Published in final edited form as:
Health Place. 2011 January ; 17(1): 222–229. doi:10.1016/j.healthplace.2010.10.004.

Adolescent smoking risk increases with wider income gaps between rich and poor

Ritesh Mistry[1,2], **William J. McCarthy**[1,2,3,4], **Roberto de Vogli**[5], **Catherine M. Crespi**[2,6], **Qian Wu**[2,6], and **Minal Patel**[1,2]

[1] University of California, Los Angeles (UCLA), Department of Health Services

[2] UCLA, Division of Cancer Prevention and Control Research

[3] UCLA, Department of Psychology

[4] WestED

[5] University College London, Department of Epidemiology

[6] UCLA, Department of Biostatistics

Abstract

Data from a state-wide survey of California middle and high school students (N=20,203) were used to assess whether county income inequality and poverty rates were associated with adolescent smoking. Greater county income inequality, but not poverty rates, was associated with higher established smoking risk (p= 0.0019). The association was stronger in males than females, whites than other ethnic groups, and urban than rural settings. Neither county income inequality nor poverty rates were associated with experimental smoking. The findings suggest that it may be important to consider and address economic inequality in the prevention and control of adolescent tobacco use.

Keywords

Tobacco; Adolescent; Income Inequality; GIS; Multilevel

INTRODUCTION

Over the past several decades, the United States has experienced an unprecedented rise in income and wealth inequalities with a steady decline in average living wages (Kopczuk et al., 2007). We sought to better understand whether such inequalities influenced tobacco use, an important health risk behavior that contributes substantially to socioeconomic disparities in chronic disease risk and mortality. Because adolescence is a period when many initiate tobacco use and it is when most U.S. adult smokers begin a lifestyle of regular use, a better understanding of whether broader economic factors influence the establishment of adolescent tobacco use could be useful for informing chronic disease prevention efforts. This paper, therefore, used data from a state-wide survey of California middle and high school students to assess whether county-level absolute income measured as the poverty rate and relative income measured as the Gini coefficient of income inequality are associated with adolescent smoking risk.

Corresponding Author: Ritesh Mistry, PhD, MPH, 650 Charles Young Drive South, Room A2-125 CHS, Box 956900, Los Angles, CA 90095-6900, Phone: 310-825-8848, Fax: 310-206-3566, riteshm@ucla.edu.

Considerable evidence links area-level absolute income to health outcomes over and above the impact of individual-level factors (Robert, 1999a), but research examining important health risk behaviors such as tobacco use is lacking. Health behaviors such as tobacco use may explain some of the area-level economic influences on health outcomes (Robert, 1999b), and research in adult populations suggests a positive link between measures of area level absolute income measures and tobacco use. For example, studies indicate that living in disadvantaged areas may be associated with increased risk of tobacco use in adults even after adjusting for individual-level characteristics (Chaix et al., 2004, Chuang et al., 2005, Diez Roux et al., 2003, Kleinschmidt et al., 1995, Reijneveld, 1998, Shohaimi et al., 2003, Tseng et al., 2001). The research in adolescent populations has been inconclusive, however. One study using U.S. national data did not find an effect of low neighborhood socioeconomic status on current youth smoking (Lee and Cubbin, 2002), while a study of a Midwestern communities found that adolescents in more socioeconomically advantaged neighborhoods were more likely to smoke than those in disadvantaged neighborhoods (Ennett et al., 1997). More recently, studies suggest the effect of area-level socioeconomic status may differ based on community and individual ethnicity. For example, a study of adolescents in Michigan, U.S. found that smoking risk was higher in disadvantaged neighborhoods with a low proportion of African Americans (Xue et al., 2007). Similarly, a study using the U.S. National Longitudinal Study of Adolescent Health found that neighborhood poverty increased the frequency and quantity of smoking in Whites but not African Americans (Nowlin and Colder, 2007).

The size of the income gap between the rich and poor has been linked with a number of health outcomes, but the mechanisms underlying the observed relationships are unclear (Lynch et al., 2004, Wilkinson and Pickett, 2005). Health behaviors may partially explain the income equality and health relationship. For example, income inequality has been linked in ecological studies with outcomes that have a strong behavioral component such as homicide rates (Hsieh and Pugh, 1993) and pregnancy rates (Gold et al., 2004, Pickett et al., 2005b) as well as chronic disease risks such as obesity (Pickett et al., 2005) and smoking rates (Barnett et al., 2004, Pampel, 2002). Ecological research has also shown that the correlation between state-level income inequality and all-cause mortality in U.S. adults may partially be explained by smoking rates (Kaplan et al., 1996, Kennedy et al., 1996). However, analysis of U.S. multilevel data has shown that state-level income inequality was not associated with adult smoking when controlling for individual-level factors (Diez-Roux et al., 2000). To our knowledge, multilevel studies about income inequality and tobacco use in smaller geographic areas such as counties have not been conducted nor have studies been conducted in adolescent populations.

Given the conflicting reports on the link between absolute and relative income and tobacco use, and given that past research on relative income and tobacco use has mainly used ecological data in adult populations, this study adds to the literature by using multilevel data to assess whether absolute and relative income were associated with tobacco use in adolescents. Absolute and relative income can have differential effects on population subgroups characterized by age, gender and ethnicity. Analysis of multilevel data is also needed to account for proximal factors often unmeasured in previous research on area level effects on tobacco use. A focus on adolescence is required to improve the understanding of whether absolute and relative income influence smoking during a developmental period when tobacco experimentation and a lifestyle of regular use are often initiated.

The conceptual approach for this study was based on the proposition that relative and absolute income could be associated with youth experimental and established smoking through material and psychosocial pathways (Figure 1). With regard to the material pathway, adolescent tobacco use risk of experimental and established smoking may be

higher in areas characterized by lower income levels and/or larger income gaps because such areas may more subject to predatory marketing (Siahpush et al., 2010, John et al., 2009), that is, have a greater availability of tobacco retailers and more tobacco advertisements, as well as have fewer tobacco use prevention programs and lower access to other community resources that could decrease adolescent tobacco use risk. Beyond the effect of absolute income, relative income may be associated with reduced political capital, especially in economically disadvantaged groups, to access and shape political decision-making to modify their material environment for tobacco and other disease prevention efforts in their communities. Poorer areas tend to have a greater density of tobacco retailers compared to more affluent areas (Schneider et al., 2005). Moreover, community availability of tobacco retailers (McCarthy et al., 2009) and exposure to tobacco advertisements (Lovato et al., 2003) have been linked with adolescent experimental and established tobacco use.

With respect to the psychosocial pathway, adolescents living in poorer areas and areas with larger income gaps may be at greater risk of established smoking because they may experience greater psychosocial stress and use tobacco more regularly as an unhealthful coping strategy. Experimental smoking may be less influenced by this pathway because it may be largely drive my availability of tobacco product and tobacco use prevention programs (i.e. the material pathway). For example, adolescents living in poorer areas and income unequal areas may be higher risk of established smoking because they may experience lower social connectedness with other community members, lower levels of community social cohesion, parental involvement and supervision, and higher levels of psychological stress compared to adolescents living in richer and more income equal areas. Furthermore, adolescents living in income unequal areas may experience greater psychosocial stress from social comparison with others regarding perceived success and life satisfaction than adolescents living income equal areas. Individuals living in less affluent areas and less income equal areas tend to report lower levels of social connectedness (Kawachi et al., 1997, Robert, 1999a) and more affective symptoms (Kahn et al., 2000). Adolescents have been known to use tobacco habitually as a negative coping behavior for emotional (Killen et al., 1997, Repetto et al., 2005) and social stress (Griesbach et al., 2003).

Guided by this conceptual approach, data from California, one of the largest economies in the world with a population of over 36 million from diverse ethnic backgrounds, were used to: 1) assess whether absolute and relative income at the county-level were associated with adolescent tobacco use, while controlling for individual and school-level covariates; 2) explore potential pathways between absolute and relative income and adolescent tobacco use by examining the potential mediating roles of school-adjacent availability of tobacco and adolescent emotional well being; and 3) assess whether the relationship between absolute and relative income and adolescent tobacco use differed based on gender, race/ethnicity, and urban/rural school setting.

METHODS

Sample

Data were from the 2003–2004 Independent Evaluation of Tobacco Use Prevention and Education Programs (IETP) student survey, one of the most extensive random sample data sources on California student tobacco use ever assembled (25,973 students in grades 7–12 in 39 California counties). The IETP used geographic stratification with a two-stage survey sampling design with schools at the first stage and classes within schools at the second stage. The response rates for schools (85.0%) and students (66.3%) were consistent with response rates reported in previous student tobacco use survey research (Wechsler et al., 1998). Participating schools and non-participating schools had comparable socioeconomic characteristics. For example, 34% of students at participating schools were eligible for

government-subsidized school meals; the corresponding proportion for non-participating schools was 34.9%. Student participation required active parental consent to this survey, which is typically associated with about 10–25% lower participation rates than is typically associated with passive parent consent (Eaton et al., 2004). The analytic sample included students with complete data on all study variables (N=20,203 in 38 counties and 245 schools).

Smoking measures

Student tobacco use was measured as established and experimental smoking. Established smoking was defined as smoking at least one cigarette on at least one day in the last 30 days and having ever smoked 100 or more cigarettes. Experimental smoking was defined as smoking at least one cigarette on at least one day in the last 30 days and having *not* smoked 100 or more cigarettes in one's lifetime.

County-level socioeconomic status

The Gini coefficient of income inequality was used to measure relative income at the county-level. (Atkinson, 1970). Gini coefficients were grouped into quartiles. Absolute income was measured as the percent of county population below the federal poverty level. These data were from the 2000 U.S. Census data.

School-level factors

To measure factors regarding the proximate environment to adolescents, included were school socioeconomic status, school-adjacent neighborhood tobacco retailer density and urban versus rural school setting. School-level parental education was used as a proxy measure for school socioeconomic status. It is the school mean of parents' self-reported educational attainment (response options: less than high school, high school grad, some college, college grad, post-graduate education), as reported annually to the California Department of Education (California Department of Education).

To measure tobacco retailer density in school-adjacent neighborhoods 2006 data from the California Board of Equalization on all licensed tobacco retailers in the state were used. Addresses associated with 21,907 out of 21,929 licenses were geocoded. ArcGIS was used to measure school-level tobacco retailer density as the number of retailers within a 1 mile buffer zone surrounding each school. For the regression analysis described below, this measure was transformed logarithmically. A more detailed description of this measure is provided elsewhere (McCarthy et al., 2009).

Definitions for “urban” or “rural” school settings were derived from the 2000 Census-designated population status associated with the school’s zip code (Hall et al., 2006) classified into one of eight categories, ranging from large cities to mid-size cities in urban fringes to rural areas. The two categories containing the word “rural” were designated rural; all other options were designated urban.

Student-level factors

Student-level risk factors most commonly associated with adolescent tobacco use risk were included such as age, gender, race/ethnicity, self-reported grades, perceived peer smoking and hopelessness. Because the IETP student survey did not collect data on household socioeconomic status, self-reported grades were used as a proxy. Past research has indicated consistent and strong associations between academic achievement and household socioeconomic status measures such as parent education and household income (Sanchez et al., 2007). Peer tobacco use, which has been strongly linked to adolescent tobacco use (Lundborg, 2006), was a dichotomous variable, indicating either respondent reports about

half or more of their peers smoke or some to none smoke. Hopelessness was measured by a single item adapted from the Centers for Disease Control and Prevention Behavioral Risk Factor Survey which asked whether respondents experienced prolonged feelings of hopelessness or sadness in the last 12 months (http://apps.nccd.cdc.gov/BRFSSQuest). This measure reflects adolescent depressiveness, which has been consistently associated with tobacco use in a number of studies (Repetto et al., 2005). A parsimonious set of the theoretically most important student-level risk factors for smoking was included.

Data were used at multiple levels in order to account for socioeconomic factors distal to the adolescents (i.e. county absolute and relative income), factor having to with adolescents' proximal environment (e.g. school socioeconomic status and school adjacent neighborhoods retailer density) and student-level characteristics.

Analysis

Stata 10.0 was used for data analysis. Means were calculated for continuous variables and proportions for categorical study variables. Because students were nested within schools and counties, multilevel logistic regression was used to address the lack of independence in observations and to account for county and school-level variance (Snijder and Bosker, 1999). Logistic regression models with random-intercepts for counties and schools were used for each tobacco use outcome separately. A hierarchical approach for covariate entry was used beginning with an unconditional model without covariates with students nested within schools and counties, then added were student-level variables followed by school-level variables, then finally county-level variables. Likelihood ratio tests were used to compare nested models. Next, as per the conceptual approach describing material and psychosocial pathways between absolute and relative income and smoking behaviors, tobacco retailer density in school-adjacent neighborhoods (material pathway) and adolescent reported hopelessness (psychosocial pathway) were evaluated as potential mediators. The causal steps approach described by Baron and Kenney (Baron and Kenny, 1986) and others (MacKinnon et al., 2007) was used. The prerequisites for mediation under this approach include a significant relationship between the independent variable (income equality or percent below poverty) and dependent variable (smoking behavior), and movement of the regression coefficient for the independent variable away from the null when the hypothesized mediator (retailer density, hopelessness) is removed from the model. The two potential mediators were evaluated singly. Finally, stratified analyses were conducted to assess whether the associations between county economic measures and smoking differed based on gender, race/ethnicity and urban/rural school setting.

RESULTS

The sample was 14.6 years old on average, and was predominantly white (43.9%) and Hispanic/Latino (31.8%). More than a quarter of the students reported feeling "hopeless" in the past 12 months (27.1%). Established smoking and experimental smoking were prevalent at 3.0% and 6.3%, respectively (Table 1). There was some variability with respect to county income inequality, county poverty levels, school tobacco retailer density and school mean parental education.

Table 2 shows multilevel regression results for established smoking, White students compared to other races/ethnicities except American Indians/Alaskan Natives, and students with lower socioeconomic status were at greater risk of established smoking. Hopelessness, a commonly reported mental health symptom, was also a significant risk factor for established smoking. None of the school-level factors were associated with established smoking and the addition of school-level variables did not improve model fit (p=0.5147). The full established smoking model which included county, student and school-level factors,

was a better fit to the data than the model containing only student and school-level factors (p=0.0255). The inclusion of county-level factors reduced the county-level variance component to nearly zero. The results indicated that county-level income inequality was associated with established smoking. Initially a continuous form of the income inequality measure was used, which was also significantly associated with established smoking (p=0.011), but for ease of interpretation the quartile form was reported in the tables. Percentage of population below poverty was not associated with established smoking.

Next the mediating role of hopelessness in the income inequality-established smoking relationship was evaluated (data not shown). There was no change in the coefficients for income inequality when hopelessness was removed from the full established smoking model indicating no evidence of mediation. Because percentage below poverty (absolute income) was not associated with established smoking, tests for mediational pathways between percent below poverty and established smoking were not indicated and were not conducted.

Table 3 shows results for experimental smoking. The addition of school-level factors improved the fit of the experimental smoking model (p=0.0012), but the addition of county-level factors did not (p=0.9253). County-level income inequality and poverty rates were not associated with experimental smoking. Higher school-level parental education, the proxy measure used for school socioeconomic status, was associated with lower odds of experimental smoking (p=0.055), while greater school-adjacent neighborhood tobacco retailer density was associated with higher odds (p=0.058); both were at a borderline significance level in the full model. Because there was no effect of income inequality or percent below poverty on experimental smoking, tests of mediation between absolute and relative income and this smoking outcome were not conducted.

Table 4 shows that effect of income inequality on established smoking differed based on gender, race/ethnicity and urban/rural schools. There were associations between county-level income inequality and established smoking risk in males, but not females, in whites but not other ethnic groups and in urban but not rural school settings (all $p<0.05$). The sample sizes in the rural and African American subgroups may have been too small (N=1,354) to detect a significant relationship.

DISCUSSION

The findings indicate that county income inequality was associated with established smoking, but county poverty rates were not. Experimental smoking was not associated with either county-level income inequality or poverty. Significant associations between county-level income inequality and established smoking risk were present in whites but not the other race/ethnic subgroups, in males but not females, and in urban but not rural school settings.

Although experimental smoking is a prerequisite step in the adoption of a regular smoking lifestyle, it may be less influenced by broader socioeconomic factors and may involve processes distinct from those required for the development of established smoking. Many adolescents tend to experiment with tobacco as a novelty behavior without progressing to habitual use. Experimentation may largely be driven by proximal peer, social and tobacco access influences while development of established smoking may involve additional influences that include more distal factors such as economic inequalities. Indeed, the results showed that proximal factors not associated with established smoking such as school-adjacent tobacco retailer density and school-level mean parental education were associated with experimental smoking.

We tested whether tobacco retailer density (material pathway) and hopelessness (psychosocial pathway) were potential mediators. Neither factor was a mediator between economic inequalities and adolescent tobacco smoking. The study of pathways will likely require longitudinal designs with more detailed information on material and psychosocial factors. For example, in this study emotional well being was measured using a single item on feelings of hopelessness over a 12-month period which does not capture the complexities of affective symptoms such as anxiety, nervousness and depressiveness. The measure of tobacco retailer density was created from a list of licensed retailers obtained from the state government which does not include non-licensed retailers of tobacco.

The presence of a significant income inequality relationship with established smoking risk in whites, but not other racial/ethnic subgroups may largely be due to the smaller sample sizes in African Americans and Asians. The regression slopes for income inequality in non-white race/ethnic groups were not significant, but were in the expected direction. The observed racial/ethnic differences might also suggest that white adolescents may be more sensitive to economic gaps between themselves and others, than are African Americans and other groups. Latinos/Hispanics and Asians, because of their immigrant background, may have different expectations, aspirations and perceptions of the economic environment in which they live and about economic equity than do native born adolescents. It would be useful to compare immigrants and non-immigrants. The historical legacy of slavery and racial discrimination experienced by African Americans in the U.S., for example, may affect how African Americans adolescents perceive and experience economic inequity, and how it might impact their health and health behavior choices. Additionally, other sociocultural factors may serve to protect adolescents from racial/ethnic minority backgrounds from smoking tobacco, as is evident from the historically lower rates of smoking in these groups compared to whites.

The association between income inequality and established smoking was not present in females, who were also at lower risk of established smoking than males. Male adolescents may process the economic environment differently than females, especially environments characterized by highly competitive, status oriented, male dominant processes. Male adolescents may smoke and use other substances to cope with psychosocial stress while females may use other negative behavioral coping strategies such as unhealthful eating and being sedentary. Female adolescents may also differ on the parenting they receive (Mistry et al., 2009) and may model parent behaviors differently (Sanchez et al., 2007). Male adolescent may be prone to emulating parental, especially paternal, smoking than females. The current findings, however, are in contrast with ecological research suggesting that the effect of relative income on smoking may be stronger in adult females than males, for example in higher income groups in the U.S. (Diez-Roux et al., 2000) and in ethnic minorities in New Zealand (Barnett et al., 2004). This suggests that analysis of the effect of relative income on smoking could benefit from examining adolescent males and females separately by income groups and ethnic groups.

Unfortunately, it was not possible to include such aspects of the family context in our analysis. The harmful effects of county income inequality on adolescent smoking may be dependent on such unmeasured family factors such as parental smoking, parenting and parent modeling by adolescents. The family, particularly parents, may serve to protect adolescents from health risks from broader social or economic process, but family members may also serve to transfer these risks to adolescents via multitude of process such as uninvolved or unsupportive parenting, or parents engaging in health risk behaviors themselves.

Strengths and Limitations

A strength of this study is the large sample size available for the analysis. However, because secondary survey data were used, the availability of variables limited the study's scope. For example, it was not possible to include important covariates such as parenting style, parent behaviors, household socioeconomic status, and immigration status. Another strength is that the study tested county-level effects within a multilevel framework that included a robust set of individual and school-level factors and variance components at each level thus reducing the likelihood of compositional bias which commonly arises in ecological studies. The important limitations of cross-sectional data also need to be acknowledged, including the caveat that the observed relationships are evidence of associations and not causation. The measures of smoking and hopelessness were based on self-reports. Previous studies, however, have shown these measures to be valid (Smith et al., 1995, Stanton et al., 1996). There were small sample sizes in some counties, but various sensitivity analyses were conducted including combining small counties as well as removing them from the sample and the results remained stable. The amount of student exposure to school and county-level variables was not known, i.e. data were not available on how long students lived in the county where they went to school and completed the tobacco use questionnaire.

Conclusions

This study found that the degree of county-level income inequality was associated with adolescent established smoking, a measure of habitual addictive smoking behavior. There was no association between county-level poverty rates and established smoking. Experimental smoking was not associated with either income inequality or poverty rates, but was associated with more proximal contextual factors, i.e. school-adjacent neighborhood socioeconomic and tobacco retailer environment. Careful attention should be paid to younger adolescents, white adolescents and adolescents from low income backgrounds, since they are at greatest risk of established and experimental smoking, and because in these adolescents the income inequality effect on establish smoking risk was most prominent. The findings suggest that it may be important to consider and address economic inequality in the prevention and control of adolescent tobacco use.

References

Atkinson AB. On the measurement of inequality. Journal of Economic Theory. 1970; 2:244–263.

Barnett R, Moon G, Kearns R. Social inequality and ethnic differences in smoking in New Zealand. Soc Sci Med. 2004; 59:129–43. [PubMed: 15087149]

Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. J Pers Soc Psychol. 1986; 51:1173–82. [PubMed: 3806354]

California Department of Education API Data files.

Diez-Roux AV, Link BG, Northridge ME. A multilevel analysis of income inequality and cardiovascular disease risk factors. Soc Sci Med. 2000; 50:673–87. [PubMed: 10658848]

Eaton DK, Lowry R, Brener ND, Grunbaum JA, Kann L. Passive versus active parental permission in school-based survey research: Does the type of permission affect prevalence estimates of risk behaviors? Evaluation Review. 2004; 28:564. [PubMed: 15486161]

Ennett ST, Flewelling RL, Lindrooth RC, Norton EC. School and neighborhood characteristics associated with school rates of alcohol, cigarette, and marijuana use. J Health Soc Behav. 1997; 38:55–71. [PubMed: 9097508]

Griesbach D, Amos A, Currie C. Adolescent smoking and family structure in Europe. Social Science & Medicine. 2003; 56:41–52. [PubMed: 12435550]

Hall SA, Kaufman JS, Ricketts TC. Defining urban and rural areas in US epidemiologic studies. Journal of Urban Health. 2006; 83:162–175. [PubMed: 16736366]

Hsieh C, Pugh M. Poverty, income inequality, and violent crime: a meta-analysis of recent aggregate data studies. Crim Just Rev. 1993; 18:182.

Kahn R, Wise P, Kennedy B, Kawachi I. State income inequality, household income, and maternal mental and physical health: cross sectional national survey. British Medical Journal. 2000; 321:1311. [PubMed: 11090512]

Kawachi I, Kennedy B, Lochner K, Prothrow-Stith D. Social capital, income inequality, and mortality. American journal of public health. 1997; 87:1491. [PubMed: 9314802]

Kopczuk, W.; Saez, E.; Song, J. Uncovering the American dream: Inequality and mobility in social security earnings data since 1937. NBER; 2007.

Lee RE, Cubbin C. Neighborhood context and youth cardiovascular health behaviors. Am J Public Health. 2002; 92:428–36. [PubMed: 11867325]

Lovato, C.; Linn, G.; Stead, L.; Best, A. Impact of tobacco advertising and promotions on increasing adolescent smoking behaviors status and date: Edited (no change to conclusions), published in, 4. 2003.

Lundborg P. Having the wrong friends? Peer effects in adolescent substance use. Journal of Health Economics. 2006; 25:214–233. [PubMed: 15964090]

MacKinnon DP, Fairchild AJ, Fritz MS. Mediation Analysis. Annual Review of Psychology. 2007; 58:593–614.

McCarthy WJ, Mistry R, Lu Y, Patel M, Zheng H, Dietsch B. Density of tobacco retailers near schools: effects on tobacco use among students. Am J Public Health. 2009; 99:2006–13. [PubMed: 19820214]

Mistry R, McCarthy WJ, Yancey AK, Lu Y, Patel M. Resilience and patterns of health risk behaviors in California adolescents. Preventive Medicine. 2009; 48:291–297. [PubMed: 19159644]

Nowlin PR, Colder CR. The role of ethnicity and neighborhood poverty on the relationship between parenting and adolescent cigarette use. Nicotine Tob Res. 2007; 9:545–56. [PubMed: 17454711]

Pickett KE, Kelly S, Brunner E, Lobstein T, Wilkinson RG. Wider income gaps, wider waistbands? An ecological study of obesity and income inequality. J Epidemiol Community Health. 2005; 59:670–4. [PubMed: 16020644]

Repetto PB, Caldwell CH, Zimmerman MA. A longitudinal study of the relationship between depressive symptoms and cigarette use among African American adolescents. Health Psychology. 2005; 24:209–219. [PubMed: 15755235]

Robert S. SOCIOECONOMIC POSITION AND HEALTH: The Independent Contribution of Community Socioeconomic Context 1. Annual Review of Sociology. 1999a; 25:489–516.

Robert SA. Neighborhood socioeconomic context and adult health. The mediating role of individual health behaviors and psychosocial factors. Ann N Y Acad Sci. 1999b; 896:465–8. [PubMed: 10681952]

Sanchez A, Norman GJ, Sallis JF, Calfas KJ, Cella J, Patrick K. Patterns and correlates of physical activity and nutrition behaviors in adolescents. American journal of preventive medicine. 2007; 32:124–130. [PubMed: 17197153]

Schneider J, Reid R, Peterson N, Lowe J, Hughey J. Tobacco outlet density and demographics at the tract level of analysis in Iowa: implications for environmentally based prevention initiatives. Prevention Science. 2005; 6:319–325. [PubMed: 16163568]

Snijder, T.; Bosker, R. Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modeling. Thousand Oaks: Sage Publications; 1999.

Wechsler H, Rigotti NA, Gledhill-Hoyt J, Lee H. Increased levels of cigarette use among college students a cause for national concern. Jama Am Med Assoc. 1998

Xue Y, Zimmerman MA, Caldwell CH. Neighborhood residence and cigarette smoking among urban youths: the protective role of prosocial activities. Am J Public Health. 2007; 97:1865–72. [PubMed: 17761584]

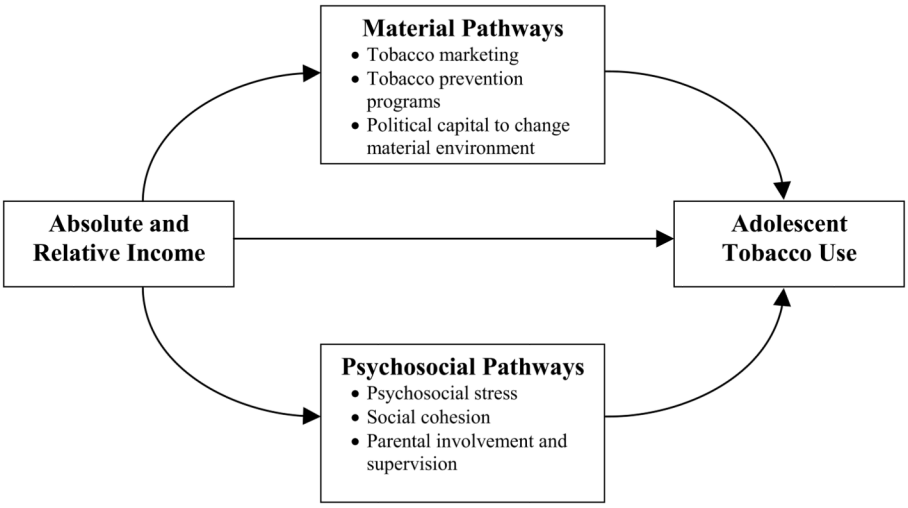

Figure 1.
Potential material and psychosocial pathways linking absolute and relative income with adolescent tobacco use

Table 1

Descriptive statistics

Student characteristics **(n=20,203)**	**Mean (SD/range) or Percent**
Age (mean years)	14.6 (1.9/5.0[a])
Gender	
Male	45.9
Female	54.1
Race/ethnicity	
White	43.9
Hispanic/Latino	31.8
Asian/Pacific Islander	15.9
African American	6.7
American Indian/Alaskan Native	1.7
Grade point average	
As	59.0
Bs	27.5
Cs	10.4
Ds	3.1
About half or more peers smoke	
Yes	28.4
No	71.6
Hopelessness	27.1
Established smoking	3.0
Experimental smoking	6.3
School characteristics (n=245)	Mean (SD/range) or Percent
Urban	90.9
Rural	9.1
Mean parent education	3.0 (0.7/3.0)
Tobacco retailers density (log transformed)	2.1 (0.9/4.4)
County characteristics (n=38)	Mean (SD/range)
Gini coefficient for income inequality	0.5 (0.02/0.1)
Percentage below poverty	13.3 (5.2/18.1)

[a]Age was top-coded at 19 years and bottom-coded at 12 years.

Table 2

Multilevel logistic regression for established smoking (N=20,203)

	Odds Ratio (95% Confidence Interval)		
	Student Level Model	**Student + School Model**	**Full Model**
Student variables			
Age (years)	***1.58 (1.49, 1.68)	***1.58 (1.49, 1.68)	***1.58 (1.49, 1.68)
Gender			
Male	***1.65 (1.39, 1.96)	***1.64 (1.38 1.95)	***1.64 (1.38, 1.95)
Female	1.00	1.00	1.00
Race/ethnicity[a]			
White	1.00	1.00	1.00
Hispanic/Latino	***0.33 (0.27, 0.41)	***0.32 (0.25 0.41)	***0.31 (0.24, 0.39)
African American	***0.33 (0.22, 0.51)	***0.33 (0.21 0.50)	***0.32 (0.21, 0.50)
Asian/Pacific Islander	***0.55 (0.42, 0.72)	***0.55 (0.41 0.72)	***0.52 (0.39, 0.69)
American Indian/Alaskan Native	0.78 (0.40, 1.52)	0.76 (0.39,1.49)	0.76 (0.39, 1.49)
Grade point average[a]			
As	1.00	1.00	1.00
Bs	***1.49 (1.22, 1.82)	***1.48 (1.21, 1.81)	***1.49 (1.22, 1.82)
Cs	***2.20 (1.72, 2.80)	***2.19 (1.72, 2.79)	***2.20 (1.74, 2.84)
Ds	***6.40 (4.71, 8.70)	***6.36 (4.68, 8.65)	***6.44 (4.73, 8.75)
Peer smoking			
Yes	***2.63 (2.21, 3.13)	***2.62 (2.20, 3.12)	***2.63 (2.21, 3.13)
No	1.00	1.00	1.00
Hopelessness	***1.79 (1.50, 2.12)	***1.79 (1.50, 2.12)	***1.77 (1.49, 2.10)
School and school-neighborhood variables			
Urban	--	0.81 (0.59,1.13)	0.87 (0.63,1.19)
Mean parent education	--	0.94 (0.79,1.12)	0.95 (0.79,1.14)
Tobacco retailers density	--	1.04 (0.92,1.18)	1.01 (0.89,1.14)
County variables			
Income inequality[a]			
Quartile 1 (low)	--	--	1.00
Quartile 2	--	--	*1.32 (1.04, 1.68)
Quartile 3	--	--	*1.33 (1.02, 1.75)
Quartile 4 (high)	--	--	**1.69 (1.23, 2.33)
Percentage population below poverty		--	0.99 (0.97, 1.02)
Random-effects parameters			
County standard deviation	0.12	0.10	< 0.000001
School standard deviation	0.23	0.25	0.21
Model comparison		[b] χ(3)= 2.29 p= 0.5147	[c] χ (4)= 11.10 p= 0.0255

* $p \leq 0.05$

** $p \leq 0.01$

*** $p \leq 0.001$

[a] Joint significance tests performed for race/ethnicity, grade point average and income inequality for each model. All tests $p \leq 0.001$

[b] The student plus school level model was compared with the student level model using the likelihood chi-squared statistic

[c] The full model was compared with the school level model using the likelihood chi-squared statistic

Table 3

Multilevel logistic regression for experimental smoking (N=20,203)

	Odds Ratio (95% Confidence Interval)		
	Experimental smoking		
	Student level Model	**Student + School Model**	**Full Model**
Student variables			
Age (years)	***1.17 (1.13, 1.22)	***1.17 (1.13, 1.22)	***1.17 (1.13, 1.22)
Gender			
Male	1.09 (0.97, 1.23)	1.09 (0.97, 1.23)	1.09 (0.97, 1.23)
Female	1.00	1.00	1.00
Race/ethnicity[a]			
White	1.00	1.00	1.00
Hispanic/Latino	1.08 (0.94, 1.24)	0.98 (0.84, 1.14)	0.98 (0.84, 1.14)
African American	**0.71 (0.54, 0.92)	**0.66 (0.51, 0.87)	**0.66 (0.50, 0.86)
Asian/Pacific Islander	0.83 (0.68, 1.01)	*0.78 (0.64, 0.96)	*0.78 (0.64, 0.96)
American Indian/Alaskan Native	1.21 (0.77, 1.90)	1.18 (0.75, 1.85)	1.18 (0.75, 1.85)
Grade point average[a]			
As	1.00	1.00	1.00
Bs	***1.62 (1.41, 1.87)	***1.61 (1.40, 1.85)	***1.61 (1.40, 1.85)
Cs	***2.45 (2.07, 2.90)	***2.42 (2.04, 2.86)	***2.42 (2.04, 2.86)
Ds	***4.30 (3.41, 5.41)	***4.21 (3.35, 5.30)	***4.22 (3.35, 5.31)
Peer smoking			
Yes	***2.40 (2.13, 2.71)	***2.40 (2.12, 2.71)	***2.40 (2.12, 2.71)
No	1.00	1.00	1.00
Hopelessness	***1.84 (1.63, 2.08)	***1.84 (1.63, 2.07)	***1.84 (1.63, 2.07)
School and school-neighborhood variables			
Urban	--	1.19 (0.92,1.54)	1.19 (0.92,1.55)
Mean parent education	--	*0.89 (0.79,0.99)	*BL1* 0.88 (0.78,1.00)
Tobacco retailers density	--	*1.09 (1.01,1.18)	*BL2* 1.09 (1.00,1.19)
County variables			
Income inequality[a]			
Quartile 1 (low)	--	--	1.00
Quartile 2	--	--	0.95 (0.81, 1.13)
Quartile 3	--	--	1.03 (0.85, 1.25)
Quartile 4 (high)	--	--	1.00 (0.80, 1.26)
Percentage population below poverty	--	--	1.00 (0.98, 1.02)
Random-effects parameters			
County standard deviation	0.04	< 0.000001	< 0.000001
School standard deviation	0.23	0.19	0.19
Model comparison		[b] χ (3)= 15.95 p=0.0012	[c] χ(4)= 0.89 p=0.9253

*$p \leq 0.05$

**$p \leq 0.01$

***$p \leq 0.001$

BL1 Borderline significance at p1=0.055

BL2 Borderline significance at p2=0.058.

[a] Joint significance tests performed for race/ethnicity, grade point average and income inequality for each model. All tests $p \leq 0.01$

[b] The student plus school level model was compared with the student level model using the likelihood chi-squared statistic

[c] The full model was compared with the student plus school level model using the likelihood chi-squared statistic

Table 4

The "Full" multilevel regression model for established smoking from Table 2 stratified by gender, race/ethnicity and urban or rural school setting

	Odds Ratio (95% Confidence Interval) [a]							
	Male	**Female**	**White**	**Hispanic/Latino**	**African American**	**Asian/Pacific Islander**	**Urban**	**Rural**
Sample size	9275	10928	8871	6432	1354	3208	*18357*	*1846*
County variables								
Income inequality [b]								
Quartile 1 (low)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Quartile 2	**1.64 (1.19,2.25)	1.02 (0.73,1.41)	*1.40 (1.07,1.84)	0.96 (0.56,1.66)	1.44 (0.42,4.93)	1.57 (0.67, 3.67)	*BL1*1.27 (0.98,1.65)	2.00 (0.97,4.11)
Quartile 3	1.35 (0.94,1.95)	1.34 (0.93,1.92)	1.36 (0.99,1.88)	1.26 (0.70,2.26)	1.59 (0.49,5.16)	1.47 (0.58, 3.74)	*BL2*1.30 (0.98,1.73)	1.87 (0.59,5.95)
Quartile 4 (high)	***2.01 (1.45,3.23)	1.17 (0.73,1.88)	**1.78 (1.20,2.64)	1.70 (0.93,3.11)	1.25 (0.23,6.69)	1.79 (0.64, 5.06)	***1.81 (1.28,2.57)	1.75 (0.62,4.90)
Percentage population below poverty	1.01 (0.97,1.04)	0.99 (0.95,1.02)	1.0 (0.98,1.04)	*0.95 (0.91,0.99)	1.01 (0.89,1.16)	1.01 (0.94,1.09)	0.99 (0.97,1.02)	0.97 (0.87,1.07)
Random-effects parameters								
County standard deviation	< 0.000001	< 0.000001	< 0.000001	< 0.000001	0.13	< 0.000001	< 0.000001	< 0.000001
School standard deviation	0.15	< 0.000001	< 0.000001	< 0.000001	0.49	0.37	0.20	0.17

* $p \leq 0.05$

** $p \leq 0.01$

*** $p \leq 0.001$

BL1 Borderline significance at p=0.068

BL2 Borderline significance at p=0.072.

[a] All models adjusted for student and school level covariates

[b] Joint significance tests performed for income inequality for each model. For males, white race/ethnicity and urban areas all tests $p \leq 0.05$