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Do high school friends still matter for health behavior in adulthood? Variations in smoking trajectories by adolescent peer smoking networks, race/ethnicity, and gender

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ABSTRACT

Peers play an influential role in the initiation of smoking during adolescence. However, there has been limited literature examining whether adolescent peers are associated with longer-term patterns of smoking. This study uses data from the National Longitudinal Study of Adolescent to Adult Health to examine whether age-based trajectories of smoking likelihood from adolescence to adulthood are associated with the number of adolescent friends who smoked and how this association differs by race/ethnicity and gender. Findings using multilevel growth curve models indicate that individuals who have more adolescent friends who smoked have higher probabilities of smoking during adolescence than those with no adolescent smoking friends. As individuals age into adulthood, the association between adolescent friends' smoking behavior and individual-level smoking begin to dissipate but does not completely disappear. Further analyses show that there are no differences in this association by gender, but there are differences by race/ethnicity. These findings suggest that high school friends continue to be associated with trajectories of smoking even twenty years after high school. These results indicate that anti-smoking campaigns should take a network approach to preventing smoking in adolescence as well as recognize that the same campaign strategy may not work for all groups.

1. Introduction

Although cigarette smoking has decreased in recent decades, around 34.1 million adults in the United States currently smoke (Cornelius et al., 2020). Despite impressive declines, smoking is still considered the leading cause of preventable disease and death in the United States (Lariscy et al., 2018; U.S. Department of Health and Human Services, 2014). The severe health consequences of smoking coupled with nicotine addictiveness necessitates continued attention to why people begin and continue to smoke. Fortunately, individuals who quit smoking before the age of 40 reduce their risk of death related to smoking by about 90 percent (Jha et al., 2013). Therefore, it is important that researchers continue to understand trajectories of smoking, particularly as individuals transition from adolescence to adulthood.

The majority of daily smokers in adulthood (87 percent) had their first cigarette before the age of 18 (U.S. Department of Health and Human Services, 2014), making adolescence a pivotal starting point with regard to smoking trajectories. During adolescence, peers become particularly influential on their friends' health behavior as adolescents begin to establish independence from their parents (Furstenberg, 2000; Harris, 2010; McVicar, 2011; Vitaro et al., 2004). Estimates suggest that during adolescence a ten percent increase in the smoking rate of peers increases the likelihood of an individual smoking by three to five percent (Fletcher, 2010). Likewise, adolescents in networks where over half of the network members smoked were twice as likely to smoke compared to adolescents with no friends who smoked (Alexander et al., 2001).

Mechanisms linking adolescent friends to the initiation of smoking include social influence and social comparison; behavioral guidance, purpose, and meaning; and belonging and companionship (Hoffman et al., 2006; Thoits, 2011). Through these mechanisms adolescents determine what are normalized and accepted behaviors through the observation of their peers. The establishment of normalized behaviors and beliefs during a sensitive period in the life course may cause imprinting effects, a continuation of these behaviors and beliefs, into adulthood (Ben-Shlomo & Kuh, 2002). These imprinting effects can be particularly important because nicotine is highly addictive; thus, smoking initiation during adolescence may set a trajectory for smoking throughout the life course. Although I have primarily focused my

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discussion on peer influences, the effect of the number of friends who smoked on trajectories of smoking probability may be due to homophily (also called selection) as well. Homophily is the principle that individuals choose friends who are similar to themselves in terms of sociodemographic, behavioral, and intrapersonal characteristics (Daw et al., 2015; McPherson et al., 2001; Moody, 2001). Homophily can lead to homogeneous friendship networks that can in turn impact individuals' attitudes and behaviors. This selection process can continue into adulthood, where people may be more likely to choose friends who have similar attitudes and behaviors, leading to the continuation of smoking. Overall, influence and selection can both play a role in smoking during adolescence and adulthood (Hall & Valente, 2007; Ragan, 2016).

Although scholars have shown that peers impact smoking during adolescence (e.g. Alexander et al., 2001; Fletcher, 2010; Haas & Schaefer, 2014), little research has examined whether adolescent friends impact smoking beyond adolescence. The few scholars who have examined this longer-term association have found that having at least 25 percent of friends who smoked during adolescence increases the probability of an individual smoking in the transition to adulthood by 3 percent (Ali & Dwyer, 2009). Likewise, Pollard et al. (2010) found that perceived best friends' smoking status and being in a friendship network with at least one smoker was associated with an increased risk for a higher trajectory of smoking. However, research on the long-term effects of adolescent friends have used varying methods, each with their own set of drawbacks (Ali & Dwyer, 2009; Pollard et al., 2010). For example, Pollard et al. (2010) only examined two schools that were part of a nationally-representative dataset and had a narrow definition of adolescent peer smoking networks. It is important to extend this analysis to more schools and include broader definitions of friendship networks in order to better understand the broader impacts of these networks. Further, there may be a graded relationship between the number of adolescent friends who smoked and individual-level smoking, whereby having more friends who smoked is associated with higher probabilities of smoking. Collapsing the measurement of adolescent friendship networks into a dichotomous measure of belonging to a smoking group, as Pollard et al. (2010) did, does not facilitate the understanding of this graded relationship. In addition, these studies by Pollard et al. (2010) and Ali and Dwyer (2009) only examined the effects of adolescent friendship smoking networks over a period of seven years or less. Therefore, it is unknown whether the lasting effects of adolescent friendship networks persist or dissipate as individuals age into adulthood. In the present study, I examine the association between the number of adolescent friends who smoked and individual-level smoking behavior over a period of 21 years, from adolescence to early mid-adulthood.

In addition, literature on this topic has not adequately addressed how the association between adolescent friends and smoking behavior operates differently among population subgroups. Previous literature has found both racial/ethnic and gender differences in the association between adolescent peer networks and health behavior during adolescence (Hoffman et al., 2006; Mason et al., 2014; McMillan et al., 2018). For example, research finds that while adolescent friends may impact smoking for all racial/ethnic groups during adolescence, the impact of these friends may be strongest for Whites (Grigsby et al., 2017; Hoffman et al., 2006; Kandel et al., 2004; Mason et al., 2014). Meanwhile, current literature provides conflicting evidence regarding the role that gender plays in the association between adolescent friends' behaviors and the health behaviors of the respondent. Research finds that women are more strongly impacted by peer influence than men with regard to delinquency, weight status, smoking, and GPA (Bruening et al., 2015; McMillan et al., 2018). Conversely, other research finds that peer influence is significant for men but not women with regard to substance use and binge drinking (Brechwald & Prinstein, 2011; Erickson et al., 2000). However, research has yet to study this association as individuals age despite the evidence that smoking trajectories vary by race/ethnicity and gender (Harris, 2010).

Due to the large secular policy changes that have occurred with cigarette smoking over the past 60 years, it is important to put the cohort I am analyzing in context. The cohort members in this study were born between 1974 and 1983 and were in middle or high school during the 1994–1995 school year. Although cigarette smoking declined from 1977 to 1991 for all age groups due to multiple policy interventions, smoking prevalence increased among adolescents from 1992 to 2001 before rapidly decreasing afterwards (Pampel & Aguilar 2008). The increase in adolescent smoking at the time this cohort were adolescents provides an interesting perspective into how smoking is changing within individuals over time in a particular cohort.

Given these gaps in the literature, this study aims to examine how age-based trajectories of smoking likelihood from adolescence to adulthood are associated with the number of adolescent friends who smoked and how this association differs by race/ethnicity and gender. Specifically, I address two research questions: First, are the number of adolescent friends who smoked associated with age-based trajectories of smoking likelihood from adolescence to adulthood? Second, does the association between the number of adolescent smoking friends and age-based trajectories of smoking likelihood differ by race/ethnicity and/or gender?

2. Material and methods

2.1. Study participants

To answer these research questions, I use all five waves of the National Longitudinal Study of Adolescent to Adult Health (Add Health), a nationally representative sample of adolescents in grades 7–12 during the 1994–1995 school year who have been followed ever since (Harris et al., 2019). The initial sample included 132 schools, within which 90, 118 students completed an initial questionnaire and a baseline longitudinal sample of 20,745 adolescents were interviewed for the Wave I in-home survey. A follow-up in-home survey, Wave II, was conducted in 1996 and included 14,738 respondents. Six years later, Wave III included 15,197 respondents aged 18–26. Another follow-up, Wave IV, was conducted in 2008–09 when respondents were 24–32 years old, yielding 15,701 respondents. Most recently, Wave V was conducted in 2016–18, with 12,300 respondents who now range in age from 34 to 43. The analytic sample for this study consists of participants who reported their smoking behavior in at least one wave and had valid responses on all other study variables. Thus, the final analytic sample includes 11,681 respondents.

2.2. Measures

My main outcome variable is smoking, which is measured in all five waves as self-reported cigarette smoking in the past 30 days. Respondents were coded as smokers if they smoked at least once in the past 30 days, while nonsmokers were those who have never smoked or had not smoked in the past 30 days; those who responded "don't know" were coded as missing. Occasional smoking (e.g., once a month) is included in the category of smoking because of the substantial health risks associated with any level of smoking (Lariscy et al., 2018; Schane et al., 2010).

Adolescent peer networks were measured by out-degree nominations, or the people the respondent nominated as their friends, from the in-school survey. Out-degree nominations include both reciprocal and non-reciprocal friendships to capture a broader measure of friendship networks. Although some of these nominations are non-reciprocal, these are people the respondent considers to be their friend and still likely impacts their smoking behavior through selection and/or influence. In

the in-school survey, respondents were asked to select up to five male and five female friends from a roster of students in their own school and corresponding sister school. This led to the potential to nominate ten friends.

Adolescent friend smoking was measured in the in-school survey by asking, "During the past twelve months, how often did you smoke cigarettes?". This variable was then recoded into a dichotomous variable, with 1 representing those who smoked once a month or more and 0 representing non-smokers and those who smoked less than once a month. This cut-point is comparable to the cutoff of the dependent variable of respondent smoking. The number of adolescent friends who smoked was calculated by adding up the number of friends who reported smoking, with a range of 0–10. The measure was top-coded at three or more due to the small number of respondents who reported having four or more adolescent friends who smoked, especially among Black respondents.

As for the remaining predictor variables, age was measured in years and centered at age 16. For analysis, age was scaled in 10-year units. Gender was assessed with a dummy variable (0 = men, 1 = women). Lastly, race/ethnicity was coded into four groups: non-Hispanic White, non-Hispanic Black, Hispanic, and Non-Hispanic Other.

2.2.1. Covariates

All models controlled for parental educational attainment (less than high school, high school degree, some college, college degree or higher), whether or not parents have ever smoked, importance of religion (very important, fairly important, fairly unimportant, and not important at all), expectations for attending college (scale of one to five), state cigarette tax (state tax per cigarette pack in cents in the state which the respondent lived during Wave I), the number of nominated friends (total number of out-degree nominations), homophily measures, number of waves of missing data, and region. The parental educational attainment measure was created by taking the highest level of education between the two parents, or the education level of one parent if only one was reported. This measure was taken from the parents' self-reports during Wave I with missing data filled in based on reports from the child. Homophily measures were used to account for selection of friends with similar characteristics. These measures were calculated as the percentage of friends similar to the respondent in terms of gender, race, and grade level. Among the homophily measures, race was collapsed to a dichotomous measure of White and non-White for parsimony.

2.3. Analysis

Multilevel growth curve models were used to examine the association between the number of adolescent friends who smoked and age-based trajectories of smoking likelihood, as well as how these results differ by race/ethnicity and gender.[1] Growth curve models have the ability to examine the long-term impact of adolescent peers' smoking without needing longitudinal network data. These models estimate interindividual differences in intraindividual change by estimating intercepts (initial values) and slopes (rates of change) for every individual (Raudenbush & Bryk, 2002). The intercept is centered at age 16, the mean age of respondents at Wave I, to aid in interpretation of the intercept. Growth curve models within the multilevel framework examine repeated measures (level 1) nested within a person (level 2), where age is the level 1 unit and persons are the level 2 unit (Raudenbush & Bryk, 2002). These models adjust for correlations and non-independence of observations due to repeated measures of individuals. Through maximum likelihood estimation, these models allow for the inclusion of respondents who have a valid measure for smoking in at least one wave.

Logistic mixed effects models were used to account for the dichotomous measurement of smoking with results reported in odds ratios. Wald tests indicated that including a quadratic term for age improves overall model fit. Therefore, all models include an age and age-squared term. Models were also run using robust standard errors. Lastly, school fixed effects were used to control for time-invariant unobservable characteristics shared by individuals within the same school.

3. Results

Weighted frequency distributions are presented in Table 1. Smoking prevalence increases from adolescence until young adulthood when smoking begins to decline. About 43 percent of respondents did not have any adolescent friends who smoked, followed by a quarter with one friend who smoked, 15 percent for those with two friends who smoked, and 16 percent for those with three or more friends who smoked.

Table 2 presents growth curve models of smoking likelihood using Waves I through V of Add Health. Model 1 estimates the relationship between the number of adolescent friends who smoked and smoking trajectories from adolescence to adulthood, controlling for race/

Table 1
Weighted means/proportions of study variables, National Longitudinal Study of Adolescent to Adult Health (Waves I–V), N = 11,681.

	% or Mean (SD)	Min	Max
Current Smoker			
Wave I	0.25	0	1
Wave II	0.33	0	1
Wave III	0.34	0	1
Wave IV	0.37	0	1
Wave V	0.25	0	1
Age			
Wave I	15.18 (1.71)	11	21
Wave II	16.11 (1.73)	11	23
Wave III	21.69 (1.75)	18	27
Wave IV	28.28 (1.80)	24	34
Wave V	37.16 (1.79)	33	43
Number of adolescent friends who smoked			
0	0.43	0	1
1	0.26	0	1
2	0.15	0	1
3+	0.16	0	1
Number of nominated friends	5.24 (2.55)	1	10
Percent similarity of friends: Gender	63.35 (23.53)	0	100
Percent similarity of friends: Race	80.16 (27.41)	0	100
Percent similarity of friends: Grade	72.79 (31.68)	0	100
Female	0.53	0	1
Race			
Non-Hispanic White	0.69	0	1
Non-Hispanic Black	0.17	0	1
Hispanic	0.09	0	1
Non-Hispanic Other	0.04	0	1
Parental Educational Attainment			
Less than high school degree	0.10	0	1
High school degree	0.27	0	1
Some college	0.31	0	1
College degree or higher	0.33	0	1
Parents ever smoked	0.66	0	1
Importance of religion			
Very important	0.44	0	1
Fairly important	0.36	0	1
Fairly unimportant	0.06	0	1
Not important at all	0.14	0	1
State tax per cigarette tax (in cents)	30.11 (17.93)	2.5	75
College plans	4.27 (1.06)	1	5
Number of waves missing	0.98 (1.07)	0	4

[1] Recent literature has used stochastic actor-based (SIENA) models to better disentangle the effects of selection and influence (Schaefer et al., 2012, 2013). However, these models require complete longitudinal network data and there are currently no nationally representative data sets which have this data from adolescence to adulthood. In addition, although SIENA models have been thought to produce more conservative estimates of peer influence a recent article by Ragan et al. (2019) finds that SIENA models produce similar or larger estimates of peer influence compared to conventional regression methods.

Table 2
Growth curve models of the number of friends who smoked on smoking trajectories by gender and race/ethnicity (N = 11,681), Add Health (Waves I-V).

	Model 1		Model 2		Model 3	
Variable	Coefficient	SE	Coefficient	SE	Coefficient	SE
Fixed effects[a]						
Intercept	0.04	(0.09)	0.04	(0.08)	0.05	(0.09)
Number of friends who smoked (reference = 0)						
1	2.27***	(0.19)	2.04***	(0.24)	2.33***	(0.25)
2	5.32***	(0.56)	4.53***	(0.66)	5.29***	(0.68)
3+	12.09***	(1.43)	9.20***	(1.40)	13.22***	(1.79)
Female	0.92	(0.06)	0.94	(0.09)	0.91	(0.06)
Race (reference = White)						
Black	0.28***	(0.03)	0.28***	(0.03)	0.29***	(0.04)
Hispanic	0.66***	(0.08)	0.66***	(0.08)	0.80	(0.13)
Other	0.47***	(0.07)	0.47***	(0.07)	0.33***	(0.07)
Number of friends who smoked x Female						
1 friend smoked x Female			1.21	(0.19)		
2 friends smoked x Female			1.31	(0.24)		
3+ friends smoked x Female			1.61*	(0.30)		
Number of friends who smoked x Race						
1 friend smoked x Black					0.81	(0.17)
1 friend smoked x Hispanic					0.72	(0.17)
1 friend smoked x Other					2.10*	(0.65)
2 friends smoked x Black					0.71	(0.21)
2 friends smoked x Hispanic					1.15	(0.31)
2 friends smoked x Other					1.69	(0.70)
3+ friends smoked x Black					0.30**	(0.11)
3+ friends smoked x Hispanic					0.70	(0.21)
3+ friends smoked x Other					1.79	(0.81)
Linear slope (age/10)	7.66***	(1.02)	15.07***	(2.67)	10.80***	(1.80)
Number of friends who smoked (reference = 0)						
1	0.48***	(0.09)	0.48**	(0.13)	0.35***	(0.08)
2	0.39***	(0.09)	0.27***	(0.09)	0.31***	(0.08)
3+	0.18***	(0.04)	0.18***	(0.06)	0.09***	(0.02)
Female			0.25***	(0.06)		
Race (reference = White)					0.56*	(0.16)
Black					0.27***	(0.09)
Hispanic					1.47	(0.66)
Other						
Number of friends who smoked x Female						
1 friend smoked x Female			1.12	(0.41)		
2 friends smoked x Female			2.33	(1.01)		
3+ friends smoked x Female			1.22	(0.52)		
Number of friends who smoked x Race						
1 friend smoked x Black					1.95	(0.92)
1 friend smoked x Hispanic					3.79*	(2.11)
1 friend smoked x Other					0.59	(0.44)
2 friends smoked x Black					2.10	(1.31)
2 friends smoked x Hispanic					1.51	(0.96)
2 friends smoked x Other					0.57	(0.55)
3+ friends smoked x Black					12.75**	(11.33)
3+ friends smoked x Hispanic					14.98***	(11.54)
3+ friends smoked x Other					3.81	(3.72)
Quadratic slope (age/10 squared)	0.24***	(0.02)	0.21***	(0.02)	0.19***	(0.02)
Number of friends who smoked (reference = 0)						
1	1.32**	(0.12)	1.32	(0.19)	1.69***	(0.21)
2	1.65***	(0.18)	2.02***	(0.34)	2.07***	(0.28)
3+	2.26***	(0.25)	1.98***	(0.33)	3.34***	(0.44)
Female			1.39**	(0.17)		
Race (reference = White)						
Black					2.13***	(0.30)
Hispanic					1.92***	(0.34)
Other					0.88	(0.20)

(*continued on next page*)

Table 2 (*continued*)

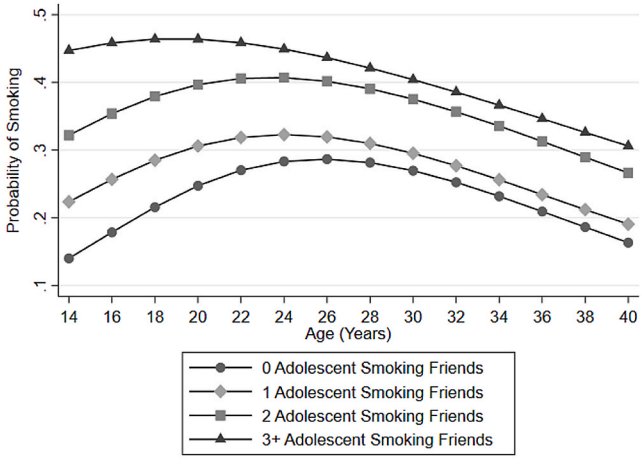
	Model 1		Model 2		Model 3	
Variable	Coefficient	SE	Coefficient	SE	Coefficient	SE
Number of friends who smoked x Female						
1 friend smoked x Female			0.97	(0.19)		
2 friends smoked x Female			0.66	(0.15)		
3+ friends smoked x Female			1.19	(0.26)		
Number of friends who smoked x Race						
1 friend smoked x Black					0.65	(0.15)
1 friend smoked x Hispanic					0.44**	(0.13)
1 friend smoked x Other					1.09	(0.45)
2 friends smoked x Black					0.66	(0.20)
2 friends smoked x Hispanic					0.62	(0.20)
2 friends smoked x Other					1.16	(0.57)
3+ friends smoked x Black					0.34*	(0.15)
3+ friends smoked x Hispanic					0.32**	(0.12)
3+ friends smoked x Other					0.36*	(0.18)
Random Effects						
Variance of age	4.18	(0.36)	4.22	(0.35)	3.85	(0.35)
Variance of constant	4.89	(0.29)	4.83	(0.28)	5.02	(0.30)

*** p<0.001, ** p<0.01, * p<0.05.

Note: Results reported as odds ratios.

[a] All models control for the number of nominated friends, homophily measures, parental SES, parents ever smoked, religious importance, state cigarette tax, college plans, and number of waves missing, and include school fixed effects.

ethnicity, gender, and other covariates. Results indicate that there is an inverse U-shape to smoking as individuals age, given by the positive linear term and negative quadratic term for age. These results are plotted in Fig. 1.[2] Results suggest that there is a graded relationship between the number of adolescent friends who smoked and smoking of the respondent at the intercept (age 16), whereby having more friends who smoked is associated with higher probabilities of smoking during adolescence. For example, those with zero adolescent smoking friends have an 18 percent predicted probability of smoking at age 16 compared to 26 percent for those with one friend who smoked, 35 percent for those with two friends who smoked, and 46 percent for those with three or more friends who smoked. As individuals age, the gap in smoking probability by the number of adolescent friends who smoked begins to decline but does not completely close. At age 30, those with no adolescent smoking friends have a 27 percent predicted probability of smoking compared to 30 percent for those with one friend who smoked, 38 percent for those who had two friends who smoked, and 41 for those who had three or more friends who smoked.



Note: Figure 1 based on results from Model 1 in Table 2.

Fig. 1. Age Trajectories of Current Smoking from Adolescent to Adulthood by the Number of Adolescent Smoking Friends; Add Health Waves I–V.
Note: Fig. 1 based on results from Model 1 in Table 2.

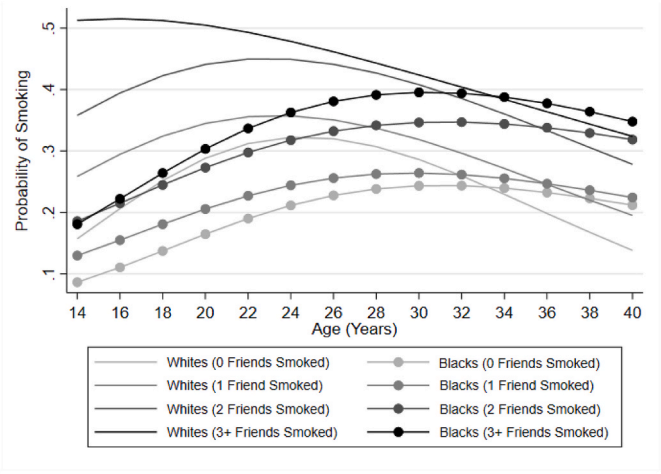
Model 2 interacts the number of adolescent friends who smoked with gender at both the intercept and slope of smoking. Overall, findings indicate no gender differences in the intercept or slope of smoking by the number of adolescent friends who smoked, with the exception of women with three or more friends who smoked having higher probabilities of smoking at age 16 than their male counterparts.

Lastly, Model 3 interacts the number of adolescent friends who smoked with race/ethnicity at the intercept and slope of smoking. Wald tests indicate that including interactions between race/ethnicity, the number of adolescent smoking friends, and age significantly improved model fit. Findings from Model 3 are graphed in Figs. 2–4. Fig. 2 displays age trajectories of smoking by the number of adolescent smoking friends for Whites and Blacks, Fig. 3 displays these trajectories for Whites and Hispanics, and Fig. 4 displays these trajectories for Whites and Other Races.

Findings indicate that having more adolescent friends who smoked is associated with higher smoking prevalence during adolescence for all racial/ethnic groups, with the rate of prevalence varying by race/ethnicity. During adolescence, Whites with three or more smoking friends have higher probabilities of smoking than their Black counterparts. In particular, Blacks who have three or more friends who smoked have comparable probabilities of smoking to Whites with no adolescent friends who smoked. Likewise, other racial/ethnic groups have lower probabilities of smoking during adolescence compared to their White counterparts. Meanwhile, there is no statistical difference between Whites and Hispanics in probabilities of smoking during adolescence by the number of smoking friends.

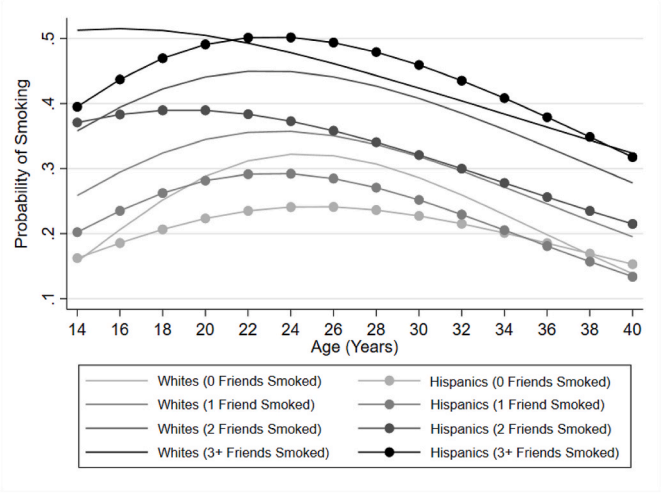
Examining smoking as individuals age, Whites, Hispanics, and other race/ethnicities experience increased probabilities of smoking until around the mid-20s when smoking prevalence begins to decline. Meanwhile, Blacks experience increasing probabilities of smoking as they age. With age, Whites, Hispanics, and other racial/ethnic groups experience decreasing disparities in smoking probabilities by the number of adolescent smoking friends, while these gaps stay relatively consistent for Blacks. The exception is the convergence of smoking probabilities for Blacks with zero and one adolescent friends who smoked, as well as the widening and later slightly narrowing of the gap for Blacks with two and three plus friends who smoked. These age trends suggest that while Whites with three or more adolescent smoking friends

[2] Results were not plotted for respondents below age 14 or above age 40 due to the low number of respondents at these ages.



Note: Figure 2 based on results from Model 3 in Table 2.

Fig. 2. Age Trajectories of Current Smoking from Adolescent to Adulthood by the Number of Adolescent Smoking Friends among Non-Hispanic Whites and Non-Hispanic Blacks; Add Health Waves I–V.
Note: Fig. 2 based on results from Model 3 in Table 2.

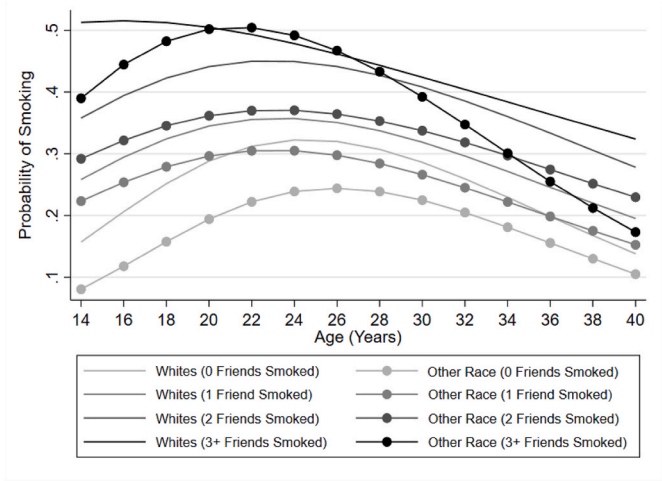


Note: Figure 3 based on results from Model 3 in Table 2.

Fig. 3. Age Trajectories of Current Smoking from Adolescent to Adulthood by the Number of Adolescent Smoking Friends among Non-Hispanic Whites and Hispanics; Add Health Waves I–V.
Note: Fig. 3 based on results from Model 3 in Table 2.

have higher smoking probabilities during adolescence than Blacks with three or more adolescent smoking friends, these groups have comparable smoking probabilities by their mid-30s.

I ran sensitivity analyses treating the number of adolescent friends who smoked as a continuous measure and analyzing only reciprocal friendships. Overall, I found these sensitivity analyses did not change the findings in a meaningful way. Further, given the importance of the adult context for smoking behavior, I ran an additional set of sensitivity analyses which included some key adult contextual variables. The addition of these adult context variables similarly did not significantly change the interpretation of the main analyses. Sensitivity results are available upon request.



Note: Figure 4 based on results from Model 3 in Table 2.

Fig. 4. Age Trajectories of Current Smoking from Adolescent to Adulthood by the Number of Adolescent Smoking Friends among Non-Hispanic Whites and Non-Hispanic Other; Add Health Waves I–V.
Note: Fig. 4 based on results from Model 3 in Table 2.

4. Discussion

Research has long documented the association between adolescent friends' behavior and smoking during adolescence. However, few studies have examined this relationship as individuals age into adulthood. In addition, no studies have examined how the longitudinal relationship between adolescent friends' smoking behavior and individual-level smoking may differ by gender and/or race/ethnicity. Thus, this study aimed to address these gaps by using a nationally representative sample of individuals from adolescence to adulthood to estimate growth curve models of smoking likelihood.

Examining age trajectories of smoking likelihood by the number of adolescent friends who smoked, results indicate that while the gap in smoking probability by the number of adolescent smoking friends begins to dissipate during young adulthood, this gap does not completely disappear, even twenty years after high school. The continued association between adolescent smoking friends and smoking behavior may be due to selection and/or influence processes. While this study is unable to piece apart these processes, previous literature offers insight into how these processes may be occurring. For example, through the observation of and interaction with their peers, adolescents determine what are normalized and accepted behaviors and model these behaviors (Akers et al., 1979). These normalized beliefs and behaviors established during a sensitive period of the life course can continue throughout adulthood, especially due to the addictiveness of nicotine (Ben-Shlomo & Kuh, 2002). Once people begin smoking, they may then select into friendship networks and other contexts in adulthood which align with their smoking behavior, thus perpetuating their smoking behavior. In fact, selection mechanisms may be playing a role in the initial association between adolescent peer smoking networks and smoking. Although I controlled for the selection of friends due to similar demographics (gender, race, and grade), there could be other dimensions of homophily– such as similarity in other health behaviors, SES background, future plans/aspirations, and propensity for risk taking–which may influence the association between adolescent peer smoking networks and smoking behavior (McPherson et al., 2001).

While findings from this study are in line with previous literature which finds that there are long-term impacts of adolescent friends' on health behavior, this study also finds that the effect of these adolescent peer networks begin to wane as individuals enter into adulthood (Ali & Dwyer, 2009; Pollard et al., 2010). These findings may indicate that adult contexts have an increasing impact on smoking behavior as individuals are further removed from adolescent peer contexts. As individuals move through life, their contexts and social relationships evolve, which can create changes in their smoking behavior (Frech, 2014; Pampel et al., 2014). Therefore, it is important for future research to investigate how adult contexts shape smoking behavior.

Examining these results by gender, findings indicate that there are no significant differences in the association between the number of friends who smoked and trajectories of smoking likelihood. These findings may suggest that the influence of friends during the sensitive period of adolescence is a shared experience for men and women that confer a similar effect on smoking probabilities regardless of differing friendship structures (Perry & Pauletti, 2011; Rose & Rudolph, 2006). Still, although there are no differences among men and women in smoking probabilities by the number of adolescent friends who smoked, differing friendship dynamics may lead to gender differences in other dimensions of smoking, such as frequency and amount. Additionally, differing findings from previous literature may be due to different measures of friendship networks.

Lastly, I find that the association between smoking likelihood and the number of adolescent smoking friends varies by race/ethnicity. While results indicate that for all racial/ethnic groups, having more adolescent friends who smoked is associated with higher smoking prevalence from adolescence to adulthood, this association is lower for Blacks and other racial/ethnic groups; this is consistent with other literature (Hoffman et al., 2006; Kandel et al., 2004). However, there are no significant differences in the impact of adolescent friends on adolescent smoking behavior between Whites and Hispanics.

Previous literature has hypothesized that smoking prevalence is lower for Black adolescents than White adolescents because Black adolescents have greater social controls that are protective against smoking, such as strong parental disapproval of smoking and involvement in religious activities (Pampel, 2008). These social controls can similarly result in the weaker association between adolescent peer smoking networks and smoking behavior for Black adolescents than White adolescents by serving as protective factors against peer influence. Research on peer influence in Hispanic populations has found that during adolescence, adolescent peers have a stronger influence on substance use than cultural beliefs (Grigsby et al., 2017). Therefore, it could be that Hispanics have fewer social controls against smoking, making them more similar to Whites than Blacks and other racial/ethnic groups in their association between adolescent friends' smoking behavior and individual-level smoking behavior. While social controls may also play a role in the lower probabilities of smoking for other racial/ethnic groups, it is difficult to determine this given the heterogeneity of those in the other racial/ethnic group, which consist of Asian, Pacific Islander, American Indian, Alaska Native, and other races/ethnicities.

This study also examined the association between adolescent friends and trajectories of smoking likelihood by race/ethnicity. Findings suggest that the effect of the number of friends who smoked on individual-level smoking behavior wanes with age for Whites, Hispanics, and other racial/ethnic groups but remains consistent for Blacks. This may be because Whites are more likely to be embedded in networks and contexts during adulthood, which disapprove of smoking, thereby forcing them to quit smoking. This may be particularly true as White young adults enter college and begin white-collar jobs. Additionally, Whites have more access to financial and social capital, such as access to counseling, nicotine replacements, and social support, than Blacks to help them quit smoking, thus mitigating the effects of adolescent friends in adulthood for Whites (Pampel, 2008). Black adults may also have a harder time quitting smoking than Whites because Black smokers are more likely to use menthol cigarettes which have been found to be more addictive than non-menthol cigarettes (National Cancer Institute, 2008; U.S. Food and Drug Administration, 2013). Estimates suggest that among adolescent smokers, over 70 percent of Black adolescents use menthol cigarettes compared to 30 percent of their White counterparts (Gardiner, 2004). Currently the U.S. Food and Drug Administration is moving to ban menthol cigarettes which could lead to 230,000 Black Americans to quit smoking in the first 13–17 months of the ban (Chung-Hall et al., 2021; U.S. Food and Drug Adminstration, 2021; Wamsley, 2021).

Literature suggests that smoking prevalence increases for Blacks in early adulthood as a coping mechanism for chronic stress associated with cumulative disadvantage (Geronimus et al., 1993; Pampel, 2008). Therefore, due to socialization mechanisms, those with friends who smoked during adolescence may be more likely to use smoking as a mechanism for this stress, thus explaining the consistent association between adolescent peer networks and smoking behavior in adulthood for Blacks. Additionally, research finds that since smoking is a behavior that is less frequent among Black adolescents, Black adolescents who do smoke are more connected to other Black youth who smoke (Daw et al., 2015). This large level of homophily can perpetuate at other stages of the life course.

4.1. Implications

These findings have implications for both anti-smoking campaigns as well as future research. Lasting associations between the number of adolescent friends who smoked and smoking behavior signal the continued need to focus anti-smoking campaigns toward adolescents in order to prevent the long-term effects of smoking. These campaigns should focus on peer groups in addition to individuals. Interventions focused on groups, called segmentation interventions, aim to change established norms and processes that can only be modified through whole group changes (Valente, 2012). These types of interventions could be beneficial in reducing smoking, A recent web-based program to prevent smoking initiation called A Smoking Prevention Interactive Experience (ASPIRE) has shown some promising results in reducing smoking initiation among those with a high number of adolescent friends who smoked (Khalil et al., 2020). Additionally, anti-smoking campaigns should not only focus on peer influence but also consider selection mechanisms, which may also be operating (Mercken et al., 2009).

Findings on differential associations between the number of friends who smoked and trajectories of smoking likelihood by race/ethnicity suggest that a "one size fits all" intervention may not be the best approach to preventing smoking (Mason et al., 2014). Rather, heterogeneity in the effect of adolescent friends by race/ethnicity needs to be taken into account in anti-smoking interventions as well as future research. It is also important to study differences across other dimensions of social stratification, such as SES, to determine how the association between adolescent friends and individual-level smoking trajectories may differ for different populations. While this study did not find significant differences in the association between the number of friends who smoked and smoking trajectories of smoking likelihood by gender, future research should aim to study the role gender plays in this association in various contexts and other measures of health behavior.

Lastly, these findings could relate to the recent increase in e-cigarettes among adolescents. E-cigarette use has more than tripled in middle and high school students since 2011 (U.S. Department of Health and Human Services, 2016). Although e-cigarettes may be less harmful than conventional cigarettes, they can still be damaging for health. In fact, individuals who smoked e-cigarettes are four times more likely to smoke conventional cigarettes than those who do not smoke e-cigarettes (Berry et al., 2019). E-cigarette smoking seems to be following a similar trend to conventional cigarette smoking, particularly regarding demographic trends in smoking behavior. Therefore, this study can be

informative on how adolescent friends may impact e-cigarette smoking during adolescence as well as the potential trajectory of e-cigarette use as individuals age.

4.2. Limitations

Although this study provides key insights in the association between the number of adolescent friends who smoked and trajectories of smoking likelihood, this research is limited in several ways. First, I cannot examine social networks later in life for this sample, which could be affecting trajectories of smoking. In this analysis, I use friendship data for the Wave I respondents from the in-school sample in order to analyze a larger population across time. Since not every student from the in-school survey was selected for the in-home survey, I do not have measures of smoking across time for all of the nominated friends. Second, I do not examine the social, economic, behavioral, and contextual factors beyond adolescence that may be influencing smoking trajectories. These include the college and workplace environment, later life SES, parenthood, etc. Third, this study only investigates smoking trajectories within one birth cohort; therefore, these findings may vary across different cohorts. Fourth, is the issue of missing data. While some of the missing data was due to study design issues (e.g., I dropped those who did not take the in-school survey, or nominated zero friends), other missing data on the number of friends who smoked and control variables were not part of the design. Missing values were not imputed because of the complexity of imputing longitudinal data with a complex survey design as well as the complexity of having to impute data on both friends and respondents. Finally, this research does not sort out the differences between selection and influence. When examining the average behavior of a group, it is difficult to separate endogenous, exogenous/contextual, and correlated effects (Manski, 1993). For example, although this study examines endogenous effects of adolescent peer smoking networks, this could be confounded by contextual and correlated effects, such as shared environments, characteristics, etc.

5. Conclusion

Despite these limitations, this study finds that the number of adolescent friends who smoked have lasting impacts on probabilities of smoking that wanes as individuals age but does not completely dissipate, even twenty years after high school. Further, results indicate that there are no significant differences in the association between the number of adolescent friends who smoked and trajectories of smoking likelihood by gender, but there are significant variations by race/ethnicity. These findings highlight the long-term impacts that adolescent peers have on smoking behavior as well as the importance of examining differential impacts of adolescent peer networks across subgroups of the population. Moreover, results indicate that anti-smoking campaigns should take a network approach to preventing smoking in adolescence as well as recognize that the same campaign strategy may not work for all groups.

Ethical statement

This research used data from the National Longitudinal Study of Adolescent to Adult Health (Add Health), a program project directed by Robert A. Hummer and designed by J. Richard Udry, Peter S. Bearman, and Kathleen Mullan Harris at the University of North Carolina at Chapel Hill (UNC–CH). Add Health has received approval by UNC-CH's Institutional Review Board.

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CRediT authorship contribution statement

Kaitlin Shartle: Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing, Visualization.

Declaration of competing interest

None.

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