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A prospective, longitudinal study of cigarette smoking status among North American Indigenous adolescents



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HIGHLIGHTS

- Female Indigenous youths had higher rates of smoking than male youths over time.
- Problem behavior theory guides us to identify predictors of smoking status.
- · Generalized estimating equation model was used to investigate longitudinal predictors of smoking status.
- · Family warmth and support was negatively associated with occasional smoking.
- · Frequent smoking was associated positively with depression symptoms and negatively with positive school activity.

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1. Introduction

Although adolescent daily cigarette use has declined in the past decade from 32% in 2002 to 19% in 2013 (Substance Abuse and Mental Health Services Administration, 2014), American Indian or Alaska Native (AI/AN) adolescents have higher rates of cigarette smoking than other ethnic/racial groups. According to a national report, AI/AN youths aged 12–17 years had the highest rate of 30-day cigarette smoking (18.9%), followed by White (10.6%), Hispanic (7.9%), Black (5.0%) and Asian (3.8%) adolescents (SAMHSA, 2009). Such high rates of cigarette smoking increase the risk for the two leading causes of death–heart disease (18.4%) and cancer (18.2%)–among American Indians (CDC, 2015). Additionally, AI/AN adults at aged 45 or older reported a significantly higher prevalence of cardiovascular disease than non-AI/AN adults (Harwell et al., 2001). We note that the prevalence rates of smoking and its consequences can vary by region and culture within AI/AN communities (Whitbeck, Yu, McChargue, & Crawford, 2009; Yu, 2011a, 2011b; Yu, Stiffman, & Freedenthal, 2005). Given the fact that AI/AN youth had the highest rates of current smoking and smoking-related health problems, efforts to provide information about establishing effective smoking cessation and prevention strategies for AI/AN smokers is an urgent public health need.

Eliminating adolescent smoking problems requires a greater understanding of various risk and protective factors. For our study, we employed Jessor and Jessor's (Jessor & Jessor, 1977) problem behavior theory (PBT) to identify factors associated with Indigenous adolescent smoking behavior. Here, Indigenous adolescents indicate American Indian youth who lived in North American Indians and Canadian First Nations tribes. The conceptual structure of PBT consists of three major systems explaining problem behavior: the personality system, the perceived environment system, and the behavior system. The theory asserts that each system serves either as instigations for or controls against engaging in problem behavior. The degree of problem behavior proneness is determined by the balance between instigations and controls across all three systems.

The personality system includes socio-cognitive variables reflecting social learning and developmental experience such as values and orientations toward self. For example, prior studies were conducted using samples of non-AI/AN youth and showed that intention to smoke (Ariza-Cardenal & Nebot-Adell, 2002; Hoving, Reubsaet, & De Vries, 2007; Skara, Sussman, & Dent, 2001) and depressive symptoms (Munafò, Hitsman, Rende, Metcalfe, & Niaura, 2008; Weiss, Mouttapa, Cen, Johnson, & Unger, 2011) may be associated with smoking status such as occasional smoking and frequent smoking.

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The perceived environment system includes social-contextual investigations toward involvement in and controls against problem behavior. A number of studies were conducted using samples of both AI and non-AI youth and reported that friends' smoking was one of the most consistent and strongest predictors of smoking (Dierker, Avenevoli, Goldberg, & Glantz, 2004; Fergusson, Lynskey, & Horwood, 1995; Mak, Ho, & Day, 2012; Yu et al., 2005). In terms of the association between racial discrimination and smoking behavior, most studies were conducted with non-AI samples, and reported that, for example, high levels of racial discrimination were significantly related to odds of lifetime smoking among African American girls aged 11 through 19 years (Guthrie, Young, Williams, Boyd, & Kintner, 2002) and of current smoking among Asian American adults ages 18 years or older (Chae et al., 2008). On the other hand, family support (e.g., spending time with family) served as a protective factor against cigarette smoking among non-AI/AN adolescents (Barnes, Hoffman, Welte, Farrell, & Dintcheff, 2007; Simons-Morton, Chen, Abroms, & Havnie, 2004).

The behavior system comprises both problem behavior (e.g., use of cigarette, alcohol and marijuana, and general deviant behavior) and conventional behavior that is socially approved for adolescents (e.g., participation in church or school activities) (Jessor & Jessor, 1977). Most research on the association between behavior system variables and smoking behavior was conducted using non-AI/AN youth. Smokers were more likely to drink alcohol and use illicit drugs than nonsmokers (Ariza-Cardenal & Nebot-Adell, 2002; Bentler, Newcomb, & Zimmerman, 2002; Dierker et al., 2004; J. Yu & Williford, 1992; M. Yu et al., 2005), and engage in deviant behavior (Brook, Balka, Rosen, Brook, & Adams, 2005; Crone & Reijneveld, 2007; Dierker et al., 2004; Forrester, Biglan, Severson, & Smolkowski, 2007). On the other hand, studies revealed that participation in positive school activities such as physical activities (Audrain-McGovern, Rodriguez, Wileyto, Schmitz, & Shields, 2006) and extracurricular activities (Brown et al., 2002; Elder, Leaver-Dunn, Wang, Nagy, & Green, 2000) were negatively related to adolescent smoking.

There are gaps in the above-mentioned studies. First, although the associations between PBT variables and adolescent cigarette smoking, there is a lack of research examining adolescent smoking status. Second, most studies were conducted using cross-sectional data. Third, only a few studies were conducted using a sample of AI/AN youth. In order to fill these gaps, this prospective, longitudinal study has two objectives: 1) to estimate prevalence of cigarette smoking status (nonsmoking, occasional smoking, and frequent smoking) over a three-year period in a sample of Indigenous adolescents; and 2) to examine the relative effects of personality system, perceived environment system, and behavior system variables on cigarette smoking status over time.

2. Methods

2.1. Research design and participants

The data were collected as part of a larger longitudinal prospective study to examine culturally specific resilience and risk factors that affect children's well-being and then to use information for the development of culturally-based interventions.

This current study is based on the first three waves of the larger study. Wave 1 data were collected from youth aged 10–13 years at each site from February through October 2002 (N = 743). There was a one-year lag between data collection for the subsequent two waves (N = 704 at Wave 2 and N = 694 at Wave 3). Four U.S. reservations and four Canadian reserves participated in the study. In our study, these reservations and reserves were classified as remote and rural. Rural locations were within somewhat close proximity to other towns, whereas remote locations were considerable distances from even small towns and were accessed by non-paved roads. Three of the Canadian Reserves were classified as "remote." Still, the reservations/reserves in this sample shared a common cultural tradition and language with minor regional

variations in dialects. The sample was representative of one of the most populous Indigenous cultures in the United States and Canada. To ensure confidentiality of tribe and participants, the study does not report participating reservation names.

The retention rates among the reservations/reserves were very high, ranging from 93% to 100%, with 93% overall retention from Wave 1 to Wave 3. Of those who left the study, 3.4% of the attrition was due to refusal to participate. Other reasons for attrition included the death of the study adolescent (two individuals) and loss of contact with the family (25 families). The attrition analyses showed that those youths who left the study had significantly higher occasional smoking (17.0% vs. 8.4%, p = .045) and frequent smoking (11.4% vs. 3.1%, p = .007) behaviors than those who remained in the study at Wave 3. Additionally, there was a significant gender difference in rates of frequent smoking among those who left the study (female, 41.7% vs. male, 0%, p = .012). Those who left the study also had significantly higher rates of living in the "remote" location (18.9% vs. 9.0, p = .034), drinking alcohol (14.8% vs. 5.4%, p = .009) and smoking marijuana (11.1% vs. 4.8%, p = .038) than those who remained in the study.

Descriptive characteristics of the study sample are provided in Table 1. Details of sampling and interview procedures were published elsewhere (Whitbeck, Yu, Johnson, Hoyt, & Walls, 2008; Whitbeck et al., 2009).

2.2. Measures

2.2.1. Cigarette smoking status (Dependent variable)

Cigarette smoking status (Dependent variable) was measured at each time point. Youths were first asked if they had ever smoked cigarettes. If youths reported ever smoking, they were asked how often in the past 12 months they smoked. The responses to the combined question resulted in a 7-point scale assessing the intensity of adolescent cigarette smoking ("0 = never," "1 = one or two times a year," "2 = less than once a month," "3 = once a month," "4 =every week," "5 = nearly every day," and "6 = every day"). Based on a wide range of definitions of smoking status (CDC, 2000; Husten, 2009), cigarette smoking status was operationally defined as three categories based on the combined question in our study: nonsmokers (have never smoked in their life, "0"), occasional smokers (smoked monthly or less, " $1, 2 \otimes 3$ "), and frequent smokers (smoked weekly or more, " $4, 5 \otimes 6$ ").

2.2.2. Intention to smoke (Personality system variable)

Intention to smoke (Personality system variable) was created for this study and measured by a single item regarding agreement to a statement: when I get older, I will smoke cigarettes. Intention to smoke was dichotomized with 1 indicating "agree" and 0 indicating "disagree."

2.2.3. Depressive symptoms (Personality system variable)

Depressive symptoms (Personality system variable) were measured using the Center for Epidemiologic Studies Depression Scale, a 20-item self-report scale to evaluate past week levels of depressive symptoms (Radloff, 1977) and has been used for Indigenous populations (e.g., Whitbeck et al., 2009). Responses were rated on a 4 point scale ("0 = 0 days," "1 = 1-2 days," "2 = 3-4 days," and "3 = 5-7 days"). Items to the 20 questions were summed. The scoring of positive items was reversed. The higher scores indicate higher depressive symptoms. The scale has a high internal consistency reliability across time with Cronbach's alpha of 0.85 at Wave 1 (actual range: 0–44), 0.83 at Wave 2 (actual range: 0–47) and 0.83 at Wave 3 (actual range: 0–46).

2.2.4. Best friends' smoking (Perceived environment system variable)

Best friends' smoking (Perceived environment system variable) was measured by a single item. Adolescents were asked, as far as they knew, how many of their three best friends smoke cigarettes. This question has

Table 1

Descriptive Information.

%/Mean	Possible range	Wave 1 (N = 743)	Wave 2 (N = 704)	Wave 3 (N = 694)
Demographic variables				
Female	0-1	50.2%	50.0%	49.6%
Remote location	0-1	10.4%	8.8%	9.7%
Household income	1 (\$5000) - 10 (\$75,000)	4.9 (\$20,001) - (\$25,000)	5.0 (\$20,001) - (\$25,000)	5.1 (\$20,001) - (\$25,000)
Family structure (Single mother)	0-1	23.1%	23.0%	23.7%
Personality system variables				
Intention to smoke	0-1	9.1%	13.6%	17.1%
Depressive symptoms	0-60	12.5	12.7	13.4
Perceived environment system variables				
# of best friends' smoking	0-3	0.5	0.9	1.1
Perceived discrimination	0-22	3.1	2.4	2.3
Family warmth and support	0-24	16.7	15.8	15.5
Behavior system variables				
Alcohol use	0-1	6.1%	18.1%	27.4%
Marijuana use	0-1	5.3%	13.8%	20.6%
Deviant behaviors	0-30	2.7	3.1	3.3
Positive school activities	0-2	1.4	1.3	1.3

been used in prior studies of Indigenous populations (e.g., Walls & Whitbeck, 2011). Responses were rated on a 4 point scale ("0 = none" to "3 = three friends").

2.2.5. Perceived discrimination (Perceived environment system variable)

Perceived discrimination (Perceived environment system variable) was measured using an 11-item scale regarding exposure to racial discrimination. This measurement was adapted from the Schedule of Racist Events (Landrine & Klonoff, 1996). Tribal advisory boards assisted the research team in adapting the original items to be applicable to Indigenous samples. Detailed information about the scale was published elsewhere (Walls, Johnson, Whitbeck, & Hoyt, 2006). Response categories ranged from "0 = never" to "2 = many times." Items were summed such that higher scores indicate higher levels of perceived discrimination. The scale has a high internal consistency reliability across time with Cronbach's alpha of 0.80 at Wave 1 (range 0–17), 0.83 at Wave 2 (range 0–18) and 0.81 at Wave 3 (range 0–20).

2.2.6. Family warmth and support (Perceived environment system variable)

Family warmth and support (Perceived environment system variable) was measured with a 12-item scale measuring the amount of agreement to statements regarding family warmth and support. The measure was adapted from the lowa Youth and Families Project (Conger & Elder, 1994) and was validated in previous studies of Indigenous populations (e.g., Melander, Hartshorn, & Whitbeck, 2013). The items, for example, include "When you do something you are supposed to do, how often do you get special attention from your family?" and "When you do something good, how often does someone in your family compliment or say nice things about what you did?" Responses were rated on a 3-point Likert scale ("0 = never," "1 = sometimes," and "2 = always"). Higher values indicate higher levels of family warmth and support. Cronbach's alpha coefficient is 0.80 at Wave 1 (range: 1–24), 0.86 at Wave 2 (range: 0–24) and 0.85 at Wave 3 (range: 2–24).

2.2.7. Alcohol use and marijuana use (Behavior system variables)

Alcohol use and marijuana use (Behavior system variables) were measured by asking a single question per substance: "Have you had a drink of alcohol in the past 12 months?" and "Have you smoked marijuana in the past 12 months?" Responses to each question were coded as a dichotomous option ("1 = yes" and "0 = no"). These questions have been used in prior research of Indigenous populations (e.g., Walls, 2008).

2.2.8. Deviant behavior (Behavior system variable)

Adolescents rated a 28-item self-report scale to evaluate the presence of things they may have done that can get people into trouble in the past 12 months. This scale was created by adapting the conduct disorder module of the Diagnostic Interview Schedule for Children-Revised (DISK-R; Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000). It includes questions regarding having stolen money, shoplifted, faked someone's name, attacked someone, threatened someone, stayed out at night more than 2 h, ran away overnight, lied to get money, broke into something on purpose, started a fire without permission, bullied someone, started a physical fight, damaged someone, and been arrested. Responses on a dichotomous scale to these 28 items were summed. The higher scores indicate greater deviant behaviors. Cronbach's alpha coefficient is 0.83 at Wave 1 (range: 0–20), 0.86 at Wave 2 (range: 0–22) and 0.85 at Wave 3 (range: 0–19).

2.2.9. Positive school activities (Behavior system variable)

Positive school activities (Behavior system variable) were created for this study and assessed by two dichotomous items that asked the adolescents whether they participated in school sports and extracurricular school activities. Response categories were "1 = participated" and "0 = did not participate."

2.2.10. Family structure (Demographics)

Adolescent caretakers were rated on their relationship to adolescents (e.g., biological mother, biological father, stepmother, stepfather, etc.). Family structure was dichotomized with 1 indicating "single biological mother" and 0 indicating "all other family structures."

2.3. Statistical analyses

Means and percentages were calculated for all demographics, the personality system, the perceived environment system, and the behavior system variables across time (Table 1). χ^2 tests were used to examine the associations between gender and smoking status at each wave (Fig. 1). We chose generalized estimating equation (GEE) models to investigate the relative effects of demographics, time, and the three system variables (personality, perceived environment, and behavior) on cigarette smoking status over a 3-year period (Table 2). The GEE methodology allows simultaneous modeling of both time-dependent variables and time-independent variables (i.e., gender and location in this study), and yields estimates of odds ratios for possible comparisons of smoking status (Davis, 1993): 1) occasional smoking vs. nonsmoking, 2) frequent smoking vs. nonsmoking, and 3) frequent smoking vs. occasional smoking, GEE models are specified in almost the same manner as







logistic regression models (McCullagh & Nelder, 1989). However, GEE is a technique that takes into account repeated measures on the same individual by controlling for autocorrelations across time (Liang & Zeger, 1986). GEE models are also useful for handling both normal and non-normal distribution data and are insensitive to missing at random (Liang & Zeger, 1986). The odds ratios of GEE models are a combination of both within- and between-subject relations (Zeger & Liang, 1986). GEE estimation is accomplished with the REPEATED statement in SAS software with the PROC GENMOD statement (Liang & Zeger, 1986).

3. Results

3.1. Sample characteristics

Table 1 presents descriptive information on demographics, and personality system, perceived environment system and behavior system variables. Across time, there was about half of each gender; approximately one in ten of the youths lived in the remote locations; and the average annual household income was between \$20,001 and \$25,000.

Regarding the patterns of the independent variables based on problem behavior theory, intention to smoke, best friends' smoking, alcohol use, and marijuana use all increased notably across time. On the other hand, the respondents reported positive aspects of each system variable: lower levels of depressive symptoms with a range from 12.5 to 13.4 (out of 60), high levels of family warmth and support with a range from 15.5 to 16.7 (out of 24), and positive school activities with a range from 1.3 to 1.4 (out of 2). Rates of all other variables were relatively stable (see Table 1).

3.2. Prevalence and patterns of occasional and frequent cigarette smoking

The 12-month prevalence and patterns of adolescent cigarette smoking status over time are detailed in Fig. 1. Nearly one in ten (8.6%) of the youths (female: 10.0%, male: 7.3%) reported smoking occasionally at the time of the first survey. The occasional smoking prevalence increased to 12.7% at Wave 2 (female: 16.2%, male: 9.2%) and 18.2% at Wave 3 (female: 22.2%, male: 14.6%). Interestingly, female youths had significantly higher rates of occasional smoking than male youths at each subsequent survey year: Wave 2 ($\chi^2 = 7.17$, p = .007) and Wave 3 ($\chi^2 = 5.61$, p = .017). The slope of female occasional smokers over the 3-year period.

Among frequent smokers, 3.8% (female: 3.6%, male: 4.1%) smoked cigarettes on a weekly or daily basis at Wave 1. The prevalence of frequent smoking increased to 9.1% (female: 11.2%, male: 7.2%) at Wave 2 and 19.7% (female: 20.1%, male: 13.8%) at Wave 3. Similar to the patterns of occasional smoking across time, female frequent smokers had significantly higher rates than male frequent smokers at Wave 3 ($\chi^2 = 14.03$, p = .0002). The slope of female frequent smokers was more linear than the one of male frequent smokers (see Fig. 1 for illustrations of the pattern).

3.3. Longitudinal predictors of occasional and frequent cigarette smoking

The results of GEE for predicting cigarette smoking status across time are presented in Table 2. Three separate sets of analyses were conducted for predicting occasional smoking (vs. nonsmoking), frequent smoking (vs. nonsmoking), and frequent smoking (vs. occasional smoking).

As shown in Model 1, residing in non-remote rural locations, being female, and time (Wave 3 vs. Wave 1) positively predicted occasional smoking. When controlling for the demographic variables and time, increases in intention to smoke, best friends' smoking, alcohol use, marijuana use, and deviant behaviors positively predicted increases in occasional smoking status over the 3-year period. On the other hand, family warmth and support negatively predicted occasional smoking (vs. nonsmoking).

Similar to the predictors of occasional smoking, Model 2 revealed that time (Wave 3 vs. Wave 1), intention to smoke, best friends' smoking, alcohol use, marijuana use, and deviant behaviors remained significant in predicting increases in adolescent frequent smoking (vs. nonsmoking). However, unlike the predictors of occasional smokers, frequent smokers were more likely to have depressive symptoms and less likely to participate in positive school activities than nonsmokers. Additionally, family warmth and support was no longer significant in predicting frequent smoking.

Model 3 showed that, after controlling for demographics, frequent smokers had a significantly higher level of intention to smoke, depressive symptoms, best friends' smoking, and marijuana use than occasional smokers. However, alcohol use and participation in deviant behaviors were no longer significant predictors of frequent smoking when compared to occasional smoking.

Table 2

Generalized estimating equations: Odds ratios and 95% confidence intervals for cigarette smoking status.

	Model 1 Occasional smoking (vs. nonsmoking)		Model 2 Frequent smoking (vs. nonsmoking)		Model 3 Frequent smoking (vs. occasional smoking)	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Demographic & time variables						
Remote (vs. rural) location at baseline ^a	0.37*	(0.16, 0.86)	1.04	(0.34, 3.13)	4.24	(0.75, 24.10)
Female (vs. male) at baseline ^a	1.63*	(1.08, 2.45)	1.51	(0.76, 3.01)	0.72	(0.40, 1.32)
Household income	0.99	(0.90, 1.08)	1.07	(0.93, 1.23)	1.01	(0.89, 1.14)
Single mother (vs. all other structure)	1.20	(0.77, 1.85)	1.03	(0.48, 2.20)	0.98	(0.56, 1.73)
Time						
Wave 2 (vs. Wave 1)	0.85	(0.54, 1.33)	0.99	(0.42, 2.28)	1.20	(0.50, 2.88)
Wave 3 (vs. Wave 1)	1.66*	(1.08, 2.56)	2.49*	(1.09, 5.72)	2.44*	(1.08, 5.54)
Personality system variables						
Intention to smoke	3.57***	(2.16, 5.88)	15.04***	(7.30, 30.99)	4.23***	(2.42, 7.39)
Depressive symptoms	1.00	(0.97, 1.02)	1.04*	(1.00, 1.08)	1.04^{*}	(1.01, 1.07)
Perceived environment system variable						
Best friends' smoking	1.62***	(1.37, 1.92)	2.42***	(1.88, 3.11)	1.81***	(1.40, 2.34)
Perceived discrimination	1.00	(0.94, 1.08)	0.94	(0.85, 1.04)	1.00	(0.92, 1.09)
Family warmth and support	0.95*	(0.90. 0.99)	0.99	(0.92, 1.06)	1.03	(0.96, 1.09)
Behavior system variables						
Alcohol use	2.86***	(1.76, 4.66)	3.43***	(1.66, 7.09)	1.42	(0.75, 2.69)
Marijuana use	4.24***	(2.43, 7.41)	8.03***	(4.05, 15.92)	2.45**	(1.35, 4.44)
Deviant behaviors	1.15***	(1.09, 1.21)	1.15**	(1.05, 1.25)	1.06	(0.99, 1.13)
Positive school activities	0.91	(0.72, 1.15)	0.62*	(0.42, 0.91)	0.64**	(0.46, 0.88)

Note. ^aTime-invaring variable; OR = odds ratio; CI = confidence interval.

****p* < .01. *****p* < .001.

4. Discussion

This study tested problem behavior theory to investigate predictors of adolescent cigarette smoking status in a longitudinal sample of Indigenous adolescents. In our study, we found that, by Wave 3 (aged 11 through 15 years), 18% (22% of the girls and 15% of the boys) smoked occasionally; and 20% (20% of the girls and 14% of the boys) smoked frequently in the past year. Although we have no Indigenous comparison groups of 12-month occasional and frequent smoking behaviors, our findings are similar to prevalence rates in a nationally representative sample of Indigenous adolescents. The 2005 NSDUH data (USDHHS, 2005) that was comparable with our Wave 3 data estimated 18% of Indigenous adolescents aged 12 through 17 years smoked cigarettes in the preceding month.

This study extends the literature in the areas of adolescent smoking by testing existing risk and protective factors for adolescent smoking status, based on a framework of problem behavior theory, in a longitudinal sample of Indigenous youth. Consistent with prior research on adolescent smoking behavior, our findings indicated that older age (Whitbeck et al., 2009; Yu, 2011a, 2011b), intention to smoke (Ariza-Cardenal & Nebot-Adell, 2002; Hoving et al., 2007), best friends' smoking (Dierker et al., 2004; Fergusson et al., 1995; Flay et al., 1994; Simons-Morton et al., 2004), and marijuana use (Yamaguchi & Kandel, 1984; J. Yu & Williford, 1992) were predictors of occasional smoking and frequent smoking (vs. both nonsmoking and occasional smoking). Alcohol use (Ariza-Cardenal & Nebot-Adell, 2002; Bentler et al., 2002; Dierker et al., 2004) and participation in deviant behaviors (Brook et al., 2005; Crone & Reijneveld, 2007; Forrester et al., 2007) predicted occasional smoking and frequent smoking (vs. nonsmoking). Depressive symptoms (Munafò et al., 2008; Whitbeck et al., 2009) and participation in positive school activities (Audrain-McGovern et al., 2006) negatively predicted only frequent smoking, while family warmth and support (Barnes et al., 2007; Simons-Morton et al., 2004) negatively predicted only occasional smoking.

Our results suggest important implications for improving existing tobacco control programs for adolescent smokers. First, programs may address the abovementioned factors in terms of smoking status. Intention to smoke, best friends' smoking, deviant behaviors, alcohol use, and marijuana use were common risk factors for both occasional smoking and frequent smoking, whereas depressive symptoms were a predictor of frequent smoking only. Hence, practitioners may consider eliminating intention to smoke, assessing best friends smoking, screening for other substance use such as marijuana use, and assessing involvement in deviant behaviors for Indigenous occasional smokers and frequent smokers. Specifically, in addressing intention to smoke, programs may emphasize self-efficacy (Ausems, Mesters, van Breukelen, & De Vries, 2003) and concurrently provide incentives or disincentives to quit. Similar to those for non-Indigenous youths, programs may also be effective when they emphasize skills to resist cigarette offerings by friends and overcome peer pressure to smoke (Stanton, Baade, & Moffatt, 2006; Yu, 2011a, 2011b). Concurrently, practitioners may also encourage their friends to stop smoking (Chen, White, & Pandina, 2001). In addition to strategies for cessation, screening and treatment for multiple substance use and deviant behaviors should be incorporated into programs. Interestingly, we found that alcohol use and involvement in deviant behaviors were associated with the difference between occasional smoking and frequent smoking. In other words, those youth who smoke occasionally can become frequent smokers if they drink alcohol and/or are involved in deviant behaviors (e.g., stolen money and bullied someone). In order to prevent occasional smokers from becoming frequent smokers, assessment of and treatment for alcohol use and deviant behaviors should be of primary consideration. Lastly, screening and treatment for depressive symptoms may also be an important component in developing a cessation program for Indigenous adolescent frequent smokers.

On the other hand, protective factors such as positive school activities, and family warmth and support uniquely predicted decreases in occasional smoking and frequent smoking, respectively. Accordingly, promoting family warmth and support may be more effective for quitting among occasional smokers, whereas promoting positive school activities may prevent nonsmokers or occasional smokers from becoming frequent smokers. Promoting these two positive factors could play important roles in strengths-based tobacco control programs, particularly for Indigenous youth. Family influence is vitally important in adolescent development among Indigenous populations because many American Indian tribes have strong and cohesive family units (Glover, 2001).

^{*}p < .05.

Additionally, focusing smoking cessation and prevention efforts earlier in adolescence is highly recommended because our data indicated cigarette smoking behavior drastically increased as the youth aged. Unlike other racial/ethnic youths, Indigenous female youths were more likely than male youths to smoke occasionally and frequently across time in our sample. Hence, it is important for service providers to understand this unique gender difference, and incorporate the difference into cessation strategies for Indigenous adolescent smokers.

This study has limitations that should be considered when interpreting findings. First, the Indigenous sample is limited to only eight geographic areas, and youth represent only one culture. Thus, our findings may not be generalizable to other AI/AN cultures and tribes, other locations, and other ethnic/racial youths. Second, all our investigations were based on self-reported data from adolescents. Hence, response bias could affect some findings (e.g., estimates of cigarette smoking). Additionally, the research design of this present study could not confirm a causal relationship between longitudinal predictors and cigarette smoking status. Future research should attempt to identify causal factors for smoking status, progression to frequent smoking and tobacco use disorder, and co-use of other forms of tobacco. Additionally, more research on smoking status should be conducted across different adolescent population segments to understand various intervention needs.

Regardless of these limitations, this study strengthens problem behavior theory in that findings are consistent with all three system variables of PBT in the sample. More importantly, this study uniquely provides evidence on the negative associations between protective variables (i.e., family warmth and support, and positive school activities) and cigarette smoking status.

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