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Adolescent cancer survivors' smoking intentions are associated with aggression, attention, and smoking history

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Abstract

Introduction—The present study examines behavioral and psychosocial factors associated with smoking intentions and experimentation among adolescent survivors of pediatric cancer.

Methods—Adolescent survivors of brain tumor and acute lymphoblastic leukemia (*n*=99) provided information about their smoking histories and their intentions to smoke in the future. Behavior rating scales were completed by survivors, parents, and teachers.

Results—Past experimentation with smoking and higher levels of self-reported aggression were associated with intentions to smoke in the future (OR=4.18, 95%CI 1.02–17.04, and OR=1.08, 95% CI 1.01–1.15, respectively), while teacher-ratings of inattention in the classroom were negatively associated with intentions to smoke (OR=0.94, 95% CI.88–.99), all $p<.05$. Experimentation with smoking was more likely among older survivors (OR=1.76, 95% CI 1.16–2.66, $p<.01$) and those whose parents had divorced (OR=4.40, 95% CI 1.21–16.06, $p<.05$).

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Discussion—A concerning minority of adolescent survivors have clear intentions to smoke, a behavior that adds to their overall health risk. Smoking intentions and experimentation are important precursors to regular smoking. Prevention efforts are needed to interrupt the progression from intentions and experimentation to established smoking and nicotine dependence in this medically vulnerable population.

Implications for cancer survivors—Assessment of an adolescent's history of parental divorce, past experimentation with smoking, and aggressive behavior will identify those survivors who are likely to consider smoking in the future. Screening for these characteristics will allow clinicians to be more vigilant in health promotion.

Keywords

Childhood cancer; Smoking; Adolescents

Most children treated for cancer in the US will achieve long-term survival thanks to advanced diagnostic and treatment approaches developed over the last several decades [1]. Still, survivorship presents unique challenges for this growing population. Formidable medical threats persist following treatment for pediatric cancer, yielding a 10-fold increased mortality risk compared to the general population [2], particularly associated with secondary malignancy, cardiac events, and pulmonary disease. Thus, it comes as no surprise that smoking has been identified as "the single most important risky health behavior" to prevent among pediatric cancer survivors [3].

Despite their elevated medical vulnerability, some survivors still choose to smoke after treatment. Estimates range from 8% to 53% across studies reporting the frequency of ever smoking among adolescent survivors [4–9]. Current smoking estimates for adolescent survivors also vary, ranging from 4% to 14% [4,6,9]. Even among non-smoking survivors, a concerning majority report some intention to smoke in the future [9]. By adulthood, between 17% and 29% of pediatric cancer survivors are established smokers [10–14], rates that approach current smoking rates in the general population [15].

Better understanding of the factors that influence survivors to smoke after treatment, despite their medical risk, is important for the development of effective prevention and intervention efforts. Most studies to date have focused on demographic correlates of survivor smoking. Many of the same variables that predict smoking among healthy individuals have been associated with smoking among adult survivors of pediatric cancer, including lower income [10], less education [10,14,16], older age [14,16,17], and Caucasian race [10,14,18].

Less is known about factors that influence survivor smoking in adolescence, the developmental stage smoking onset occurs for most [19]. Based on the few studies available, adolescent survivors of pediatric cancer appear to be more likely to have intentions to smoke in the future if they are older, have previous smoking experience, have parents who smoke, have less knowledge about the negative effects of smoking, and/or have more favorable beliefs about the benefits of smoking [4,9,20]. Correlates of having intentions to smoke among adolescents being treated for cancer are similar to those identified among adolescent survivors [21–23]. Notably, having intentions to smoke during adolescence was shown to predict tobacco use up to a decade later in a sample of pediatric cancer survivors [22].

Examination of psychological and behavioral risk factors of survivor smoking in the literature is noticeably sparse and inconclusive. Childhood attention problems and adulthood executive dysfunction were found to predict smoking among adult survivors of childhood cancer [24], while psychological distress was associated with an increased smoking rate and nicotine dependence among current smokers from the same cohort [16]. Among pre-

adolescents currently undergoing cancer treatment, intentions to smoke in the future were associated with increased rebelliousness [23].

Taken together, these findings provide little direction in terms of which characteristics are most important for identifying adolescent survivors at risk for current or future smoking. Many factors known to influence adolescent smoking in the general population (e.g., externalizing behavior, depression, family functioning, pubertal timing) have not been explored in survivor samples. As a result, we were interested in exploring associations between problematic behaviors and characteristics and the smoking intentions and experimentation reported by adolescent survivors.

Pierce and colleagues [25] described smoking acquisition as a process. The pathway to nicotine dependence involves progression along a continuum of smoking behaviors, spanning from preparation (e.g., expectations about smoking, intentions to smoke in the future) to established daily smoking [26–30]. Important transitions along this continuum include: 1) moving from never having smoked a cigarette to experimenting with cigarettes, and 2) moving from experimenting to regular smoking [25,30–32]. Both intentions to smoke and experimentation are strong risk factors for later smoking [25,31,33]. Better understanding of the earliest stages of smoking acquisition (i.e., intentions and experimentation) and the factors associated with progression from one step to the next should help with the timely identification of adolescents at risk for smoking.

In the present study, we explored the smoking intentions and experimentation reported by adolescent survivors of pediatric brain tumor or acute lymphoblastic leukemia (ALL). The primary aim of the study was to develop a profile of psychosocial and behavioral characteristics across contexts (home and school) that identify adolescent survivors most susceptible to smoking.

Methods

Participants

Children and parents/guardians participated in this study while attending outpatient clinic visits at a large pediatric oncology hospital. Patients diagnosed with ALL or brain tumor were eligible if they were at least 1 year since completion of primary treatment with no evidence of active disease, were between the ages of 12 and 17 years (inclusive), were able to speak and understand English, and were accompanied by an English-speaking parent or legal guardian. Patients were excluded from participation if significant impairment in intellectual functioning was documented in the medical record.

Parents/guardians were contacted prior to the child's next scheduled medical visit to introduce the study. If the family expressed interest, a study visit was added to the child's schedule. We contacted 114 families, with 107 agreeing to meet with study staff to learn more about the study and engage in the informed consent/assent process. In total, 100 parent–child dyads agreed to participate and completed study measures. No differences were identified between those patients who declined participation (57% ALL, 43% male) and those who participated in the study.

One participant was identified as an established smoker at enrollment. Since precursors to regular smoking were the focus of this investigation, data for this participant were excluded from analyses. As such, results presented are from 99 survivors (50 brain tumor, 49 ALL). Demographic and clinical characteristics of the sample are reported in Table 1. Age at diagnosis ranged from 0.7 to 15.2 years (M=6.6, SD=3.8). Time since completion of treatment ranged from 1.1 to 16.0 years (M=6.3, SD=3.5). All participants with ALL had

been treated with chemotherapy and 12% also received cranial irradiation. Of participants with brain tumor, 52% had received chemotherapy, 76% cranial irradiation, 84% neurosurgery, and 26% shunt placement.

Participating parents/legal guardians included 78 mothers, 15 fathers, 1 stepmother, 2 stepfathers, 2 grandmothers, and 1 grandfather. Most parents (*n*=64) were married to the child's other biological parent. Other parents were single/never married (*n*=5), divorced (*n*=11), divorced/remarried (*n*=13), widowed (*n*=2), or married to someone other than the child's parent (*n*=4). Most parents were employed (49% full time, 13% part-time). One quarter of respondents reported being home fulltime to care for their children. Only five families reported an annual household income less than $20,000. The remaining families were fairly evenly distributed across the remaining income groups: $20,000–$39,999 (*n*=16), $40,000–$59,999 (*n*=18), $60,000–$79,999 (*n*=18), $80,000–$99,999 (*n*=17), and $100,000+ (*n*=24). Most parents/guardians reported completing at least some post-secondary education (67%).

Procedures

Procedures were approved by the Institutional Review Board of the participating hospital. Children and parents/guardians were seen separately for administration of study measures. Parents/guardians provided consent and contact information for the child's primary teacher who was asked to complete a rating scale assessing the child's classroom behavior. A $10 gift card was offered to each participating child and teacher as compensation for time and effort.

Measures

Demographic and clinical variables—Demographic variables included age, sex, and race. Race was categorized as White or non-White due to the low frequency of Asian, Latino, and American Indian participants in this sample. Variables associated with socioeconomic status were also examined, including household income, parent employment status, and parent education. History of parental divorce was also examined as an indicator of familial structure and stress. Clinical variables included diagnosis, time from diagnosis, and time from treatment.

Intentions to smoke—This scale consists of 6 items and measures intentions to smoke in the future. The measure has been used repeatedly with samples of pre-adolescent and adolescent cancer patients and survivors [4,9,20]. Responses are rated on a 5-point scale ranging from *1) Very Unlikely* to *5) Very Likely*. Item responses are summed, with higher total scores representing greater intentions to smoke in the future. Dropping one item from the scale produced good internal reliability based on a Cronbach's alpha coefficient of .87. Using the 5-item scale, the range for possible intentions scores is 5 to 25. A dichotomous intentions variable (*No Intentions* versus *Intentions*) was calculated due to the restricted variability in intentions scores identified in this sample. This categorization has been used successfully with this population [9,21]. This scale demonstrated strong predictive validity in a sample of pediatric cancer survivors, where intentions were significantly associated with smoking initiation up to 10 years later [22].

Experimentation with smoking—Assessment of smoking behavior was obtained from the Smoking Uptake Continuum scale [31]. These items (individually or in combination) are standard in epidemiological studies of adolescent smoking in the U.S. and have demonstrated adequate validity and reliability [25,34–37]. Due to the restricted range of smoking experience reported in our sample, we used a dichotomous smoking classification of past experimentation with smoking (*Never Experimented* versus *Experimented*). We

derived this classification from the item that asks, “Have you ever tried or experimented with cigarette smoking, even a few puffs?”

Conners 3rd Edition™ (Conners 3)—The Conners 3 was designed to assess cognitive, emotional, and behavioral symptoms associated with ADHD and related disorders. The self-report (99 items), parent-report (110 items), and teacher-report versions (115 items) were all administered in this study. Standardization based on a large, representative national sample demonstrated strong psychometric properties, with internal consistency reliability across scales ranging from 0.81 to 0.90 (self-report), 0.83 to 0.94 (parent-report), and 0.78 to 0.97 (teacher-report) [38]. Discriminate validity was established on several clinical samples, including distinguishing between youth with and without an ADHD diagnosis [38]. Further, the factor structure exhibited stability in cross validation. The Conners Rating Scales have been used extensively with pediatric oncology samples [39–43]. Norm-derived T-scores for the content scales were used in analysis (sample means reported in Table 2).

Statistical analysis

Univariate and multivariate logistic regression models were used. First, separate univariate models were used to identify relationships between the dependent variables (intentions to smoke, experimentation with smoking) and the independent variables (demographic, clinical, and behavioral characteristics). All independent variables identified in univariate analyses with p-values ≤ .10 were included in subsequent multiple logistic regression models. Each multiple logistic regression model included no more than seven independent variables. One final multiple logistic regression model was produced for each of the two dependent variables (smoking intentions and experimentation). Only those independent variables that remained statistically significant at $p<.05$ were retained in the final fitted multivariate models.

Results

Descriptive results

Most survivors in this sample (68%) expressed no intention to smoke in the future, with an Intentions score of 5 (the lowest end of the range of scores). Even among participants reporting some intentions, most fell at the lower end of the intentions spectrum, with scores ranging from 6 to 20 (mean=8.4, SD=2.8). Smoking experience was also limited. Only 13 participants reported ever experimenting with smoking in the past. Demographic and clinical characteristics of the sample are reported in Table 1.

Intentions to smoke

Univariate logistic regressions were used to identify demographic variables, clinical characteristics, and behavior ratings associated with intentions to smoke (significance values are reported in Tables 1 and 2). Having intentions to smoke was significantly associated with past experimentation with smoking (OR=4.13, 95% CI 1.23–13.90, $p<.05$), more self-reported aggression (OR=1.04, 95% CI 1.00–1.09, $p<.05$), and fewer teacher-reported problems with inattention (OR=0.94, 95% CI 0.88–0.99, $p<.05$) and learning (OR=0.96, 95% CI 0.92–0.99, $p<.05$). No other significant associations were found between intentions and demographic, clinical, and behavioral variables. Of note, no socioeconomic indicators (household income, parent education, or parent employment status) were found to be significantly associated with intentions (data not shown).

Multiple logistic regression was used to explore a combined model using only those variables found to be significantly associated with intentions. Teacher-reported learning problems were highly correlated with teacher-reported inattention, and the former did not

remain significant after accounting for the latter and was removed from the model. In the final model (Table 3), past experimentation with smoking and self-reported aggression scores were positively associated with having intentions to smoke (OR=4.18, 95% CI 1.02–17.04, and OR=1.08, 95% CI 1.01–1.15, respectively) while teacher-reported inattention scores were negatively associated with intentions (OR=0.94, 95%CI.88–.99), all $p<.05$. All three predictors accounted for a significant amount of unique variance in intentions scores indicating that past smoking experience and more aggressive behavior may be risk factors for having intentions to smoke in the future. At the same time, smoking intentions were associated with having fewer problems with inattention in the classroom.

Experimentation with smoking

Univariate logistic regressions were conducted to identify demographic and clinical variables associated with past experimentation with cigarettes (significance values are reported in Tables 1). Behavior ratings from the Conners 3 parent-report, self-report, and teacher-report content scales (Table 2) as well as socioeconomic indicators (data not shown) were also examined in relation to smoking experimentation, but no significant associations were identified. Experimentation was found to be significantly associated with older age (OR=1.77, 95% CI 1.20–2.63, $p<.01$) and parental divorce (OR=4.74, 95% CI 1.41–15.92, $p<.05$). In a combined multiple logistic regression model (Table 4), both age (OR=1.76, 95% CI 1.16–2.66, $p<.01$) and parental divorce (OR=4.40, 95% CI 1.21–16.06, $p<.05$) remained significant. After accounting for age, survivors who experienced parental divorce had more than four times the odds of experimental smoking than survivors whose parents had not divorced. Although 54% of divorced parents reported being remarried at the time of the study, remarriage did not change the association found between divorce and experimentation when included in analysis.

Discussion

Nearly one-third of the adolescent survivors in our sample reported having intentions to smoke in the future. Fewer reported past experimentation with cigarettes. This indicates that a concerning minority of adolescent survivors remain at risk for smoking, a behavior that could amplify the medical risk already associated with survivorship. Prevention efforts are needed to interrupt the progression from intentions and experimentation to regular smoking and nicotine dependence for this at-risk group. The associations found in this study inform a profile of behavioral and psychosocial characteristics of adolescents post-treatment for pediatric ALL or brain tumor who may be most susceptible to smoking.

Intentions have been shown to predict future smoking among survivors [22] as well as healthy adolescents [25], making it an important indicator of smoking risk. In this sample, intentions to smoke in the future were most strongly associated with past experimentation. As such, preventing early smoking experiences and helping adolescents develop committed attitudes against smoking are paramount for health promotion efforts with adolescent survivors. Prevention is particularly important since survivors who are established smokers have more difficulty quitting than healthy controls [11,12,14].

The emergence of aggression as a correlate of intentions to smoke in this sample is consistent with associations between smoking and externalizing behavior identified among healthy adolescents [44–47]. Likewise, more aggressive and less prosocial behavior correlated with smoking in older adolescent and young adult survivors of childhood cancer [48]. Rebelliousness was also associated with having intentions to smoke among adolescents with cancer [23] and with smoking status among healthy teens [49]. Although adolescent survivors are not at increased risk for aggression compared to healthy peers [50], those

survivors who do exhibit aggressive behavior may require both psychosocial and health behavior screening and intervention.

The influence of cognitive functioning in the development of health behaviors is an important consideration for this population since some cancer treatments (e.g., cranial irradiation, intrathecal chemotherapy) place survivors at risk for lasting cognitive deficits in attention, concentration, and executive functioning [54–62]. Survivors in this sample were less likely to have intentions to smoke if they exhibited inattention in the classroom. This finding contrasts with reports of attention problems significantly increasing smoking risk in the general population [51–53]. Further, a recent study of smoking among adult survivors of childhood cancer found that attention problem symptoms (experienced both in childhood and adulthood) increased smoking risk [24]. Our failure to detect a similar relationship in our sample may shed light on the development of smoking behavior within the context of survivorship. Attention problems may exert an influence on smoking maintenance behaviors but not on the precursors to regular smoking, like intentions and experimentation. Alternatively, differences in the measurement and definition of attention problems across studies may explain differing results.

Our study did not assess important social factors that could help to explain the negative association we identified between intentions to smoke and classroom inattention. Possibly, some survivors with post-treatment attention problems end up with a restricted social network, thereby limiting their exposure to smoking experiences that would otherwise increase smoking susceptibility. Having fewer intentions to smoke could be indicative of exclusion from normative peer relationships and experiences for this group, an important consideration for future investigations.

Better understanding of family structure and functioning may help identify adolescent survivors at risk for smoking. Parental divorce was strongly associated with smoking experimentation in this study, even after controlling for the significant effect of age. Although little research has directly explored family structure and smoking in the general population, available studies do suggest that children who have experienced parental divorce or separation and/or live in single-parent households are more likely to smoke [63–66]. In fact, smoking was found to mediate the increased mortality risk for adults, particularly women, who experienced parental divorce in childhood [67,68].

The mechanism underlying the association between parental divorce and experimentation remains unclear. Parental divorce may serve as a proxy for childhood adversity, which has been found to increase smoking risk in adolescence and adulthood in the general population [69]. Experiencing a divorce, coupled with the challenges of cancer treatment and survivorship, could contribute to emotional distress for some adolescents, predisposing them to risky peer associations or dysfunctional coping strategies that ultimately lead to smoking. In this sample, survivors who experienced parental divorce were found to have higher ratings on several parent-report behavior scales (data not shown); however, behavioral ratings were not associated with experimentation directly (Table 2). Alternatively, divorce may have a more direct influence if divorced parents themselves are more likely to smoke, thereby placing their children at risk through social modeling and cigarette availability. Unfortunately, parental smoking rates were not obtained in this study. Although questions remain, the strong association found here suggests that clinicians may need to pay special attention to adolescents who have survived cancer *and* experienced parental divorce as they may be particularly vulnerable to experimental smoking.

Findings must be considered in light of study limitations. Sample characteristics may limit the generalizabilty of findings. Parents reported incomes and educational attainment levels

that trended toward a higher socioeconomic distribution associated with lower smoking rates in the general population [70,71]. Small sample size may have limited our ability to identify other factors related to the development of smoking behavior, particularly given the relatively low base rate of smoking among young survivors. For example, diagnosis was not significantly related to experimentation even though twice as many ALL survivors had experimented with smoking compared to brain tumor survivors. The lack of data on parent and peer smoking (established predictors of early smoking behavior) limits our understanding of how behavioral and family variables interact with important social factors in this population. Finally, we used cross-sectional data. Longitudinal research is needed to follow changes in intentions and smoking experiences over time within the context of survivorship and to track the development of regular smoking in relation to the psychosocial risk factors identified in this study.

Adolescents without a firm commitment to abstain from smoking exhibit a “cognitive susceptibility” to later smoking behavior [25]. Through the early identification of survivors susceptible to smoking, prevention efforts can be implemented to stop survivors from becoming established smokers. Assessing adolescent survivors’ intentions to smoke with a brief screening measure or asking about current and intended smoking experiences can provide valuable information to clinicians at routine clinic visits. Further, clinicians should be made aware that adolescent survivors who are aggressive and those who have experienced parental divorce may be especially vulnerable to smoking.

Abbreviations

ADHD	Attention-Deficit/Hyperactivity Disorder
ALL	Acute Lymphoblastic Leukemia

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Table 1

Demographic and clinical characteristics of survivors by intentions and experimentation status

	All participants		Intentions to smoke			Experimented with smoking		
Characteristic	**N**		***n***	**Row %**	***p***	***n***	**Row %**	***p***
Total Sample	99		32	32.3		13	13.1	
Diagnosis								
Brain tumor	50		17	34.0	.719	4	8.0	.137
ALL	49		15	30.6		9	18.4	
Sex								
Female	50		14	28.0	.354	5	10.0	.356
Male	49		18	36.7		8	16.3	
Race/ethnicity								
White, non-Hispanic	85		29	34.1	.353	11	12.9	.890
Non-White	14		3	21.4		2	14.3	
Parental Divorce								
Yes	24		8	33.3	.903	7	29.2	.012*
No	75		24	32.0		6	8.0	
Experimented with Smoking								
Yes	13		8	61.5	.022*	–	–	–
No	86		24	27.9		–	–	–
	M±SD	Range	M±SD	Range	p	M±SD	Range	p
Age at study participation	14.94±1.88	12.06–17.99	14.79±2.03	12.11–17.98	.591	16.44±1.68	12.17–17.99	.004**
Years since diagnosis	8.36±3.89	1.74–16.93	7.54±3.41	1.93–15.75	.149	8.08±3.53	1.74–14.10	.781
Years since chemotherapy	6.70±3.50	1.35–15.48	5.63±2.65	1.35–12.95	.066	5.25±2.80	1.40–10.63	.125
Years since radiation therapy	5.48±3.92	1.24–15.76	4.90±2.78	1.50–11.48	.437	5.21±2.73	1.24–8.57	.849

n(%)=participants in each row that have intentions to smoke or have experimented with smoking. Some survivors are represented in more than one treatment category. *p*-values are reported for univariate logistic regression analyses comparing intentions and experimentation status across demographic and clinical variables

* $p<.05$,

** $p<.01$

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Table 2

Sample means for conners 3 content scales by reporter

Conners 3 content scales	*n*[a]	Mean±SD	Range	Intentions to smoke *p*	Experimented with smoking *p*
Parent-report					
Inattention	98	56.51±12.82	38–100	.170	.698
Hyperactivity/Impulsivity	99	52.65±10.73	40–86	.242	.924
Learning problems	99	57.42±14.28	39–101	.802	.859
Executive functioning	99	55.08±11.61	37–84	.716	.624
Aggression	99	50.55±10.69	41–101	.695	.638
Peer relations	99	61.59±23.14	41–139	.069	.873
Self-report					
Inattention	98	53.63±11.39	33–95	.441	.838
Hyperactivity/Impulsivity	99	52.19±9.22	37–77	.145	.268
Learning problems	98	55.27±12.71	38–98	.114	.393
Aggression	99	48.35±10.27	39–88	.048*	.963
Family relations	99	47.79±7.66	39–74	.092	.443
Teacher-report					
Inattention	84	50.64±12.36	38–101	.022*	.057
Hyperactivity/Impulsivity	84	48.61±9.84	42–95	.082	.124
Learning problems	83	55.64±14.26	43–98	.047*	.084
Executive functioning	83	49.10±9.66	37–78	.161	.173
Aggression	83	47.70±6.15	43–79	.137	.091
Peer relations	83	53.07±13.42	42–110	.121	.212

Content scale scores are T-scores (mean=50, SD=10). Higher scores indicate more problematic functioning in that domain. *p*-values are reported for univariate logistic regression analyses comparing intentions and experimentation status across content scales

[a] *n* varies across Conners 3 content scales when scores were not calculated due to skipped items (*n*=1 across parent-, self-, and teacher-report forms), teacher-report forms not returned by teachers (*n*=7), and teacher-report forms not included for parent-instructed homeschooled children (*n*=8)

* $p<.05$

Table 3

Multiple logistic regression of variables associated with intentions to smoke (*n*=84)

Variable	β	SE	Odds ratio (95% CI)	*p*
Experimented				
No			1.0	
Yes	1.43	0.72	4.18 (1.02–17.04)	.046*
Aggression (self-report)	0.08	0.03	1.08 (1.01–1.15)	.017*
Inattention (teacher-report)	−0.07	0.03	0.94 (0.88–0.99)	.040*

Odds ratio of 1.0 indicates the reference group for the categorical variable.

Participants were excluded from the final model when missing Conners 3 teacher-report data (*n*=15). Seven variables with $p<0.1$ in univariate analyses (Tables 1 and 2) were initially included as independent variables in the multiple logistic regression model. Only variables that remained significant at $p<.05$ were retained in the final model.

* $p<.05$

Table 4

Multiple logistic regression of variables associated with experimenter status (*n*=99)

Variable	β	SE	Odds ratio (95% CI)	*p*
Age at study (years)	0.56	0.21	1.76 (1.16–2.66)	.007**
Parental divorce				
No			1.0	
Yes	1.48	0.66	4.40 (1.21–16.06)	.025*

Odds ratio of 1.0 indicates the reference group for the categorical variable. Five variables with $p<.10$ in univariate analyses (Tables 1 and 2) were initially included as independent variables in the multiple logistic regression model. Only variables that remained significant at $p<.05$ were retained in the final model.

* $p<.05$,

** $p<.01$