interviews were conducted at different times, and parents were instructed not to be in the room while their child was being interviewed. Responses to these questions were used to identify the presence of at least one parent smoker and whether at least one parent smoked in the home.

### 2.2. Saliva collection and determination of cotinine levels

Participants were mailed a saliva kit and consent/assent form in advance of their 5th wave interview. At the conclusion of the interview, participants were asked to open the saliva kit. Instructions for completing the test and providing informed consent/assent were reviewed. Participants were then instructed to fill two plastic tubes with approximately 6 ml of saliva, seal the tubes, and place into a postage-paid envelope. A total of 353 youth (57% of those interviewed) mailed the envelopes to the University of Miami, where they were stored in a freezer until all samples were obtained. Despite instructions to the contrary, some participants returned saliva samples prior to their interview. The range of saliva sample acquisition in reference to the interview date ranged from − 156 to + 181 days; the median value was +9 days.

Saliva samples were analyzed at the Clinical Pharmacology Lab of San Francisco General Hospital at the University of California, San Francisco. Cotinine levels were determined by high-performance liquid chromatography/atmospheric pressure chemical ionization tandem mass spectrometry (Bernert et al., 1997).

### 2.3. Analyses

Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and kappa, an index of concordance that corrects for chance agreement (Cohen, 1960), were calculated for each comparison, with the presence/absence of detectable cotinine (> 0.10 ng/ml) in the saliva as the criterion.

Table 1
Gender-specific sensitivity, specificity, positive predictive value, negative predictive value, and kappa values for youth and parental reports of secondhand smoke for youth with and without detectable salivary cotinine levels

| Self-report measure | *n** | Sensitivity | Specificity | PPV | NPV | Kappa | 95% CI |
|---|---|---|---|---|---|---|---|
| Child reports parent(s) smokes | 341 | 43.1 | 93.3 | 63.3 | 86.0 | 0.41 | 0.29–0.53 |
| Female youth | 174 | 47.1 | 92.1 | 59.3 | 87.8 | 0.43 | 0.25–0.60 |
| Male youth | 167 | 39.5 | 94.6 | 68.2 | 84.1 | 0.40 | 0.23–0.57 |
| Parent reports self/spouse smokes | 304 | 31.3 | 92.3 | 65.2 | 74.4 | 0.27 | 0.16–0.39 |
| Female youth | 157 | 30.8 | 90.5 | 61.5 | 72.5 | 0.24 | 0.09–0.40 |
| Male youth | 147 | 31.8 | 94.2 | 70.0 | 76.4 | 0.31 | 0.15–0.47 |
| Child and parent report parent(s) smokes | 304 | 49.0 | 91.7 | 54.3 | 89.9 | 0.42 | 0.29–0.56 |
| Female youth | 157 | 50.0 | 90.1 | 50.0 | 90.1 | 0.40 | 0.21–0.59 |
| Male youth | 147 | 48.0 | 93.4 | 60.0 | 89.8 | 0.45 | 0.25–0.65 |
| Child reports parent(s) smokes in the home | 341 | 45.6 | 93.4 | 63.3 | 87.3 | 0.44 | 0.31–0.56 |
| Female youth | 174 | 48.5 | 92.2 | 59.3 | 88.4 | 0.44 | 0.26–0.61 |
| Male youth | 167 | 42.9 | 94.7 | 68.2 | 86.2 | 0.43 | 0.26–0.61 |
| Parent reports self/spouse smokes in the home | 304 | 69.2 | 89.9 | 39.1 | 96.9 | 0.44 | 0.29–0.59 |
| Female youth | 157 | 57.1 | 87.4 | 30.8 | 95.4 | 0.32 | 0.12–0.52 |
| Male youth | 147 | 83.3 | 92.6 | 50.0 | 98.4 | 0.58 | 0.37–0.79 |
| Child and parent report parent(s) smokes in the home | 304 | 85.0 | 89.8 | 37.0 | 98.8 | 0.47 | 0.32–0.62 |
| Female youth | 157 | 70.0 | 87.1 | 26.9 | 97.7 | 0.33 | 0.12–0.53 |
| Male youth | 147 | 100.0 | 92.7 | 50.0 | 100.0 | 0.63 | 0.43–0.84 |

* *n* = the number of participants who responded to the secondhand smoke question.

## 3. Results

Twelve admitted and/or likely youth smokers with cotinine levels > 14.7 ng/ml were excluded from the analysis (McNeill et al., 1987). The median cotinine value for the remaining participants was 0.10 ng/dl (5th and 95th percentiles: 0.10 and 1.04); 14.5% (49/341) of the sample had cotinine levels above the detection threshold. Table 1 presents

Table 2
Age-Specific sensitivity, specificity, positive predictive value, negative predictive value, and kappa values for youth and parental reports of secondhand smoke for youth with and without detectable salivary cotinine levels

| Self-report measure | *n** | Sensitivity | Specificity | PPV | NPV | Kappa | 95% CI |
|---|---|---|---|---|---|---|---|
| *Child reports parent(s) smokes* | | | | | | | |
| 13–14 years | 120 | 34.4 | 90.9 | 57.9 | 79.2 | 0.29 | 0.10–0.48 |
| 15 years | 94 | 38.5 | 93.8 | 50.0 | 90.5 | 0.36 | 0.08–0.63 |
| 16 years | 82 | 47.1 | 96.9 | 80.0 | 87.5 | 0.52 | 0.28–0.76 |
| 17 years | 45 | 70.0 | 91.4 | 70.0 | 91.4 | 0.61 | 0.33–0.89 |
| *Parent reports self/spouse smokes* | | | | | | | |
| 13–14 years | 112 | 23.9 | 87.9 | 57.9 | 62.4 | 0.13 | − 0.03–0.29 |
| 15 years | 87 | 25.0 | 92.5 | 50.0 | 80.5 | 0.21 | − 0.02–0.45 |
| 16 years | 66 | 40.0 | 97.8 | 88.9 | 78.9 | 0.45 | 0.21–0.68 |
| 17 years | 39 | 60.0 | 93.1 | 75.0 | 87.1 | 0.57 | 0.26–0.87 |
| *Child and parent report parent(s) smokes* | | | | | | | |
| 13–14 years | 112 | 37.5 | 88.6 | 47.4 | 83.9 | 0.28 | 0.07–0.50 |
| 15 years | 87 | 50.0 | 92.4 | 40.0 | 94.8 | 0.38 | 0.07–0.69 |
| 16 years | 66 | 53.8 | 96.2 | 77.8 | 89.5 | 0.57 | 0.30–0.83 |
| 17 years | 39 | 83.3 | 90.9 | 62.5 | 96.8 | 0.65 | 0.34–0.96 |
| *Child reports parent(s) smokes in the home* | | | | | | | |
| 13–14 years | 120 | 36.7 | 91.1 | 57.9 | 81.2 | 0.32 | 0.12–0.51 |
| 15 years | 94 | 41.7 | 93.9 | 50.0 | 91.7 | 0.38 | 0.10–0.66 |
| 16 years | 82 | 50.0 | 97.0 | 80.0 | 88.9 | 0.55 | 0.30–0.79 |
| 17 years | 45 | 70.0 | 91.4 | 70.0 | 91.4 | 0.61 | 0.33–0.89 |
| *Parent reports self/spouse smokes in the home* | | | | | | | |
| 13–14 years | 112 | 54.5 | 87.1 | 31.6 | 94.6 | 0.31 | 0.08–0.55 |
| 15 years | 87 | 80.0 | 92.7 | 40.0 | 98.7 | 0.49 | 0.18–0.81 |
| 16 years | 66 | 66.7 | 91.7 | 44.4 | 96.5 | 0.48 | 0.15–0.80 |
| 17 years | 39 | 100.0 | 88.6 | 50.0 | 100.0 | 0.61 | 0.28–0.94 |
| *Child and parent report parent(s) smokes in the home* | | | | | | | |
| 13–14 years | 112 | 75.0 | 87.5 | 31.6 | 97.8 | 0.38 | 0.14–0.62 |
| 15 years | 87 | 75.0 | 91.6 | 30.0 | 98.7 | 0.39 | 0.06–0.72 |
| 16 years | 66 | 100.0 | 91.9 | 44.4 | 100.0 | 0.58 | 0.26–0.90 |
| 17 years | 39 | 100.0 | 88.6 | 50.0 | 100.0 | 0.61 | 0.28–0.94 |

* *n* = the number of participants who responded to the secondhand smoke question.

the overall and gender-specific sensitivity, specificity, PPV, NPV, and kappa values for the youth, parental, and combined youth and parental reports of youth secondhand smoke exposure. Sensitivity for most measures was 0.60 or lower, while specificity was above 87.0 for all comparisons. PPV and NPV ranged from 26.9 to 70.0 and 72.5 to 100.0, respectively. Kappa values ranged from 0.24 to 0.63, indicating 'slight' to 'moderate' agreement levels as defined by Landis and Koch (Landis & Koch, 1977). Agreement between youth and parent that at least one parent smoked inside the home yielded the best combination of sensitivity (85.0) and specificity (89.8), although these estimates were stronger for male youths than for female youths.

Specificity values did not systematically vary as a function of youth age, ranging from 87.1–97.8 (Table 2). However, there was a consistent pattern of low sensitivity, PPV and kappa values in younger adolescents, particularly among those 13–15 years of age. Only the combination measure of youth and parent agreement on an adult smoking in the home demonstrated modest sensitivity levels for youth in this age range (75.0). However, kappa values showed only 'slight' agreement for this combination measure (0.38–0.39).

## 4. Discussion

This study is the first to compare the accuracy of youth and parental secondhand smoke reports in a community-based sample of adolescents 13–17 years of age. Several conclusions can be drawn from these findings: 1) sensitivity and NPV are enhanced, with no reduction in specificity but lowered PPV, when parental smoking practices in the home are assessed rather than merely determining the smoking status of the parents; 2) specificity and NPV vary little across self-report measures and remain high (i.e., all estimates > 0.72); 3) sensitivity, specificity, PPV, and kappa all tend to be lower in younger versus older youth irrespective of the source of the information; 4) combining responses from child and parent enhances sensitivity; 5) the optimum combination of sensitivity and specificity is obtained when both child *and* parent report that at least one parent smokes in the home. It should be noted that using either the youth *or* the parental report to classify secondhand smoke exposure status did not result in improved accuracy over the youth and parental reports of secondhand smoke (results not shown).

Several study limitations should be noted. First, the low prevalence of cotinine above the detection threshold prevented us from examining the degree to which youth and their parents accurately report the *level* of secondhand smoke exposure. Further, because of the low prevalence, subgroup statistics for gender and age should be interpreted with caution. Serial saliva collection would have also led to more precise biological verification of secondhand smoke exposure (Woodward & al-Delaimy, 1999); some investigators have suggested that assessment of multiple biological sources (e.g., hair and salivary cotinine) may be required to measure secondhand smoke exposure with a very high degree of precision (Hovell et al., 2000). Since interviews were conducted by phone, and saliva samples were remotely

collected, it is possible (but not likely) that some interviews were completed by persons who were not actual parent/child pairs. This possibility was minimized by mailing the saliva collection kits directly to youth participants with instructions not to open them until instructed to do so by the telephone interviewer. It should be also noted that determination of cotinine levels via mailed saliva samples produces results similar to those obtained from duplicate samples not sent through the mail (Greeley et al., 1992).

While the median difference between interview date and receipt of the saliva sample was only nine days, the range of this difference was broad (i.e., − 156 to 181) and approximately 30% of samples arrived greater than four weeks prior to or four weeks following the telephone interview. It is possible that accuracy could have been adversely affected in some of the participants if parents either quit smoking or starting smoking again during the period between interview date and the collection of the saliva sample. In order to examine this possibility, a series of subgroup analyses were run on participants stratified by level of discrepancy between interview and sample arrival dates (i.e., ± 2 weeks; ± > 2 weeks≤4 weeks; ± > 4 weeks≤8 weeks; > 8 weeks). We found only partial and inconsistent evidence of declining accuracy in these four groups. For example, Kappa values for the measure child and parent report that one or both parent smokes in the home were 0.49, 0.53, 0.37, and 0.41, respectively in these subgroups. These findings suggest that overall agreement may have been somewhat higher if all saliva samples had been returned within four weeks of the interview date.

Although the Florida Youth Cohort Study was designed to be representative of the youth of that state, our youth participation rate in the fifth wave was 51%, and among these, 57% provided us with a saliva sample. Furthermore, youth who reported at baseline that one or more parents were smoking in the home were more likely to be non-participants than were youth who completed the fifth wave interview and agreed to provide a saliva sample (79% versus 21%; $p<0.04$). It is unclear what effect this differential non-response had, but one possible scenario is that the youth and parents who participated in this study were more "accurate" reporters than youth and/or parents who could not be located or who declined participation. We did not ask youth if adults other than parents were smoking in the home. This omission likely had only minimal impact on our reported results since there were just three instances when the only adult smoker was someone other than a parent or guardian. Finally, we did not identify non-household sources of secondhand smoke, although other investigators have found that the inclusion of non-household sources does not appreciably improve accuracy (Fried et al., 1995).

To summarize, the accuracy of individual youth and parental reports of adolescent exposure to secondhand smoke is poor and will lead to misclassification, particularly among adolescents 13–15 years of age. However, combining child and parent reports of secondhand smoke exposure in the home results in good agreement with salivary cotinine results. Investigators unable to add biological verification of secondhand smoke exposure to their research protocols should consider collecting secondhand smoke information from both adolescents and their parents.

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## Appendix A. Secondhand smoke interview questions administered to youth and parents

YOUTH QUESTIONS:
1. *Do any of the adults that you live with smoke?*
{a} Yes {b} No {c} Don't Know {d} Refused
2. *Does your mother or stepmother smoke cigarettes, cigars, or pipes?*
{a} Yes, Cigarettes Only {b} Yes, Cigars Only {c} Yes, Pipes Only
{d} Yes, All Or Two Of The Above {e} No {f} No Female Adult Living In The Household
{g} Don't Know {h} Refused To Answer
3. *Does she smoke inside of the house?*
{a} Yes {b} No {c} Don't Know {d} Refused To Answer
4. *Does your father or stepfather smoke cigarettes, cigars, or pipes?*
{a} Yes, Cigarettes Only {b} Yes, Cigars Only {c} Yes, Pipes Only
{d} Yes, All Or Two Of The Above {e} No {f} No Female Adult Living In The Household
{g} Don't Know {h} Refused To Answer
5. *Does he smoke inside of the house?*
{a} Yes {b} No {c} Don't Know {d} Refused To Answer
ADULT QUESTIONS:
1. *Do any of the adults that live with you, including yourself, ever smoke cigarettes?*
{a} Yes {b} No {c} Don't Know {d} Refused To Answer
2. *Does cigarette smoker #1(2, 3, etc.) smoke inside the house?*
{a} Yes {b} No {c} Don't Know {d} Refused To Answer
{a} Yes {b} No {c} Don't Know {d} Refused To Answer
{a} Yes {b} No {c} Don't Know {d} Refused To Answer
3. *Do any of the adults that live with you, including yourself, ever smoke cigars?*
{a} Yes {b} No {c} Don't Know {d} Refused To Answer
4. *Does cigar smoker #1(2, 3, etc.) smoke inside the house?*
{a} Yes {b} No {c} Don't Know {d} Refused To Answer
5. *Do any of the adults that live with you, including yourself, ever smoke pipes?*
{a} Yes {b} No {c} Don't Know {d} Refused To Answer
6. *Does pipe smoker #1(2,3, etc.) smoke inside the house?*
{a} Yes {b} No {c} Don't Know {d} Refused To Answer

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