CIGARETTE SMOKING INITIATION AMONG YOUTH IN THE UNITED STATES: NATIVITY, ACCULTURATION, PEER INFLUENCES, AND FAMILY BONDING

By

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ABSTRACT

CIGARETTE SMOKING INITIATION AMONG YOUTH IN THE UNITED STATES: NATIVITY, ACCULTURATION, PEER INFLUENCES, AND FAMILY BONDING

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A large body of prior evidence suggests that foreign-born or less-acculturated immigrants experience a lower risk of initiating smoking of tobacco cigarettes, smoking at a lower frequency and intensity, compared to U.S.-born peers or more acculturated immigrants. This evidence is consistent with a proposition that immigration-associated shifts of environmental conditions and processes help to shape smoking patterns, but threats to validity include immigration-related selection bias and possibly confounding effects of birth cohort.

This dissertation research has three aims. The first is to estimate effects of immigration (into the U.S.) on initiation of cigarette smoking, with separate estimates for sex and race/ethnicity subgroups. The second is to estimate the degree to which dynamic acculturation status might affect a person's risk/time to start of cigarette smoking, and potential subgroup variations by sex and race/ethnicity. The third aim estimates a potential indirect effect of nativity status on time-to-initiation for smoking, through peer influence and parent-child bonding.

The study population for this dissertation research consisted of 7^{th}-12^{th} grade school-attending adolescents in the United States, with a nationally representative sample as organized for the National Longitudinal Study of Adolescent Health (ADD HEALTH). ADD HEALTH followed these participants into adulthood during a 14-year period with four in-home assessment visits. To evaluate my hypotheses, I turned to survival analysis methods, including a new approach that can be used to study mediational processes for time-to-event outcomes.

The dissertation research estimates include contrasts of smoking risk experiences for adolescents before and after immigration, with evidence of immigration-associated increased risk. First, upon immigration, adolescents were more likely to start tobacco cigarette smoking, with a hazard ratio (HR) of 1.6, and a 95% confidence interval (CI) = (1.1, 2.5), as compared with similar adolescents before immigration. Post-estimation exploration disclosed a more prominent effect estimate for females (HR=3.5; 95% CI = (1.6, 7.5); smaller HR for males with $p > 0.05$), as well as concentration of risk for Asian females and for Hispanic females after immigration ($p<0.05$). Similar effect estimate was obtained for Hispanic males after immigration, but not for non-Hispanic whites or blacks. It follows that environmental shifts associated with immigration may well play an important role in shaping the differences in risk and time to initiation. Second, immigrant female adolescents with greater acculturation within the U.S. had greater risk and earlier initiation, as compared with less acculturated females (HR=1.23; 95% CI = 1.1, 1.4). Post-estimation exploration suggested concentration of this risk among Hispanic females. Third, in a contrast of foreign-born versus U.S.-born adolescents, the mediational model from survival analysis of time-to-event data suggested mediation of a nativity effect on smoking initiation via peer influence (~17%, 95% CI=(7.1, 22.1)), with no tangible intermediate pathway through strength of bonding to one's family of origin.

This dissertation research project's evidence clarifies the degree to which youthful immigration into the U.S. might affect risk of starting to smoke tobacco cigarettes, as well as potential mechanisms. Especially for Asian and Hispanic female immigrants, possibly for Hispanic males, public health attention is needed, possibly with subgroup-targeted prevention initiatives that focus upon interpersonal processes involving peer influence and resistance skills.

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KEY TO ABBREVIATIONS

ACASI – Computer-Assisted Self-Interview

ADD HEALTH – National Longitudinal Study of Adolescent Health

ATS – Adult Tobacco Survey

BRFSS – Behavior Risk Factor Surveillance System

CAPI – Computer-Assisted Personal Interview (CAPI)

CDC – Centers for Diseases Control and Prevention

CI – Confidence Interval

GYTS – Global Youth Tobacco Survey

HR – Hazard Ratio

IRB – Institutional Review Board

NHIS – National Health Interview Survey

NYTS – National Youth Tobacco Survey

SE – Standard Error

US – United States

USDHHS – United States Department of Health and Human Services

WHO – World Health Organization

WPRO – Western Pacific Regional Office

YRBSS – Youth Risk Behavior Surveillance System

YTS – Youth Tobacco Survey

CHAPTER 1 INTRODUCTION AND AIMS

Tobacco cigarette smoking among the United States (U.S.) immigrant population is becoming an increasingly important issue to study for several reasons. First, the U.S. immigrant population continues to grow. According to the 2015 American Census Survey, this population has reached the highest level in U.S. history, with 42.4 million immigrants accounting for more than 13% of the entire U.S. population. Second, tobacco companies have increased their efforts in marketing and developing strategies specifically targeted at immigrant populations, whereas tobacco control policies specifically targeted at this population remain very limited (Muggli, Pollay, Lew, & Joseph, 2002, Acevedo-Garcia, Barbeau, Bishop, Pan, & Emmons, 2004). Third, there are large differences in tobacco smoking frequency and occurrence among immigrants by sex and country of birth (Ellickson, Orlando, Tucker, & Klein, 2004; Wade, Lariscy, & Hummer, 2013; Wade, Lariscy, & Hummer, 2013b). These disparities point toward worse health outcomes for some subgroups of the immigrant population. Finally, some immigrants may, for a variety of reasons (e.g. language barriers, legal status, lack of health insurance, lack of familiarity with the U.S. healthcare system), have limited access to healthcare services, including tobacco prevention and control programs, that are available to the native-born population (Goldman, Smith, & Sood, 2005; Ku & Matani, 2001; Siddiqi, Zuberi, & Nguyen, 2009). Given these reasons, tobacco smoking behaviors among U.S. immigrants deserve a more prominent place in epidemiological research.

Among all the different smoking behaviors, this dissertation research project focuses on tobacco cigarette smoking initiation, a crucially important behavior that is a pre-condition for later smoking behaviors and health consequences (Breslau, Fenn, & Peterson, 1993; Robinson, Berlin, & Moolchan, 2004; Hwang & Park, 2014; Klein, Sterk, & Elifson, 2013).

In the dissertation research, I conceptualize the immigration process as one that includes major shifts in environmental conditions and processes during and after the transition from the country of birth or origin into the U.S. aim to study whether immigration-introduced changes can impact immigrants' cigarette smoking behaviors (specifically the risk and time to initiation for tobacco cigarette smoking), evaluate how much the acculturation process affects the hazard of initiating smoking, and study the effects of factors that potentially mediate the effect of nativity status (U.S.- vs foreign-born) on the risk of initiation. The specific aims are:

AIM1. To estimate the degree to which immigration to the U.S. is associated with the risk and timing to the first onset of cigarette smoking, with a conceptual model that accounts for time-varying immigration status, and baseline characteristics of sex, race/ethnicity, parental smoking status, family SES status, subjects' school attachment and self-esteem. Aim 1 also examines subgroup variations by sex and race/ethnicity.

AIM2. To assess the effect of time-varying acculturation status on the risk and timing to first onset of cigarette smoking, while adjusting for baseline characteristics such as sex, race/ethnicity, parental smoking status and other relevant covariates. In addition, aim 2 investigates whether the effect varies among sex and race/ethnicity groups.

AIM3. To explore the mechanism of how nativity status (U.S.- vs foreign-born) might affect the risk of smoking initiation by studying the potential mediational effects of peer smoking influence and parent-child bonding (family connectedness) during this process. I will assess the potential indirect effect of nativity status on time to initiation of cigarette smoking through peer influence and parent-child bonding.

CHAPTER 2 BACKGROUND AND SIGNIFICANCE

2.1 Epidemiology of Cigarette Smoking

2.1.1 General U.S. Population

Since the Surgeon General's report on tobacco smoking and adverse health outcomes in 1964, the adult smoking prevalence continuously dropped from about 40% in 1960s to about 18% in recent years (National Health Interview Survey, 1965–2012). Despite that, in the U.S., cigarette smoking remains one of the greatest challenges in public health. It is currently the leading cause of morbidity and mortality in the U.S. The annual smoking attributable mortality is around 480,000 that is approximately one in five deaths. In addition, more than 16 million Americans currently suffer from smoking related diseases (Surgeon General's Report 2014).

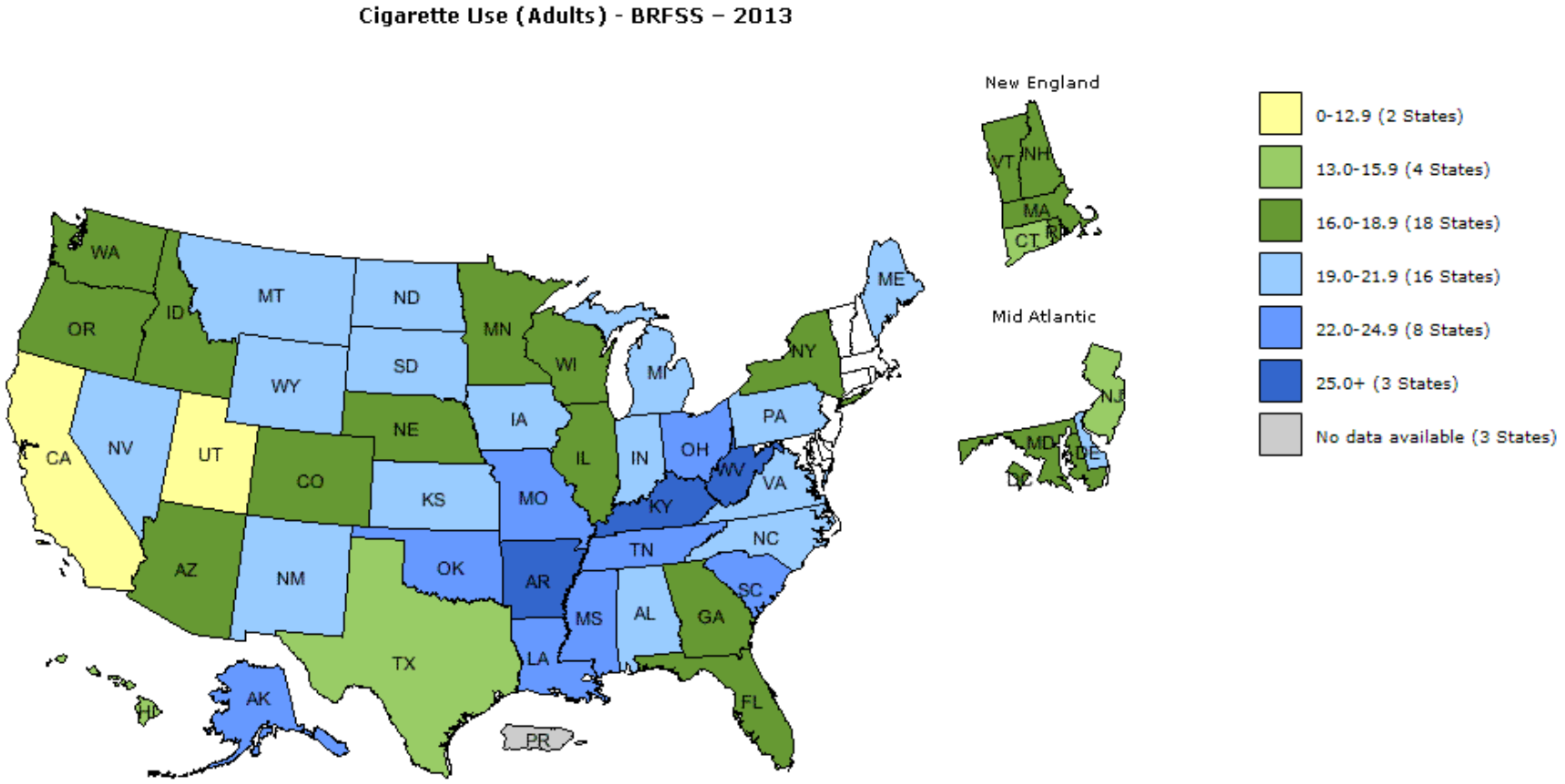
In addition to the adverse health consequences, cigarette smoking also poses heavy economic burden on individual smokers as well as on the whole society. As cigarette prices vary by state, the average cost on cigarette for a pack-a-day smoker can range from nearly $2,000 in Virginia and Missouri a year to $4,690 in New York (Selena Maranjian "The Surprising Cost of a Pack a Day in All 50 States" 2014). Nationwide, the U.S. spends 170 billion dollars on direct medical cost and another 156 billion dollars on lost productivity annually (Surgeon General's report 2014; Xu, Bishop, Kennedy, Simpson, & Pechacek, 2015).

According to 2014 Mortality and Morbidity Weekly Report ("Current Cigarette Smoking among Adults — United States, 2005–2013"), over 42 million (18.1%) U.S. adults were current cigarette smokers, among which 78.4% smoked daily. Male adults were more likely to be current cigarette smokers than female adults (20.5% vs. 15.3%). Young adults and mid-aged group presented the higher smoking prevalence (~20%) compared to older people (>65 years old) at

8.8%. Among different race/ethnicity groups, non-Hispanic Asian had the lowest prevalence of 9.6% followed by Hispanics (12.1%). Non-Hispanic Blacks presented slightly lower risk of 18.3% compared to non-Hispanic Whites at 19.4%. The group with highest prevalence was American Indians/Alaska Natives (26.1%). This report also showed that tobacco smoking differed greatly by education level - higher education background was associated with lower risk of smoking. People with graduate degree had the lowest prevalence of 5.6% vs 41.4% from people with a graduate education degree certificate. Correspondingly, adults who lived below the poverty level were almost twice likely to smoke compared to adults who lived above poverty level (29.2% vs 16.2%).

Cigarette smoking prevalence in adults also varies by geographic regions. The lowest prevalence was in Utah (10.3%) and highest in West Virginia (27.3%). Cigarette smoking prevalence for other states are presented in Figure 2.1 (for adults). Separate prevalence estimates for males and females can be found in Table 2.1.

Figure 2.1 Current Cigarette Use among Adults (Behavior Risk Factor Surveillance System) 2013



Source: Behavorial Risk Factor Surveillance System (BRFSS)

Table 2.1 Cigarette Smoking Prevalence, Adults 18 Years and Older, by State, U.S., 2011-2013

State	Cigarette smoking					
	2011		2012		2013	
	%	(95% CI)	%	(95% CI)	%	(95% CI)
Alabama	24.3	(22.9–25.8)	23.8	(22.4–25.2)	21.5	(19.9–23.1)
Alaska	22.9	(21.0–25.0)	20.5	(18.9–22.3)	22.6	(20.8–24.4)
Arizona	19.3	(17.2–21.3)	17.1	(15.6–18.6)	16.3	(14.4–18.4)
Arkansas	27	(24.8–29.2)	25	(23.4–26.8)	25.9	(24.1–27.8)
California	13.7	(12.9–14.4)	12.6	(11.8–13.4)	12.5	(11.7–13.5)
Colorado	18.3	(17.2–19.4)	17.7	(16.8–18.7)	17.7	(16.8–18.6)
Connecticut	17.1	(15.8–18.6)	16	(14.9–17.2)	15.5	(14.3–16.8)
Delaware	21.8	(19.9–23.6)	19.7	(18.2–21.3)	19.6	(18.0–21.2)
District of Columbia	20.8	(18.8–22.9)	19.6	(17.4–22.0)	18.8	(16.9–20.9)
Florida	19.3	(18.2–20.5)	17.7	(16.3–19.2)	16.8	(16.0–17.8)
Georgia	21.2	(19.9–22.6)	20.4	(18.9–22.0)	18.8	(17.6–20.1)
Hawaii	16.8	(15.5–18.3)	14.6	(13.3–15.9)	13.3	(12.2–14.5)
Idaho	17.2	(15.6–18.9)	16.4	(14.7–18.3)	17.2	(15.7–18.8)
Illinois	20.9	(19.2–22.7)	18.6	(17.0–20.3)	18	(16.6–19.6)
Indiana	25.6	(24.3–27.0)	24	(22.8–25.2)	21.9	(20.8–23.1)
Iowa	20.4	(19.1–21.6)	18.1	(17.0–19.3)	19.5	(18.3–20.7)
Kansas	22	(21.2–22.8)	19.4	(18.4–20.4)	20	(19.3–20.7)
Kentucky	29	(27.5–30.5)	28.3	(26.9–29.7)	26.5	(25.1–27.8)
Louisiana	25.7	(24.3–27.2)	24.8	(23.2–26.3)	23.5	(21.5–25.6)
Maine	22.8	(21.7–23.9)	20.3	(19.2–21.4)	20.2	(19.0–21.5)
Maryland	19.1	(17.8–20.5)	16.2	(15.0–17.4)	16.4	(15.3–17.5)
Massachusetts	18.2	(17.3–19.2)	16.4	(15.6–17.2)	16.6	(15.6–17.7)
Michigan	23.3	(22.0–24.6)	23.3	(22.1–24.6)	21.4	(20.3–22.5)
Minnesota	19.1	(18.1–20.1)	18.8	(17.8–19.8)	18	(16.9–19.3)

Table 2.1 (Cont'd)

State	Cigarette smoking					
	2011		2012		2013	
	%	(95% CI)	%	(95% CI)	%	(95% CI)
Mississippi	26	(24.6–27.4)	24	(22.5–25.5)	24.8	(23.3–26.4)
Missouri	25	(23.5–26.6)	23.9	(22.4–25.5)	22.1	(20.6–23.6)
Montana	22.1	(20.8–23.4)	19.7	(18.6–20.9)	19	(17.9–20.1)
Nebraska	20	(19.3–20.7)	19.7	(18.9–20.6)	18.5	(17.5–19.5)
Nevada	22.9	(21.0–25.0)	18.1	(16.6–19.8)	19.4	(17.4–21.5)
New Hampshire	19.4	(18.0–20.9)	17.2	(15.8–18.6)	16.2	(15.0–17.6)
New Jersey	16.8	(15.9–17.8)	17.3	(16.4–18.3)	15.7	(14.7–16.7)
New Mexico	21.5	(20.3–22.7)	19.3	(18.2–20.5)	19.1	(17.9–20.3)
New York	18.1	(16.9–19.4)	16.2	(14.9–17.6)	16.6	(15.5–17.8)
North Carolina	21.8	(20.5–23.1)	20.9	(19.9–21.9)	20.3	(19.1–21.5)
North Dakota	21.9	(20.3–23.5)	21.2	(19.6–22.9)	21.2	(19.8–22.7)
Ohio	25.1	(23.8–26.4)	23.3	(22.2–24.4)	23.4	(22.2–24.6)
Oklahoma	26.1	(24.7–27.6)	23.3	(22.0–24.6)	23.7	(22.4–25.0)
Oregon	19.7	(18.3–21.2)	17.9	(16.4–19.4)	17.3	(15.9–18.8)
Pennsylvania	22.4	(21.3–23.6)	21.4	(20.4–22.3)	21	(19.9–22.0)
Rhode Island	20	(18.6–21.5)	17.4	(16.0–18.9)	17.4	(16.1–18.8)
South Carolina	23.1	(21.9–24.4)	22.5	(21.4–23.7)	22	(20.8–23.2)
South Dakota	23	(21.1–25.0)	22	(20.5–23.5)	19.6	(18.1–21.2)
Tennessee	23	(20.7–25.5)	24.9	(23.4–26.4)	24.3	(22.6–26.1)
Texas	19.2	(18.0–20.4)	18.2	(17.0–19.4)	15.9	(14.8–17.0)
Utah	11.8	(11.0–12.7)	10.6	(9.8–11.4)	10.3	(9.6–11.1)
Vermont	19.1	(17.7–20.5)	16.5	(15.2–17.9)	16.6	(15.4–17.9)
Virginia	20.9	(19.4–22.5)	19	(17.7–20.3)	19	(17.9–20.2)
Washington	17.5	(16.4–18.7)	17.2	(16.3–18.1)	16.1	(15.1–17.1)
West Virginia	28.6	(27.0–30.3)	28.2	(26.7–29.7)	27.3	(25.9–28.7)
Wisconsin	20.9	(19.2–22.7)	20.4	(18.7–22.1)	18.7	(17.2–20.3)

Table 2.1 (Cont'd)

State	Cigarette smoking					
	2011		2012		2013	
	%	(95% CI)	%	(95% CI)	%	(95% CI)
Wyoming	23	(21.5–24.6)	21.8	(19.9–23.7)	20.6	(19.1–22.2)
Median Prevalence (all states)	21.2		19.6		19	

Source: Centers for Disease Control and Prevention Behavioral Risk Factor Surveillance System, 2013 Public use data file

The same pattern retained for adolescents. Among adolescent, the lowest cigarette smoking prevalence was also found in Utah (4.4%) and highest in West Virginia with prevalence of 19.6%.

Table 2.2 Current Cigarette Use Prevalence, High School Students, by State and City/County, U.S., 2013

State	Current cigarette use					
	Female		Male		Total	
	%	(95% CI)	%	(95% CI)	%	(95% CI)
Alabama	14.2	(11.2–18.0)	21.5	(17.4–26.2)	18	(15.5–20.8)
Alaska	8.2	(5.5–12.0)	12.5	(9.5–16.3)	10.6	(8.2–13.4)
Arizona	11.6	(9.7–13.9)	16.4	(13.2–20.1)	14.1	(11.8–16.6)
Arkansas	16.1	(12.8–20.0)	22.2	(18.5–26.3)	19.1	(16.4–22.2)
Connecticut	11.4	(8.3–15.5)	15.1	(12.4–18.4)	13.5	(11.1–16.3)
Delaware	12.7	(10.8–14.8)	15.6	(13.1–18.6)	14.2	(12.5–16.0)
Florida	9.2	(8.2–10.4)	12.2	(10.6–14.0)	10.8	(9.7–12.0)
Georgia	11.8	(8.9–15.5)	13.7	(10.1–18.4)	12.8	(9.8–16.6)
Hawaii	9.7	(8.3–11.4)	10.7	(9.0–12.8)	10.4	(9.1–11.9)
Idaho	11.4	(8.5–15.1)	12.8	(10.2–15.9)	12.2	(9.8–15.0)
Illinois	12.4	(9.1–16.5)	15.8	(12.7–19.4)	14.1	(11.3–17.4)
Kansas	8.7	(6.9–10.8)	11.8	(9.6–14.4)	10.2	(8.8–11.9)
Kentucky	15.5	(12.3–19.4)	20.3	(16.4–24.9)	17.9	(15.0–21.2)
Louisiana	9.7	(7.0–13.2)	14.4	(10.9–18.8)	12.1	(9.5–15.2)
Maine	11	(9.5–12.7)	14.4	(12.5–16.5)	12.8	(11.3–14.5)
Maryland	10	(9.4–10.6)	13.2	(12.6–13.9)	11.9	(11.4–12.4)
Massachusetts	9.3	(7.7–11.2)	12.1	(10.3–14.1)	10.7	(9.5–12.1)
Michigan	10.6	(7.8–14.4)	13	(9.9–16.9)	11.8	(8.9–15.5)
Mississippi	16.8	(14.1–19.9)	17.7	(14.0–22.1)	17.2	(14.5–20.4)

Table 2.2. (Cont'd)

State	Current cigarette use					
	Female		Male		Total	
	%	(95% CI)	%	(95% CI)	%	(95% CI)
Missouri	13.2	(11.0–15.8)	16.1	(12.6–20.2)	14.9	(12.9–17.2)
Montana	14.4	(12.1–17.0)	16	(14.1–18.2)	15.2	(13.4–17.2)
Nebraska	10.8	(8.2–14.1)	10.9	(8.7–13.7)	10.9	(9.1–12.9)
Nevada	10.9	(8.1–14.4)	9.8	(7.6–12.6)	10.3	(8.1–13.2)
New Hampshire	13.2	(10.2–16.8)	14.2	(11.5–17.3)	13.8	(11.6–16.4)
New Jersey	11.5	(9.3–14.1)	14.3	(11.4–17.7)	12.9	(10.8–15.3)
New Mexico	12.3	(10.3–14.5)	16.4	(13.7–19.6)	14.4	(12.2–17.0)
New York	9.5	(8.2–11.1)	11.7	(9.6–14.2)	10.6	(9.3–12.2)
North Carolina	11.8	(8.6–15.8)	18	(14.3–22.3)	15	(12.8–17.3)
North Dakota	19.5	(16.3–23.2)	18.4	(15.4–21.8)	19	(16.6–21.7)
Ohio	13.4	(10.5–16.9)	16.7	(11.6–23.5)	15.1	(11.5–19.6)
Oklahoma	17.9	(14.2–22.3)	19.1	(15.7–23.0)	18.5	(15.5–22.0)
Rhode Island	7.9	(5.4–11.4)	8	(5.4–11.6)	8	(5.8–11.0)
South Carolina	11.9	(9.5–14.9)	19.8	(15.5–24.9)	16	(13.3–19.0)
South Dakota	16.3	(13.0–20.3)	16.5	(11.4–23.4)	16.5	(12.5–21.4)
Tennessee	14.5	(11.6–17.9)	16.5	(13.5–20.0)	15.4	(13.0–18.3)
Texas	11.7	(9.7–14.2)	16.5	(13.3–20.3)	14.1	(11.9–16.8)
Utah	3.5	(2.5–4.8)	5.3	(3.5–7.9)	4.4	(3.2–5.9)
Vermont	—¶	—	—	—	—	—
Virginia	10.4	(8.9–12.1)	11.6	(9.9–13.6)	11.1	(9.6–12.7)
West Virginia	18.3	(14.9–22.3)	21	(17.1–25.4)	19.6	(16.8–22.7)
Wisconsin	9.6	(7.0–13.1)	13.7	(11.2–16.7)	11.8	(9.9–14.1)
Wyoming	17.9	(14.8–21.5)	16.5	(13.5–20.0)	17.4	(14.7–20.4)
Median	11.7		15.1		13.8	
Range	(3.5–19.5)		(5.3–22.2)		(4.4–19.6)	

¶ Not available. Source: Kann L, Kirchen s. Shank SL et, Youth risk behavior surveillance System 2013.

As to newly incident cases, each day, in the U.S. over 3800 adolescents try smoking cigarette for the first time. Nearly 90% of initiation happened during adolescence and 99% before the age of 26 (CDC, Youth and Tobacco Use Report). Among young adults a study conducted in 1999 which was restricted to 18-24 year olds college students found that 70% of their study sample had tried smoking, 42% were active smokers, 19% were active frequent smokers and 13% were daily smokers. In addition, this study found that female college students presented similar risk of initiating/trying smoking with their male peers (Sherry A. Everett et al., 1999). In 2012, CDC conducted a systematic review of smoking initiation among young adults in the U.S. and Canada. This review focuses on 18-25 years old that lived in the U.S. or Canada. This review concluded that there were disparities in young adult initiating smoking by sex, race, and education background. Different from Everrte's earlier study, the CDC literature review using more recent data concluded that young female adults were less likely to initiate smoking compared to their male counterparts. This report also found that African Americans and Asian/Pacific Islanders were more likely to initiate during their adulthood than adolescence period. Among Whites, those attended college or military were more likely to initiate in college or in the military (Freedman, Nelson, & Feldman, 2011). Another study conducted in 2004 followed 6,259 subjects that were recruited from 30 middle schools in California and Oregon for multiple years and found that by the age of 13 half of the non-Hispanic Whites had initiated smoking, about 60% of African American peers also had initiated. Asian 13 years old had the lowest risk at about 38% while close to 70% of Hispanic peers had tried cigarette smoking. By the age of 18, close to 75% of the non-Hispanic Whites have tried smoking and the rate is slightly higher for non-Hispanic Blacks. Asian counterparts remain the lowest among all groups with about 60% having initiated, and by this age nine out of ten Hispanics have tried smoking

(Ellickson, Orlando, Tucker, & Klein, 2004). More recent estimates based on 2013 Youth Risk Behavior Survey estimated 42.9% of White high school students, 43.2% of Hispanic peers and 34% of African American peers had ever tried smoking. This report also estimated that 10.1% of Whites younger than 13 years old had smoked a whole cigarette, 6.7% for African American peers and 9.2% for Hispanic peers (Morbidity and Mortality Weekly Report, June 13, 2014).

As to trend over time, smoking incidence rate decreased in young males from over 5% in 1940s to 3% in 1983 the rate then bounced up in 1990s, while for females the rate increased from slightly over 1% in 1940s to over the 3% in 1990s (Anderson & Burns, 2000). The study was conducted in late 1990s and the more recent trends and estimates for 21st century are not available as of this dissertation research. The different trends for males and females may reflect the tobacco epidemic in the U.S. – females lag behind in picking up cigarette smoking. Another trend is that people tend to start smoking earlier in life. In 1950s people were more likely to initiate during their adulthood and in mid 1960s the initiation rate during adolescence was still somewhat lower than initiation during adulthood, while in 1980s the peak age of initiation occurred during adolescence.

2.1.2 The U.S. Immigrant Population

Most of existing literature found that foreign-born immigrants had lower smoking prevalence compared to native-born peers. Based on Baluja's estimates in 2003, smoking prevalence estimates for native-born 15 years and older was 22.6% compared to foreign-born peers at 13.4%. The same pattern was present once disaggregated by race/ethnicity groups, 23.0% of native-born non-Hispanic white compared to 16.8% of foreign-born non-Hispanic White, 21.8% of native-born non-Hispanic Blacks compared to 7.8% of foreign-born non-Hispanic Blacks, 15.5% of Asian/Pacific Islanders and 11.8% of foreign-born peers, and at last

17.9% of native-born Hispanics vs 13% of foreign-born Hispanics were active smokers (Baluja, Park, & Myers, 2003a).

Different from U.S.-born population, there was a greater sex difference in smoking among foreign-born immigrants. Over twenty percent of foreign-born non-Hispanic white males were current smokers (20.1%) while for females the prevalence was 14.1%. The difference was even more prominent for other race/ethnicity groups. Foreign-born non-Hispanic black males had smoking prevalence of 12.2% while the prevalence for females was only 3.8%. The smoking prevalence for foreign-born Asian males was 19.7% compared to 5.0% for their female peers. Hispanic males born in foreign countries had a smoking prevalence of 18.9% while for their female peers the prevalence was at 6.7% (Baluja, Park, & Myers, 2003a).

Another study conducted using 2006 Tobacco Use Supplement to the Current Population Survey (n=44,202) compared lifetime smoking by nativity status within each racial/ethnic group. This study focused on a younger population of 15-34 year olds. Among foreign-born Whites 20.2% reported having smoked compared to 26.8% of U.S.-born peers. Lifetime smoking prevalence was 9.5% for foreign-born Blacks versus 13.9% of U.S.-born Blacks. Among Asian, lifetime smoking prevalence was slightly lower for foreign-born (11.1%) compared to U.S.-born at 11.7%. This study separated Mexican Americans from other Hispanics. Foreign-born Mexican Americans had life time prevalence of 11.4% and their U.S.-born peers had the prevalence of 14.2%. The prevalence of other foreign-born Hispanics was 10.7% vs 16.8% for their U.S.-born counterparts.

The same study also provides prevalence estimate of light/intermittent vs moderate/heavy smoking. Overall, moderate/heavy smoking was more prevalent in U.S.-born youth than foreign-

born peers. The prevalence had a wide range - 1.3% for foreign-born Mexican Americans to 10.7% for U.S.-born Whites (Wade et al., 2013b).

A different study by Joseph Lariscy and co-authors was published the same year with consistent findings. In this study, data from The Legacy Young Adult Cohort Study - a nationally representative survey was used to study tobacco use by nativity and race/ethnicity groups stratified by sex. This study found that U.S.-born 18-34 year olds presented higher level of tobacco use across a variety of forms in both males and females. Among females, the lifetime smoking of cigarette in foreign-born Hispanics young females was less than a third of the U.S.-born peers (16.7% vs. 55.9%). While the current smoking prevalence (past 30 days) for foreign-born young Hispanic female was less than a quarter of their U.S.-born peers (4.0% vs 16.7%). Among young Hispanic females, 1.5% of foreign-born considered and reported them to be smoker while 9.8% of U.S.-born considered and reported themselves to be smokers. The trend was similar for other tobacco products among females. The reported tobacco use gap was smaller among males. According to self-reported measures, 32.3% of foreign-born young Hispanic males had tried cigarettes while 56.7% of U.S.-born peers reported having tried cigarettes. 13.6% of foreign-born Hispanic males reported smoking within past 30 days compared to 35.5% of U.S. born peers. Only 4.3% of foreign-born Hispanic male considered and reported being a smoker compared to 18% of the U.S.-born counterparts (Lariscy et al., 2013).

Inconsistent findings were published by Pamela Stoddard using The National Health Interview Survey data. In this study, the author used time-dependent discrete survival analysis to compare the risk of initiating smoking among Mexican immigrants before and after the immigration. This study found that the risk of initiation reduced after the immigration to the U.S. and it was thought to be due to stricter tobacco control programs, laws, and enforcement in the

U.S. However the study was limited by the fact that the precise age at immigration was not reported, it was imputed based on a five-year time window (Stoddard, 2009).

2.1.3 Global Situation

Tobacco smoking is a global epidemic. It is thought of as the largest public health challenge that the world ever faced. Despite the fact that smoking rates declined or leveled off in developed countries, the consumption of tobacco in developing countries has increased quickly over the past decades. According to a 2015 World Health Organization (WHO) report, over one billion people were cigarette smokers at that point of time worldwide. The Number of cigarettes consumed each year has also been on rise. In 2014, around 5.8 trillion cigarettes were smoked worldwide. Although cigarette consumption decreased in developed countries, it was offset by an increase in many developing countries.

Worldwide, tobacco smoking is the number one cause of preventable morbidity and mortality. It is estimated that six million people die prematurely because of cigarette smoking and among them 600,000 die from second-hand smoke including 165,000 children. The disease burden disproportionately falls on developing countries. According to the WHO estimate, about 1 billion out of 1.22 billion smokers live in developing countries or transitional economics. It is projected that eight million people will die each year by 2030, over 80% of whom will be from developing countries.

It was estimated that each year tobacco use costs the world $500 billion in health care expenditures, losses of productivity, and other indirect costs. In some low-income countries/regions, expenditures on tobacco compromises the basic needs of life such as food and health care (Tobacco and the developing world report, 2009).

Data related to smoking rates by country and sex, especially from developing countries, is limited. Overall, existing estimates from different data sources tend to be close but do not agree completely. Based on the Tobacco Control Country Profiles database, prevalence of smoking was highest for males aged 15 and older (51%) in Western Pacific region. For females the highest prevalence (22%) was found in European region. Worldwide, on average males smoke four times as much as females (48% vs 12%) (Corrao, Guindon, Cokkinides, & Sharma, 2000). In 2011, the World Bank estimated adult smoking prevalence rate by sex for more than 190 countries worldwide. According to this report, on average, every two out of three males from Indonesia and Kiribati were smokers; they had an alarmingly high prevalence of 67% followed by males from Russian Federation at 59%. The lowest smoking prevalence were reported for countries in Africa (e.g. SaoTome and Principe, Congo, Republic of Niger) and the prevalence was between 8-9% for these countries. Among females, the highest prevalence were reported for Austria at 47%, followed by Chile, Greece and France between 32-38%. The lowest prevalence was reported by African countries and countries in Mid-east, (including countries such as Afghanistan, Niger, Eritrea, Oman, Zimbabwe, Iran, Kenya, Sri Lanka, Malaysia, Libya, Egypt, Arab Rep) where the prevalence estimates were about 1%. Prevalence of adult smoking for other countries/regions are presented in Table 2.3.

Table 2.3 Prevalence of Adult Smoking by Sex and Country/Region (The World Bank Organization)

County/Region	Sex		County/Region	Sex	
	M	F		M	F
Afghanistan	..	..	Luxembourg	27	22
Albania	52	8	Macedonia, FYR	..	..
Algeria	..	..	Madagascar	..	..
American Samoa	..	..	Malawi	27	7
Andorra	39	28	Malaysia	45	2
Angola	..	..	Maldives	..	..
Antigua and Barbuda	..	..	Mali	33	3
Argentina	32	21	Malta	32	22
Armenia	55	2	Marshall Islands	..	..
Aruba	..	..	Mauritania	39	4
Australia	18	15	Mauritius	41	4
Austria	37	36	Mexico	23	8
Azerbaijan	49	0	Micronesia, Fed. Sts.	..	..
Bahamas, The	..	..	Moldova	45	5
Bahrain	40	7	Monaco	..	..
Bangladesh	44	1	Mongolia	49	6
Barbados	13	1	Montenegro	..	..
Belarus	49	11	Morocco	43	2
Belgium	28	21	Mozambique	33	6
Belize	..	..	Myanmar	35	8
Benin	16	1	Namibia	36	12
Bermuda	..	..	Nepal	39	14
Bhutan	..	..	Netherlands	28	25
Bolivia	34	19	New Caledonia	..	..
Bosnia and Herzegovina	49	31	New Zealand	..	..
Botswana	..	..	Nicaragua	..	..
Brazil	21	12	Niger	16	0
Brunei Darussalam	29	3	Nigeria	16	1
Bulgaria	45	30	Northern Mariana Islands	..	..
Burkina Faso	33	5	Norway	26	25
Burundi	..	..	Oman	19	1
Cambodia	45	4	Pakistan	41	4
Cameroon	34	1	Palau	..	..
Canada	20	14	Panama	13	3
Cabo Verde	20	4	Papua New Guinea	..	..
Cayman Islands	..	..	Paraguay	31	9

Table 2.3 (Cont'd)

County/Region	Sex		County/Region	Sex	
	M	F		M	F
Central African Republic	..	..	Peru	..	7
Chad	..	..	Philippines	46	9
Channel Islands	..	..	Poland	35	26
Chile	42	37	Portugal	32	14
China	49	2	Puerto Rico	..	..
Hong Kong SAR, China	..	..	Qatar	..	..
Macao SAR, China	..	..	Romania	40	23
Colombia	17	7	Russian Federation	60	23
Comoros	24	7	Rwanda	..	6
Congo, Dem. Rep.	..	..	Samoa	45	20
Congo, Rep.	32	2	San Marino	..	..
Costa Rica	20	9	Sao Tome and Principe	..	..
Cote d'Ivoire	..	..	Saudi Arabia	26	3
Croatia	39	32	Senegal	22	1
Cuba	53	20	Serbia	46	40
Curacao	..	..	Seychelles	44	9
Cyprus	..	..	Sierra Leone	55	13
Czech Republic	38	29	Singapore	28	5
Denmark	21	19	Sint Maarten (Dutch part)	..	..
Djibouti	..	..	Slovak Republic	41	18
Dominica	..	..	Slovenia	24	19
Dominican Republic	19	10	Solomon Islands	..	..
Ecuador	15	4	Somalia	..	..
Egypt, Arab Rep.	46	0	South Africa	32	7
El Salvador	..	..	South Sudan	..	..
Equatorial Guinea	..	..	Spain	34	28
Eritrea	..	..	Sri Lanka	29	1
Estonia	44	25	St. Kitts and Nevis	..	..
Ethiopia	9	1	St. Lucia	..	..
Faeroe Islands	..	..	St. Martin (French part)	..	..
Fiji	41	13	St. Vincent and the Grenadines	..	..
Finland	25	20	Sudan	..	..
France	31	26	Suriname	..	..
French Polynesia	..	..	Swaziland	18	2
Gabon	..	..	Sweden	22	23
Gambia, The	..	..	Switzerland	28	21

Table 2.3 (Cont'd)

County/Region	Sex		County/Region	Sex	
	M	F		M	F
Georgia	59	6	Syrian Arab Republic	..	..
Germany	34	29	Tajikistan	..	..
Ghana	12	1	Tanzania	29	4
Greece	54	34	Thailand	42	2
Greenland	..	..	Timor-Leste	..	..
Grenada	..	..	Togo	..	..
Guam	..	..	Tonga	48	13
Guatemala	..	..	Trinidad and Tobago	..	..
Guinea	..	..	Tunisia	..	..
Guinea-Bissau	..	..	Turkey	43	14
Guyana	..	..	Turkmenistan	..	..
Haiti	21	3	Turks and Caicos Islands	..	..
Honduras	37	2	Tuvalu	..	..
Hungary	35	27	Uganda	18	3
Iceland	19	17	Ukraine	51	14
India	23	2	United Arab Emirates	..	..
Indonesia	72	4	United Kingdom	22	20
Iran,Islamic Rep.	23	1	United States	21	16
Iraq	..	..	Uruguay	30	22
Ireland	24	24	Uzbekistan	26	1
Isle of Man	..	..	Vanuatu	..	..
Israel	42	20	Venezuela, RB	..	..
Italy	29	20	Vietnam	48	1
Jamaica	30	6	Virgin Islands (U.S.)	..	..
Japan	36	11	West Bank and Gaza	..	..
Jordan	64	10	Yemen, Rep.	..	..
Kazakhstan	46	10	Zambia	27	5
Kenya	26	2	Zimbabwe	32	2
Kiribati	67	43	World	36	7
Korea, Dem. Rep.	..	..	Low income	..	..
Korea, Rep.	52	4	Middle income	38	4
Kosovo	..	..	Lower middle income	34	3
Kuwait	..	..	Upper middle income	42	5
Kyrgyz Republic	50	4	Low & middle income	37	4
Lao PDR	60	11	East Asia & Pacific	51	3
Latvia	51	24	Europe & Central Asia	44	13
Lebanon	43	29	Latin America & Caribbean	22	10
Lesotho	50	0	Middle East & North Africa	..	..

Table 2.3 (Cont'd)

County/Region	Sex		County/Region	Sex	
	M	F		M	F
Liberia	25	3	South Asia	27	3
Libya	..	..	Sub-Saharan Africa	22	3
Liechtenstein	..	..	High income	33	19
Lithuania	41	22	Euro area	33	25

Note: ".." represents data unavailable

Source: World Bank's website http://wdi.worldbank.org/table/2.20.

According to the World Bank report, male adults had higher smoking prevalence than female adults in all countries with the exception of Austria where nearly half of the women smoked and women's smoking prevalence was slightly higher than men's (female at 47% vs male at 46%), some other European countries (e.g. United Kingdom, Iceland, and Sweden) and Dominican Republic had similar smoking prevalence for adult males and females. The rest of the countries all reported higher prevalence for males. Overall, the male – female difference was smaller in developed countries, while the gap can be very large in many developing countries such as Indonesia where 67% males smoke, as compared to just 3% of females. Another example was China where about half of the males smoked compared to that only 2% of females. However, for younger age groups, according to findings from Global Youth Tobacco Survey (GYTS), young girls and young boys did not differ much in smoking prevalence. About a quarter of these young smokers initiated before reaching the age of ten (Global Youth Tobacco Survey Collaborating Group, 2003; "Tobacco use among youth," 2002).

In regions other than Europe the prevalence of smoking was higher in 13-15 years old girls than in those who were 15 years or older (World Health Organization Global Health Observatory 2015). This sends an alarming message that potentially the prevalence of smoking among females will potentially increase among females in the future. These differences in smoking prevalence by sex and age groups between developed and developing countries are mainly due to the shift of global tobacco epidemic, which will be discussed in the next section.

As to newly incident cases, very rare data has been published. According to WHO smoking statistics report ("WPRO | Smoking Statistics," May 2002), it was estimated that each day 80,000 to 100,000 children worldwide started smoking and about half of them were from

Asia. About 50% of those who initiated smoking during their adolescence would continue to smoke for 15-20 years on average.

China, Russia, United States, Japan and Indonesia are the top five cigarette-consuming countries. China alone consumes more than 35 percent of the world's cigarettes with nearly 1/5 of the world population and about half of all male smokers followed by the United States and Russia.

The five largest tobacco companies in the world are the China National Tobacco Corporation, Philip Morris International, British American Tobacco, Japan Tobacco International and Imperial Tobacco. According to EuroMonitor, China National Tobacco owns a 43.2% share of the market, while the next largest competitor is Philip Morris International which owns 14.3% of the global market, followed by British American Tobacco, Japan Tobacco and Imperial Tobacco which has 11.6%, 9.4% and 4.9% of the market share respectively. All other tobacco companies have a combined share of 16.6% of the global market.

2.2 The Global Tobacco Epidemic

2.2.1 Tobacco Controversy

The association between tobacco smoking and adverse health outcomes has been suspected for decades. In 1964, Surgeon general's report established that tobacco smoking is associated with a variety of adverse outcomes which include cancer, emphysema, chronic bronchitis and cardiovascular disease. Despite the report, tobacco industry spent great effort to confuse and mislead the message during following decades. (Cummings, Brown, & O'Connor, 2007; Kyriss & Schneider, 2012). As more and more research on tobacco and health outcome were published and showing consistent evidence across different study populations, geographic regions and over time the controversy is less debated and more and more Americans became

aware of the health hazard associated with tobacco smoking ("The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General", 2014).

2.2.2 Tobacco Control and Regulation Programs

Since the 1964 Surgeon General's report, a lot of efforts have been made to control tobacco use in the U.S. In 1965 Federal Cigarette Labeling and Advertising Act was passed and this act requires labeling cigarette packages with health warning message. Federal Trade Commission was required to submit report on tobacco company labeling and advertising practices annually. A few years later, in 1970 Public Health Cigarette smoking Act was passed which banned advertising of cigarette on television and radio. During January 1966 to October 1970, the label "CAUTION: CIGARETTE SMOKING MAY BE HAZARDOUS TO YOUR HEALTH" was used. In 1984 the Comprehensive Smoking Education act was passed, this was an amendment to the Cigarette Labeling and Advertising Act. The comprehensive smoking education act requires the use health warning labels on cigarette packages and advertisements. In 1986, increasing attention was paid to control smokeless tobacco product – smokeless tobacco advertising on television and radio were banned. Report on smokeless tobacco product needs to be submitted to Department of Health and Human Services every other year. The sales, advertising and marketing need to be reported to Federal Trade Commission annually. In addition, labels like 'WARNING: This product can cause mouth cancer', 'WARNING: This product is not a safe alternative to cigarettes', 'WARNING: This product can cause gum disease and tooth loss.', 'WARNING: Smokeless tobacco is addictive.' were required to display on a quarterly rotating basis. In 1992, an amendment was made to Alcohol, Drug Abuse, and mental Health Administration Reorganization act which prohibit the sale and distribution of tobacco products to minors by enforcing laws and conducting random inspections of tobacco outlets. In

1996, another law was passed to restrict the sale to minor. In 2000, Vendell H.Ford Aviation investment and Reform Act was passed which prohibits smoking on all flights within the U.S. and between the U.S. and foreign countries. Then in 2009, Family Smoking Prevention and Tobacco Control Act was passed, this act restricts the sale of cigarette by prohibiting sale of cigarette with certain flavors (such as orang, grape etc.) , in addition it prohibits the labeling of tobacco products with words like 'light', 'low', 'mild' or other depiction . The latest control act was passed in 2010, this act regulate the traffic of cigarette (e.g. mailing of cigarettes and smokeless tobacco are banned through the U.S. postal service, requiring internet retailers to verify age of their customers, requiring the online retailers to pay federal state and tribal taxes for tobacco products).

It is very clear that tobacco regulation is becoming more stringent over the past several decades. According to CDC report on national tobacco control programs, the main goals of national tobacco programs are to prevent smoking initiation among youth, promote quitting among active smokers, eliminate exposure to second-hand smoke and reduce smoking disparities ("Best Practices for Comprehensive Tobacco Control Programs—2014", CDC, 2014).

Besides policies and regulations, there are three other important components of national tobacco control program which are 1. Population-based community interventions (such as increasing the unit price of cigarette, restricting minor's access, conducting public education/mass media campaigns along with other community interventions). 2. Counter-marketing. 3. Surveillance and evaluation such as Youth Risk Behavior Surveillance System (YRBSS), Youth Tobacco Survey (YTS), National Survey of Drug Use and Health (NSDUH), National Youth Tobacco Survey (NYTS), Adult Tobacco Survey (ATS) etc.

With better understanding of tobacco smoking and risk factors, control programs have been developed to target different population. However, tobacco control program designed for immigrant population remains very limited despite this is a population more vulnerable to smoking associated adverse health outcomes (Dillon & Chase, 2010; Gebhardt et al., 2012).

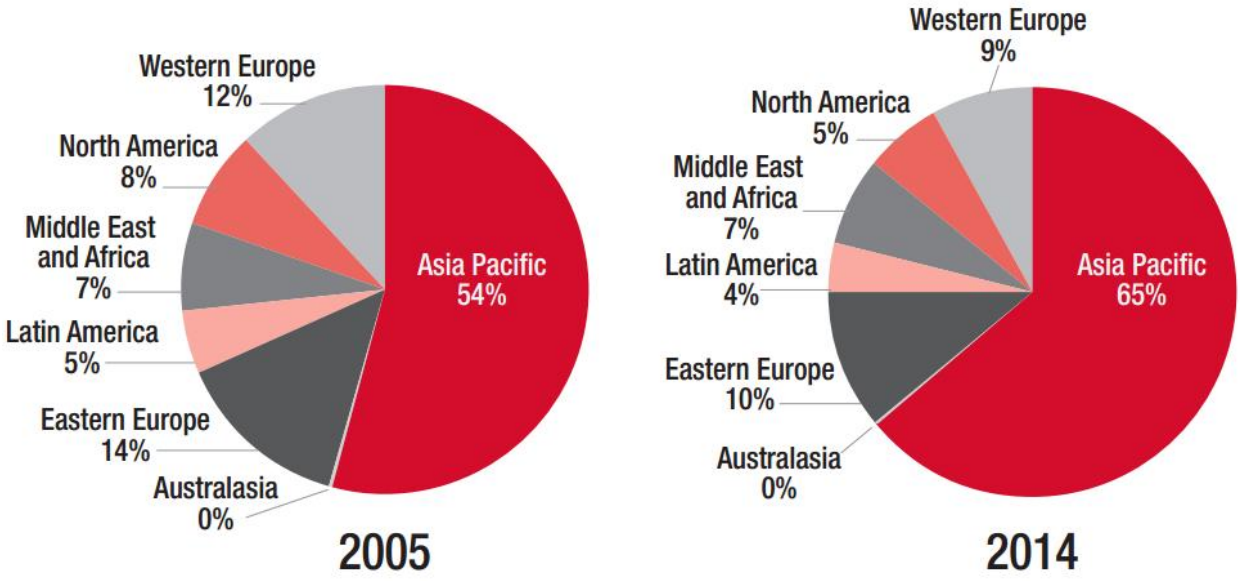
2.2.3 Tobacco Epidemic

With increasing population awareness of health hazard of tobacco smoking along with more stringent tobacco control programs - restriction of marketing, advertising, regulation of sales and taxes the prevalence of adult smoking dropped from above 40% in 1960s to less than 18% in 2015. As the consumption of cigarette in the U.S. dropped over the past few decades, tobacco companies increasingly shift their main market to overseas developing countries (Biswas, 2013; Borzekowski & Cohen, 2013).

Despite the steady decrease of cigarette consumption in developed countries, cigarette consumption increased dramatically worldwide. According to Tobacco Atlas 2012 (Tobacco Atlas, 2012, www.tobaccoatlas.org), global cigarette consumption increased over 100 times from about 50 billion cigarettes in 1900 to 5884 billion in 2009. Number of smokers worldwide reached highest level in history. Even though number of smokers reduced remarkably in developed countries, it was offset by the increasing trend in developing countries. University of Washington conducted a comprehensive study to examine global tobacco use and found that by 2012 there were 967.3 million daily smokers around the globe, out of these 725.5 million were from developing countries(Ng M, Freeman MK, Fleming TD, & et al, 2014).

A recent report found that within past decade, cigarette sales kept increasing in Asia, Middle East and Africa while sales in other regions all declined (tobacco free kids organization campaign 2015).

Figure 2.2 Global Cigarette Market by Region



Source: Euromonitor International, 2014

Following tobacco epidemic, tobacco smoking, attitude and perception of tobacco smoking in developing countries changes accordingly (Z. M. Chen, Xu, Collins, Li, & Peto, 1997; Narain & Sinha, 2011; Reiss, Lehnhardt, & Razum, 2015; Ward et al., 2006). Different age-sex cohorts perceive and behave differently about tobacco smoking – tobacco smoking becomes much more common in younger generations in low and middle income countries/regions and maybe perceived more socially acceptable among younger generation, this phenomenon results in an age-cohort effect.

This cohort effects should be taken into account when comparing smoking behaviors of the U.S. immigrants that were foreign-born and U.S.-born peers. As recent immigrants from developing countries are more likely to be smokers and they may perceive tobacco smoking as less risky on health and more socially acceptable compared to those who immigrated to the U.S. in earlier time. With more restricting regulations and increasing awareness of smoking associated health hazard, in the U.S. and other western countries norms and perception about smoking also

change and prevalence have been decreasing. Comparison between the U.S.-born and immigrants from different birth cohorts can be biased by the cohort effect. Existing literature comparing tobacco smoking behaviors by nativity (foreign-born vs. U.S.-born) usually are based on cross-sectional data which mixed different cohorts and thus cause biased results.

2.3 Acculturation and Health of Immigrants Population

2.3.1 Acculturation Theory

Park and Burgess proposed classic straight line assimilation theory in early 1920s. This theory advocates that as immigrants reside in the U.S. over time and over generations they will converge to the white mid-class (Waters, Tran, Kasinitz, & Mollenkopf, 2010; Warner and Srole 1945). This theory was shown by many social studies to be working well until 1960s when the majority of the immigrants' population was from Europe. Those social studies showed that over time the intermarriage rate, employment rate of immigrants drew near to the native born U.S. population (Rosenthal, 1963; Thernstrom, 1980).

Before 1960s, the immigration was based on a national origins quota system. With the civil rights movement, in 1965 the immigration and naturalization act (Hart-Celler Act) was passed which was based on 1) reuniting immigrant families and 2) attracting skilled people to the United States. Mainly due to the immigration law (and other factors) immigrant population increased significantly in addition to the fact that the immigrants component changed dramatically. In 1980s Latino immigrants surpassed European immigrants and became the largest group of new immigrant population. The trend shifted again in 2010, as new immigrants from Asia quickly escalated and reached 36% of new immigrants arrived that year and exceeded the Latino new immigrants (31%) for the first time ("The Rise of Asian Americans", 2013).

With the different composition of the new immigrant population the classical 'straight-line' assimilation theory does not provide a good theoretic model any longer as these new immigrants population adjust to the new culture by responding very differently.

A newer theory - segmented acculturation theory becomes more popular in explaining how the new immigrant population adapts to the U.S. environment as an alternative to straight-line theory. Based on segmented acculturation theory, immigrants can either assimilate upward to the mid-class or for some racial disadvantaged groups they may be blocked from assimilating to mid-class thus they either separate themselves in ethnic enclaves or move downward to the lower class and stay in permanent poverty (Portes & Rumbaut, 2001; Portes & Zhou, 1993).

In early 1980s, John Berry proposed a model of acculturation which was later widely accepted. The bi-dimensional acculturation is built on how well does the subject adapt to the host cultural while retain the home culture. Based on this framework, four subgroups are posited: assimilation, integration, marginalization, separation. Assimilation occurs when the subject non-selectively adapt the host cultural and completely lose the original cultural identity. Integration refers that the subjects accept the host culture while also retain the original cultural identity. Separation refers the group that neither adapt to the host culture nor maintain the original cultural while separation occurs when the subjects retain the home culture and complete reject the host culture thus they are separated from the main stream culture in host country.

Because of these diverging rather than converging trend, it will be essentially important to pay attention to each group and study the acculturation effect on their health behaviors and outcome. Also as acculturation status is dynamic, measuring acculturation status over time will help researchers to understand how dynamic acculturation status can affect immigrants' health behaviors.

Figure 2.3 John Berry's Model of Acculturation

		Is it considered to be of value to maintain one's cultural heritage?"	
		No	Yes
"Is it considered to be of value to develop relationships with the larger society?"	Yes	Assimilation	Integration
	No	Marginalization	Separation

2.3.2 Acculturation and Immigrant Population Health

Existing literature has shown consistently that immigrants have certain health outcomes that are better when compared with their U.S.-born racial/ethnic peers. This phenomenon is called 'healthy immigrant effect' or 'immigrant paradox'. This section reviews literature on acculturation and immigrants' health outcome.

Results from previous studies have not been entirely consistent but majority of the studies suggest that 'healthy immigrant effect' withdraw over time. As immigrants became more acculturated (mostly measured by length of residence time in the U.S.) the favorable health outcomes deteriorated over time and approached or even exceeded those from native-born peers. This pattern has been shown for a variety of health outcomes such as obesity (Lauderdale & Rathouz, 2000; Gopal K. Singh & Siahpush, 2002; Goel, McCarthy, Phillips, & Wee, 2004; Himmelgreen et al., 2004; Kaplan, Huguet, Newsom, & McFarland, 2004; Abraído-Lanza, Armbrister, Flórez, & Aguirre, 2006; Antecol & Bedard, 2006; Barcenas et al., 2007), cancer (Ziegler et al., 1993; John, Phipps, Davis, & Koo, 2005), heart disease (Mooteri, Petersen,

Dagubati, & Pai, 2004; Diez Roux et al., 2005), smoking (Singh and Siahpush, 2002; Abraido-Lanza et al, 2005), alcohol consumption (Gil, Wagner, & Vega, 2000; Guilamo-Ramos, Jaccard, Johansson, & Turrisi, 2004; Abraído-Lanza, Chao, & Flórez, 2005a), substance use disorders(Vega, Sribney, Aguilar-Gaxiola, & Kolody, 2004; Alegría et al., 2008; J. Breslau, Borges, Hagar, Tancredi, & Gilman, 2009;), birth outcomes (Alexander & Kotelchuck, 1996; David & Collins, 1997; Families & Hernandez, 1999; Fang, Madhavan, & Alderman, 1999; G K Singh & Yu, 1996)) and mortality (Landale, Oropesa, Llanes, & Gorman, 1999; G. K. Singh & Siahpush, 2001). The few exception that have been reported includes that physical activities/exercises increased with years of residence (Abraído-Lanza, Chao, & Flórez, 2005b), another exception is that suicide rate declines as immigrants reside in the U.S. for longer period of time.

Many possible explanations have been offered, the most prevailing explanations are migration related selections and behavior changes due to acculturation. Migration related selections refer that those choose to immigrate, are able to immigrate and stay in the host country can have different characteristics from those who were born in host country and those who were foreign born and do not wish to immigrate, are not able to immigrate and do not stay in the host country. In addition, as discussed in section 2.3, with the change in immigration policies, the reasons for immigration and the composition of immigrants changed dramatically over time. For example, majority of early immigrants from China (before 1980s) had limited 'human capital', faced language barrier, immigrated illegally and mainly ended up in lower labor class (e.g. as miners, laborers, servants) while more recent immigrants from China usually come with higher education background (e.g. students, professionals), they are better with English and are from wealthier families. When compare immigrants vs U.S.-born peers using the older vs newer

immigrants, different conclusions may be drawn. According to 'selection' explanation, the differences in health outcomes can actually be confounded by the characteristics of the cohorts.

The second explanation is acculturation. Acculturation is a process of adopting the culture, value, norms and behaviors in another group. When immigrants first immigrate, they may maintain their original values and attitudes from their country of origin which can be protective. During the acculturation process immigrants may lose their original values, norms. In addition as immigrants become more acculturated they may become more influenced by their native-born peers and behave more like Americans. Another possible pathway can be loosened family/community bonding. Strong family-bonding in immigrant families and community cohesion have been consistently shown to be protective and act as buffer against adverse behaviors. Immigrant parents are usually more attached to their original culture and it takes longer for them to adopt a new culture while immigrant children usually adopt at a much faster rate. The different rate in acculturation can cause clash between their values. The disagreement can lead to conflict and loosen parent-child bonding which are usually protective against adverse and risky behaviors (e.g. substance uses, sexual activities).(Fleming, Kim, Harachi, & Catalano, 2002; Hill, Hawkins, Catalano, Abbott, & Guo, 2005a; Mahabee-Gittens et al., 2011a; Phinney, Ong, & Madden, 2000).

2.3.3 History of Immigrants and Migration-related Selection

In this research, immigration-related selection refers to the phenomena that people who choose to immigrate, are able to immigrate, and who stay in the U.S may present different characteristics from the general U.S.-born population. Existing literature has shown that among Latino population, immigrants to U.S. are healthier and wealthier than the non-immigrating population (Barquera, Durazo-Arvizu, Luke, Cao, & Cooper, 2008; Crimmins, Soldo, Kim, &

Alley, 2005; Landale, Gorman, & Oropesa, 2006; Rubalcava, Teruel, Thomas, & Goldman, 2008). Among other race/ethnicity groups same tendency are observed (Kennedy, McDonald, & Biddle, 2006; Kuerban, 2015).

Previous studies compare smoking behaviors between foreign-born immigrants and U.S.-born peers without taking into account of migration-related selection is very likely to bias the inferences from the studies. However, the limitation has rarely been addressed by previous research (Bosdriesz et al., 2013). This might be due to the lack of appropriate transnational data which contains both data from country of origin and data from the U.S. However, even with transnational data, some characteristics will be unmeasurable and cause residual confounding in the analysis.

Under this situation, some advanced statistical modeling tools can be used to analyze the data by comparing the risk of the two similar individual immigrants of who one has immigrated to U.S. while the other has not at a certain time point. Thus the comparisons are made within populations that immigrate to U.S. eventually and the results are less affected by selection bias.

Numerous studies have found that differences in smoking behaviors between U.S.-born counterparts and foreign-born immigrants diminished with generations and elapsed residence time in the U.S. (X. G. Chen, Unger, Cruz, & Johnson, 1999; Epstein, Botvin, & Diaz, 1998; Marin, Perez-Stable, & Marin, 1989; Shelley et al., 2004; G. K. Singh & Siahpush, 2002). The diminished differences over time have been thought to be due to acculturation and assimilation process (Acevedo-Garcia, Pan, Jun, Osypuk, & Emmons, 2005, Portes, Fernández-Kelly, & Haller, 2005). However, all of these results are from cross-sectional data which can be confounded by many factors including cohort effect. The cohort effect is associated with tobacco epidemic shift globally and is discussed earlier in the section.

2.4 Smoking Behaviors in U.S.-born vs. Foreign-born Population

In the U.S., the tobacco smoking behaviors are found to be different between foreign-born immigrants and U.S.-born peers across different race/ethnicity groups. These studies suggest that environmental factors play a role in shaping different smoking behaviors between U.S.-born and foreign-born populations.

Among Blacks, U.S.-born Blacks present a significant higher risk of smoking compared to their foreign-born peers. A study by Bennett compares smoking behavior among Blacks by their region of birth showed that U.S.-born Blacks were about six times more likely to smoke than those born in the Caribbean (OR=0.16, 95% CI=(0.08, 0.34)) and more than four times more likely to smoke than those born in Africa(Bennett et al., 2008a). Another study using earlier national representative data also found that U.S.-born Blacks were 2.7 times more likely to be current smoker than foreign-born Blacks (King, Polednak, Bendel, & Hovey, 1999). Similar findings were replicated by a study using data from 1992 Cancer Epidemiology supplement and the Year 2000 Objectives supplement for 1993-95 of the National Health Interview Survey, this study also showed that U.S.-born Blacks (prevalence~28%) were about 2.5 times more likely to be current smokers compared to foreign-born Blacks (prevalence ~ 11%).

Overall, U.S.-born Hispanics also present higher risk of smoking compared to foreign-born peers, although effect of nativity may differ by sex and migration age groups. A previous research by Eliseo J. Pérez-Stable studied Latino adult smoking behavior by recruiting subjects from concentrated Latino residence area. This study found that overall foreign-born respondents were less likely to smoke (OR = 0.77, 95% CI = (0.66, 0.90)) than U.S.-born peers. Additionally, further stratified analysis by sex found foreign-born males had a higher risk than native-born

peers while foreign-born females had a lower risk than their U.S.-born peers respondents (Eliseo J. Pérez-Stable et al., 2001). Another study using data from Los Angeles Latinos population showed a monotonic relationship between immigration age and smoking - younger age at immigration is associated with higher odds of smoking. Compared to U.S.-born peers the odds increase from 0.51, 0.59 to 0.79 in Latino immigrants who migrated during childhood, adolescence and adulthood (Kimbro, 2009a). Besides current smoking status, a recent study by Becky Wade showed that foreign-born Latinos were less likely to be an ever smoker. In addition, among smokers foreign-born smoked less compared to U.S.-born. In both Mexican Hispanics and the Other Hispanics, U.S.-born smokers were more likely to be moderate/heavy smokers (Wade, Lariscy, & Hummer, 2013c). Another study by Lopez-Gonzalez also presented strong evidence that Latino Americans born outside of the U.S. were less likely to be ever smoker and among those who ever smoked they tended to smoke less compared to their U.S.-born peers , the difference was more dramatic in females than in males (Lopez-Gonzalez, Aravena, & Hummer, 2005).

The sex difference is even more dramatic in Asian American population. Existing literature has been very consistent that Asian females born outside of the U.S. have significant lower prevalence of smoking than U.S.-born counterparts. The nativity effect on Asian males are not very consistent. A study of Asian American adult by Chae showed that the prevalence of current smoking among U.S.-born females was almost two folds of that from foreign-born Asian females. However, foreign-born Asian men had a higher current smoking prevalence vs. U.S.-born men (24.9% vs. 15.6%) (Chae, Gavin, & Takeuchi, 2006a).

The difference of nativity effect by sex is likely to be due to the fact that female smoking is not socially acceptable in many Asia countries so the prevalence is extremely low (with a few

exceptions such as Koreans, Japanese). On the other hand, male smoking is deemed more acceptable by social norms and with tobacco companies shifting focus of market to developing countries, marketing strategies all promote smoking in developing countries. The prevalence of smoking reach alarming high in some Asian countries.

Foreign-born Hispanics, Asian females, Blacks, and Whites have lower prevalence of tobacco smoking compared to their U.S.-born counterparts (Bennett et al., 2008b; Gorman, Lariscy, & Kaushik, 2014; Kimbro, 2009b; King et al., 1999; E. J. Pérez-Stable et al., 2001). In addition, U.S.-born males were 1.6 times more likely to be daily smokers than foreign-born peers, the difference was even more dramatic for females as U.S.-born females were 2.6 times more likely to be daily smokers compared to foreign-born female(Acevedo-Garcia et al., 2005). There were some exceptions of foreign-born males presenting higher prevalence of tobacco smoking (Baluja, Park, & Myers, 2003b; Chae, Gavin, & Takeuchi, 2006b), these male immigrants were usually from countries with exceptional high smoking prevalence for male. Among current smokers, foreign-born Hispanics, Asian, Blacks, and Whites smoke less compared to their U.S.-born counterparts and foreign-born youth tend to start smoking at a later age compared to their U.S.-born peers (Hu, Pallonen, & Meshack, 2010).

2.5 Smoking Initiation

Among all different smoking behaviors, my dissertation research focuses on smoking initiation for the reason that smoking initiation is an important behavior that is connected with later smoking behaviors and also health consequences. Nicotine - a natural ingredient of tobacco leaves is super addictive. In fact, it was found to be one of the most addictive substances (Le Foll & Goldberg, 2009; Stolerman & Jarvis, 1995). It was estimated that one in every three people who tried tobacco smoking for the first time would become regular smoker in later life

("Preventing Tobacco Use Among Young People A Report of the Surgeon General" USDHHS 1994, p. 67.). Also, due to the addictive feature of nicotine, of those tobacco smokers who wanted to quit smoking, less than 5% could be successful at a time (Centers for Disease Control and Prevention (CDC), 2004).

In addition, the timing of initiation also plays an important role in later smoking behavior. It has been consistently shown that the younger the smoking initiation occurs, the greater the risk of regular smoking. Existing literature have shown that smoking prevention programs usually do not have effects on students who initiated smoking before middle school. Additional studies have shown that compared to those initiated smoking at later age, early initiators were less likely to try quitting smoking or to succeed in quit attempts and were more likely to persist in smoking to adulthood than older initiators (N. Breslau, Fenn, & Peterson, 1993b; N. Breslau & Peterson, 1996; J. Chen & Millar, 1998; Everett et al., 1999; Taioli & Wynder, 1991). Based on these findings, it has been advocated to delay the cigarette smoking initiation age as a strategy for preventing use.

As mentioned above, to lower the tobacco smoking rate in the U.S. one important strategy is to effectively prevent smoking initiation. Another strategy is to delay the initiation as much as possible since the risk of smoking initiation decrease dramatically once reach adulthood (Edwards, Carter, Peace, & Blakely, 2013), in fact 88% of smokers initiated before age 18, very few smokers initiated after their teenage years (CDC 2012 "The Tobacco Epidemic Continues Because Youth and Young Adults Begin to Use—and Become Addicted to—Cigarettes and Smokeless Tobacco Products"). Both strategies mentioned above promote better understanding of environment influences on the risk of initiating smoking which motivates the three study aims of my dissertation.

2.6 Peer Influences and Family Connectedness on Tobacco Smoking

The mechanism of how nativity might affect the risk of starting cigarette smoking is still not clearly understood. During the acculturation process, immigrants are experiencing culture changes which have effect on future behavior and conceptions. I am specifically interested in the effect of peer influences and family connectedness during this adaption process in this dissertation research.

2.6.1 Peer Influence on Tobacco Smoking

Influence of peer smoking has consistently been shown to be a strong risk factor of initiating cigarette smoking in youth (D'Amico & McCarthy, 2006; Flay et al., 1994; Maxwell, 2002). Christine Jackson conducted a longitudinal study in 1998 to study risk factors associated with early initiation. This study followed 633 fifth grade students over three years period and found that having friends smoking increased the initiation risk by more than three folds (Jackson, Henriksen, Dickinson, Messer, & Robertson, 1998). Another longitudinal study of 9^{th} and 10^{th} graders (predominantly Hispanic) adolescents also showed that having friends smoking was a risk factor for smoking initiation, after adjusting for subject characteristics having friends smoking increased the risk of initiation by 1.8 folds. (Valente, Fujimoto, Soto, Ritt-Olson, & Unger, 2013). Velez and Ungemack showed in their 1995 work that among Puerto Rican youth, having adverse peer influence was the strongest predictor of later drug involvement (Velez, C. N., & Ungemack, J. A., 1995).

Immigrant youth can be more vulnerable to peer influences as young immigrants tend to adopt mainstream norms, values, and behaviors from their friends which immigrant youth perceives as mainstream behaviors.

2.6.2 Family Connectedness (parent-child bonding)

It is consistently shown in the literature that close family connectedness can have an important protective role against substance abuse amongst youth (Griffin et at., 2000, Velleman, Templeton, & Copello, 2005). Numerous studies have shown that strong parent-child bonding protect youth against initiating cigarette smoking (Hill, Hawkins, Catalano, Abbott, & Guo, 2005b; Mahabee-Gittens et al., 2011b).

Family connectedness is the core of familyism and it is thought to be the source of emotional and social support especially for Hispanics and African Americans (Michael D. Reiter's book "Subsance abuse and the family"). However, the connectedness in immigrant families may change after immigration and loosen over time as the family immigrates to the U.S. for longer period of time. This is because that immigrant parents and children acculturate at different rates, which can cause a clash over cultural values and create familial conflict that weaken family bonding and parental authority (Choi, He, & Harachi, 2008). This phenomena is called 'Acculturation Gap" and has been discussed in details in Birman Dina's book and article (Birman, 2006). The effect of acculturation on the risk of initiating cigarette smoking may be mediated by peer influence and parent-child bonding. These potential mediation effects are not well understood in the young immigrant population.

CHAPTER 3 MATERIALS AND METHODS

Chapter 3 provides details of the materials and methods for each of the three studies comprising this dissertation research. The first section of the chapter describes the study population and research approach, including the longitudinal design and other facets of methods that the three research projects have in common. The second half of the chapter mainly focuses on describing and explaining the analysis approach for each study individually.

3.1 National Longitudinal Study of Adolescent to Adult Health (ADD HEALTH)

3.1.1 Study Background, Design, and Population

The study population for the National Longitudinal Study of Adolescent to Adult Health (ADD HEALTH) was specified to encompass school-attending adolescents in grades 7 through 12 during the 1994/95 academic year. The ADD HEALTH research team recruited a nationally representative sample of this study population, with a longitudinal design to follow these cohorts into adulthood. As of the time of this dissertation research project, four follow-ups of the cohort have been conducted, the most recent one in 2008. This project is still ongoing with a plan for the fifth wave of data collection between 2015 and 2018.

In ADD HEALTH assessments, a wide range of domains is covered, including various aspects of social, economic, psychological and physical well-being. Data on individuals as well as contextual data on neighborhood, school, peer groups, and family are collected to capture varioius levels of sources of variation in frequency and occurrence of health outcomes being studied. As such, the ADD HEALTH research team has created a unique opportunity to study social, behavioral and biological factors as might affect health and health behavior trajectories as the baseline cohorts develop through adolescence and adulthood.

3.1.2 Sampling Approach

ADD HEALTH is school-based. To ensure the representativeness of the sample, several sampling strategies were used. First, a comprehensive list of the U.S. high schools was obtained from quality education data (QED) database, the list consists of 26, 666 schools which includes public, private and parochial schools. Then multi stage sampling method was used. At first stage, 80 eligible high schools were selected systematically and with weights proportional to the size of stratification. High schools with an 11th grade and more than 30 students were considered eligible to participate in the study. These eligible high schools were stratified by characteristics such as urbanicity (urban, suburban, rural), school size (125 or fewer, 126 – 350, 351 -775, 776 or more students), school type (public, private, parochial), census region (Northeast, Midwest, South, West) and race composition (black 0%, 1-6%, 7-33%, 34 -100%, and while 0%, 1-66%, 67-93%, 94-100%). More than 70% of originally selected 80 high schools agreed to participate; the remaining schools were replaced by similar high schools within the same stratum. Then the eligible corresponding feeder schools (defined as includes a 7^{th} grade and had at least five graduates to the high school) were selected with probability proportional to the number of students that were sent to the high school. 56 feeder schools were selected but four of them declined to participate in the study which left 52 feeder schools for this study. In the first stage sampling, 132 schools (80 high schools and associated 52 middle/junior high schools) were selected and constitute a nationally representative sample of American high schools and associated feeder schools.

Administrators at each of the 132 schools were asked to take a survey about the school attribute. 7^{th}-12^{th} graders from participating schools were asked to take the in-school survey and a total sample of over 90,000 students completed the in-school questionnaire.

Table 3.1 Attributes of the ADD HEALTH Sampling Design at Each Level of Sampling Unit

	Sampled Unit	
	Schools	Adolescents
Attributes related to being selected to participate in Add Health	*HIGH SCHOOLS:* *Size of School:* <125 students 126-350 students 351-775 students ≥776 students *School Type:* public private parochial *Location:* urban suburban rural *Region:* Northeast Midwest South West *Percent White:* 0 % 1 to 66 % 67 to 93% 94 to 100% *FEEDER SCHOOLS:* Percent of entering class for linked High School coming from the feeder school *	*WAVE I ADOLESCENTS:* *Race/Ethnicity over-sampled Groups:* High SES Black Cuban Puerto Rican Chinese *Genetic Sample* Twins Full Siblings Half Siblings Unrelated in Same Household *Disabled Youth over-sampled Group* *Purposively Selected Schools:* All students selected from 16 schools
Panels of Data affected by Attribute of Sampled Unit		
School Administrator		
In-School Wave I Wave II Wave III Wave IV		

Source: "Guidelines for Analyzing ADD HEALTH Data", Carolina Population Center, University of North Carolina at Chapel Hill

At stage two, the core of Wave I in-home sample was selected with unequal probability from the school year roster and from those not in school roster but completed in-school survey. Each participating school stratifies students based on sex and grade. Within each stratum about 17 students were randomly selected and each school pairs yield about 200 adolescents. A total of 18,924 students were selected and formed the core of the Wave I in-home interview sample. The core sample is essentially self-weighted and yields a nationally representative sample of 7-12 graders. Wave I in-home interview sample also include supplemental samples (n=1,821) to

oversample certain ethnicity groups (e.g. Cuban, Puerto Rican and Chinese), also siblings were oversampled to study genetic factors, adoption status and disability were also taken into account for over sampling certain populations.

Wave II was conducted in 1996, participants were mainly from Wave I participants with the exception of taking away disabled sample and those were 12 graders at Wave I. Besides that, to increase the size of genetic sample some adolescents that did not participate in Wave I were interviewed at Wave II. A total of 14,736 study participants were interviewed at wave II, of these 13,569 were from core of wave I sample, the other 1,167 were from the oversampled supplemental sample.

The cohort was then followed up again in 2002-2003. At wave III, Wave I respondents who could be tracked were interviewed (n=15,170), those who were not in the wave I core sample but were part of the genetic sample were also interviewed (n=27).

The latest follow-up was conducted in 2007-2008. At Wave IV, sample from Wave I in-home respondents that could be followed were interviewed, as in Wave III the subjects from Wave I but without sampling weights were not interviewed at Wave IV (n=15,701).

Table 3.2 presents the number of participants that were interviewed at each wave and number of dropped out sample along with the reasons of drop out.

Table 3.2 ADD HEALTH Sample Size, Response Rate, and Description at Each Wave

	Sample size	Response rate	Description
Wave I	20,745	78.90%	Nationally representative sample of 7^{th} – 12^{th} graders in the U.S.
Wave II	14,738	88.20%	Same as Wave I in-home interview sample with the exceptions of 1. Majority of 12 grade respondents dropped out after Wave I. 2. Disabled sample in Wave I was dropped. 3. Two adolescents who did not participate in the Wave I participated Wave II.
Wave III	15,197	77.40%	Wave I respondents who could be followed up and re-interviewed plus 1. 1,507 partners of original respondents. 2. 1,372 subjects dropped out at wave II.
Wave IV	15,701	80.40%	Wave I in-home respondents who could be followed up and re-interviewed plus. 1. 2,136 subjects dropped out at wave III.

Source: "Guidelines for Analyzing ADD HEALTH Data", Carolina Population Center, University of North Carolina at Chapel Hill

In Figure 3.1, the sample at each wave was divided into 'core' sample and 'over sampled'sample. 'Core' sample is a nationally representative sample of 7^{th}-12^{th} graders while 'Over sampled' sample includes additional sample of minority race groups (High SES Blacks, Cubans, Puero Ricans and Chinese) and ADD HEALTH study also over sampled disabled youth sample. In my dissertation reseach, only subjects in the 'core' sample were used.

Figure 3.1 Flow Chart of ADD HEALTH Longitudinal Data

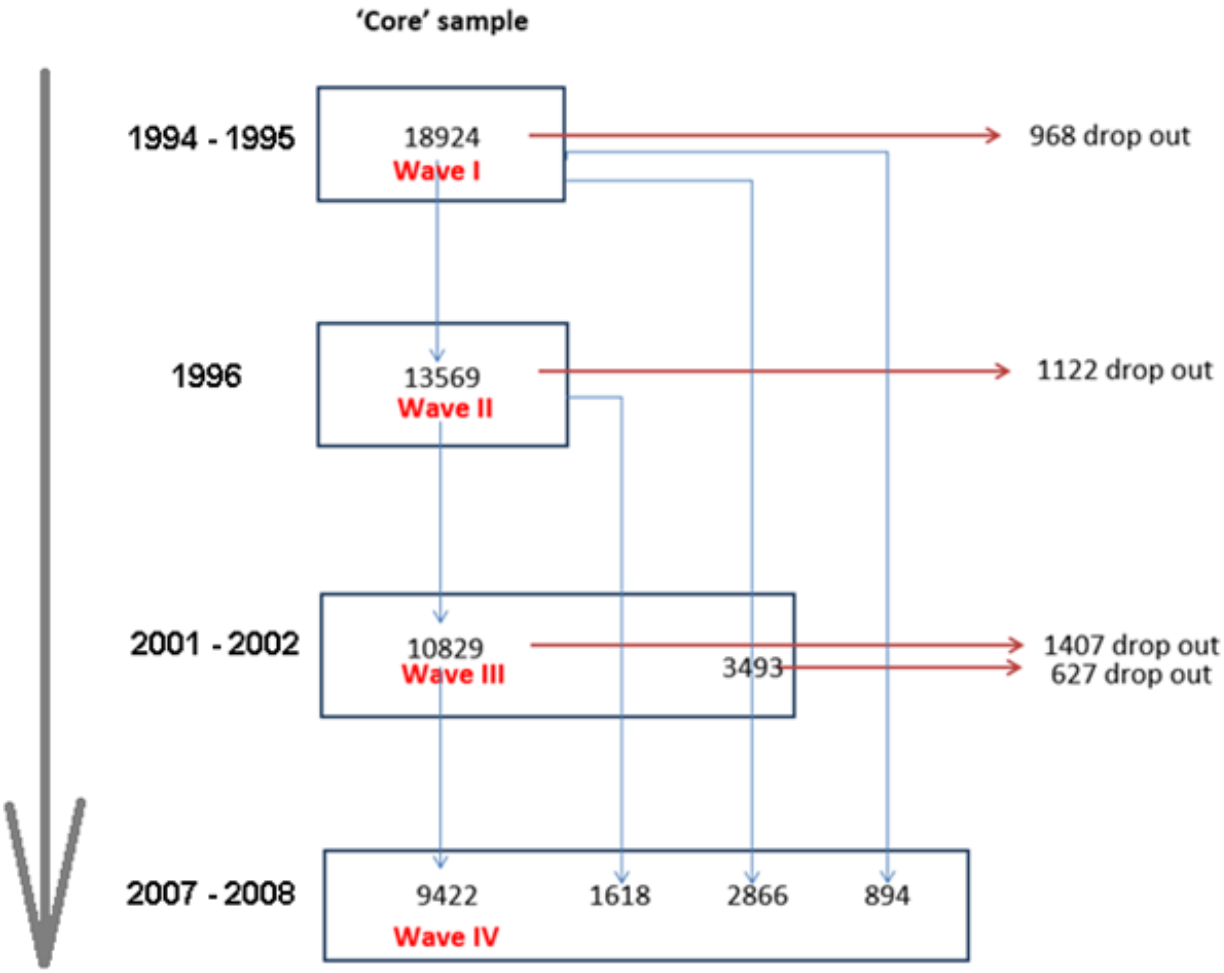


Table 3.3 Attributes of ADD HEALTH Sampling Design

Design Attribute	Usual Impact on	Variables in ADD HEALTH Data Used to Adjust for the Sampling Design
Stratification	Reduce Variance	Poststratification Variable: Census Region
Clustering of Students	Increase Variance	Primary Sampling Unit Variable: School Identification Variable
Unequal Probability of Selection	Increase Variance	SAMPLING Weights: Cross-sectional Weights for Schools Cross-sectional Weights for analyzing each Wave of Data Cross-sectional Weights for analyzing special sub-samples from Wave III Longitudinal Weights for conducting analyses combining data from multiple Waves Multilevel Weights for two-level analysis where schools and adolescents are the levels of interest

Source: "Guidelines for Analyzing ADD HEALTH Data", Carolina Population Center, University of North Carolina at Chapel Hill

3.1.3 Methodology, Confidentiality, and Human Subjects Protection

Written informed consent was obtained from legal guardian and the adolescent before first in-home interview was conducted. Patents were also interviewed during Wave I for information about the demographic information of parents and family composition, other characteristics and adolescents' health information.

In home interview was conducted using both computer-assisted personal interview (CAPI) and computer-assisted self-interview (ACASI). Self-administered interview portion is

designed for sections with sensitive information such as sexual activities. This method increased confidentiality of responses and thus promoted more complete and honest responses.

All study materials and procedures were reviewed and approved by University of North Carolina School of Public Health institutional review board (IRB) for the protection of human subjects. To protect study participant's confidentiality, all personal identifiable information (e.g. names, birthdays, address) were removed from and could not be linked to respondent's interview data.

Public-use data only include a subset of questions and respondents. Restricted use data is only accessible to committed researchers who need to go through a strict application procedure and maintain limited access. Certain data like special, high school transcript data are only available in a secure data facility at Carolina Population Center.

3.1.4 Study Population

Adolescents that were enrolled in the U.S. schools and were between 7^{th} to 12^{th} grade during 1994 – 1995 school year comprised the target population for ADD HEALTH.

Study sample of ADD HEALTH consists of a U.S. nationally representative sample of over eighteen thousands of adolescents that were 7^{th} – 12^{th} graders during 1994-1995 school year. Then the sample was followed with four in-home interviews by 2008. More home interviews are being conducted from 2015 to 2018, these data is not available at this point.

Table 3.4 Sampling Weights Used for Cross-sectional Data and Longitudinal Data

Data Set (Year collected)	Sampling Weight Variable (N)	Type	Sample	Target Population
Wave I (1995)	GSWGT1 (N=18,924)	Cross-sectional weight	Adolescents chosen with a known probability of being selected from 1994-1995 enrollment rosters of the U.S. schools	Grade 7-12[1] in 1994-1995
Wave II (1996)	GSWGT2 (N=13,570)	Cross-sectional weight	Adolescents interviewed at Wave II. 13,568 of these adolescents were also interviewed at Wave I	Grade 7-11[1] in 1994-1995
Wave III (2001)	GSWGT3_2 (N=14,322)	Cross-sectional weight	Wave I respondents who were interviewed at Wave III	Grade 7-12[1] in 1994-1995
Wave III (2001)	GSWGT3 (N=10,828)	Longitudinal weight	Eligible Wave I Respondents interviewed at both Wave II & Wave III	Grade 7-11[1] in 1994-1995
Wave IV (2008)	GSWGT4_2 (N=14,800)	Cross-sectional weight	Wave I respondents who were interviewed at Wave IV	Grade 7-12[1] in 1994-1995
Wave IV (2008)	GSWGT4 (N=9,421)	Longitudinal weight	Eligible Wave I respondents who were interviewed at Wave II, III & IV	Grade 7-11[1] in 1994-1995
Wave IV (2008)	GSWGT134 (N=12,288)	Longitudinal weight	Eligible Wave I respondents who were interviewed at Wave III & IV	Grade 7-12[1] in 1994-1995

[1] The Target Population for these samples is comprised of adolescents who were enrolled in the U.S. schools during the 1994-1995 academic year for the specified grades.

Source: "Guidelines for Analyzing ADD HEALTH Data", Carolina Population Center, University of North Carolina at Chapel Hill

The final analytical sample used in the first study of this dissertation work includes 18,924 subjects that were in the 'core' sample and who completed the first in-home interview. In the second study, subjects that initiated before immigration were excluded because acculturation couldn't be measured before baseline in-home interview. In the third study, 9,421 subjects that completed all of the four in-home interviews and were also in the 'core' sample were used.

3.1.5 Measurement of Key Study Variables

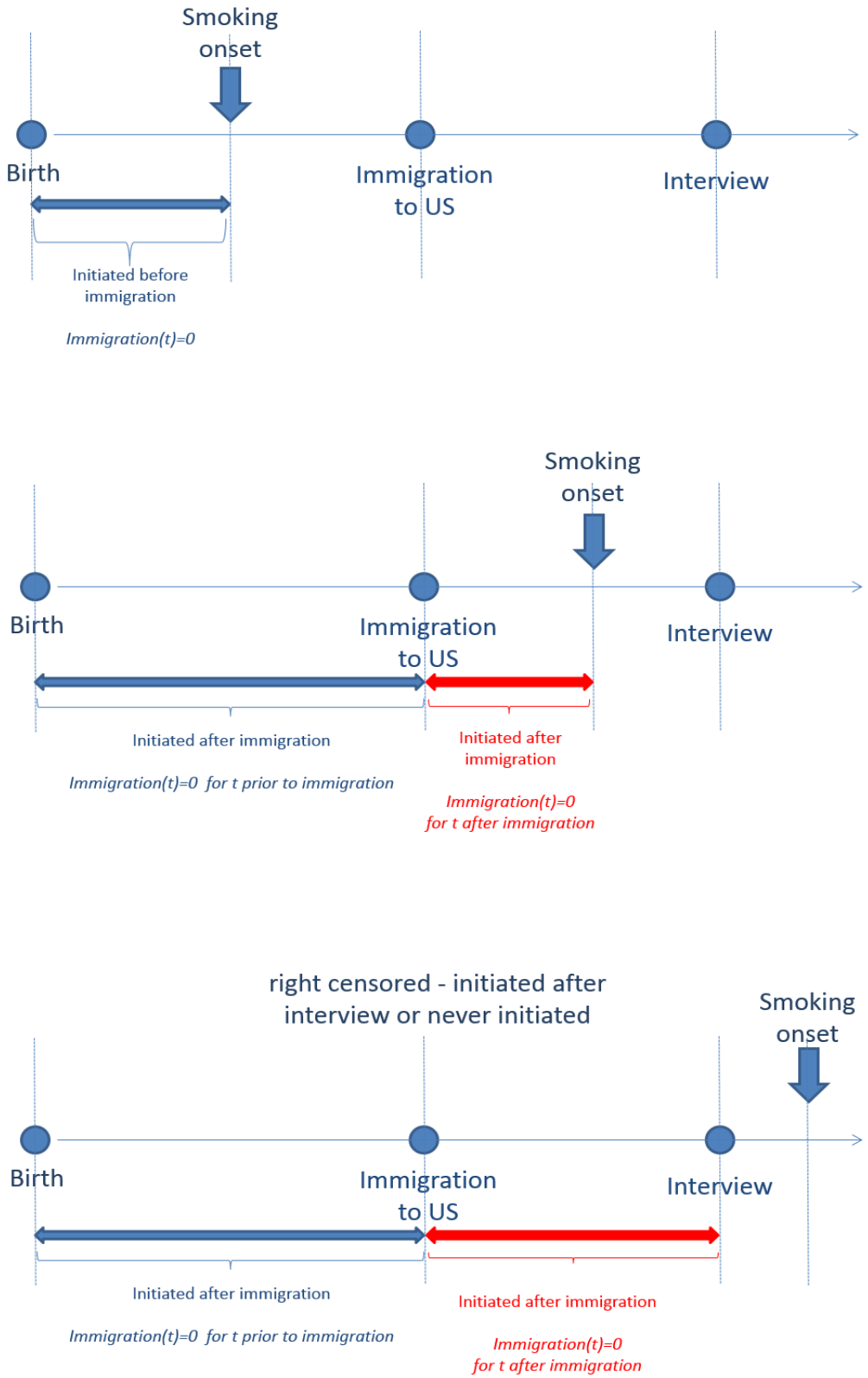
3.1.5.1 Study 1: Immigration to the U.S. and the Risk of Smoking Initiation

The exposure variable immigration status is a time dependent covariate, it is defined as

$$x(t) = \begin{cases} 0 & (\textit{if subject has not immigrated to U.S. at time } t) \\ 1 & (\textit{if subject has immigrated to U.S. at time } t) \end{cases}$$

Immigration status changes from 0 to 1 at the time point when the subject immigrated to the U.S. The time of immigration is based on the self-reported immigration age (in years). All U.S.-born subjects have x (t) =1 throughout the study.

Figure 3.2 Visual Presentation of Time Dependent Immigration Variable



The outcome variable is self-reported age of initiating cigarette smoking. Smoking initiation is defined as smoking a whole cigarette for the first time in life. Initiation age was asked at each of the four waves. The age reported at the earliest wave will be used. As least time has passed since the onset of initiation, less recall bias is expected.

Following baseline characteristics are adjusted in the model as they may serve as potential confounders.

Sex (male vs. female) is self-reported. It is collected from Wave I in-home interview. Family heritage groups (non-Hispanic white, non-Hispanic Black, American Indian/ Native American, Asian/ Pacific Islander, Hispanic, other, multiple races) are self-reported. It is also collected from Wave I in-home interview.

Parental ever smoking status (at least one of the residential parents ever smoked vs. neither of the residential parents has ever smoked). At wave I in-home interview, participants were asked whether their residential father/mother had ever smoked cigarette. Then the parental ever smoking status were collapsed to groups of 'at least one of the parents smoked', and 'neither parents ever smoked'.

Baseline family income level is a continuous variable ranges from 0-999 thousand. Each subject was asked about their before tax received in 1994, which included subject's own income, the income of everyone else in the same household and income from other sources such as welfare benefits, dividends, etc. Family income level were collapsed into four groups based on quartiles.

Baseline self-esteem is a latent variable which is constructed from six items in the personality and family questionnaire. There are moderately strong to very strong positive inter-correlations among the six items so a measurement model was used to generate the latent

variable (Appendix Table 1). The subject will be asked whether they agree with the following statement about themselves and their answers range from “strongly agree”, “agree”, “neither agree nor disagree”, “disagree” to “strongly disagree”, they may also refuse to answer or answer “don’t know”.

Table 3.5 Items for Measuring Self-esteem

Variables	Description
SE1	You have a lot of good qualities
SE2	You like yourself just the way you are
SE3	You have a lot to be proud of
SE4	You feel like you are doing everything just about right
SE5	You feel socially accepted
SE6	You feel loved and wanted

School attachment is a latent variable and is constructed from six items in Academic and Education section. Each participant were asked their school experience and whether they agree or disagree with following statements. The answers also range from “strongly agree”, “agree”, “neither agree nor disagree”, “disagree to strongly disagree”, they may also refuse to answer or answer “don’t know”. There are moderately strong to very strong positive inter-correlations among the six items so a measurement model was used to generate the latent variable (Appendix Table A.2).

Table 3.6 Items for Measuring School-attachment

Variables	Description
SA1	[If SCHOOL YEAR:] You feel close to people at your school. [If SUMMER:] Last year, you felt close to people at your school
SA2	[If SCHOOL YEAR:] You feel like you are part of your school. [If SUMMER:] Last year, you felt like you were part of your school
SA3	[If SCHOOL YEAR:] Students at your school are prejudiced. [If SUMMER:] Last year, the students at your school were prejudiced
SA4	[If SCHOOL YEAR:] You are happy to be at your school. [If SUMMER:] Last year, you were happy to be at your school
SA5	[If SCHOOL YEAR:] The teachers at your school treat students fairly. [If SUMMER:] Last year, the teachers at your school treated students fairly.
SA6	[If SCHOOL YEAR:] You feel safe in your school. [If SUMMER:] Last year, you felt safe in your school.

3.1.5.2 Study 2: Acculturation and the Risk of Smoking Initiation

The exposure variable acculturation status is a time dependent covariate, it is measured by a latent variable which is constructed from language primarily spoken in the household (collapsed to English vs. Other), number of years live in the U.S., proportion of the neighborhood population that is language-isolated, proportion of the neighborhood population that is foreign-born). For each subject, measures of acculturation level are calculated at each of the first three waves. Time dependent acculturation level is defined as

$$x(t) = \begin{cases} Acculturation_1 & (if\ time\ between\ wave\ I\ and\ wave\ II) \\ Acculturation_2 & (if\ time\ between\ wave\ II\ and\ wave\ III) \\ Acculturation_3 & (if\ time\ after\ wave\ IV) \end{cases}$$

Where $Acculturation_1$, $Acculturation_2$ and $Acculturation_3$ are the acculturation status measured at wave I, II and III.

The outcome variable is self-reported age of initiating cigarette smoking. Smoking initiation is defined as smoking a whole cigarette for the first time in life. Initiation age was asked at Wave I, Wave III and Wave IV, if initiation had not occurred by the last interview, then initiation age would be treated as missing; otherwise, the initiation age reported at the earliest interview was used because least time had passed since the onset of initiation to the interview and less recall bias was expected.

Following baseline characteristics were potential confounders, and therefore were adjusted in the model. Self-reported sex (male vs. female) was collected from Wave I in-home interview. Race/ethnicity was recoded based on self-reported race and ethnicity information which collapsed subjects into non-Hispanic White, non-Hispanic Black, American Indian/ Native American, Asian/ Pacific Islander, Other, Hispanic and multiple races. Race and ethnicity information was also collected from Wave I in-home interview. Parental ever smoking status (at least one of the residential parents ever smoked vs. neither of the residential parents had ever smoked) was collected from wave I in-home interview. In the interview, participants were asked whether their residential father/mother had ever smoked cigarette, and then the parental-ever smoking status were collapsed into groups of 'At least one of the parents smoked', and 'neither parents ever smoked'. Baseline family income was a continuous variable ranged from 0-999 thousand dollars which included subject's own income, the income of everyone else in the same

household and income from other sources such as welfare benefits, dividends, etc. In the analysis, family income was grouped into four categories based on quartiles.

Baseline self-esteem is a latent variable which is constructed from six items in the personality and family questionnaire. The subject will be asked whether they agree with the following statement about themselves and their answers range from strongly agree, agree, neither agree nor disagree, disagree to strongly disagree, they may also refuse to answer or answer don't know. The six items that are used to construct the latent self-esteem variable include can be found in Table 3.5.

School attachment is a latent variable and is constructed from six items in Academic and Education section. Each participant was asked their school experience and whether they agree or disagree with following statements. Their answers range from strongly agree, agree, neither agree nor disagree, disagree to strongly disagree, they may also refuse to answer or answer don't know. The six items can be found in Table 3.6.

3.1.5.3 Study 3. Mediation Effect of Peer Smoking and Family Connectedness

The outcome variable is age of initiation. This information is described in previous two studies and can be found in section 3.1.5.1 and 3.1.5.2.

Covariates that will be adjusted in the model include

Sex (male vs. female), family heritage group (self-reported race/ethnicity), parental ever smoking status, total family annual income level, baseline self-esteem and school attachment these variables are also defined in section 3.1.5.1 and 3.1.5.2.

Mediator variables I am specifically interested are peer smoking influence and family.

Peer smoking influence was measured by the question “Of your 3 best friends, how many smoke at least 1 cigarette a day?” at Wave I. In the analysis, it was collapsed into ‘None’ vs ‘at least one of the best friends smoke at least 1 cigarette a day’.

Family connectedness was measured 13 items from four questionnaires. A comprehensive score was calculated from the 13 items using an algorithm introduced by Dr. Resnick and colleagues in their paper (Resnick MD et al., 1997). The score was then dichotomized into binary variable using median as the cut-off point. The items along with answer scales are presented in Table 3.7.

Table 3.7 Items for Measuring Family Connectedness

	Questionnaire	Question	Answer scales
FC1	Protective Factors	"How much do you feel that people in your family understand you?"	1- not at all to 5 - very much
FC2		"How much do you feel that you and your family have fun together?"	1- not at all to 5 - very much
FC3		"How much do you feel that your family pays attention to you?"	1- not at all to 5 - very much
FC4	Non-resident father and Non-resident mother	"How close do you feel to your biological mother?"	**1**- not close at all" to "5 - extremely close
FC5		"How close do you feel to your biological father?"	**1**- not close at all" to "5 - extremely close
FC6	Personality and family	"Most of the time, your mother is warm and loving toward you."	'1 Strongly agree' to '5 Strongly disagree'
FC7		"Overall, you are satisfied with your relationship with your mother."	'1 Strongly agree' to '5 Strongly disagree'
FC8		"Most of the time, your father is warm and loving toward you."	'1 Strongly agree' to '5 Strongly disagree'
FC9		"Overall, you are satisfied with your relationship with your father."	'1 Strongly agree' to '5 Strongly disagree'
FC10	Relations with Parents	"How close do you feel to your {MOTHER/ADOPTIVE MOTHER/STEPMOTHER/ FOSTER MOTHER/etc.}?"	1- not at all to 5 - very much
FC11		"How much do you think she cares about you?"	1- not at all to 5 - very much
FC12		"How close do you feel to your {FATHER/ADOPTIVE FATHER/STEPFATHER/FOSTER FATHER/etc.}?"	1- not at all to 5 - very much
FC13		"How much do you think he cares about you?"	1- not at all to 5 - very much

3.2 Analysis Plan

3.2.1 Study 1: Immigration to the U.S. and the Risk of Smoking Initiation

The study assessed the effect of immigration to the U.S. on the risk of initiating cigarette smoking. Time dependent covariate survival analysis (time-to event analysis) was used to estimate the effect. The immigration variable was defined as

$$x(t) = \begin{cases} 0 \quad (\textit{if subject has not immigrated to U.S. at time } t) \\ 1 \quad (\textit{if subject has immigrated to U.S. at time } t) \end{cases}.$$

First, exploratory analyses were performed to shed light on the characteristics of the study population. Complex survey design effects were adjusted in the exploratory analysis. As the study sample was made of eligible wave I respondents who were interviewed at Wave I and were part of the 'core' sample (n=18,924) the longitudinal weight of GSWGT1 was used for this research as recommended in the ADD HEALTH documentation (Ping Chen and Kim Chantala, 2014). Schools served as clusters and regions served as strata in these analyses. Continuous covariates were summarized using SAS 9.4 proc surveymeans and categorical variables were summarized using SAS proc surveyfreq.

Following this initial analysis step latent variables of self-esteem and school attachment were constructed. Proc Calis, SAS 9.4 (Cary, NC) was used for constructing the latent variables from measurement model. Standardized factor scores of self-esteem and school attachment were used for further analysis.

Next, Bivariate analysis (time to initiation analysis) were run for time dependent immigration variable and each of the baseline covariate. Results are presented in Table 4.2.

After above exploratory analysis, the adjusted time to initiation model were run, potential confounders of sex, race group, parental smoking status, family income, self-esteem and school attachment were all adjusted in the model as categorical variables.

At last, subgroup variations of the immigration effect by sex, race/ethnicity were assessed by including interaction terms of immigration status and sex, immigration status and race/ethnicity, and the three way interaction term of immigration status, sex and race/ethnicity in the model.

Time to event analysis was performed using Proc Surveyphreg, SAS 9.4. Complex survey design effect of cluster (schools), strata (region) and weights (GWSGST1) were adjusted, Taylor linearization were used to estimate the variance of each estimate. Efron method is used to adjust for the tied observations in the data. Time dependent immigration status was created within SAS Proc Surveyphreg. For the details of the program codes please see Appendix A.3.2.

As sensitivity analysis, discrete time survival analysis was also performed. A person year dataset was created for this analysis. Each subject contributed the study with different person year time. For each person, one row was created for each year from birth to the year when the person initiated or censored. Time invariant covariates had same value for each subject over years, immigration status variable changed from 0 to 1 the year when the subject immigrated. For U.S.-born subjects, immigration status was set to 1 since birth year. Proc surveylogistic was used for discrete time survival analysis, same complex survey design effect of cluster (schools), strata (region) and weights (GWSGST1) were adjusted. The program codes for sensitivity analysis can be found in Appendix A.3.2.

Figure 3.3 Hypothesized Latent Structure of Self-esteem, with Local Independence of Error Terms

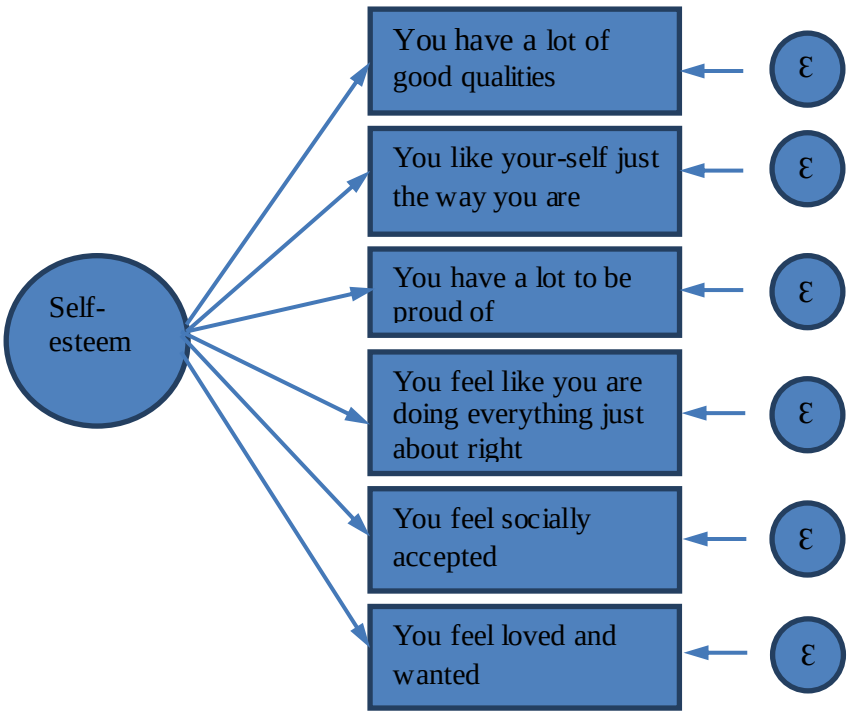
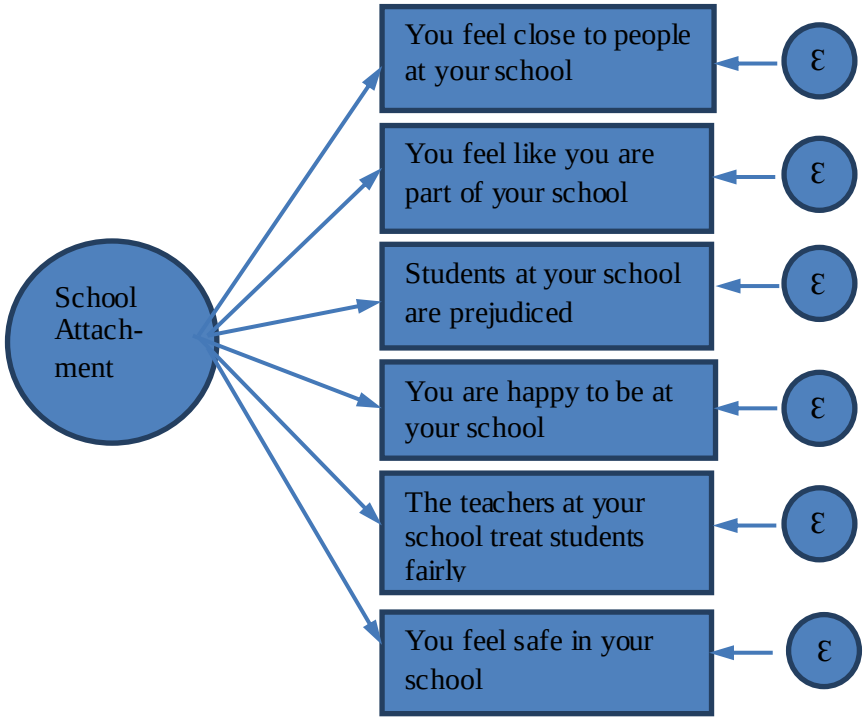


Figure 3.4 Hypothesized Latent Structure of School Attachment, with Local Independence of Error Terms



3.2.2 Study 2: Acculturation and the Risk of Initiation Tobacco Smoking

Aim 2

The analysis assessed the effect of dynamic acculturation level on the risk/time to initiation of cigarette smoking. Time dependent covariate survival analysis (time-to event analysis) was used to estimate the effect. Acculturation level was time variant; at each wave it was studied as a latent variable which is constructed from measurement model.

$$x(t) = \begin{cases} Acculturation_1 & (if\ time\ between\ wave\ I\ and\ wave\ II\ ) \\ Acculturation_2 & (if\ time\ between\ wave\ II\ and\ wave\ III\ ) \\ Acculturation_3 & (if\ time\ after\ wave\ III\ ) \end{cases}$$

where $Acculturation_1$, $Acculturation_2$ $Acculturation_3$ are acculturation level at wave I, wave II and wave III.

Both unadjusted and adjusted time to event analysis were conducted. In the latter analysis, potential confounders of sex, family heritage group, parental smoking status, SES, self-esteem and school attachment were all adjusted in the model as categorical variables.

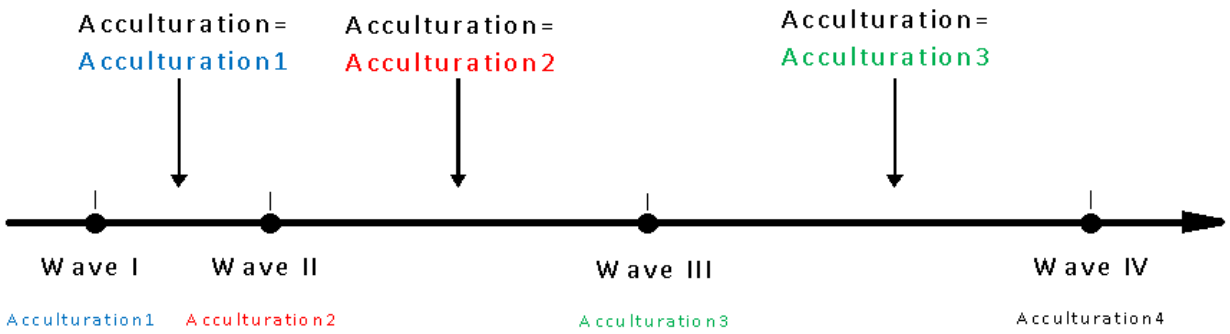
Two way interaction between acculturation and sex, acculturation and race/ethnicity and three way interaction among acculturation, sex and race/ethnicity were also assessed in the model.

Analyses were performed by using SAS 9.4 (Cary, NC) Proc surveyphreg. Complex survey design were adjusted, Taylor linearization were used to estimate the variance of each estimate. Efron method was used to adjust for the tied observations in the data. For the details of the SAS program coding please see Appendix A.3.4.

As in study 1, discrete time survival analysis was also performed as sensitivity analysis. A person year dataset was created for this analysis. Each subject contributes different person year time to the study. For each person, one row was created for each year from birth to the year when the person initiated smoking or censored. Time invariant covariates have unchanged value for each subject over years while acculturation status variable changed over years depends on time intervals defined by baseline and follow-up home interviews as shown in Figure 3.5. Proc surveylogistic was used for discrete time survival analysis, same complex survey design effect of

cluster (schools), strata (region) and weights (GWSGST1) were adjusted. The program codes for sensitivity analysis can be found in Appendix A.3.4.

Figure 3.5 Visual Presentation of Time Dependent Acculturation Variable



3.2.3 Study 3. Mediation Effect of Peer Smoking and Family Connectedness

Aim 3

The analysis evaluated how much of the total effect of nativity status was mediated through peer smoking influences and family connectedness. Existing statistical methods of studying mediation factors include Baron and Kenny's approach which only works for linear models that do not involving interaction terms, Robin Greenland and Pearl's approach can differ substantially for different data types of mediators and outcomes. In addition, the calculation can be very tedious.

The approach proposed by Lange offers a unified model for decomposing the total effect into different pathways by directly modeling natural direct and indirect effects of exposure variable (through mediators) and the results are easier to interpret. This method can be applied to a variety of data. Lange et al. have shown that for time to event outcome, binary exposure and binary mediator the method can generate unbiased estimates for direct and indirect effects under

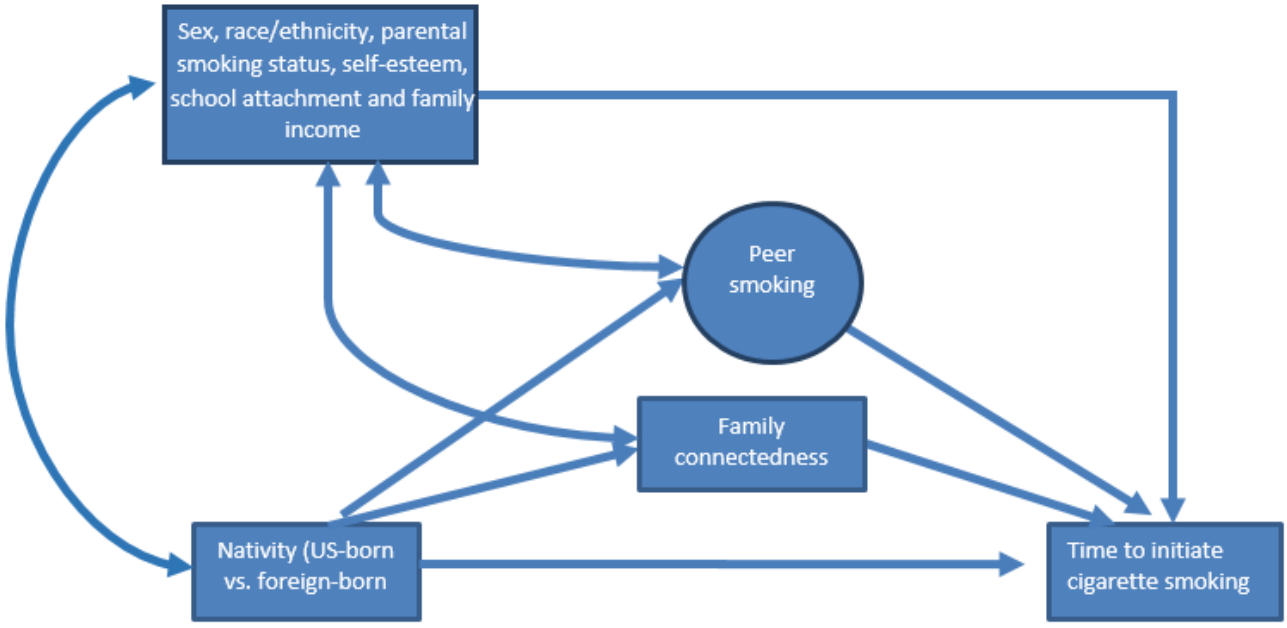
certain assumptions (Lange, Rasmussen, & Thygesen, 2014; Lange, Vansteelandt, & Bekaert, 2012).

This approach was used in study 3 to estimate effect of peer smoking and family connectedness on the path between nativity and time to initiate smoking. The conceptual model is depicted in Figure 3.5. It decomposes the total exposure effect on the outcome into different causal pathways and quantifies the indirect effect of each pathway. This approach uses marginal structural models to estimate direct and indirect effects. It is based on a counterfactual framework.

The assumptions for this approach include that the 1. Multiple causal pathways are not intertwined. The mediators on each pathway should not be dependent on each other. 2. There are no unmeasured confounders. 3. Censoring is non-informative. 4. Proportional hazards.

In this study the approach decomposed the total effect of nativity (U.S. vs foreign-born) on timing to smoking initiation into natural direct effect and natural indirect effect through peer smoking influence and family connectedness (Figure 3.5) while adjusted for baseline characteristics e.g. sex, race/ethnicity, parental smoking status, self-esteem, school attachment and family income.

Figure 3.6 Conceptual Model



In order to use this counterfactual approach, the original dataset needs to be duplicated. As I am interested in two pathways (peer smoking influences and family connectedness) and both mediators are binary, the original dataset was duplicated $2^2 = 4$ times, so that all possible combinations of the mediators could be formed. Then in each duplicated dataset, the exposure variable (nativity status) was set to the opposite value of the original value while keep other variables the same so it is 'counterfactual'. After that, following procedures was performed.

Step one, using the original dataset to estimate the effect of nativity status while adjusting for baseline confounders.

Step two, regressing the peer smoking influence and family connectedness on nativity separately using the original dataset. As both peer smoking and family connectedness were

dichotomized, ordinary logistic regression models were used. Probability of M (meditators - binary peer smoking, binary family connectedness) given A (nativity status) and confounders were calculated - $p(M \mid A, C)$.

Step three, testing the assumption that multiple pathways were not intertwined, the correlation between peer smoking and family connectedness were assessed.

Step four, applying the fitted model from step two on the replicated 'counterfactual' dataset, so the probability of mediators would be predicted when the nativity status had the opposite value. Probability of M given the counterfactual value of A, and confounders were predicted - $p(M \mid A^*, C)$.

Step five, computing the weight by dividing the predicted probability from step four by the predicted probability from step two W= $p(M \mid A^*, C) / p(M \mid A, C)$. For multiple rows, $W_i = \frac{1}{P(A=A_i \mid C=C_i)} \prod_{k=1}^{K} \frac{P(M^k=M_i^k \mid A=A_i^k, C=C_i)}{P(M^k=M_i^k \mid A=A_i, C=C_i)}$, where subscript *i* refered to row *i* in the replicated data set and M_i and C_i were the values for mediators and covariates in row *i*.

Step six, multiplying the weights obtained from step five with the sampling weights to build a final weight to adjust for in the last step analysis.

Step seven, in the time to event analysis, proportional hazard model was performed adjusting for sex, race/ethnicity, parental smoking status, self-esteem and school attachment. The model also took into account of the weights (obtained from step six) along with strata and clustering effect to generate valid estimates. Program codes can be found at Appendix 3.5.

Step eight, direct and indirect effect estimates could be obtained from the estimates of A and A* in the model.

In Lange 2012 paper, the authors pointed out 95% confidence interval could be obtained as the estimate +/- 1.96 times a stand error. However, bootstrap method was preferred to obtain a more conservative confidence interval.

Step nine, bootstrap method was used to get the 95% confidence interval. 500 samples was randomly drawn and the estimates from 500 samples were sorted, the 2.5% and 97.5% quantile of the estimates were used to as the lower and upper bound of the confidence interval.

The analysis assessed the mediation effect of peer smoking influences and family connectedness on the hazard rate of initiating cigarette smoking. The methodology proposed by Lange T (2012) was used in this dissertation research for mediation analysis.

Latent variables of self-esteem and school attachment were constructed in SAS proc Calis as described in section 3.2. The SAS program is presented in Appendix A. 3.1.

Potential confounders of sex, family heritage group, parental smoking status, social economic status, self-esteem and school attachment were all adjusted in the model as categorical variables and age at immigration was treated as continuous variable.

Analysis were performed by using SAS 9.4 (Cary, NC). Complex survey design were adjusted, Taylor linearization were used to estimate the variance of each estimate.

CHAPTER 4 RESULTS

4.1 Study 1: Immigration to the U.S. and the Risk of Smoking Initiation

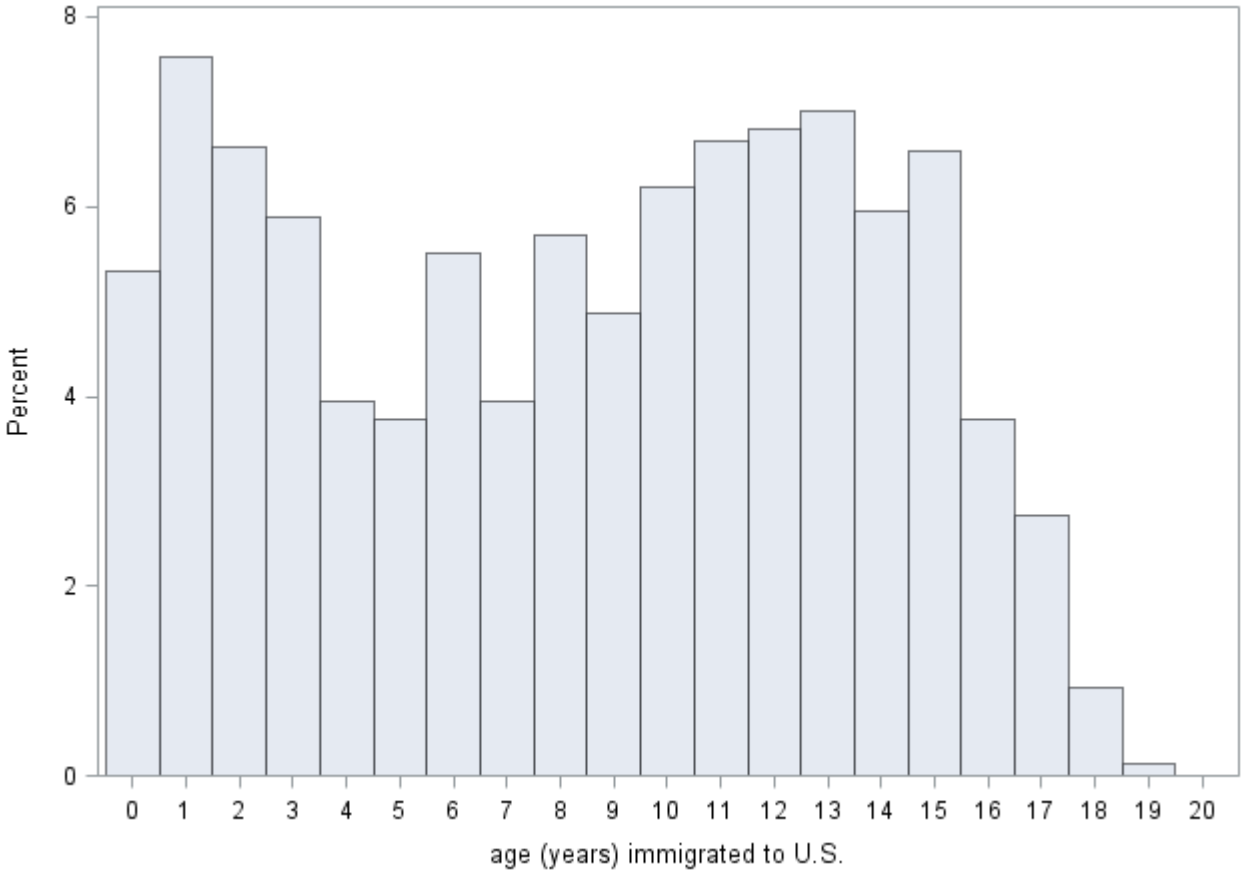
First some characteristics of the study population are presented. Complex survey design effects were adjusted in the analysis.

Table 4.1 Characteristics of the Study Sample

Categorical variables		Unweighted Frequency	Weighted Percent
Race / Ethnicity	Asian or Pacific Islander	1,247	3.34
	American Indian/ Native American	101	0.47
	Black American	3,790	15.03
	Hispanics	3,230	12.15
	White	9,608	64.85
	Multiple races	713	3.27
	Other	169	0.89
Sex	Male	9,288	50.92
	Female	9,634	49.08
Parental smoking	Neither parent ever smoked	3,953	23.72
	At least one of the parents ever smoked	11,848	76.28
Continuous variable	Label	Unweighted Frequency	Mean (Std Error)
	Total family income (in thousands)	14,019	45.19 (1.7)

Histogram of age immigrated to the U.S. among foreign-born subjects is presented below.

Figure 4.1 Age Immigrated to the U.S. among Foreign-born Subjects



Next, bivariate analysis were conducted, time to event analysis were run for each of the covariate separately without adjusting for the rest of the covariates. Based on these unadjusted models, females were less likely to initiate cigarette smoking compared to male. Blacks, Hispanics and Asian all presented statistically significant lower hazard of initiating smoking compared to Whites. Study subjects with smoking parents were an estimated 1.5 times more likely to initiate smoking. Categorized family income was not associated with hazard of initiation. At last, both self-esteem and school attachment show a clear trend and association with

initiation as expected – higher self-esteem and stronger school attachment were protective factors against initiating smoking.

Table 4.2 Bivariate Analysis from Cox Proportional Hazard Model

Analysis of Maximum Likelihood Estimates						
	Parameter	Estimate	Standard Error	Pr > |t|	Hazard Ratio	95% Hazard Ratio Confidence Limits
Sex	Female	-0.12	0.03	<.0001	0.88	(0.83 , 0.94)
	Male	0	.	.	1	. .
Race/Ethnicity	Hispanics	-0.36	0.06	<.0001	0.7	(0.62 , 0.79)
	American Indian or Native American	0.47	0.12	<.0001	1.6	(1.27 , 2.02)
	Asian or Pacific Islander	-0.7	0.09	<.0001	0.49	(0.41 , 0.59)
	Black or African American	-0.68	0.06	<.0001	0.51	(0.45 , 0.57)
	Multiple races	0	0.07	0.9685	1	(0.86 , 1.15)
	Other	-0.41	0.14	0.0028	0.66	(0.51 , 0.87)
	White	0	.	.	1	. .
Parental smoking	At least one of the parents ever smoked	0.42	0.04	<.0001	1.52	(1.41 , 1.64)
	Neither parent ever smoked	0	.	.	1	. .
Self-esteem	first quantile	0.34	0.04	<.0001	1.41	(1.31 , 1.52)
	second quantile	0.14	0.04	0.0008	1.15	(1.06 , 1.25)
	third quantile	0.06	0.03	0.0731	1.07	(0.99 , 1.14)
	forth quantile	0	.	.	1	. .
Attachment to school	first quantile	0.47	0.04	<.0001	1.6	(1.48 , 1.73)
	second quantile	0.21	0.04	<.0001	1.23	(1.14 , 1.33)
	third quantile	0.07	0.03	0.0492	1.07	(1 , 1.15)
	forth quantile	0	.	.	1	. .
Total family income	first quantile	-0.09	0.06	0.1185	0.91	(0.81 , 1.03)
	second quantile	0.04	0.04	0.3307	1.04	(0.96 , 1.13)
	third quantile	0.01	0.04	0.6936	1.02	(0.94 , 1.09)
	forth quantile	0	.	.	1	. .

Results from time to event analysis prior to covariate adjustment showed an estimated 2.1 fold excess hazard of initiating tobacco smoking compare to a person that had not immigrated to the U.S. at that time point (hazard ratio=2.1. 95% CI=1.5, 2.7 ; Table 4.3 unadjusted model). After adjusting for covariates, the hazard ratio dropped to 1.63 with 95% CI= (1.06, 2.49), with $p<0.05$.

Table 4.3 Unadjusted Cox Proportion Hazard Model, Multivariable Cox Proportional Hazard Model Estimating Time Dependent Immigration Effect

	Log(slope) Estimate	Standard Error	P-value	Hazard Ratio	95% HR CI
Unadjusted Model	0.72	0.15	<.0001	2.05	(1.54, 2.74)
Multivariable Model*	0.49	0.21	0.025	1.63	(1.06, 2.49)
Multivariable model for male only*	0.02	0.25	0.931	1.02	(0.62, 1.68)
Multivariable model for female only*	1.26	0.39	0.001	3.52	(1.64, 7.54)
Multivariable model for Whites only*	-0.09	0.46	0.846	0.91	(0.37, 2.29)
Multivariable model for Asian or Pacific Islander only*	0.6	0.35	0.087	1.82	(0.92, 3.63)
Multivariable model for Black or African American only*	-0.96	0.52	0.07	0.38	(0.14, 1.08)
Multivariable model for Hispanics only*	1.15	0.31	0.0003	3.17	(1.70, 5.90)
Multivariable model for other races only*	-0.52	0.73	0.472	0.59	(0.14, 2.49)
Multivariable model for Multiple races*	1.24	1.18	0.293	3.46	(0.34, 35.51)

Note: * covariates adjusted include sex, race/ethnicity, total family income, parental smoking, self-esteem and attachment to school.

Next, subgroup variation between sex groups is assessed by including a product-term of immigration status and sex group. Based on the results presented in Table 4.3, the estimated immigration effect on smoking initiation is larger for females than males. For males, HR=1.02 (95% CI=0.6, 1.6), while for females, HR=3.52 (95% CI= 1.64, 7.54). Subgroup variations were also noticed among race/ethnicity groups. For example, Hispanics are an estimated three times more likely to smoke after immigration (HR=3.17; 95% CI= 1.70, 5.90). Elevated hazards also were found for Asian or Pacific Islanders, with HR=1.82 (95% CI= 0.92, 3.63). The opposite trend was found for Blacks, with a reduced hazard by more than 60% in association with U.S. immigration.

Three way product terms for immigration status, sex, race/ethnicity were also investigated, and disclosed that the estimated hazard for Asian females was 3.7 times larger after immigration. For Hispanic females, the effect estimate is reflected in HR = 6.47 (both with $p < 0.005$). Among males, both Whites and Blacks have lower risk after immigration (HR=0.5 and 0.35, respectively), while the risk was double for Hispanic males (HR=2.02; 95% CI= 1.05, 3.91).

Sensitivity analysis results are presented in Table 4.5. Results from proportional hazard models and from discrete survival time analysis were compared and the estimates did not differ appreciably.

Table 4.4 Effect of Immigration by Race/ethnicity and Sex with Other Covariates Adjusted in the Model.

	Female					Male				
	Parameter Estimate	Standard Error	P-value	Hazard Ratio	95% HR CI	Parameter Estimate	Standard Error	P-value	Hazard Ratio	95% HR CI
White	0.66	0.47	0.1643	1.93	(0.76, 4.87)	-0.7	0.35	0.0472	0.5	(0.25, 0.99)
Black or African American	-0.04	0.71	0.9561	0.96	(0.23, 3.94)	-1.04	0.52	0.0471	0.35	(0.13, 0.99)
American Indian or Native American ǂ	--	--	--	--	(--, --)	--	--	--	--	(--, --)
Asian or Pacific Islander	1.31	0.46	0.0049	3.7	(1.50, 9.14)	0.4	0.35	0.2636	1.49	(0.74, 2.98)
Hispanics	1.87	0.53	0.0006	6.47	(2.26, 18.51)	0.7	0.33	0.0363	2.02	(1.05, 3.91)
Multiple races	1.63	1.23	0.1866	5.1	(0.45, 57.67)	0.43	1.03	0.6766	1.54	(0.2, 11.88)
Other	0.21	0.89	0.8114	1.24	(0.21, 7.23)	-1.46	0.86	0.0905	0.23	(0.04, 1.26)

Note: three way interactions among immigration status, sex, and race/ethnicity are included in the model along with two way interaction terms, while adjusting for sex, race/ethnicity, total family income, parental smoking, self-esteem and attachment to school

ǂ no estimates are presented due to small sample

Table 4.5 Sensitivity Analysis Comparing Proportional Hazard Model with Discrete Survival Time Analysis Model on Immigration Effects

		Analysis of Maximum Likelihood Estimates			
		Estimate	Standard Error	Pr > |t|	Hazard Ratio
Unadjusted model	Proc SurveyPhreg	0.70	0.14	<.0001	2.012
	discrete time analysis Proc Surveylogistic	0.74	0.15	<.0001	2.104
Adjusted model (adjusted for sex, race/ethnicity, total family income, parental smoking, self-esteem and attachment to school)	Proc SurveyPhreg	0.48	0.21	0.0228	1.613
	discrete time analysis Proc Surveylogistic	0.50	0.22	0.023	1.652

4.2 Study 2: Acculturation and the Risk of Smoking Initiation

The measurement model results for the two latent variables - school attachment and self-esteem are presented in Appendix. The findings from unadjusted and adjusted time dependent covariate time to event analysis are presented in Table 4.4.

Based on the unadjusted time to event analysis, time varying acculturation status is positively associated with the risk of initiating tobacco smoking. At a time point, a more acculturated immigrant adolescent is more likely to start smoking than a similar peer who is less acculturated. However, once covariate adjustments are made for race, sex, parental smoking, family income, self-esteem and school attachment, the hazard ratio estimates are no longer are noteworthy with alpha set at 0.05 (HR=1.07; 95% CI = 0.98, 1.18). These results are presented in Table 4.5.

Table 4.6 Unadjusted Cox Proportion Hazard Model, Multivariable Cox Proportional Hazard Model Estimating Time Dependent Acculturation Effect

	Log(slope) Estimate	Standard Error	P-value	Hazard Ratio	95% HR CI
Unadjusted Model	0.07	0.04	0.046	1.08	(1.001, 1.16)
Multivariable Model*	0.07	0.05	0.148	1.07	(0.98, 1.18)
Multivariable model for male only*	-0.05	0.07	0.493	0.95	(0.83, 1.10)
Multivariable model for female only*	0.21	0.06	0.0003	1.23	(1.10, 1.38)
Multivariable model for Whites only*	0.02	0.27	0.95	1.02	(0.60, 1.73)
Multivariable model for Asian or Pacific Islander only*	0.15	0.14	0.284	1.16	(0.89, 1.51)
Multivariable model for Black or African American only*	0.07	0.06	0.301	1.07	(0.94, 1.21)
Multivariable model for Hispanics only*	0.06	0.19	0.75	1.06	(0.73, 1.54)
Multivariable model for other races only*	-0.17	0.19	0.373	0.84	(0.57, 1.23)
Multivariable model for Multiple races*	-0.17	0.32	0.604	0.85	(0.45, 1.60)

Note: * covariates adjusted include sex, race/ethnicity, total family income, parental smoking, self-esteem and attachment to school.

In addition, the percentile of Whites in the school is used as a measure of school racial dispersion and adjusted in the model as a baseline covariate. The adjustment of this variable does not change the 'main effect' model results significantly. The model results are presented in Appendix Table 3 A.

Next, subgroup variation between sex groups is assessed by including a product-term for acculturation status and male sex. Based on the results presented in Table 4.6, the estimated acculturation effect on smoking initiation is higher among females than males. Among males, acculturation status may have little effect on risk and timing of initiation (HR=1.0; 95% CI = (0.8, 1.2), while among females, the null hypothesis is rejected and an association is seen (HR=1.23; 95% CI = 1.1, 1.4. Analyses stratified by race/ethnicity groups did not disclose association between acculturation level and hazard of initiating smoking.

Table 4.7 Sensitivity Analysis Comparing Proportional Hazard Model with Logistic Regression Model for Estimation of Acculturation Effects

	Analysis of Maximum Likelihood Estimates				
		Estimate	Standard Error	P-value	Hazard Ratio
Unadjusted model	Proc SurveyPhreg	0.07	0.04	0.0718	1.07
	Proc Surveylogistic	0.1	0.04	0.0055	1.107
Adjusted model (adjusted for sex, race/ethnicity, total family income, parental smoking, self-esteem and attachment to school)	Proc SurveyPhreg	0.07	0.04	0.1411	1.068
	Proc Surveylogistic	0.06	0.04	0.1198	1.067

Three way product-terms for immigration status, sex, race/ethnicity were also investigated. Irrespective of Hispanic background, white adolescent females had elevated hazards for smoking onset after immigration. For example, among Hispanic females, acculturation is positively associated with the risk of initiation (HR=1.24; 95% CI = 1.11, 1.38). This was not found for male subgroups (all $p > 0.05$).

Table 4.8 Effect of acculturation level by race/ethnicity and sex with other covariates adjusted in the model.

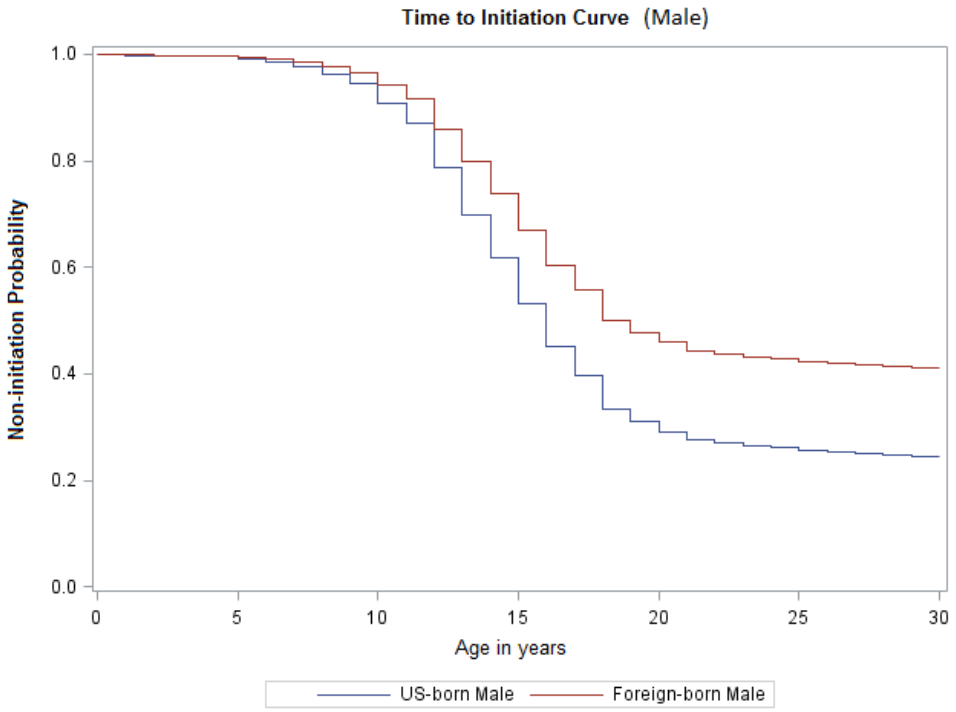
	Female					Male				
	Estimate	SE	P-value	HR	95% CI	Estimate	SE	P-value	HR	95% CI
White	0.35	0.21	0.0996	1.42	(0.93, 2.17)	-0.07	0.16	0.6556	0.93	(0.68, 1.27)
Black or African American	-0.08	0.36	0.8253	0.92	(0.46, 1.87)	0.09	0.32	0.7857	1.09	(0.58, 2.08)
Asian or Pacific Islander	-0.06	0.22	0.7773	0.94	(0.60, 1.46)	0.2	0.24	0.4013	1.23	(0.76, 1.97)
Hispanics	0.21	0.06	0.0002	1.24	(1.11, 1.38)	-0.05	0.1	0.6132	0.95	(0.78, 1.16)
American Indian or Native American ǂ	-2.19	0.51	<.0001	0.11	(0.04, 0.31)	0.05	1.49	0.9723	1.05	(0.06, 20.11)
Multiple races	-0.2	0.33	0.538	0.82	(0.43, 1.56)	-0.13	0.29	0.6517	0.88	(0.50, 1.55)
Other	1.2	1.24	0.3375	3.31	(0.28, 38.62)	-0.5	0.35	0.155	0.61	(0.31, 1.21)

Note: three way interactions among immigration status, sex, and race/ethnicity are included in the model along with two way interaction terms, while adjusting for sex, race/ethnicity, total family income, parental smoking, self-esteem and attachment to school

ǂ no estimates are presented due to small sample

4.3 Study 3: Mediation Effect of Peer Smoking and Family Connectedness

Figure 4.2 Time to smoking initiation curves by nativity and sex.



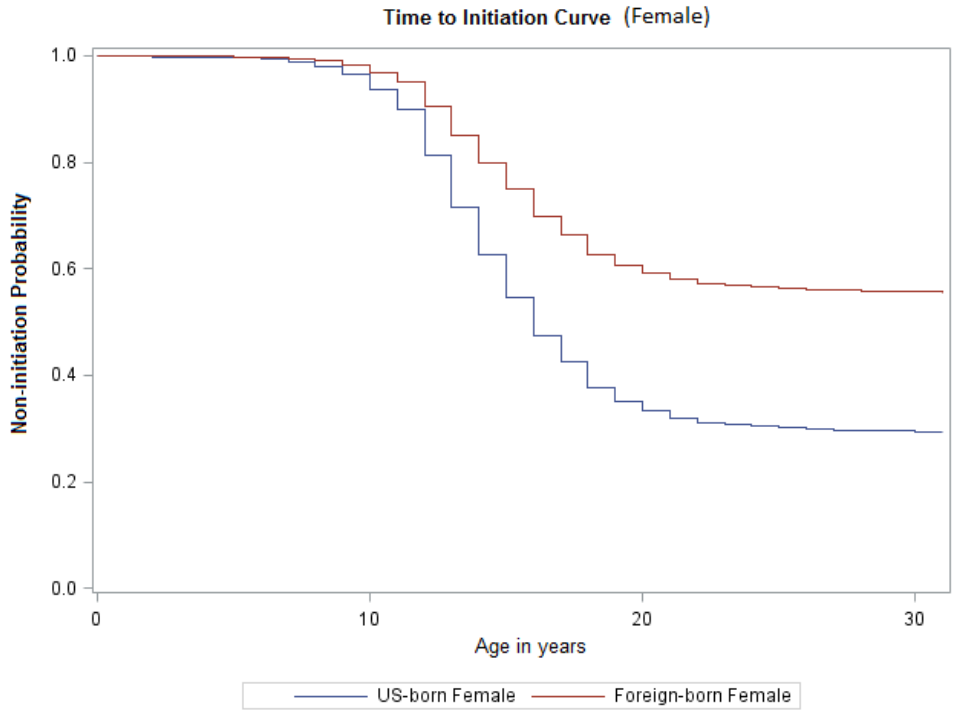


Table 4.9 Effect of nativity on risk/timing of initiating smoking

		Estimate	SE	P-value	HR	95% CI
Nativity (Born in the U.S. vs not)	Overall	0.35	0.08	<.0001	1.42	(1.20, 1.68)
	Female	0.5	0.13	0.0001	1.66	(1.29, 2.13)
	Male	0.21	0.1	0.0386	1.24	(1.01, 1.51)

Being born in the U.S. is associated with higher hazard of initiating smoking in both males and females, with effect estimates as shown in Table 4.9. Next, the analysis plan for estimation of mediational pathways was carried out, and this total effect was dis-assembled into direct and indirect effects through two pathways (Table 4.10).

Table 4.10 Mediation analysis: Estimated Total, Direct And Indirect Effects With 95% Confidence Intervals

Estimated Effect (foreign-born vs. U.S.-born)	HR	95% CI
Estimated total effect	1.343	[1.20; 1.51]
Estimated direct effect	1.33	[1.15; 1.43]
Estimated indirect effect (through family connectedness)	1.002	[1.001; 1.003]
Estimated indirect effect (through peer smoking influence)	1.05	[1.04; 1.05]
Estimated indirect effect (through both family connectedness and peer smoking influence)	1.052	[1.041; 1.053]

Proportion of effect mediated through proposed pathway: Log (indirect effect)/Log (total effect) =log (1.052)/log (1.343) = 17.2% (95% CI = 7.1%, 22.1%). (95% Confidence intervals shown here and in Table 4.10 were obtained from bootstrap methods.) Therefore, it seems that about 17% of the total effect of nativity on initiating smoking is mediated

through the peer smoking and family bonding pathways, subject to limitations and the model specified for this research.

CHAPTER 5: DISCUSSION, LIMITATIONS/STRENGTHS, AND FUTURE RESEARCH

This chapter summarizes the main findings and results of the three studies. Previous literature and possible explanations are discussed, based on existing knowledge. The strengths and limitations of each study are elaborated. Finally, future research directions and public health implications are discussed.

5.1 Summary of Study Findings

The main results can be summarized succinctly.

In study 1, the main results indicated that immigration to the U.S. apparently does not have a significant effect on the risk/time to smoking initiation for adolescent males (HR=1.02; 95% CI= 0.62, 1.68), but this might not be the case for adolescent females. For females, immigration into the U.S. is associated with more than a three-fold increase in the risk of initiating cigarette smoking among females (HR=3.52; 95% CI= 1.64, 7.54).

In post-estimation exploratory analyses, three-way product-terms for immigration status, sex, and race/ethnicity were investigated, and the hazard for Asian females was found to be 3.7 times greater once immigration occurs, and for Hispanic females, the effect estimate is even greater, with a hazard ratio of almost 6.5 (both $p < 0.005$). This exploratory analysis suggests two subgroups of males with reduced hazards for initiation of tobacco cigarette smoking, once immigration occurs: non-Hispanic white males and non-Hispanic black males. However, there was an estimated doubling of the hazard for Hispanic males (HR=2.02; 95 %= 1.05, 3.91).

In study 2, the main discovery was an acculturation-associated elevated risk of starting to smoke tobacco cigarettes among females, but no such elevation for males. The male estimate of the acculturation effect is null (HR=0.95; 95% CI= 0.83, 1.10). The female estimate shows a modest departure from the null (HR = 1.3; 95% CI = 1.1, 1.6). Post-estimation exploratory data analyses with stratification for race/ethnicity disclosed null associations, but a three-way product term analysis disclosed subgroup variations of potential importance for non-Hispanic white females and Hispanic females, but not for other groups of females, nor for males. For example, HR= 1.4 for non-Hispanic females ($p < 0.01$). For Hispanic females, HR = 1.24 (95% CI = 1.11, 1.38).

The main finding from Study 3 is a suggestion that nativity (being born overseas) is associated with risk of starting to smoke and that an estimated 17% of the total effect of nativity on the risk of initiation might explained through the indirect pathway of peer smoking influence. Very little of the nativity effect seems to be explained through the indirect pathway of parent-child bonding (family connectedness).

5.2 Limitations and Strengths

5.2.1 Limitations

Before detailed discussion, several important limitations deserve mention. One major limitation of this research is the measure of acculturation. Acculturation is a complicated process of cultural and psychological changes, so a composite assessment should include measures from different aspects. In this study, the measure is restricted to a few items (language is primarily used, as well as number of years lived in U.S., percentage of foreign-born people in the neighborhood, and percentage of linguistically isolated people in the neighborhood), which cannot capture other aspects of acculturation (e.g. self-

identification, school race/ethnicity composition, culture, values, etc.). This limitation has been mentioned in previous literature where the ADD HEALTH dataset was used for acculturation-related studies.

Another limitation is that all three studies reply on self-reported measures. Some efforts were made to promote more honest and complete answers, especially for sensitive questions, by using a computer-assisted interview. But the answers cannot be objectively measured and evaluated. The self-reported data will cause some measurement errors, as has been discussed by many epidemiological studies.

Although ADD HEALTH is a longitudinal study that follows the cohort prospectively, major events are not reported or recorded at the moment (instantaneously), and some events had already happened before the study began. Information on these data depends on recalling past events, which will lead to less accuracy or even some errors in the measurement.

A limitation specific to study two is that the data is left truncated—subjects who initiated before wave I cannot be included in the analysis due to the fact that their peer smoking influences and family connectedness cannot be measured before the initiation, thus temporal sequences cannot be established for these study subjects. Excluding this group of subjects will bias the results as the characteristics of early initiators are probably different from those who did not initiate before wave I.

At last, as this dissertation is based on secondary data. Residual confounding can be another limitation. Potential confounders such as school performance and level of impulsivity cannot be adjusted in the analysis (O'Loughlin JL, et al, 2013).

5.2.2 Strengths

This research, based on a proposition that immigration into the U.S. involves major shifts of environmental conditions and processes that might affect risk of adolescent smoking initiation. It postulates a series of research questions that study the important behavior of smoking initiation among U.S. immigrants by answering the questions of 'whether', 'how much' and 'how' immigration might impact the risk of initiating tobacco smoking. Aim 1 assesses whether there is an effect on smoking initiation once someone has immigrated to the U.S. If so, how great is the effect? Aim 2 then digs deeper by answering the question of how much the acculturation process is associated with age to initiate smoking following immigration. Study aim 3 explores the mechanism by decomposing the total nativity effect into direct and indirect effects, and evaluating the mediation roles of peer smoking influences and family connectedness.

These are very important questions to study as the number of immigrants has continuously grown during the past several decades, and has reached the highest levels in U.S. history, with the majority of immigrants now coming from Latin America and Asia. These new immigrants form a vulnerable population in terms of health for reasons such as low social economic status, language barriers, lack of insurance and a lack of familiarity with the U.S. healthcare system. This population deserves more attention from researchers, public health officers and policy makers. In addition, smoking initiation is an important behavior that is associated with later smoking behavior and health consequences. There is some literature on smoking behaviors among immigrants but very few have looked at initiation (Parrinello et al., 2013), and those that do are flawed, either in the design of the study or the sample.

Besides the importance of the research question, there are some other advantages to this research. It uses a longitudinal dataset, which allows acculturation levels to be measured repeatedly over time. With this, we can study how the risk of initiation is affected as acculturation levels change. Previous studies on acculturation levels and smoking behavior are mainly based on cross-sectional data, which have led to a series of issues like a confounding cohort effect and difficulty in establishing temporal sequences. By using longitudinal data, not only can we study the time-dependent acculturation effect on smoking initiation but we are also able to address cohort effects and temporal sequence issues.

Another strength of this study lies in the use of advanced statistical tool and approaches, which allow me to make less-biased inferences, and even answer some questions that were hard to deduce with traditional approaches. Previous studies comparing smoking behaviors between foreign-born and U.S.-born populations are almost always contaminated by migration-related selection. This selection effect is discounted when time-dependent survival models are used, since only those who eventually immigrated to the U.S. are studied. The effect of immigration was estimated by comparing the hazard of initiating smoking among those who have immigrated with those who have not immigrated to the U.S. at a point in time. Study aim 3 used the approach proposed by Lange et. al, published in 2012. To the best of my knowledge, there are very few methods available to study mediation effects for a time-to-event model, and the existing ones contain major limitations. Lange's approach is based on a counterfactual framework, and claims that it can yield an unbiased estimate for binary exposure and binary mediator(s) modeled under

its assumptions. This approach could also adjust for a complex survey design effect (cluster, strata and weights), which makes it ideal to for use in this research's aim 3.

In addition, the measurement model was used to construct a more comprehensive measure of acculturation levels, self-esteem, peer smoking influences and family connectedness. By using this measurement model, different weights were estimated and given to items in the domain, so each item in the domain can contribute to the measurement of the latent variable. Previous research mostly used either one single item to measure certain characteristics (e.g. acculturation) or used the mean or sum of a number of items to measure the characteristics (e.g. school connectedness). The measurement model can, without a doubt, improve the validity of the measurement.

Other strengths of this research include having a relatively large sample that can detect modest-level associations, allow subgroup variations to be investigated, and make the study more powerful. Standardized computer-assisted assessment methods were used to promote more honest and complete answers for sensitive questions about tobacco smoking behaviors, relationships with parents, school experiences, and self-esteem related questions.

5.3 Health Implications

Overall, these findings suggest that the risk of initiation of tobacco cigarette smoking increased after immigration. These findings suggest new public health action steps in the form of prevention initiatives targeted at newly arrived immigrant population. Since the subgroup variation analysis showed that the risk of initiation tripled for females after immigration, intervention/prevention programs might be aimed at reducing and delaying initiation for them. For foreign-born males, the impact of immigration was null, but the smoking rate is high in this population. Thus, intervention programs targeted to males need

to focus more on quitting or reducing smoking frequency/intensity. In addition, intervention programs tailored to the immigrant population should take immigrants' race/ethnicity background and acculturation levels into account. For example, the hazard of initiation increased more than six times for Hispanic females after immigration, and more than three times for Asian females, making culturally and linguistically appropriate prevention programs targeted to these groups critical. For males, the hazard of initiation drops significantly for foreign-born black and white males after immigration, while the hazard doubles for Hispanic males. Tobacco control programs should focus on reducing the initiation rate for foreign-born white and black males even further. For Hispanic males, both prevention and control programs are necessary. In addition, as the acculturation level is positively associated with the hazard of initiating smoking in females, the acculturation level of immigrants should be taken into account when designing intervention/prevention programs.

In the mediation analysis, the pathway of peer smoking explains about 17% of the nativity effect. As peer smoking has an adverse influence on initiating smoking for those who are foreign-born, programs are needed to improve individual interpersonal skills, and teach individuals how to refuse cigarette offers (i.e., resistance skills).

5.4 Future Directions

It is projected that the immigrant population in the U.S. will continue to increase, and will reach 438 million by 2050. At that time, nearly one-in-five (19%) Americans will be foreign-born immigrants. Besides the numbers, the composition of racial and ethnic groups will look very different. Non-Hispanic Whites, which comprise about 2/3 of the current population, will drop to less than one-half of the national population. The

proportion of Hispanics is projected to double, and reach 29% by 2050. Asians will also increase to about 9% of the population. Blacks stay about the same, at about 13%. These rapid growth and changes in the immigrant population are associated with a variety of new issues and challenges to U.S. immigrants' health and related behaviors that deserve a more central place in social, cultural and epidemiological studies.

Future studies are needed to extend the work from this research to better understand the trajectory from initiating cigarette smoking to becoming a regular smoker, to the later development of nicotine dependence among the immigrant population, and whether this trajectory is associated with the acculturation process. Furthermore, the mechanism of how the acculturation stage might affect the smoking trajectory needs to be explored and investigated.

In addition, since under 20% of the total effect of nativity is explained through the pathway of having friends smoking and loose family bonding, other potential mediators and mechanisms might be explored. Exposure to tobacco advertisements and media campaigns should be high priorities in this line of research.

APPENDICES

APPENDIX A: Tables

Table A.1 Spearman Correlation of Items Used to Measure Self-esteem

	H1PF30 HAVE LOTS OF GOOD QUALITIES	H1PF32 HAVE A LOT TO BE PROUD OF	H1PF33 LIKE SELF AS ARE	H1PF34 DO EVERYTHING JUST RIGHT	H1PF35 FEEL SOCIALLY ACCEPTED	H1PF36 FEEL LOVED AND WANTED
H1PF30 S18Q30 HAVE LOTS OF GOOD QUALITIES-W1	1	0.631	0.460	0.402	0.475	0.483
H1PF32 S18Q32 HAVE A LOT TO BE PROUD OF-W1	0.630	1	0.570	0.469	0.499	0.576
H1PF33 S18Q33 LIKE SELF AS ARE-W1	0.460	0.570	1	0.552	0.488	0.500
H1PF34 S18Q34 DO EVERYTHING JUST RIGHT-W1	0.402	0.469	0.552	1	0.491	0.452
H1PF35 S18Q35 FEEL SOCIALLY ACCEPTED-W1	0.475	0.499	0.488	0.491	1	0.570
H1PF36 S18Q36 FEEL LOVED AND WANTED-W1	0.483	0.576	0.500	0.452	0.570	1

Table A.2 Spearman Correlation of Items Used to Measure School Attachment

	H1ED19 FEEL CLOSE TO PEOPLE AT SCHOOL	H1ED20 FEEL PART OF YOUR SCHOOL	H1ED21 STUDENTS AT SCHOOL PREJUDICED	H1ED22 HAPPY AT YOUR SCHOOL	H1ED23 TEACHERS TREAT STUDENTS FAIRLY	H1ED24 FEEL SAFE IN YOUR SCHOOL
H1ED19 S5Q19 FEEL CLOSE TO PEOPLE AT SCHOOL-W1	1	0.569	-0.111	0.451	0.242	0.292
H1ED20 S5Q20 FEEL PART OF YOUR SCHOOL-W1	0.5687	1	-0.130	0.535	0.278	0.344
H1ED21 S5Q21 STUDENTS AT SCHOOL PREJUDICED-W1	-0.111	-0.130	1	-0.163	-0.179	-0.168
H1ED22 S5Q22 HAPPY AT YOUR SCHOOL-W1	0.451	0.535	-0.163	1	0.363	0.384
H1ED23 S5Q23 TEACHERS TREAT STUDENTS FAIRLY-W1	0.242	0.278	-0.179	0.363	1	0.358
H1ED24 S5Q24 FEEL SAFE IN YOUR SCHOOL-W1	0.292	0.344	-0.168	0.384	0.358	1

Table A.3 Main Effect Model of Acculturation with School Racial Distribution Adjusted

Analysis of Maximum Likelihood Estimates						
Parameter	DF	Estimate	Standard Error	t Value	Pr > |t|	Hazard Ratio
Acculturation	128	0.06	0.05	1.27	0.2077	1.06
Female	128	-0.21	0.06	-3.51	0.0006	0.81
Hispanics	128	0.47	0.16	2.91	0.0043	1.60
American Indian or Native American	128	0.75	0.46	1.63	0.1063	2.12
Asian or Pacific Islander	128	0.23	0.16	1.43	0.156	1.26
Multiple races	128	0.45	0.19	2.43	0.0165	1.58
Other races	128	0.66	0.20	3.25	0.0015	1.93
White	128	0.40	0.11	3.66	0.0004	1.49
At least one of the parents ever smoked	128	0.09	0.03	2.63	0.0096	1.09
Family income <=$22,000	128	-0.15	0.06	-2.72	0.0073	0.86
Family income between $2,2000 and $40,000	128	0.03	0.05	0.65	0.5197	1.04
Family income>= $40,000	128	0.03	0.05	0.69	0.4934	1.03
Selfesteem (1st quantile)	128	-0.01	0.07	-0.19	0.8522	0.99
Selfesteem (2nd quantile)	128	0.02	0.06	0.3	0.7656	1.02
Selfesteem (3rd quantile)	128	-0.04	0.05	-0.84	0.4008	0.96
Schoolat (1st quantile)	128	0.02	0.06	0.3	0.7631	1.02
Schoolat (2nd quantile)	128	0.03	0.06	0.55	0.5849	1.03
Schoolat (3rd quantile)	128	0.00	0.05	0.05	0.9636	1.00
Percent white in school (1st quantile)	128	-0.09	0.14	-0.63	0.5281	0.92
Percent white in school (2nd quantile)	128	0.00	0.07	0.02	0.9813	1.00
Percent white in school (3rd quantile)	128	0.04	0.07	0.56	0.576	1.04

Table A.4 Main Effect Model of Acculturation without School Racial Distribution Adjustment

Analysis of Maximum Likelihood Estimates						
Parameter	DF	Estimate	Standard Error	t Value	Pr > |t|	Hazard Ratio
Acculturation	128	0.07	0.04	1.48	0.1411	1.07
Female	128	-0.21	0.06	-3.52	0.0006	0.81
Hispanics	128	0.49	0.15	3.17	0.0019	1.63
American Indian or Native American	128	0.78	0.45	1.72	0.0871	2.17
Asian or Pacific Islander	128	0.24	0.16	1.49	0.1395	1.27
Multiple races	128	0.48	0.19	2.55	0.0118	1.61
Other races	128	0.67	0.21	3.28	0.0013	1.96
White	128	0.44	0.10	4.43	<.0001	1.55
At least one of the parents ever smoked	128	0.09	0.03	2.76	0.0066	1.10
Family income <=$22,000	128	-0.15	0.06	-2.73	0.0073	0.86
Family income between $2,2000 and $40,000	128	0.03	0.05	0.64	0.5242	1.04
Family income>= $40,000	128	0.03	0.05	0.72	0.475	1.04
Selfesteem (1st quantile)	128	-0.01	0.07	-0.17	0.865	0.99
Selfesteem (2nd quantile)	128	0.01	0.06	0.21	0.8335	1.01
Selfesteem (3rd quantile)	128	-0.04	0.05	-0.79	0.4335	0.96
Schoolat (1st quantile)	128	0.02	0.06	0.32	0.7481	1.02
Schoolat (2nd quantile)	128	0.03	0.06	0.57	0.5707	1.03
Schoolat (3rd quantile)	128	0.00	0.05	0.04	0.9645	1.00

APPENDIX B: SAS Programming Codes

SAS Time Dependent Survival Model Assessing the Immigration Status on the Hazard of Initiating Smoking

```
/* Hypothesis 1, time dependent covariate time to event analysis*/

/* Test immigration effect, without adjusting for confounders*/
proc surveyphreg data=model1;
cluster PSUSCID;
strata REGION;
weight GSWGT1;
model time1*eversmoke(0)=imtatus/rl ties=efron;
if agetous=0 then imtatus=1;
if  agetous>=time1 then imtatus=0:
if (agetous<time1 and agetous~=.) then imtatus=1;
run;

/* Test immigration effect, without adjusting for confounders*/
proc surveyphreg data=model1;
cluster PSUSCID;
strata REGION;
weight GSWGT1;
class race  eth bio  sex (ref='1.Male') parentsmk income selfesteem  cat schoolat  cat/param=ref;
model time1*eversmoke(0)=imtatus bio_sex race_eth parentsmk income selfesteem_cat
schoolat  cat/rl ties=efron:
if agetous=0 then imtatus=1;
if  agetous>=time1 then imtatus=0:
if (agetous<time1 and agetous~=.) then imtatus=1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test immigration effect on female */
proc surveyphreg data=model1;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio  sex(ref='2.Female') income race  eth parentsmk schoolat  cat selfesteem  cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex acc0*bio_sex  income race_eth parentsmk schoolat_cat
selfesteem  cat/rl ties=efron;
if agetous=0 then imtatus=1;
if  agetous>=time1 then imtatus=0:
if (agetous<time1 and agetous~=.) then imtatus=1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;


/* Test immigration effect on Male */
proc surveyphreg data=model1;
```

```
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex(ref='1.Male') income race_eth parentsmk schoolat_cat selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex acc0*bio_sex income race_eth parentsmk schoolat_cat
selfesteem_cat/rl ties=efron;
if agetous=0 then imtatus=1;
if agetous>=time1 then imtatus=0;
if (agetous<time1 and agetous~=.) then imtatus=1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test immigration effect on whites */
proc surveyphreg data=model1;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex race_eth(ref='White') income parentsmk schoolat_cat selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex acc0*race_eth income race_eth parentsmk schoolat_cat
selfesteem_cat/rl ties=efron;
if agetous=0 then imtatus=1;
if agetous>=time1 then imtatus=0;
if (agetous<time1 and agetous~=.) then imtatus=1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test immigration effect on Blacks */
proc surveyphreg data=model1;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex income race_eth(ref='American Indian or Native American') parentsmk schoolat_cat
selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex acc0*race_eth income race_eth parentsmk schoolat_cat
selfesteem_cat/rl ties=efron;
if agetous=0 then imtatus=1;
if agetous>=time1 then imtatus=0;
if (agetous<time1 and agetous~=.) then imtatus=1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;


/* Test immigration effect on Asian*/
proc surveyphreg data=model1;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex race_eth(ref='Asian or Pacific Islander') income parentsmk schoolat_cat
selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex acc0*race_eth income race_eth parentsmk schoolat_cat
selfesteem_cat/rl ties=efron;
```

```
if agetous=0 then imtatus=1;
if  agetous>=time1 then imtatus=0;
if (agetous<time1 and agetous~=.) then imtatus=1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test immigration effect on Asian*/
proc surveyphreg data=model1;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio  sex race  eth(ref='Asian or Pacific Islander') income parentsmk schoolat_cat
selfesteem  cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex acc0*race_eth  income race_eth parentsmk schoolat_cat
selfesteem  cat/rl ties=efron;
if agetous=0 then imtatus=1;
if  agetous>=time1 then imtatus=0;
if (agetous<time1 and agetous~=.) then imtatus=1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test immigration effect on Hispanics*/
proc surveyphreg data=model1;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio  sex race  eth(ref=Hispanics') income parentsmk schoolat  cat selfesteem  cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex acc0*race_eth  income race_eth parentsmk schoolat_cat
selfesteem  cat/rl ties=efron;
if agetous=0 then imtatus=1:
if  agetous>=time1 then imtatus=0;
if (agetous<time1 and agetous~=.) then imtatus=1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;


/* Test immigration effect on White female*/
proc surveyphreg data=model1;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio  sex(ref='2.Female') race_eth(ref='White') income parentsmk schoolat_cat
selfesteem  cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex race_eth acc0*race_eth acc0*bio_sex
acc0*bio  sex*race  eth income race_eth parentsmk schoolat_cat selfesteem_cat/rl ties=efron;
if agetous=0 then imtatus=1:
if  agetous>=time1 then imtatus=0;
if (agetous<time1 and agetous~=.) then imtatus=1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;
```

```
/* Test immigration effect on White Male*/
proc surveyphreg data=model1;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex(ref='1.Male') race_eth(ref='White') income parentsmk schoolat_cat
selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex race_eth acc0*race_eth acc0*bio_sex
acc0*bio_sex*race_eth income race_eth parentsmk schoolat_cat selfesteem_cat/rl ties=efron;
if agetous=0 then imtatus=1;
if agetous>=time1 then imtatus=0;
if (agetous<time1 and agetous~=.) then imtatus=1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test immigration effect on Black female*/
proc surveyphreg data=model1;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex(ref='2.Female') race_eth(ref='Black or African American') income parentsmk
schoolat_cat selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex race_eth acc0*race_eth acc0*bio_sex
acc0*bio_sex*race_eth income race_eth parentsmk schoolat_cat selfesteem_cat/rl ties=efron;
if agetous=0 then imtatus=1;
if agetous>=time1 then imtatus=0;
if (agetous<time1 and agetous~=.) then imtatus=1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test immigration effect on Black Male*/
proc surveyphreg data=model1;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex(ref='1.Male') race_eth(ref='Black or African American') income parentsmk
schoolat_cat selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex race_eth acc0*race_eth acc0*bio_sex
acc0*bio_sex*race_eth income race_eth parentsmk schoolat_cat selfesteem_cat/rl ties=efron;
if agetous=0 then imtatus=1:
if agetous>=time1 then imtatus=0;
if (agetous<time1 and agetous~=.) then imtatus=1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test immigration effect on Asian female*/
proc surveyphreg data=model1;
cluster PSUSCID;
strata REGION;
weight gswgt1;
```

```
class bio_sex(ref='2.Female') race_eth(ref='Asian or Pacific Islander') income parentsmk
schoolat_cat selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex race_eth acc0*race_eth acc0*bio_sex
acc0*bio_sex*race_eth income race_eth parentsmk schoolat_cat selfesteem_cat/rl ties=efron;
if agetous=0 then imtatus=1;
if agetous>=time1 then imtatus=0;
if (agetous<time1 and agetous~=.) then imtatus=1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test immigration effect on Asian Male*/
proc surveyphreg data=model1;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex(ref='1.Male') race_eth(ref='Asian or Pacific Islander') income parentsmk
schoolat_cat selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex race_eth acc0*race_eth acc0*bio_sex
acc0*bio_sex*race_eth income race_eth parentsmk schoolat_cat selfesteem_cat/rl ties=efron;
if agetous=0 then imtatus=1;
if agetous>=time1 then imtatus=0;
if (agetous<time1 and agetous~=.) then imtatus=1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test immigration effect on Hispanics female*/
proc surveyphreg data=model1;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex(ref='2.Female') race_eth(ref='Hispanics') income parentsmk schoolat_cat
selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex race_eth acc0*race_eth acc0*bio_sex
acc0*bio_sex*race_eth income race_eth parentsmk schoolat_cat selfesteem_cat/rl ties=efron;
if agetous=0 then imtatus=1;
if agetous>=time1 then imtatus=0;
if (agetous<time1 and agetous~=.) then imtatus=1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test immigration effect on Asian Male*/
proc surveyphreg data=model1;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex(ref='1.Male') race_eth(ref='Hispanics') income parentsmk schoolat_cat
selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex race_eth acc0*race_eth acc0*bio_sex
acc0*bio_sex*race_eth income race_eth parentsmk schoolat_cat selfesteem_cat/rl ties=efron;
if agetous=0 then imtatus=1;
if agetous>=time1 then imtatus=0;
```

```
if (agetous<time1 and agetous~=.) then imtatus=1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;
```

Appendix B.2. SAS Logistic Regression Model Assessing the Immigration Status on the Hazard of Initiating Smoking

```
/*Hypothesis 1. Discrete time survival analysis SAS code*/

/*step 1, create person time dataset*/


data count:
set model1;
if time~=.;
do i=1 to int(time);
if i=1 and int(time)=1 then do event1=eversmoke;output;end;
else if i<int(time) then do event1=0;output; end;
else if i=int(time) then do event1=eversmoke;output;end;
end;
run;

data count2;
set count;
if int(agetous)=0 then immig=1;
else
if i<=int(agetous) then immig=0;
else if i>int(agetous) and agetous~=. then immig=1;
run;


/*step 2, discrete survival time analysis*/

proc surveylogistic data=count2;
cluster PSUSCID;
strata REGION;
weight GSWGT1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
class bio  sex(param=ref ref='2.Female') race  eth(param=ref ref='Black or African American')
parentsmk income selfesteem_cat schoolat_cat;
class i;
model event1(ref=first)= i immig bio_sex  immig*bio_sex race_eth parentsmk income
selfesteem_cat schoolat_cat;
run;
```

Appendix B.3. SAS Time Dependent Survival Model Assessing the Acculturation Status on the Hazard of Initiating Smoking

```
/* Hypothesis 2, time dependent covariate time to event analysis*/

/* Test acculturation effect, without adjusting for confounders*/
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
weight gswgt1;
model time1*eversmoke(0)=acc0 /rl ties=efron;
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
run;

/* Test acculturation effect, adjusting for donfounders*/
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex income race_eth parentsmk schoolat_cat selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex income race_eth parentsmk schoolat_cat
selfesteem_cat/rl ties=efron;
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test acculturation effect on female */
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex(ref='2.Female') income race_eth parentsmk schoolat_cat selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex acc0*bio_sex income race_eth parentsmk schoolat_cat
selfesteem_cat/rl ties=efron;
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;


/* Test acculturation effect on female */
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex(ref='2.Female') income race_eth parentsmk schoolat_cat selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex acc0*bio_sex income race_eth parentsmk schoolat_cat
selfesteem_cat/rl ties=efron;
```

```
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test acculturation effect on Male */
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex(ref='1.Male') income race_eth parentsmk schoolat_cat selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex acc0*bio_sex income race_eth parentsmk schoolat_cat
selfesteem_cat/rl ties=efron;
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test acculturation effect on whites */
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex race_eth(ref='White') income parentsmk schoolat_cat selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex acc0*race_eth income race_eth parentsmk schoolat_cat
selfesteem_cat/rl ties=efron;
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test acculturation effect on Blacks */
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex income race_eth(ref='American Indian or Native American') parentsmk schoolat_cat
selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex acc0*race_eth income race_eth parentsmk schoolat_cat
selfesteem_cat/rl ties=efron;
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;


/* Test acculturation effect on Asian*/
```

```
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex race_eth(ref='Asian or Pacific Islander') income parentsmk schoolat_cat
selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex acc0*race_eth income race_eth parentsmk schoolat_cat
selfesteem_cat/rl ties=efron;
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test acculturation effect on Asian*/
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex race_eth(ref='Asian or Pacific Islander') income parentsmk schoolat_cat
selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex acc0*race_eth income race_eth parentsmk schoolat_cat
selfesteem_cat/rl ties=efron;
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test acculturation effect on Hispanics*/
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex race_eth(ref=Hispanics') income parentsmk schoolat_cat selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex acc0*race_eth income race_eth parentsmk schoolat_cat
selfesteem_cat/rl ties=efron;
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;


/* Test acculturation effect on White female*/
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex(ref='2.Female') race_eth(ref='White') income parentsmk schoolat_cat
selfesteem_cat/param=ref;
```

```
model time1*eversmoke(0)=acc0 bio_sex race_eth acc0*race_eth acc0*bio_sex
acc0*bio_sex*race_eth income race_eth parentsmk schoolat_cat selfesteem_cat/rl ties=efron;
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test acculturation effect on White Male*/
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio  sex(ref='1.Male') race_eth(ref='White') income parentsmk schoolat_cat
selfesteem  cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex race_eth acc0*race_eth acc0*bio_sex
acc0*bio_sex*race_eth income race_eth parentsmk schoolat_cat selfesteem_cat/rl ties=efron;
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test acculturation effect on Black female*/
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio  sex(ref='2.Female') race  eth(ref='Black or African American') income parentsmk
schoolat  cat selfesteem  cat/param=ref:
model time1*eversmoke(0)=acc0 bio_sex race_eth acc0*race_eth acc0*bio_sex
acc0*bio_sex*race_eth income race_eth parentsmk schoolat_cat selfesteem_cat/rl ties=efron;
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test acculturation effect on Black Male*/
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio  sex(ref='1.Male') race  eth(ref='Black or African American') income parentsmk
schoolat  cat selfesteem  cat/param=ref;
model time1*eversmoke(0)=acc0 bio  sex race  eth acc0*race  eth acc0*bio  sex
acc0*bio_sex*race_eth income race_eth parentsmk schoolat_cat selfesteem_cat/rl ties=efron;
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
```

```
run;

/* Test acculturation effect on Asian female*/
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex(ref='2.Female') race_eth(ref='Asian or Pacific Islander') income parentsmk
schoolat_cat selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex race_eth acc0*race_eth acc0*bio_sex
acc0*bio_sex*race_eth income race_eth parentsmk schoolat_cat selfesteem_cat/rl ties=efron;
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test acculturation effect on Asian Male*/
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex(ref='1.Male') race_eth(ref='Asian or Pacific Islander') income parentsmk
schoolat_cat selfesteem_cat/param=ref:
model time1*eversmoke(0)=acc0 bio_sex race_eth acc0*race_eth acc0*bio_sex
acc0*bio_sex*race_eth income race_eth parentsmk schoolat_cat selfesteem_cat/rl ties=efron;
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test acculturation effect on Hispanics female*/
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
weight gswgt1;
class bio_sex(ref='2.Female') race_eth(ref='Hispanics') income parentsmk schoolat_cat
selfesteem_cat/param=ref;
model time1*eversmoke(0)=acc0 bio_sex race_eth acc0*race_eth acc0*bio_sex
acc0*bio_sex*race_eth income race_eth parentsmk schoolat_cat selfesteem_cat/rl ties=efron;
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;

/* Test acculturation effect on Asian Male*/
proc surveyphreg data=model2;
cluster PSUSCID;
strata REGION;
```

```
weight gswgt1;
class bio_sex(ref='1.Male') race_eth(ref='Hispanics') income parentsmk schoolat_cat
selfesteem_cat/param=ref:
model time1*eversmoke(0)=acc0 bio_sex race_eth acc0*race_eth acc0*bio_sex
acc0*bio_sex*race_eth income race_eth parentsmk schoolat_cat selfesteem_cat/rl ties=efron;
if (agew2>=time1 and agew1<time1) then acc0=acc1;
if (agew3>=time1 and agew2<time1 ) then acc0=acc2;
if (agew4>=time1 and agew3<time1 ) then acc0=acc3;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
run;
```

Appendix B.4. SAS Discrete Time Survival Model Assessing the Acculturation Status on the Hazard of Initiating Smoking

```
/* Hypothesis 2, sensitivity analysis */
/*step 1, creating person time dataset*/

data count _model2;
set model2;
if time~=.;
do i=1 to int(time);
output;end;
run;

data count2_model2;
set count_model2;
if i>=agew1int and i<agew2int then acc0=acc1;
else if i>=agew2int and i<agew3int then acc0=acc2;
else if i>=agew3int and i<agew4int then acc0=acc3;

if i=1 and int(time)=1 then event1=eversmoke;
else if i<int(time) then event1=0;
else if i=int(time) then event1=eversmoke;

run;


data count2_model2;
set count  model2:
if int(agetous)=0 then immig=1;
else
if i<=int(agetous) then immig=0;
else if i>int(agetous) and agetous~=. then immig=1;
run;


data count2_s_model2;
set count2  model2;
aid1=input(aid, 12.);
```

```
keep bio_sex i immig time time1 aid  agetous liage PSUSCID REGION GSWGT1 onsetage
H1TO2  ageonsetW2  H3TO3  H4TO2 eversmoke event1 bio_sex  race_eth parentsmk income
selfesteem_cat schoolat_cat acc1 acc2 acc3 agew1 agew2 agew3 agew4;
run;

/*step 2, discrete survival time analysis*/

proc surveylogistic data=count2_model2;
cluster PSUSCID;
strata REGION;
weight GSWGT1;
format bio_sex sexf. race_eth racef. parentsmk parsmkf.;
class bio_sex(param=ref ref='1.Male') race_eth(param=ref ref='Black or African American')
parentsmk income selfesteem_cat schoolat_cat;
class i;
model event1(ref=first)= i acc0 bio_sex acc0*bio_sex race_eth parentsmk income selfesteem_cat
schoolat_cat;
test: test acc0;
run;
```

Appendix B.5 Mediation Analysis Code

```
/* Hypothesis 3, mediation analysis */

/* data manipulation, create duplicated datasets*/
data data1;
set model3;
borninusstar1=0;
borninusstar2=0;
borninus=H1GI11;
if borninus=borninusstar1 & borninus=borninusstar2 then do
mfamilybd=familybdind;mpeersmk=peerind;end;
if borninus~=borninusstar1 & borninus=borninusstar2 then do
mfamilybd=.;mpeersmk=peerind;end;
if borninus=borninusstar1 & borninus~=borninusstar2 then do
mfamilybd=familybdind;mpeersmk=.;end;
if borninus~=borninusstar1 & borninus~=borninusstar2 then do mfamilybd=.;mpeersmk=.;end;
run;

data data2;
set model3;
borninusstar1=1;
borninusstar2=0;
borninus=H1GI11;
if borninus=borninusstar1 & borninus=borninusstar2 then do
mfamilybd=familybdind;mpeersmk=peerind;end;
if borninus~=borninusstar1 & borninus=borninusstar2 then do
mfamilybd=.;mpeersmk=peerind;end;
if borninus=borninusstar1 & borninus~=borninusstar2 then do
mfamilybd=familybdind;mpeersmk=.;end;
```

```
if borninus~=borninusstar1 & borninus~=borninusstar2 then do mfamilybd=.;mpeersmk=.;end;
run;

data data3;
set model3;
borninusstar1=0;
borninusstar2=1;
borninus=H1GI11;
if borninus=borninusstar1 & borninus=borninusstar2 then do
mfamilybd=familybdind;mpeersmk=peerind;end;
if borninus~=borninusstar1 & borninus=borninusstar2 then do
mfamilybd=.;mpeersmk=peerind;end;
if borninus=borninusstar1 & borninus~=borninusstar2 then do
mfamilybd=familybdind;mpeersmk=.;end;
if borninus~=borninusstar1 & borninus~=borninusstar2 then do mfamilybd=.;mpeersmk=.;end;
run;

data data4;
set model3;
borninusstar1=1;
borninusstar2=1;
borninus=H1GI11;
if borninus=borninusstar1 & borninus=borninusstar2 then do
mfamilybd=familybdind;mpeersmk=peerind;end;
if borninus~=borninusstar1 & borninus=borninusstar2 then do
mfamilybd=.;mpeersmk=peerind;end;
if borninus=borninusstar1 & borninus~=borninusstar2 then do
mfamilybd=familybdind;mpeersmk=.;end;
if borninus~=borninusstar1 & borninus~=borninusstar2 then do mfamilybd=.;mpeersmk=.;end;
run;

data data5;
set data1 data2 data3 data4;
run;

data data5;
set data5;
atemp=h1gi11;
run;

proc logistic data=data5;
class mfamilybd atemp bio_sex race_eth parentsmk income selfesteem_cat schoolat_cat;
model mfamilybd=atemp bio_sex race_eth parentsmk income selfesteem_cat
schoolat_cat/link=logit;
score out=data5;
run;

data data5;
set data5;
if familybdind=0 then weightdir=p_0;
if familybdind=1 then weightdir=p_1;
```

```
keep aid weightdir familybdind mpeersmk mfamilybd atemp h1Gi11 borninusstar1 borninusstar2
time1 eversmoke peerind psuscid region gswgt1 bio_sex race_eth parentsmk income selfesteem_cat
schoolat_cat;
run;

data data5;
set data5;
atemp1=borninusstar1;
run;

proc logistic data=data5;
class mfamilybd atemp1 bio_sex race_eth parentsmk income selfesteem_cat schoolat_cat;
model mfamilybd=atemp1 bio_sex race_eth parentsmk income selfesteem_cat
schoolat  cat/link=logit;
score out=data5;
run;

data data5;
set data5:
if familybdind=0 then weightindir=p  0;
if familybdind=1 then weightindir=p_1;
keep aid weightindir mpeersmk familybdind mfamilybd atemp h1Gi11 borninusstar1 borninusstar2
time1 eversmoke weightdir peerind psuscid region gswgt1 bio_sex race_eth parentsmk income
selfesteem_cat schoolat_cat;
run;



data data5;
set data5;
wfamilybd=weightindir/weightdir;
run;

data data5;
set data5;
atemp=h1gi11;
run;

proc logistic data=data5;
class mpeersmk atemp bio  sex race  eth parentsmk income selfesteem  cat schoolat_cat;
model mpeersmk=atemp bio_sex race_eth parentsmk income selfesteem_cat
schoolat_cat/link=logit;
score out=data5;
run;

data data5;
set data5;
if peerind=0 then weightpeerdir=p  0;
if peerind=1 then weightpeerdir=p_1;
```

```
keep aid wfamilybd weightindir mpeersmk peerind weightpeerdir familybdind mfamilybd atemp
h1Gi11 borninusstar1 borninusstar2 time1 eversmoke weightdir peerind psuscid region gswgt1
bio_sex race_eth parentsmk income selfesteem_cat schoolat_cat;
run;

data data5;
set data5;
atemp1=borninusstar2;
run;

proc logistic data=data5;
class mpeersmk atemp1 bio_sex race_eth parentsmk income selfesteem_cat schoolat_cat;
model mpeersmk=atemp1 bio_sex race_eth parentsmk income selfesteem_cat
schoolat_cat/link=logit;
score out=data5;
run;

data data5;
set data5:
if peerind=0 then weightpeerindir=p_0;
if peerind=1 then weightpeerindir=p_1;
keep aid wfamilybd weightindir mpeersmk peerind weightpeerdir weightpeerindir familybdind
mfamilybd atemp h1Gi11 borninusstar1 borninusstar2 time1 eversmoke weightdir peerind psuscid
region gswgt1 bio_sex race_eth parentsmk income selfesteem_cat schoolat_cat;
run;



data data5;
set data5;
wpeersmk=weightpeerindir/weightpeerdir;
run;

/* final weight equals sampling weight times the weight derived from predicted probabilities- */
data data5;
set data5;
w=wpeersmk*wfamilybd;
finalw=GSWGT1*w;
run;


proc surveyphreg data=data5;
cluster psuscid;
strata region;
weight finalw;
class selfesteem_cat schoolat_cat;
class bio_sex race_eth parentsmk income;
model time1*eversmoke(0)=borninus borninusstar1 borninusstar2 bio_sex race_eth parentsmk
income selfesteem_cat schoolat_cat;
run;
```

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