NATIVITY AND INTERGENERATIONAL TRANSMISSION OF SMOKING

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Objective. To examine the association between nativity and intergenerational transmission of smoking.
Design. Data were drawn from the National Longitudinal Study of Adolescent Health, a nationally representative study of adolescents in the United States with waves in 1994/95, 1996, 2001/02, and 2007-2008. A total of 5,464 individuals in grades 9-11 in 1994/95 are followed for eleven years. Latent class growth analysis is used to identify a set of developmental trajectories of daily smoking. Multinomial logit models are then used to predict trajectory membership based on nativity and maternal smoking.
Results. A set of five developmental trajectories is identified (never-smokers, occasional smokers, early starts, consistent heavy, and late starts). Race/ethnic differences in trajectory membership are initially observed, with non-Hispanic whites being significantly more likely to belong to most of the smoking trajectories compared to non-Hispanic blacks, Hispanics, and non-Hispanic Asians. For Hispanics and non-Hispanic Asians, observed differences in trajectory membership are attributable to the respondent or the respondent's mother being foreign-born. Non-Hispanic blacks remain less likely than non-Hispanic whites to belong to any smoking trajectory after controls on nativity. Mother's smoking history strongly predicted membership in all smoking trajectories relative to never-smoked. The protective effect of mother's foreign-born status against the consistent heavy trajectory was completely counteracted when the mother also had a history of smoking.
Conclusion. Most of the observed greater likelihood of non-Hispanic whites belonging to any of the developmental smoking trajectories than other race/ethnic groups is attributable to nativity status. There are virtually no significant differences in the developmental smoking patterns of native-born non-Hispanic white, Hispanic, and non-Hispanic Asian individuals; however, non-Hispanic blacks are significantly less likely than non-Hispanic whites to belong to any smoking trajectory. Individuals whose mothers had a history of smoking were at elevated risk of smoking. Foreign-born status is protective, except against the consistent heavy trajectory where the mother was foreign born and also smoked.

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Introduction

Adolescent smoking continues to be an important health issue because of its relation to adult tobacco consumption and numerous subsequent health outcomes, and because its prevalence has not declined to the same extent as it has for adults (Nelson et al., 2008). Despite considerable public health efforts to curb adolescent smoking, 22% of 8th graders and 46% of 12th graders report that they have tried smoking (Johnston, O'Malley, Bachman & Schulenberg, 2009). By 12th grade, nearly 1 in 4 adolescents report current (past month) smoking (Johnston et al., 2009). Signs of physical addiction to nicotine can occur early in the smoking onset process (Gervais, O'Loughlin, Meshefedjian, Bancej & Tremblay, 2006) and estimates suggest that between 20%-60% of adolescent smokers are dependent on nicotine (Colby, Tiffany, Shiffman & Niaura, 2000). Thus, the critical periods for successful smoking prevention and intervention are during adolescence and the transition to young adulthood.

Developmental pathways

Although smoking behavior tends to increase during adolescence and emerging adulthood (Kandel & Logan, 1984), substantial variability in the developmental pathways of smoking has been found using latent class growth analyses. These trajectory models typically identify between four and six smoking trajectories in adolescence, with relatively larger samples identifying larger numbers of trajectories. Commonly identified trajectory classes include never smokers, light smokers, increasers, and persistent heavy smokers (Brook, Balka, Ning & Brook, 2007; Colder et al., 2001; Lessov-Schlagger et al., 2008; Pollard et al. 2010; Riggs, Chou, Li & Pentz, 2007; White, Nagin, Replogle, & Stouthamer-Loeber, 2004).

Studies have identified risk factors associated with trajectory group membership, with the potential to identify particular subgroups of adolescent smokers who might be important intervention targets. For example, adolescents with less negative attitudes towards smoking, and with lower levels of mental well-being are at particular risk of smoking escalation (Soldz & Cui, 2002; White, Johnson, & Buyske, 2000).

Intergenerational transition of smoking

Those with a family history of smoking smoke more in a typical day, smoke for more years, have higher probabilities of developing nicotine dependence, have more positive beliefs about the psychological consequences of smoking, and report stronger motives for smoking (Chassin et al 1994). The escalation of smoking and stability of smoking behavior in adolescents has also been linked to parental smoking (Lieb et al 2003; Soldz & Cui 2002). In particular, mother's smoking is more influential than father's (Kandel and Wu 1995; Scragg & Glover 2007; Sullivan, Bottorff & Reid 2011).

Maternal smoking (both prenatal and postnatal) is linked to adolescent smoking through mechanisms that include genetic transmission of vulnerability and gene-environment interactions (Kahn et al 2003; Rutter 2005; Taylor & Rogers 2005) as well as learned behavior arising from observation of significant others (Avenevoli & Merikangas 2003; Chassin et al. 1998; Slomkowski et al 2005).

The role of parental smoking in socialization and modeling of behaviors may also include differential tolerance of smoking in the home, greater availability of tobacco products, models of

smoking behaviors, and may affect children's beliefs about smoking in ways that makes smoking more likely (Chassin et al. 1998; Cumsille 2003)

Parental smoking effects on adolescent smoking have are not moderated by parent education, family structure, adolescent age, or race/ethnicity (Ashley et al 2008), but we do not know if this is true also for nativity.

Nativity and smoking

There is a large literature that demonstrates the protective effect of foreign-born status on health (e.g., Acevedo-Garcia et al 2010). This is reflected in smoking prevalence rates, which are lower for immigrants than for native-born individuals (Baluja et al 2003). The underlying factors generating immigrant health advantage have been attributed to both positive health selectivity (Antecol & Bedard 2006; Landale, Oropesa & Gorman 2000) and better health behaviors (Abraido-Lanza, Chao & Florez 2005; Cho et al. 2004) among immigrants compared to the native-born. The health behaviors are reinforced by stronger social support systems (Marmot & Syme 1976; Vega & Amaro 1994).

Research indicates that second-generation (i.e., children of immigrants) differ from third and higher generation as a function of socialization processes and protective factors present in immigrant families and communities (Portes & Rumbaut 2001; Rumbaut & Portes 2001). The health advantage of immigrants appears to deteriorate with each generation of residence in the United States (Acevedo-Garcia et al. 2007; Ceballos 2011; de la Rosa 2002; Ruiz et al 2006). Immigrants arrive with a set of maternal characteristics, behaviors, and social relations (e.g., low smoking and drinking behaviors, strong family ties) that facilitate favorable outcomes. Increased duration in the US contributes to acculturative change, including less healthy diets and increased alcohol and tobacco use (Callister & Birkhead 2002; de la Rosa 2002; Lara et al 2005).

The growing size of the foreign-born population underscores the importance of examining various risk behaviors according to immigrant status. Studies linking nativity to smoking behavior typically examine prevalence, not developmental trajectories. Race/ethnic origin is also associated with smoking, although there is a dearth of nationally representative trajectory studies; Hispanic youth have higher rates of smoking than black youth (closer to non-Hispanic whites) (CDC 2009; Johnston et al. 2009).

The present study

Our study addresses three primary aims. First, we identify developmental trajectories of cigarette smoking in a nationally representative cohort of youth who were initially recruited in grades 9-11 and interviewed four times over an eleven-year period. Second, we investigate race/ethnic, immigrant generation, and maternal smoking differences in these developmental trajectories. Third, we examine the extent to which maternal smoking effects differ by immigrant generation (interaction effect).

We build on prior work by employing a large, ethnically diverse nationally representative longitudinal sample of individuals that contains significant numbers of respondents to compare race/ethnic groups, immigrant generation, and maternal smoking across smoking trajectories defined by detailed personal cigarette consumption information (quantity-frequency interaction, or QFI) at four points in time (eleven years). Prior literature identifies maternal smoking as a risk factor for adolescent smoking, although studies of its role in developmental trajectories are

scarce. Similarly, the literature identifies nativity (compared to foreign-born status) as a risk factor for adolescent smoking, but lacks examination of the role of immigrant status on developmental trajectories. Further, the strong family ties associated with immigrant families may exacerbate the negative influence of maternal smoking. However, to our knowledge, the question of how the protective effect of immigrant status interacts with the increased risk attributed to maternal smoking has not previously been investigated.

Methods

Sample

This analysis is based on data drawn from Waves I through IV of the National Longitudinal Study of Adolescent Health (Add Health). Add Health is a nationally representative study of adolescents in grades 7 through 12 in the United States in 1995 who have been followed with multiple interview waves into young adulthood. The sampling frame included all high schools in the United States. Over 90,000 participants from 145 schools were given a basic interview at school. Data from this interview were used to generate a baseline sample of 20,745 adolescents ages 12-19 to complete a follow-up interview at home in 1995 (Wave I), 1996 (Wave II), 2001/2002 (Wave III) and 2007/2008 (Wave IV). Over 15,000 Add Health respondents were re-interviewed at Wave IV. The overall sample is representative of United States schools with respect to region of the country, urbanicity, school type (e.g., public, parochial, private non-religious, military), ethnicity, and school size. See Harris et al. (2008) for more details on the Add Health design and longitudinal data. Regression analyses are corrected for complex sample design effects using strata, cluster, and weight variables (Chantala & Tabor, 1999).

The overall analysis proceeds in two stages: first we identify smoking trajectories, next we link those trajectories to race/ethnicity, maternal smoking, and immigrant generation information. For all analyses we follow the sample of students who were in grades 9 through 11 at Wave I across all three Waves[1]. At Wave I, these individuals range in age from 14-18 (94% were ages 15-17). In the first stage of the analysis (identification of smoking trajectories), we rely on respondents in grades 9 - 11 from all of the schools who had valid smoking information at all four waves (N=5,775) in order to maximize the information available. In the second stage of the analysis, we exclude respondents without a resident mother (4.8%) or who were missing information on any of the other control variables, for a final sample size of 5,082.

Variables

Smoking trajectory group membership

The final outcome measure in our analysis is the estimated smoking trajectory to which an individual belongs. The smoking trajectories are derived as described in the analytic strategy section, based on the average number of cigarettes an individual consumed per day at each of the four Waves. Average number of cigarettes per day was calculated as: [(reported number of days

[1] Respondents in grade 12 at baseline were not interviewed at Wave II, and thus we have excluded them from the analysis. Preliminary analyses conducted separately for each grade indicated that the smoking trajectories of grades 9 – 11 were comparable, while grades 7 and 8 were not; thus the lower grades are also excluded here. In order to maximize model power, grades 9-11 were ultimately combined, rather than examined individually, in light of their similarity in trajectory patterns.

the respondent smoked in the past 30 days) X (the reported number of cigarettes smoked each day on the days the respondent smoked)] divided by 30. If the respondent indicated that he or she had not smoked in the past 30 days, the average cigarettes per day variable had a value of 0. Table 1 presents summary statistics for the dependent and independent variables used in the analyses. The average number of cigarettes consumed per day generally increased across the waves, from 1.3 at Wave I to 2.8 at Wave IV.

[Table 1 About Here]

Race/ethnicity

Race/ethnicity is assessed using respondents' self reports at Wave I. Individuals are categorized as non-Hispanic white, non-Hispanic black, Hispanic, non-Hispanic Asian. Respondents were first asked "Are you of Hispanic or Latino origin?" We code respondents who gave a positive response to this question "Hispanic." Respondents were then asked "What is your race? You may give more than one answer." Possible responses included "White," "Black or African American," "American Indian or Native American," "Asian or Pacific Islander," and "Other." Respondents who were not initially coded Hispanic are coded into one of the three non-Hispanic categories. Respondents who included more than one response to the race question are coded to maximize cell size for "non-Hispanic Asian" or "non-Hispanic black" in that order. American Indians and Others were dropped due to sample size limitations in the multinomial models.

Immigrant Generation

Immigrant generation is based on respondent's reports of whether they, their resident mother, or their resident father were born outside the United States; a series of four dummy variables are included that reflect the foreign-born status of respondents (1 = yes) and their parents (both parents foreign-born, only mother foreign born, only father foreign born).

Control variables

Additional control variables include gender, age at Wave I, and a binary indictor of whether the resident mother has ever smoked (based on respondent report).

Statistical analyses

We use PROC TRAJ in SAS 9.1.3 to perform latent class growth analysis (Nagin, 1999) and identify the discrete developmental trajectories of cigarette consumption using the average number of cigarettes smoked per day during the past 30 days.

The latent class growth analysis method relies on a multinomial modeling strategy (estimating the parameters of finite mixture models by maximum likelihood), permitting cross-group differences in the level and shape of trajectories in a fashion that is more flexible than latent growth curve analyses with only four data points (Jones, Nagin, & Roeder, 2001; Nagin & Tremblay, 2001). This procedure has previously been applied to the first three waves of Add Health data to examine smoking trajectories (Pollard et al. 2010), trajectories of depression (Costello, Swendsen, Rose, & Dierker, 2008), and delinquency trajectories (Aalsma & Tong, 2008). We incorporate sample weights in all analyses. See Jones, Nagin and Roeder (2001) for a detailed discussion of the likelihood function and estimation of these models.

Trajectories are calculated based on individuals who were in grades 9 – 11 at Wave I. Sampling weights reflecting eligible Wave I respondents interviewed at all four Waves are used in the estimation of trajectory groups. For later regression analyses, these are the trajectories into which respondents are assigned.

There is no definitive statistic for determining the optimal number of trajectory groups that describes the data. However, the BIC criterion is generally used when testing latent class growth models (e.g., Laub, Nagin & Sampson, 1998). The model with the smallest absolute BIC is chosen. The BIC rewards parsimony and tends to favor fewer groups, but it is known to be consistent (Keribin, 1998). Respondents are assigned to the trajectory for which they have the largest posterior probability estimate – the group that best conforms to the individual's observed behavior (Muthén & Shedden, 1999).

Once trajectory groups are identified using SAS PROC TRAJ and individuals have been assigned to the trajectories, two nested multinomial logit models of trajectory group membership are estimated, including information on race/ethnicity, gender, age, and whether the mother ever smoked. The second model adds nativity status (mother foreign-born, father foreign-born, both parents foreign born, respondent foreign born), and interacts mother foreign-born status with mother ever smoked. Regression analyses are corrected for complex sample design effects using strata, cluster, and weight variables (Chantala & Tabor, 1999).

Results

Estimated smoking trajectories

Figure 1 presents the results of the latent class growth analysis. Sequential comparisons of models with k and k + 1 classes indicate that a five-class model provides the best fit to the data. The BIC indicates that the five-class model fits the data better than the four- or six-class models[2]. The five-class model also produces well-defined classes; mean group assignment probabilities for the five classes range from 76.7% to 89.5%. These predicted probabilities are generally in keeping with similar trajectory analyses from other data sources (e.g., Orlando, Tucker, Ellickson & Klein, 2004 reported predicted probabilities ranging from 79%-95%). We only present results based on the five-class (optimal) model. The five trajectory classes of smoking are: Never-smokers (53.8%, weighted), Occasional (21.9%), Early Starts (8.0%), Consistent Heavy (7.2%), and Late Starts (9.0%).

[Figure 1 About Here]

Consistent Heavy smokers consumed an average of 15 cigarettes a day (nearly a pack a day) across all four waves. Early Starts smoked an average of eight cigarettes per day at Wave I, but declined more than half across the Waves to about three per day by Wave IV.

Late Starts began with very low (close to zero) consumption at Wave I, but increased rapidly to about the level of Consistent Heavy smokers at Wave III, leveling off to about twelve at Wave IV. The majority of Occasional Smokers are nonsmokers until Wave IV, with the overall average beginning very low and increasing to an average of two per day by Wave IV. Never-smokers abstained from smoking at all Waves.

[2] The five class model BIC is -29,463, while the four and six class model BICs are -29,434 and -29,430 respectively. The models include intercept, linear, and quadratic functions of time.

Predicted trajectory group membership using race/ethnicity and nativity

Using the set of trajectories just identified, a series of nested multinomial logistic regressions is estimated and summarized in Table 2. First, trajectories are estimated as a function of race/ethnicity and basic controls (sex, age, and mother ever smoked) (Panel A). Second, nativity status variables are added as well as an interaction between mother foreign-born and mother ever smoked (Panel B). The "Never-smoker" group serves as the reference category.

[Table 2 About Here]

Results in Panel A indicate substantial race/ethnic variation across smoking trajectories after controlling for sex, age, and mother's smoking. Specifically, non-Hispanic blacks are significantly less likely to belong to any of the smoking trajectories than non-Hispanic whites. Hispanics are also significantly less likely to belong to the Early Start, Consistent Heavy, and Late Start trajectories than non-Hispanic whites. Non-Hispanic Asians are less likely to belong to the Early Start trajectory than non-Hispanic whites.

As shown in Panel B, foreign-born status of the mother or the respondent are protective and significantly associated with reduced likelihood of belonging to the early start, late start, and consistent heavy smoking trajectories. Adjusting for nativity in Panel B attenuates differences in trajectory membership for Hispanics and Asians, but does little to attenuate the trajectory membership differences for blacks. Panel B indicates that the Hispanic differences in membership in the two highest-smoking trajectories (Consistent Heavy and late Starts) are attributable to foreign-born status; after controlling for foreign-born status of both the mother and the respondent, Hispanics are not significantly less likely than whites to belong to these two trajectories. Similarly, once foreign-born status is taken into account, the reduced likelihood that non-Hispanic Asians belong to the Early Start trajectory become nonsignificant.

The interaction between mother's nativity status and mother's smoking is observed to almost completely counteract the protective effect of foreign-born status against membership in the consistent heavy smoking trajectory.

Discussion

Analyses based on this nationally representative sample indicate that among individuals originally in grades 9-11 (primarily ages 15-17), and followed over an eleven-year period, there are five unique developmental trajectories of cigarette smoking: Never-smokers, Occasional Smokers, Early Starts, Consistent Heavy and Late Starts. Most race/ethnic differences in trajectory membership were attributable to nativity status, with foreign-born status (of respondents or of their mothers) providing a protective effect. However, black adolescents remained less likely to belong to any smoking trajectory in addition to nativity effects. Of note, foreign-born status provided no protective effect against the Consistent Heavy trajectory when the mother also smoked.

The lasting impact of nativity on tobacco use has potential implications not only for the development of nicotine dependence and health problems, but for broader young adult outcomes that are associated with early tobacco use. Membership in increasingly high use trajectories has been linked to obvious outcomes, such as nicotine dependence and self-rated health, in multiple

studies (Lessove-Schlagger et al., 2008; Orlando et al., 2004; Riggs, Chou, Li & Pentz, 2007). However, smoking trajectory group membership has also been linked to a wider range of outcomes in young adulthood. For example, Orlando et al. (2004) found that never smokers were more likely to have graduated college than any of the smoking groups, and "triers" (who had the lowest smoking level) were more likely to graduate than smoking groups with higher levels of use. Orlando and colleagues (2004) further linked the trajectory classes to deviant behaviors such as theft, predatory violence, and selling drugs, with never smokers and triers being the least likely to partake in the behaviors. Tucker, Ellickson, Orlando and Klein (2006) similarly linked college graduation to smoking trajectory group membership among women in this same cohort, as well as arrest rates, risk of early sex, early parenthood, welfare receipt, and income level. Never smokers and triers generally had more favorable outcomes than stable highs and early increasers. Thus, nativity may be indirectly related to these important long-term outcomes through their influence on smoking trajectory class membership; foreign-born individuals or those born to immigrant mothers may carry the protective smoking effect of immigration forward into a variety of other outcomes.

The results in Table 2 (Panel B) suggest that individuals who are foreign-born are less likely to belong to the Early Start or Consistent Heavy smoking trajectories; these two trajectories are characterized by the highest levels of smoking at younger ages. Thus, immigrants are somewhat protected from early high levels of smoking. However, foreign-born mothers who smoked eliminated the protective effect of foreign born status against membership in the consistent heavy trajectory. Further, members of the Late Start trajectory ultimately smoke at levels close to those of the Consistent Heavy trajectory; there is no protective effect of being foreign-born against this eventually high consumption pattern. Individuals with foreign-born mothers, on the other hand, are protected against belonging to the Late Start trajectory.

It should be noted that maternal influence may be conceptualized as working through multiple mechanisms, including both socio-environmental and biologically mediated pathways. The present study does not distinguish these pathways, but the immigrant effect speaks to socio-environmental, rather than biological, pathways.

It is also important to note that the results are based on students in grades 9-11 at baseline. The trajectories of this high school group were distinct from those at the younger middle school grade levels (not shown). This suggests both that there may be some developmental turning point at this particular portion of the life course, and also that the associations between race/ethnicity, nativity, and smoking trajectory may vary by age. Future research that explicitly examines the moderating effect of age on these links would be welcome.

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Table 1. Description of Study Variables (Unweighted)	
Variable	**Mean or Proportion**
Male	0.461
Age (at Wave 1)	15.9
Race/ethnicity	
Non-Hispanic White	0.545
Non-Hispanic Black	0.198
Non-Hispanic Asian	0.082
Hispanic	0.175
Mother Ever Smoked (Wave 1)	0.449
Mother Foreign Born (only)	0.033
Father Foreign-Born (only)	0.032
Both Parents Foreign-Born	0.170
Respondent Foreign Born	0.089
Avg. Cigarettes / Day @ Wave 1	1.29
Avg. Cigarettes / Day @ Wave 2	1.79
Avg. Cigarettes / Day @ Wave 3	2.98
Avg. Cigarettes / Day @ Wave 4	2.80
Note: N = 5,082	

Table 2. Multinomial Logit Models Predicting Trajectory Membership (Coefficients)

	Occasional (n = 1,064)	Early Starts (n = 367)	Consistent Heavy (n = 274)	Late Starts (n = 402)	Never-smokers (reference) (n = 2,975)
Panel A					
Male	0.363 **	-0.146	0.373 *	0.623 ***	
Age	-0.024	0.172 *	0.334 ***	-0.116 †	
Mother Ever Smoked	0.376 ***	0.742 ***	1.306 ***	0.679 ***	
Race/Ethnicity (vs. non-Hispanic White)					
Black	-0.345 *	-1.965 ***	-3.047 ***	-1.251 ***	
Hispanic	-0.005	-1.112 ***	-0.984 *	-0.919 **	
Asian	-0.009	-0.664 *	-0.315	-0.146	
Panel B					
Male	0.388 **	-0.202	0.364 *	0.628 ***	
Age	-0.041	0.157 *	0.354 ***	-0.105 †	
Mother Ever Smoked	0.358 ***	0.680 ***	1.286 ***	0.572 ***	
Race/Ethnicity (vs. non-Hispanic White)					
Black	-0.306 *	-1.884 ***	-2.947 ***	-1.299 ***	
Hispanic	0.224	-0.800 *	-0.460	-0.370	
Asian	0.196	0.001	-1.015	0.493	
Mother Foreign-Born (only)	0.213	0.076	-0.134	-1.473 *	
Father Foreign-Born (only)	-0.250	-0.595	0.061	0.211	
Both Parents Foreign-Born	-0.199	-0.152	-0.750	-1.432 *	
Repondent Foreign-Born	-0.357	-2.227 *	-4.679 ***	0.071	
Mother FB * Mother Smoked	0.235	1.296	4.363 ***	0.707	

† $p<.10$ *$p<.05$, **$p<.01$, ***$p<.001$

Figure 1. Trajectories of Average Cigarettes per Day: Grades 9-11 at Wave 1