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Introduction

Adolescent smoking is an important health issue because nicotine is one of the most addictive substances known [1] and about 80% of adults who use tobacco initiated cigarette smoking before age 18 years in the United States [2]. Although tobacco use may not be immediately life-threatening to adolescent smokers, cigarette smoking is a serious risk factor for poorer perceived health, mental problems, and a variety of physiological symptoms [3]. With more than one-third of high school students reporting smoking at least once a month and 17% reporting smoking a cigarette almost every day [4, 5], teen cigarette smoking is a significant public health concern in our society [2].

An extensive amount of research has theorized and tested numerous pathways linking social context to adolescent smoking behavior. The *social learning and social development theories* emphasize the importance of the learning process which includes social interactions with influential others such as parents, peers, schoolmates, and neighbors. So adolescents are typically protected from smoking if the socializing agents discourage smoking and cigarettes are less accessible [6-10]. In addition, parental control, parent-child closeness, parent-child communication, and parental involvement in the child's daily life have all been linked to adolescent risk behavior including cigarette smoking [9, 11-14]. Complementarily, the *socioeconomic resources perspectives* argue that low parental socioeconomic status (SES) puts adolescents at risk [15, 16] . Parental education is a protective factor against children's deviant behaviors because parental education is positively linked to parental expectations on children's academic achievement and it probably contributes to more constructive and efficient parenting styles. Household income has also been found to be protective, perhaps due to its linkage with parental education, positive parental styles, and other advantaged life circumstances. Moreover, the *social strain theories* maintain that exposure to stressors should be linked to increased smoking [12, 17]. Parental conflict and separation, as an additional feature of family processes and is not necessarily related to family SES, can act as a stressor and has been positively linked to adolescent smoking likely through raising depressive symptoms and rebelliousness in adolescents [9]. Other stressors that have been proposed to promote teen smoking include attending an academically competitive school. The argument runs that school-level academic expectations can be a marker of the school's competitiveness and can result in a stressful school environment [12]. Here neighborhood theories seem relevant as well in that neighborhood is another possible source of strain an adolescent may face. While little research has specifically addressed neighborhood effects on adolescent smoking, numerous studies have confirmed that poor neighborhood environment is detrimental to health and health behavior across the life span [18]. It is possible then that neighborhood or community context exerts additional impact on adolescent smoking net of factors at more proximate levels [19].

Compared to contextual factors at the family, peer, school, and neighborhood level, individual factors may have a stronger impact on smoking [13]. For instance, poor school performance, low self-esteem, work for pay, and perceived physical maturity have been found to be positively associated with smoking [17, 20-22], whereas immigrant status has been shown to be strongly protective for both adults and adolescents against poor health practices.

Although findings of these risk factors of adolescent smoking is readily available, little research has simultaneously examined the impact of a wide range of risk factors at multiple levels to adjudicate among different theories of the causes of adolescent smoking. As has been argued previously [19, 23-25], we need to recognize and analyze the contributions of overlapping and interacting contexts and explore an ecological model of health and health behavior while taking various social settings into account.

In addition, while many studies have reported that determinants of adolescent smoking seem to be nonspecific to racial/ethnic groups [13, 14], there have been persistent racial/ethnic disparities with Whites routinely having the highest prevalence rate among all major racial/ethnic groups [12]. To date, little research has specifically attempted to explain these racial/ethnic differences, so we know little about why adolescents from different racial/ethnic groups have different risks of smoking.

Using a nationally representative longitudinal sample, this study aims to fill in the void in the literature by investigating factors at the individual, family, peer, school, and neighborhood levels that are important for adolescent cigarette smoking. Moreover, we explore mechanisms that potentially explain racial and ethnic disparities in adolescent smoking.

Data

The analysis in this study uses publicly accessible data from waves 1 and 2 of the National Longitudinal Study of Adolescent Health. The sampling frame consists of all high schools in the United States that had an enrollment of over 30 students and the junior high and middle schools that sent their graduates to these schools in the 1994-1995 school year. From this frame, 134 schools (80 high schools and 54 middle or junior high schools) were selected to be in the sample. Using appropriate sample weights, 18,924 students from these schools make up a representative sample of adolescents enrolled in the seventh through twelfth grades in the United States. Approximately one year after the first interview, members of the original sample who had not yet graduates were reinterviewed. Students completed 14,738 surveys, and sample weights could be constructed for 13,570. This study uses data for adolescents who completed both waves of the survey. More detailed information on the National Study of Adolescent Helath, has been published elsewhere [22]. The public data of the ADD health consists of a randomly selected subsample of the original data. After imputing missing values using the best-subset regression method, and excluding missing values that are not easily imputed (e.g., immigrant status), we have 3,348 cases in our analysis. We are right now in the process of getting full ADD Health data and will repeat all the analysis presented here once we have the data. All independent variables are from wave 1 and the dependent variable (daily smoking) is from wave 2.

Measures

. Daily smoking. Ever smoked at least 1 cigarette every day for 30 days by Wave 2.
. Race/ethnicity: non-Hispanic White, non-Hispanic Black, Hispanic, Asian, Other
. Immigrant generation: first (foreign born plus foreign born parents), second (US born   plus foreign born parents), third or more (US born plus US born parents).
. Physical maturity: advanced physical development compared to others of the same age.

. Intelligence: perceived intelligence relative to average.
. Self-esteem: believe self has a lot of good qualities
. Work: weekly earnings, weekly allowance, weekly work hours for pay
. Grade: average grade of four subjects (math, English, history or social studies, and science)
. Peer: peer smoking (number of smokers among 3 closest friends), frequency of hanging out with friends ('times hang out with friends last week')
. Family: parental smoking (at least one parent smokes), parental education (10 levels), annual household income, family structure (intact family vs. others), parental conflict (parents fight a lot), parental control (8 items; α=0.60), closeness with parents (8 items; α=0.85), parent-child communication (6 items; α=0.61), parental involvement (9 items; α=0.61), mom's academic expectation (expect the child to go to college)
. School: self-perceived comfort level with school environment (7 items; α=0.77), average perceptions of students' relationship (mean score of the item 'do you think students are getting along in this school?'), average perceptions of academic expectation in school (mean score of the item 'what do you think are the chances you will: graduate from college?'), prevalence of smoking in school (average score of the item "during the past 12 months, how often do you smoke cigarettes?')
. Neighborhood: median household income, satisfaction with neighborhood ('how happy are you with living in the neighborhood?'), use recreation facilities ('do you use a physical fitness or recreation center in your neighborhood?'), neighbors look out for each other ('people in this neighborhood look out for each other')

Statistical modeling

Weighted logistic regression models were fit to test the risk factors of adolescent daily smoking and examine the ways through which race/ethnicity affects daily smoking. The analysis has taken the complex sampling into account.

Results

Table 1 presents coefficients of logit models exploring a social determinant model of on adolescent daily smoking. Model 1 examines previously identified risk factors at the individual level. Controlling for these individual characteristics, Whites seem to be more likely to be daily smokers than Blacks and Latinos, and third generation immigrants are significantly more likely than first generation immigrants to smoke. Physical maturity, frequency of hanging out with friends, and weekly earnings are positively linked to smoking, whereas better grade and satisfaction with school life are protective against smoking. Model 2 keeps risk factors that are found significant in the previous model and adds parental SES indicators. Interestingly, in the presence of the strong effects of individual risk factors, parental SES seems not important for adolescent smoking. Model 3 adds perceived neighborhood structural and social environment and illustrates that none of parental SES indicators and neighborhood perceptions exerts additional impact on adolescent smoking after controlling for several salient demographic, physical, socioeconomic, and psychosocial factors at the individual level. These parental SES and neighborhood variables are thus subsequently excluded from the analysis. Model 4 tests whether social learning process matters to smoking net of individual factors. And we find strong evidence that adolescent smoking is strongly linked to parental smoking, peer smoking, and high prevalence of smoking in school. Model 5 further tests two school-level variables including academic

expectation in school and students' relationship in school. None of the two school-level variables is significant. Model 6 examines whether parenting styles have any further influence and shows that only closeness with parents exhibits some protective effect with borderline significance. Model 7 is a conclusive model that includes all risk factors at different levels that have been proved significant in previous models. According to this model, non-immigrant status, physical maturity, weekly earnings, frequent hanging out with friends, parental smoking, peer smoking, and prevalence of smoking in school are significant risk factors for smoking, whereas average grade and closeness with parents are protective factors. In this model, it appears Blacks are significantly less likely to smoke daily than Whites and there is no significant difference between other ethnic minority groups and Whites in terms of smoking. We then went on to explore what specific factors can explain this Black-White difference in youth smoking.

Table 2 presents seven models that explore the mechanisms underlying racial and ethnic differences in adolescent smoking. Model 1 serves as the baseline model. It appears that Whites are more likely to smoke daily than Blacks, Latinos, and Asians, but the lower risks of Latino and Asian adolescents are substantially accounted for by their immigrant status. A significantly higher proportion of Latinos and Asians are first or second generation immigrants. Among non-immigrants (third generation or above), Whites are not more likely to smoke than Asians and Hispanics in adolescence. By contrast, Black-White difference in adolescent smoking is hardly changed by immigrant status, which is consistent with their even lower proportion of first and second generation immigrants compared to Whites. On the other hand, less physical maturity, less frequency of hanging out with friends, lower average earnings in a non-summer week, higher level of closeness with parents, and lower prevalence of smoking among parents, peers, and schoolmates among Blacks constitute a set of pathways through which Black race is linked with lower levels of daily smoking than Whites. The coefficient of Black is reduced nearly 30% by these mediating variables (from Model 1 to Model 7, Table 2). However, there is still a large amount of Black-White difference in smoking that remains unexplained. Future qualitative and quantitative research is warranted to further unfold this intriguing difference between Whites and Blacks in adolescent daily smoking.

Summary Conclusions

Multi-level ecological modeling that takes various social contexts into account is necessary for us to advance our understanding of the causes of adolescent daily smoking. Racial/ethnic differences are remarkable but White-Asian and White-Hispanic differences are mainly due to higher proportions of immigrants among Asians and Hispanics. However, White-Black difference is not explainable by immigrant status. Racial/ethnic effect should be distinguished from immigrant effect when studying ethnic minority health. Traditional models of racial/ethnic differences in health do not apply for why Whites, on average being more advantaged in terms of various social, economic, and psychological resources, are more likely to engage in smoking as a deviant risk behavior among adolescents. Having stronger sense of physical maturity, more disposable income, more contacts with friends, lower levels of closeness with parents, and higher prevalence of smoking among important socializing agents among white adolescents are important explanatory factors for Whites' having higher rate of daily smoking in adolescence but they only partially explain this relationship. More theoretical and empirical work is needed to better understand this phenomenon.

Table 1: Coefficients of Logit Models on Adolescent Smoking (exploring a social determinant model of adolescent smoking)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Age	0.126**	0.130**	0.131**	0.029	0.021	0.005	0.017
	(0.040)	(0.040)	(0.040)	(0.048)	(0.053)	(0.051)	(0.047)
Male	-0.421**	-0.438**	-0.429**	-0.285	-0.275	-0.222	-0.241
	(0.137)	(0.141)	(0.136)	(0.144)	(0.144)	(0.155)	(0.148)
Black	-1.646**	-1.700**	-1.688**	-1.141**	-1.117**	-1.112**	-1.118**
	(0.174)	(0.170)	(0.168)	(0.175)	(0.177)	(0.179)	(0.175)
Latino	-0.567*	-0.610**	-0.605**	-0.274	-0.264	-0.263	-0.276
	(0.221)	(0.226)	(0.225)	(0.238)	(0.237)	(0.239)	(0.237)
Asian	0.008	0.007	0.014	0.012	-0.014	-0.062	-0.060
	(0.323)	(0.328)	(0.323)	(0.413)	(0.418)	(0.428)	(0.422)
Native	-0.097	-0.110	-0.104	-0.016	0.016	0.073	0.005
	(0.322)	(0.330)	(0.332)	(0.333)	(0.338)	(0.342)	(0.330)
Second Generation Immigrant	0.273	0.263	0.277	0.183	0.190	0.178	0.183
	(0.376)	(0.378)	(0.376)	(0.415)	(0.420)	(0.415)	(0.415)
Third Generation Immigrant	0.954**	0.966**	0.975**	0.745	0.742	0.778*	0.760
	(0.339)	(0.335)	(0.331)	(0.382)	(0.384)	(0.387)	(0.386)
Physical Maturity	0.190**	0.188**	0.188**	0.143*	0.141*	0.142*	0.147*
	(0.055)	(0.056)	(0.056)	(0.060)	(0.060)	(0.059)	(0.058)
Self-perceived Intelligence	-0.070						
	(0.052)						
Self-esteem	-0.159	-0.175*	-0.162	-0.176*	-0.178*	-0.127	-0.141
	(0.085)	(0.083)	(0.084)	(0.089)	(0.089)	(0.083)	(0.078)
Weekly Earnings	0.280*	0.364**	0.377**	0.249**	0.249**	0.250**	0.253**
	(0.121)	(0.099)	(0.106)	(0.087)	(0.088)	(0.086)	(0.086)
Weekly allowance	0.001						
	(0.006)						
Weekly work hours for pay	0.106						
	(0.111)						
Average grade	-0.773**	-0.795**	-0.788**	-0.407**	-0.420**	-0.409**	-0.419**
	(0.098)	(0.092)	(0.092)	(0.095)	(0.094)	(0.097)	(0.093)
Hang out with friends	0.312**	0.311**	0.315**	0.245**	0.244**	0.252**	0.248**
	(0.061)	(0.059)	(0.059)	(0.064)	(0.065)	(0.063)	(0.064)
Feeling good about school	-0.282**	-0.279**	-0.262**	-0.114	-0.116	-0.068	
	(0.075)	(0.074)	(0.079)	(0.075)	(0.077)	(0.079)	
Parental education		-0.020	-0.019				
		(0.025)	(0.025)				
Annual household income		0.000	0.000				
		(0.001)	(0.001)				
Intact family structure		-0.055	-0.049				
		(0.112)	(0.113)				
Neighborhood median income			0.000				
			(0.000)				
Happy with neighborhood			-0.013				
			(0.070)				
Neighborhood has recreation facilities			-0.239				
			(0.135)				

Neighbors look out for each other			0.133				
			(0.132)				
Parental smoking				0.220**	0.230**	0.225**	0.217**
				(0.056)	(0.059)	(0.059)	(0.056)
Peer smoking				0.814**	0.824**	0.803**	0.807**
				(0.053)	(0.054)	(0.056)	(0.057)
Prevalence of smoking in school				0.345*	0.353*	0.353*	0.362**
				(0.137)	(0.135)	(0.137)	(0.133)
Academic expectation in school					0.038	0.038	
					(0.051)	(0.052)	
Students get along in school					-0.060	-0.097	
					(0.095)	(0.103)	
Parental conflict						-0.073	
						(0.095)	
Parental control						-0.051	
						(0.039)	
Closeness with parents						-0.100	-0.110*
						(0.055)	(0.045)
Parent-child communication						0.025	
						(0.058)	
Mom's academic expectation						0.003	
						(0.048)	
Parental involvement						-0.047	
						(0.043)	

N=3348 individuals

Standard errors in parentheses

* significant at 5%; ** significant at 1%

Table 2: Coefficients of Logit Models on Adolescent Smoking (explaining black-white differences in adolescent smoking)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Age	0.237**	0.247**	0.150**	0.206**	0.083	0.239**	0.020
	(0.033)	(0.033)	(0.040)	(0.035)	(0.045)	(0.036)	(0.049)
male	-0.132	-0.140	-0.235	-0.042	-0.119	-0.218	-0.121
	(0.114)	(0.115)	(0.126)	(0.115)	(0.131)	(0.123)	(0.140)
Black	-1.390**	-1.398**	-1.303**	-1.383**	-1.057**	-1.536**	-0.995**
	(0.162)	(0.163)	(0.163)	(0.165)	(0.187)	(0.167)	(0.171)
Latino	-0.730**	-0.256	-0.324	-0.273	-0.117	-0.310	-0.165
	(0.199)	(0.204)	(0.204)	(0.214)	(0.230)	(0.206)	(0.232)
Asian	-0.906**	-0.151	-0.057	-0.347	-0.075	0.076	-0.123
	(0.267)	(0.292)	(0.295)	(0.315)	(0.392)	(0.301)	(0.399)
Native	-0.269	-0.116	-0.068	-0.072	-0.068	-0.280	-0.002
	(0.317)	(0.320)	(0.327)	(0.315)	(0.349)	(0.354)	(0.340)
Second generation immigrant		0.409	0.228	0.414	0.230	0.345	0.122
		(0.395)	(0.363)	(0.405)	(0.423)	(0.391)	(0.407)
Third generation immigrant		1.277**	0.963**	1.308**	0.847*	1.279**	0.726
		(0.329)	(0.315)	(0.350)	(0.374)	(0.322)	(0.372)
Physical maturity			0.184**				0.129*
			(0.053)				(0.057)
Hang out with friends			0.326**				0.245**
			(0.062)				(0.065)
Weekly earning (non-summer)			0.254*				0.212*
			(0.122)				(0.084)
Weekly allowance			-0.002				
			(0.005)				
Weekly work hours for pay			0.116				
			(0.106)				
Parental control				0.015			
				(0.033)			
Mom's academic expectation				-0.120**			
				(0.041)			
Closeness with parents				-0.221**			-0.139**
				(0.033)			(0.044)
Parental smoking					0.245**		0.238**
					(0.060)		(0.058)
Peer smoking					0.934**		0.873**
					(0.054)		(0.055)
Prevalence of smoking in school					0.455**		0.424**
					(0.130)		(0.130)
Students get along in school						0.178*	
						(0.068)	
Academic expectation in school						-0.334**	
						(0.047)	

N=3348 individuals

Standard errors in parentheses

* significant at 5%; ** significant at 1%

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