

## Accuracy and Concordance in Reporting for Secondhand Smoke Exposure among Adolescents Undergoing Treatment for Cancer and Their Parents

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Few studies have examined adolescent reporting accuracy for secondhand smoke exposure (SHSe), and never for youth with cancer. SHSe reporting from adolescents being treated for cancer ( $M_{\text{age}} = 14.92$  years,  $SD = 1.67$ ) was examined against parent/guardian reports and urine cotinine among 42 adolescent–parent dyads. Number of days in hospital-based lodgings prior to assessment emerged as the strongest predictor of urine cotinine ( $\beta = -0.46$ ,  $p = 0.003$ ) and adolescent SHSe reporting significantly predicted urine cotinine ( $\beta = 0.37$ ,  $p = 0.011$ ) beyond relevant demographic and contextual variables (overall  $R^2 = 0.40$ ,  $F(6, 35) = 3.90$ ,  $p = 0.004$ ). Findings support adolescents as accurate reporters of discrete SHSe occurrences.

**Keywords:** secondhand smoke exposure, SHSe, urine cotinine, reporting accuracy, reporting agreement and concordance

**S**ECONDHAND SMOKE EXPOSURE (SHSe) for children undergoing treatment for cancer is of particular concern given the consequences of exposure<sup>1</sup> and their increased risks for future health problems.<sup>2,3</sup> Children with cancer who reside in smoking households are more likely to present with a history of pulmonary and respiratory problems than those in non-smoking households.<sup>4</sup> Research focused on SHSe in pediatric cancer patients has used parent/guardian reports as an accurate measure of children's exposure, which has been validated against urine cotinine, a biomarker of nicotine.<sup>5</sup> However, parents/guardians may provide only an incomplete proxy measure of their child's exposure, as they cannot report on all settings their children encounter. The few studies that have examined accuracy of child-reported household SHSe suggest that children are generally accurate in identifying salient smoking-related risk factors (i.e., smoking status of adults living in the home), but are less accurate in reporting on duration of exposure and rates of smoking indoors<sup>6</sup> and may underreport exposure.<sup>7</sup>

Adolescence is a period of autonomy seeking, marked by the development of personal health behaviors and attitudes,<sup>8,9</sup> and is a critical period for smoking-related risk behaviors<sup>10,11</sup> and adopting SHSe avoidance habits. Consequently, although the parents/guardians of adolescents typically provide reports of their children's SHSe,<sup>12</sup> adolescents themselves may be uniquely suited to report on SHSe. To develop effective programs appropriately designed to help adolescents with

cancer avoid exposure, their ability to recognize and assess their own SHSe must first be assessed. The purpose of the current study is to build upon previous research on the validity of children's exposure reports<sup>6,7</sup> by assessing exposure reporting among a sample of adolescents undergoing cancer treatment against parent/guardian estimates and the gold standard for exposure—urine cotinine.

### Methods

#### Participants

Data were collected from 44 parent/guardian and adolescent pairs as part of a larger intervention aimed at reducing SHSe among children living in a smoking household who are undergoing cancer treatment.<sup>13</sup> Adolescent patients were predominantly male ( $n = 27$ , 61.36%) and ranged in age from 11.91 to 17.69 years ( $M_{\text{age}} = 14.92$ , standard deviation [SD] = 1.67). Age was normally distributed in this sample. Adolescent patients were either White/Caucasian ( $n = 35$ , 79.55%) or Black/African American ( $n = 9$ , 20.45%). Additional demographic and medical information is presented in Table 1.

#### Procedure

Parents/guardians of adolescents who lived with at least one adult smoker were recruited from a pediatric oncology

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TABLE 1. DEMOGRAPHIC AND MEDICAL INFORMATION FOR ADOLESCENT PATIENTS AND PARENTS/GUARDIANS

<i>Adolescent variables at study time</i>	<i>n=44</i>
Age in years—mean (SD)	14.92 (1.67)
Range	11.91–17.69
Gender	
Male	27 (61.36%)
Female	17 (38.64%)
Race/ethnicity	
White/Caucasian	35 (79.55%)
Black/African American	9 (20.45%)
Diagnosis	
Central nervous system	3 (6.82%)
Leukemia/lymphoma	34 (77.27%)
Solid tumor	7 (15.91%)
Months since diagnosis—mean (SD)	4.92 (7.27)
Range	1.08–36.96
Days in hospital-provided lodgings—mean (SD)	0.66 (0.83)
0 days	22 (50.00%)
1 day	18 (40.91%)
2 days	1 (2.27%)
3 days	3 (6.82%)
<i>Parent variables at study time</i>	<i>n=44</i>
Age in years—mean (SD)	41.17 (7.30)
Range	29.53–61.16
Gender	
Male	7 (15.91%)
Female	37 (84.09%)
Race/ethnicity	
White/Caucasian	36 (81.82%)
Black/African American	8 (18.18%)
Marital status	
Married	28 (63.64%)
Divorced/separated	4 (9.09%)
Never married	12 (27.27%)
SES/income <sup>a</sup>	
Low	18 (40.90%)
Middle	12 (27.27%)
High	14 (31.82%)
Parent-reported smoking status	
Smoker	32 (72.73%)
Non-smoker	12 (27.27%)

<sup>a</sup>Hollingshead score of 4 or 5=Low, 3=Middle, and 1 or 2=High (Hollingshead AB. Four factor index of social status. New Haven, CT: Yale University; 1975. Unpublished manuscript). SD, standard deviation; SES, socioeconomic status.

hospital in the Southeast United States. Data used in the current study were drawn from the baseline assessment conducted between December 2002 and December 2008. Pairs were eligible for participation if the adolescent patient was non-smoking (per parent report) at the initial screening, at least 30 days post-diagnosis, on active treatment, and exposed to SHS in the home or car setting (per parent report) at the time of recruitment. When two parents/guardians were available, the one who most frequently accompanied the child to the hospital for clinical visits participated. Of the 44 recruited, 35 (79.55%) were mothers/stepmothers, 7 (15.91%) were fathers/stepfathers, and 2 (4.55%) were other relatives. Prior to the assessment, social workers and medical teams

were consulted to ensure that adolescents were not in medical or psychological crisis at the time of assessment. During scheduled hospital visits, graduate-level research assistants aided parents/guardians and adolescents in completing questionnaires about parent/guardian smoking behavior and adolescent SHSe. Parents/guardians and adolescents completed questionnaires in separate rooms during a single session (<60 minutes). Adolescents indicated whether they had smoked a cigarette in the last month to amend their parents'/guardians' reports on their smoking status at the time of study enrollment.

### Measures

**Demographic and diagnostic information.** Parents/guardians completed a demographic questionnaire inquiring about their age, gender, race/ethnicity, marital status, and socioeconomic status (SES; Hollingshead AB. Four factor index of social status. New Haven, CT: Yale University; 1975. Unpublished manuscript). Adolescents' medical records provided age, gender, race/ethnicity, cancer diagnosis, and diagnosis date.

**Parent- and adolescent-reported SHSe.** Both adolescents and parents/guardians reported the number of residents who "live in the home and smoke cigarettes," whether or not they personally smoked, whether smoking was allowed in the home, and how many days over the past week the adolescent was in the same room or car as someone smoking. The number of possible exposure days ranged from 0 to 7 and was assessed separately for home and car exposure. To gain a more representative proxy for exposure, the number of days exposed in the home and car were averaged so the range was defined from 0 to 7 and called "total exposure."

**Urine cotinine assays.** Adolescents provided urine samples to assess cotinine levels. Cotinine, a metabolite of nicotine, reliably measures recent SHSe<sup>14</sup> and is appropriate for use among children undergoing cancer treatment.<sup>5</sup> The half-life of urinary cotinine in children exposed to SHS is approximately 28 hours (range: 9.7–99.42 hours)<sup>15</sup> and demonstrates good sensitivity and specificity in analysis of SHSe.<sup>14,16</sup> Although analytic techniques for identifying smokers vary across studies, cotinine cut-off levels of 50 ng/mL demonstrate strong sensitivity and specificity in discriminating self-reported smoking status<sup>17,18</sup> and were used to indicate active smoking in the current study.

**Residential status of adolescents prior to assessment.** While all adolescents included in the study were exposed to SHS, adolescent patients commuted to the hospital from home or stayed as outpatients in hospital-provided residential facilities during their treatment. Although smoking is restricted in hospital-provided residential facilities, all participants experienced recent SHSe, as indicated by parental reports and urine cotinine levels. Exposure may have occurred when leaving the facility, in a car with a smoker, in hospital and hospital-provided lodging designated outdoor smoking areas, or when parents disregarded smoking policies. In order to address the potential influence of a smoking-restricted environment on SHSe reporting, information was collected for the residential status of patients 3 days prior to

TABLE 2. HIERARCHICAL REGRESSION ANALYSES EXAMINING ADOLESCENT- AND PARENT-REPORTED SECONDHAND SMOKE EXPOSURE AS A PREDICTOR OF URINE COTININE LEVELS (N=42)

Step	B	SE B	$\beta$	$sr^2$	R <sup>2</sup> (Adj. R <sup>2</sup> )	$\Delta R^2$	Overall F
Step 1					0.28 (0.18)	0.28*	2.75*
Adolescent age	1.30	0.68	0.28	0.31			
Adolescent gender	-2.44	2.35	-0.15	-0.17			
Adolescent race/ethnicity	4.50	2.96	0.23	0.25			
SES	1.15	0.95	0.17	0.20			
Days in hospital-based lodging	-4.29	1.43	-0.46**	-0.45**			
Step 2 (adolescent-reported SHSe)					0.40 (0.30)	0.12*	3.90**
Adolescent age	0.89	0.65	0.19	0.23			
Adolescent gender	-2.88	2.18	-0.18	-0.22			
Adolescent race/ethnicity	3.99	2.74	0.20	0.24			
SES	0.93	0.88	0.14	0.18			
Days in hospital-based lodging	-4.26	1.32	-0.46**	-0.48**			
Adolescent-reported exposure	1.51	0.56	0.37*	0.41*			
Step 2 (parent-reported SHSe)					0.45 (0.36)	0.18**	4.81**
Adolescent age	1.56	0.60	0.34*	0.40*			
Adolescent gender	-3.50	2.10	-0.22	-0.27			
Adolescent race/ethnicity	6.22	2.66	0.31*	0.37*			
SES	1.45	0.84	0.22	0.28			
Days in hospital-based lodging	-4.46	1.26	-0.48**	-0.51**			
Parent-reported exposure	1.95	0.58	0.44**	0.49**			

\* $p < 0.05$ ; \*\* $p < 0.01$ .

$\beta$ , standardized beta coefficient; B, unstandardized beta coefficient; SE B, unstandardized standard error; SES, socioeconomic status; SHSe, secondhand smoke exposure;  $sr^2$ , semi-partial correlation.

assessment to correspond with optimal urine cotinine detection.<sup>14</sup> The number of days adolescents resided in hospital-provided lodging ranged from 0 to 3 days, with higher scores indicating more days of hospital-provided lodging. Half of participants (50.00%;  $n = 22$ ) reported 0 days, 40.91% ( $n = 18$ ) reported 1 day, and 9.09% ( $n = 4$ ) spent 2 or 3 days in hospital-provided lodging.

**Results**

Prior to conducting analyses, urine cotinine scores were examined for outliers. To account for potential adolescent smoking behavior, adolescents were excluded from analyses if they exhibited a urine cotinine level that was suggestive of active smoking behavior (>50 ng/mL)<sup>17,18</sup> or reported having smoked a cigarette in the past month. This resulted in the exclusion of one participant with high urine cotinine levels (157.48 ng/mL) who also reported smoking in the past month. One additional adolescent was excluded due to incomplete SHSe questionnaires, resulting in 42 dyads used in analyses. No demographic or medical differences were observed between excluded participants and those included in analyses ( $p > 0.05$ ).

Parents/guardians reported an average of 2.74 (SD=2.82) days of home exposure over the past week and 1.74 (SD=1.85) days in which the adolescent was exposed in the car. On average, adolescents reported 3.00 (SD=2.83) days of home exposure and 2.57 (SD=2.38) days of car exposure in the past week. Parents/guardians and adolescents demonstrated moderate agreement on total exposure ( $r = 0.36$ ;  $p = 0.019$ ).<sup>19</sup> This agreement remained when the parent/guardian and adolescent reports of SHSe were considered separately for home ( $r = 0.39$ ;  $p = 0.012$ ) and car ( $r = 0.49$ ;  $p = 0.001$ ). Parents/guardians and adolescents demonstrated moderate agreement for the number of smokers living in the home (Spear-

man's  $\rho = 0.67$ ;  $p < 0.001$ ) and almost perfect concordance on whether smoking was allowed in the home ( $\kappa = 0.83$ ;  $p < 0.001$ ).

Adolescents' urine cotinine levels ranged from 0.06 to 38.71 ng/mL ( $M = 5.99$ ,  $SD = 7.89$ ) and were significantly associated with both adolescent ( $r = 0.42$ ;  $p = 0.005$ ) and parent ( $r = 0.33$ ;  $p = 0.034$ ) reports for total exposure. To examine further the accuracy of adolescent reports of SHSe, a hierarchical linear regression analyses was conducted with adolescent age, gender, race/ethnicity, parent-reported SES, and adolescents' number of days in hospital-provided lodging (0–3 days) in the first step, and adolescent-reported exposure in the second step (Table 2). The first step of the model significantly predicted urine cotinine levels, with number of days in hospital-provided lodging as the sole significant predictor. Adolescent-reported total exposure significantly improved the model and accounted for an additional 12% of the variance. In order to provide a comparison for adolescent SHSe reporting, a second hierarchical logistic regression was conducted examining parent-reported exposure (Table 2). The first step of the model significantly predicted urine cotinine levels with the number of days adolescents resided in hospital-provided lodging as the single significant predictor. The addition of parent-reported total exposure was a significant predictor of urine cotinine, accounting for an additional 17% of the variance. The number of days adolescents resided in hospital-provided lodgings was not significantly correlated with adolescent or parent reports of exposure and was not a confounding variable.

**Discussion**

This study is the first to examine the accuracy and concordance of SHSe reporting among an adolescent cancer population. We extended previous research on adolescent

self-reports of exposure to a different medically compromised population, considered multiple exposure environments (i.e., home and car), and concentrated on adolescent patient reporters. This study found that adolescents, as well as their parents/guardians, were accurate in reporting on discrete SHSe factors, which is consistent with previous studies on non-cancer populations.<sup>6,7</sup> Adolescents undergoing cancer treatment agreed with their parents/guardians on the number of smokers in the home and on household smoking rules. In addition to adolescent- and parent-reported exposure, the number of days spent in hospital-provided lodging emerged as a significant predictor of urine cotinine levels, demonstrating the importance of setting in SHSe and exposure reporting. Future studies designed to examine the specific role of setting and environmental context in exposure reporting among adolescents are warranted.

Previous SHSe interventions have focused on reducing caregiver-based exposure (e.g., reduction in caregiver cigarette smoking or smoking in their children's presence),<sup>20</sup> but no studies have focused directly on adolescents' behavior, such as increasing adolescent avoidance of SHSe. The only reported exposure avoidance intervention to date demonstrated a significant reduction in nicotine exposure among pre-adolescents who received avoidance training compared to the control condition.<sup>21</sup> Understanding adolescents' abilities to recognize and quantify SHSe in their environment is critical for continued attempts to reduce SHSe.

Although informative, the results of this study must be interpreted in light of several limitations. The unique focus of this study on adolescents undergoing cancer treatment inherently limited the sample size and, consequently, diversity in racial/ethnic representation such that findings may not generalize to other populations. Future studies should also consider examining the proportion of time adolescents spend with their parents/guardians, as it may be closely related to SHSe and reporting accuracy. It is also important to note that estimates of exposure may be biased if the timing of the urine samples reflects episodic high or low exposure events. In addition, the self-reported exposure variable used in this study assessed the prior week while the cotinine levels represent only recent exposure due to limited half-life of this biomarker. Lastly, to provide a more accurate proxy variable for home and car exposure, the number of days exposed in the home and car were averaged and may not reflect exact exposure in either the home or car. Prospective or timeline follow-back measurement of exposure, multiple urine-cotinine assays, collection of contextual (i.e., when, how, and where exposure occurs) and more nuanced (i.e., number of cigarettes exposed to instead of days of exposure) information about exposure should be considered as research expands on this unique population.

In conclusion, findings suggest that adolescents undergoing treatment for cancer have a general awareness of variables related to tobacco exposure and are able to report accurately on their personal SHSe. As adolescents experience an increased amount of control over their health decision making,<sup>8</sup> they have a greater role in preventing their personal SHSe by avoiding exposure or by actively demanding change to reduce their risk. Understanding SHSe reporting accuracy in adolescence is necessary for the next step in exposure reduction programs—interventions designed to enhance adolescents' exposure avoidance behavior.

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## Author Disclosure Statement

No competing financial interests exist.

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