Does one cigarette make an adolescent smoker, and is it influenced by age and age of smoking initiation? Evidence of association from the U.S. Youth Risk Behavior Surveillance System (2011)

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ABSTRACT

Objectives. Evidence that age of smoking initiation represents a risk factor for regular smoking in adolescence is complicated by inconsistencies in the operational definition of smoking initiation and simultaneous inclusion of age as an explanatory variable. The aim of this study was to examine the relationship between age, age of smoking initiation and subsequent regular smoking.

Methods. A secondary analysis was conducted of the U.S. Youth Risk Behavior Survey 2011. A sex stratified multivariable logistic regression analysis was used to model the likelihood of regular smoking with age and age of smoking initiation as explanatory variables and race/ethnicity as a covariate.

Results. After controlling for race/ethnicity, age and age of smoking initiation were independently associated with regular smoking in males and females. Independent of age, a one year's decrease in the age of smoking initiation was associated with a 1.27 times increase in odds of regular smoking in females (95% CI: 1.192–1.348); and similar associations for males (OR: 1.28; 95% CI: 1.216–1.341).

Conclusion. While the majority of high school students do not become regular smokers after initiating smoking, earlier initiation of smoking is associated with subsequent regular smoking irrespective of sex or race/ethnicity. These findings have potentially important implications for intervention targeting.

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Introduction

Smoking remains a major cause of mortality in the U.S. and preventing people from becoming smokers remains a key tobacco control strategy (Chen et al., 2012; Farrelly et al., 2013; Oza et al., 2011). One suggested risk factor for becoming a regular smoker is the age at which one first tries smoking — i.e., smoking initiation (Elders et al., 1994; Lantz, 2003). The idea behind the relationship between regular smoking and the age of smoking initiation relies on (contested) research showing that very small levels of exposure to nicotine in children can result in a "loss of autonomy" (Dar and Frenk, 2010; Difranza, 2010; DiFranza et al., 2000, 2007; Reidpath et al., 2013; Soteriades et al., 2011). Establishing the validity of the relationship is important because it is used to argue for resource allocation and the targeting of interventions (Soteriades et al., 2011).

Interpreting the evidence on the age of smoking initiation as a risk factor for subsequent regular smoking in population data is complicated by inconsistencies in the operational definition of smoking initiation (Reidpath et al., 2013). Definitions have included the first time a person

smoked, "*part of a cigarette*" (Bohnert et al., 2009); the first time they smoked, "*a whole cigarette*" (CDC, 2011; Chen and Unger, 1999), and the first time they tried even, "*one or two puffs of a cigarette*" (WHO and CDC, 2008). Smoking, "a whole cigarette", "part of a cigarette", or having, "a puff" of a cigarette implies very different kinds of events, and the heterogeneity of definitions carries the risk of different conclusions being drawn about smoking initiation from the same data (Reidpath et al., 2013).

Surprisingly, there is little population based research that looked explicitly at the relationship between age of initiation and subsequent smoking behavior. An exception to this is a study by Everett et al. (1999) using 1991–1997 US, Youth Behavioral Risk Surveillance (YBRS) data. They found that a 16–18 year old who had initiated smoking at the age of 8 had an odds 2.2 times greater of being a current daily smoker than a 16–18 year old who initiated smoking at the age of 13 or 14 (p. 330). The study by Everett et al., however, did not control for age in the analysis.

One recent attempt to look at age and age of smoking initiation was a secondary analysis of Global Youth Tobacco Survey (GYTS) data from 13 to 15 year old students in three European countries (Reidpath et al., 2013). That study found a somewhat uncertain relationship between the age of smoking initiation and subsequent smoking behavior. In Latvia, which had the highest smoking prevalence, a relationship was

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found in females between one year's decrease in the age of initiation and regular smoking for "smoking every day over the past 30 days" and for "smoking at least 10 days over the past 30 days" (OR: 1.16 and 1.13 respectively). In males the relationship was only found for "smoking every day the past 30 days" (OR: 1.09). In contrast, in Montenegro and Slovenia, which both had lower smoking prevalence, there was no significant relationship.

The GYTS, however, uses, "*one or two puffs of a cigarette*" as the measure of smoking initiation. This is the lowest threshold for marking smoking initiation in population surveys, and the lack of a significant relationship in two of the countries may say more about the operational definition of smoking initiation than it does about the relationship between age of smoking initiation and subsequent regular smoking in adolescence.

For a head-to-head comparison of smoking initiation measures, different measures are needed within the same survey. Unfortunately, these do not appear to exist within the same dataset. The U.S. Youth Risk Behavior Survey (YRBS) 2011, however, does ask similar questions to the GYTS about smoking initiation and regular smoking, but uses the stronger marker of smoking initiation — the age at which an adolescent first smoked *a whole cigarette*. While not ideal, these data do provide a point of contrast against the GYTS data, and allow for a further examination of the effect of the age at which an adolescent initiates smoking and subsequent smoking behavior. It was the main aim of the current work, therefore, to quantify the relationship between age of initiation (using the stronger marker of smoking initiation) and regular smoking, using the YRBS 2011 data.

Methods

The study relied on a secondary analysis of data from the YRBS 2011 — a school-based survey established by U.S. Centers for Disease Control and Prevention (CDC) (Brener et al., 2004, 2013; Eaton et al., 2012). The YRBS 2011 used a three-stage, stratified, cluster design to produce a nationally representative sample of high school students in grades 9 to 12 attending both public and private schools (Eaton et al., 2012). The survey collected self-report data on a range of risk factors including tobacco use and consumption. The public use dataset of the YRBS 2011 was downloaded from the CDC website (http://www.cdc.gov/healthyyouth/yrbs/data/index.htm). The data included individual responses to the tobacco use and consumption-related questions, limited demographic variables, as well as the variables to support a design-based analysis (primary sampling unit, stratum, and design weights).

Sample

The YRBS 2011 sampled a total of 15,425 high school students (49.97% female and 50.03% male). The focus in this study was on a sub-group analysis of respondents who had initiated smoking; that is, they responded to the question, "How old were you when you smoked a whole cigarette for the first time?" Students with no response or responding, "I have never smoked a whole cigarette" were excluded from the analysis. The sub-group analysis was based on a sample of 4913 students (53.9% male and 46.1% female) ranging in age from 12 or younger to 18 or older (mean = 16.3).

Outcome variables

Following the approach of the earlier study of smoking initiation (Reidpath et al., 2013), two dichotomous outcome variables were created representing levels of regular smoking: students who had smoked everyday in the last 30 days (Everyday); and students who had smoked for at least 10 days in the last 30 days (At least 10 days). These were derived from the possible categorical responses: "0 days", "1 or 2 days", "3 to 5 days", "6 to 9 days", "10 to 19 days", "20 to 29 days", or "All 30 days". The "At least 10 days" outcome maintained comparability with the previous study of age of smoking initiation and regular smoking (Reidpath et al., 2013), and balanced the available ordered

categories against capturing students who were regular smokers but who may not have smoked everyday.

Explanatory variables

Sex, age in years, and age of smoking initiation of respondents were used as explanatory variables. The age and sex of respondents were taken unadjusted from the YRBS 2011.

The estimated continuous age of smoking initiation was assumed to be the greatest age possible from among the categorical responses to, "How old were you when you smoked a whole cigarette for the first time?" Possible response categories were: "I have never smoked a whole cigarette", "8 years old or younger", "9 or 10 years old", "11 or 12 years old", "13 or 14 years old", "15 or 16 years old", or "17 years old or older".

Respondents in the, "8 years old or younger" category were assumed to be 8 years of age at the time of smoking initiation. Similarly, respondents in the, "15 or 16 years old" category were assumed to have initiated smoking when they were 16, unless their self-reported age was 15, in which case the age of smoking initiation was treated as 15. The greatest possible age was selected because it provided the most conservative estimate of the effect of early initiation.

Smoking initiation was operationalized as the smoking of a whole cigarette. Both outcome variables required a student to have smoked more than one cigarette, so it was not possible that the moment of smoking initiation was also the moment that a student was counted as having established regular smoking in the outcome variables; although it was possible that initiation and regular smoking did occur in the same month.

Race/ethnicity was treated as a covariate. It was categorized according to the YRBS 2011 survey, collapsing small cells into an 'Other' category. The categories were Hispanic, White, Black, Hispanic + (Hispanic/Latino plus another racial/ethnic group), non-Hispanic + (more than one racial/ethnic group, but not Hispanic/Latino), and Other.

Statistical analysis

A design-based analysis was conducted to ensure that correct standard errors were estimated (Lumley, 2010). Multivariable logistic regression stratified by sex was used to model the likelihood of smoking reported in the previous 30 days with age and age of smoking initiation as explanatory variables with race/ethnicity as a covariate. Data analysis was conducted in the R statistical environment (R Core Team, 2013), using the "survey" package (Lumley, 2010), to take account of the PSU, strata, and probability weights (CDC, 2012).

Example probability curves from the modeled results of regular smoking were also generated (Fig. 1). Probabilities of regular smoking given race, age, age of smoking initiation, and sex may be calculated from the inverse logistic function: $e^{X\beta} / (1 + e^{X\beta})$; where β is a vector parameters estimated, and X is a matrix of elements representing levels of the explanatory variables.

Results

Descriptive statistics for the unweighted and weighted samples are shown in Table 1.

In the weighted sample, the prevalence of smoking everyday in the last 30 days was 13.9%, and smoking at least 10 days in the last 30 was 24.3%. The average age of smoking initiation was 13.7 years.

Table 2 shows the bivariable relationships between the explanatory variables and the covariates, and the two smoking outcome variables.

The odds of males smoking in at least 10 of the last 30 days were 1.2 greater than females (95%CI: 1.01–1.40); but the odds were no greater for smoking everyday in the last 30 days. Smoking was also strongly associated with race/ethnicity. Every group was significantly less likely to