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# The Continuum-of-Addiction: Cigarette Smoking in Relation to Price Among Americans Aged 15–29

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## SUMMARY

We studied the relationship between current cigarette smoking and price among 34,145 respondents, aged 15–29 years, to the 1992–1993 Tobacco Use Supplements to the Current Population Survey. The price elasticity of current smoking varied inversely with age: -0.831 (standard error 0.402) for ages 15–17; -0.524 (st. err. 0.256) for ages 18–20; -0.370 (st. err. 0.188) for ages 21–23; -0.202 (st. err. 0.175) for ages 24–26; and -0.095 (st. err. 0.157) for ages 27–29. In response to higher prices, older youth were more likely to reduce the number of cigarettes smoked per day than to quit entirely. Among 15-to-17-year-olds, smoking cigarettes "some days" was more sensitive to price than smoking "every day." Cigarette smoking was inversely related to the prices of premium brands, but not discount brands.

**KEY WORDS:** tobacco, addiction, prevention and public health policy

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## INTRODUCTION

We posited a continuum-of-addiction model of the onset of cigarette smoking. In such a model, children, adolescents and young adults progress through a sequence of stages: trying one cigarette; experimenting with cigarettes; regular smoking; and ultimately nicotine dependence. At each successive stage, symptoms of withdrawal become more pronounced and successful quitting becomes less likely [1].

Based upon the continuum-of-addiction model, we hypothesized that: (a) among adolescents and young adults, the price-sensitivity of demand for cigarettes declines with increasing age; (b) among the youngest smokers, those who have not yet smoked every day are the most price-sensitive; and (c) when faced with higher cigarette prices, adolescent smokers are less likely to progress to regular, daily cigarette use, while young adult smokers are more likely to try to reduce the number of cigarettes smoked. Since young persons in the U.S. are known to prefer brand-name cigarettes to discount or no-name brands [2], we further hypothesized that: (d)

the demand for cigarettes among young people is more responsive to the price of premium brands than discount brands.

## DATA AND METHODS

We extracted the records of 77,475 respondents, aged 15 to 29, to the combined September 1992, January 1993, and May 1993 Tobacco Use Supplements (TUS) to the Current Population Survey [3]. Of these respondents, 41,396 (or 53.4%) resided in one of 47 metropolitan statistical areas for which we had monthly data on the average retail prices of cigarettes. The price data, derived from bar-code scanning of sales in large food stores in each market, included average retail prices for all brands, premium brands, and discount brands [4]. In a subset of 22 markets, we also had data on the average retail prices of deep-discount and generic brands.

We defined a current smoker as a respondent who answered "yes" to the question "Have you smoked at least 100 cigarettes in your life?" and who answered "every day" or "some days" to the question "Do you now smoke cigarettes every day, some days, or not at all?" To assess variations in the effect of price at different ages, we partitioned our sample into five age groups: 15–17 years; 18–20 years; 21–23 years; 24–26 years; and 27–29 years. For each age group, we separately estimated a discrete-choice, probit model where the probability of current smoking depended on price, sex, single year of age, race, ethnicity, education, income, whether respondent was still in school, and proxy versus self-response. In total, we had 34,145 complete observations on smoking status and all right-hand-side (RHS) variables.

In each age group, among respondents who reported smoking every day, we also estimated ordinary least squares regressions in which the natural logarithm of the number of cigarettes smoked per day depended linearly on price and the same RHS variables. In both probit and log-linear equations, the sampling weights provided in the TUS were used. In the probit equations, price elasticities were computed at the sample means of the independent variables. Asymptotic standard errors were computed by the delta method.

## RESULTS

The probability of current smoking was inversely related to both price and family income (Table 1). The absolute value of price elasticity declined with increasing age (Figure 1). A generalized least squares regression of price elasticity versus age across the five age groups yielded an absolute decline of 0.053 per year (st. err. 0.0058, $P = 0.003$). While the elasticity of current smoking declined in absolute value with age, the conditional price elasticity of number of cigarettes smoked per day rose in absolute value with age. Overall, the combined price elasticity fell with age (Table 2).

**Table 1. Probit Analyses of Current Cigarette Smoking by Age Group[a]**

| | Age Group | | | | |
|---|---|---|---|---|---|
| Independent Variable | 15–17 | 18–20 | 21–23 | 24–26 | 27–29 |
| Price, All Brands ($/pack) | -0.0239 | -0.0412 | -0.0426 | -0.0243 | -0.0124 |
| | (0.0115) | (0.0201) | (0.0217) | (0.0210) | (0.0206) |
| Age Indicator #1[b] | -0.0607 | -0.0461 | -0.0517 | -0.0168 | -0.0063 |
| | (0.0068) | (0.0116) | (0.0123) | (0.0121) | (0.0120) |
| Age Indicator #2[b] | -0.0355 | -0.0154 | -0.0319 | -0.0044 | 0.0075 |
| | (0.0059) | (0.0112) | (0.0119) | (0.0121) | (0.0118) |
| Female Sex | -0.0100 | -0.0315 | -0.0451 | -0.0328 | -0.0505 |
| | (0.0056) | (0.0097) | (0.0104) | (0.0101) | (0.0098) |
| Hispanic Origin | -0.0518 | -0.1359 | -0.1730 | -0.1781 | -0.1854 |
| | (0.0047) | (0.0084) | (0.0103) | (0.0102) | (0.0103) |
| Black | -0.0649 | -0.1420 | -0.1314 | -0.1093 | -0.0859 |
| | (0.0045) | (0.0083) | (0.0108) | (0.0114) | (0.0117) |
| Asian or Pacific Islander | -0.0367 | -0.0984 | -0.0725 | -0.1111 | -0.0804 |
| | (0.0081) | (0.0157) | (0.0250) | (0.0228) | (0.0250) |
| Highest Grade Attained | -0.0077 | -0.0326 | -0.0435 | -0.0392 | -0.0384 |
| | (0.0028) | (0.0031) | (0.0027) | (0.0023) | (0.0022) |
| Family Income < $25,000 | 0.0422 | 0.0407 | 0.0399 | 0.0361 | 0.0834 |
| | (0.0083) | (0.0122) | (0.0121) | (0.0114) | (0.0119) |
| Family Income $50,000+ | -0.0192 | -0.0129 | -0.0224 | -0.0333 | -0.0373 |
| | (0.0063) | (0.0125) | (0.0147) | (0.0145) | (0.0131) |
| School as Major Activity[c] | -0.0554 | -0.1094 | -0.0994 | -0.0799 | -0.0403 |
| | (0.0107) | (0.0101) | (0.0126) | (0.0187) | (0.0275) |
| Proxy Respondent | -0.0289 | -0.0724 | -0.0731 | -0.0549 | -0.0341 |
| | (0.0055) | (0.0097) | (0.0111) | (0.0118) | (0.0123) |
| Predicted Probability of Smoking at Sample Mean | 0.054 | 0.147 | 0.216 | 0.225 | 0.245 |
| Number of Observations | 6,210 | 5,713 | 6,748 | 7,295 | 8,179 |

**Notes to Table 1:**

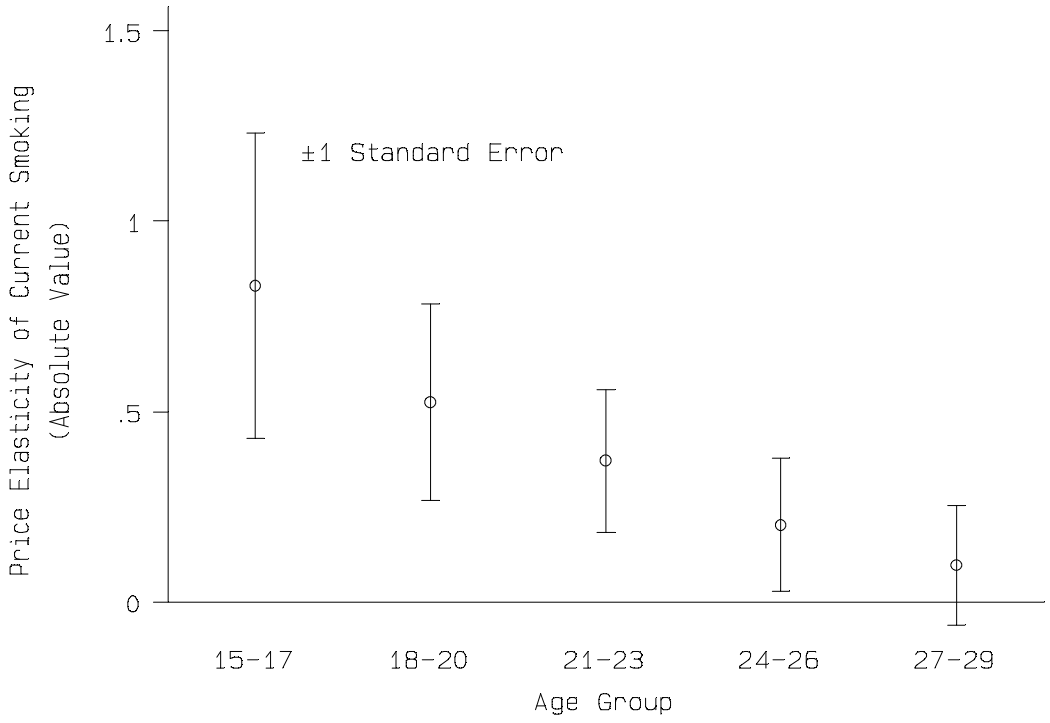
a. Coefficients represent the effect of a change in each independent variable on the probability of current smoking, evaluated at the sample means of all right-hand-side variables. For each continuous right-hand-side variable $x_i$ (i.e., Price and Highest Grade Attained), this represents the first partial derivative $\partial F/\partial x_i$ of the normal cumulative distribution function $F$. For the remaining binary right-hand-side variables, it represents the effect on $F$ of a discrete change in each variable $x_i$. All standard errors, reported in parentheses under each coefficient, were estimated by the delta method.

b. Indicator variables for the first two years of each three-year age group, e.g., ages 15 and 16 for the group aged 15–17.

c. Those who answered "Going to school" in response to "What were you doing most of last week?"

Fig. 1. Price Elasticity of Current Cigarette Smoking by Age Group.




In some probit analyses and conditional regressions on the 15-to-17-year-old sample, our explanatory variables included indices of the degree of state or local governmental restrictions on youth cigarette access, including bans on smoking in schools, bans on cigarette sampling, and restrictions on vending machine sales [5]. None of these variables had a significant negative effect at the 10-percent significance level. (Results not shown.) They were therefore dropped from the multivariate models reported here.

We estimated the same probit equations as in Table 1 with two different dependent variables: the probability of currently smoking cigarettes "some days" only; and the probability of currently smoking cigarettes "every day" only. The probability of smoking "some days" appeared highly sensitive to price among 15-to-17-year-olds, but not in the older age groups. Thus, among 15-to-17-year-olds, the price elasticity of smoking some days was -1.854 (st. err. 0.711), while the price elasticity of smoking every day was -0.304 (st. err. 0.501). Among 18-to-20-year-olds, the price elasticity of smoking some days was -0.155 (st. err. 0.534), while the price elasticity of smoking every day was -0.596 (st. err. 0.304).

**Table 2. Estimated Price Elasticities by Age Group[a]**

| Age Group | Current Smoking | Cigarettes per Day | Combined |
|---|---|---|---|
| 15-17 | -0.831 | -0.165 | -0.996 |
| | (0.402) | (0.276) | (0.487) |
| 18-20 | -0.524 | -0.255 | -0.779 |
| | (0.258) | (0.165) | (0.306) |
| 21-23 | -0.370 | -0.274 | -0.644 |
| | (0.188) | (0.184) | (0.263) |
| 24-26 | -0.202 | -0.455 | -0.657 |
| | (0.175) | (0.120) | (0.212) |
| 27-29 | -0.095 | -0.234 | -0.329 |
| | (0.157) | (0.107) | (0.190) |

Notes to Table 2:

a. Standard errors, computed by delta method, shown in parentheses below each estimate.

In addition, we estimated probit equations and conditional regressions with two alternate price variables: the average price of premium-brand cigarettes and the average price of discount cigarettes. When each of these prices was entered separately as an independent variable, the premium-brand price elasticity was consistently higher than the all-brand elasticity, while the discount price elasticity was lower and not statistically significant (Table 3, "Separate Equations"). When both prices were included as independent variables in the same equation, the estimated coefficients of the discount prices were mostly positive and statistically significant (Table 3, "Single Equation"). The positive relation between price and consumption was most marked in our analyses of subsamples of low-income youth, especially when the average price of all discount cigarettes was replaced by average price of deep-discount and generic brands. (Results not shown.)

Table 3. Estimated Price Elasticities for Premium-Brand and Discount Prices[a]

| Age Group (years) | Dependent Variable | Independent Price Variable(s) | | | |
|---|---|---|---|---|---|
| | | Separate Equations | | Single Equation | |
| | | Premium | Discount | Premium | Discount |
| 15-17 | Current Smoking | -1.023 | -0.553 | -1.069 | 0.041 |
| | | (0.517) | (0.366) | (0.836) | (0.591) |
| | Cigarettes per Day | -0.237 | -0.152 | -0.151 | -0.069 |
| | | (0.371) | (0.247) | (0.668) | (0.445) |
| 18-20 | Current Smoking | -0.735 | -0.091 | -1.601 | 0.799 |
| | | (0.328) | (0.236) | (0.526) | (0.376) |
| | Cigarettes per Day | -0.410 | -0.057 | -0.987 | 0.504 |
| | | (0.217) | (0.153) | (0.366) | (0.258) |
| 21-23 | Current Smoking | -0.529 | -0.059 | -1.106 | 0.563 |
| | | (0.236) | (0.175) | (0.364) | (0.270) |
| | Cigarettes per Day | -0.492 | -0.104 | -1.070 | 0.525 |
| | | (0.176) | (0.129) | (0.295) | (0.216) |
| 24-26 | Current Smoking | -0.297 | 0.069 | -0.911 | 0.577 |
| | | (0.222) | (0.162) | (0.350) | (0.254) |
| | Cigarettes per Day | -0.550 | -0.320 | -0.524 | -0.023 |
| | | (0.156) | (0.110) | (0.267) | (0.187) |
| 27-29 | Current Smoking | -0.123 | 0.178 | -0.716 | 0.575 |
| | | (0.199) | (0.146) | (0.305) | (0.224) |
| | Cigarettes per Day | -0.427 | -0.114 | -0.808 | 0.346 |
| | | (0.138) | (0.099) | (0.225) | (0.162) |

Notes to Table 3:

a. Standard errors, computed by delta method, shown in parentheses below each estimate.

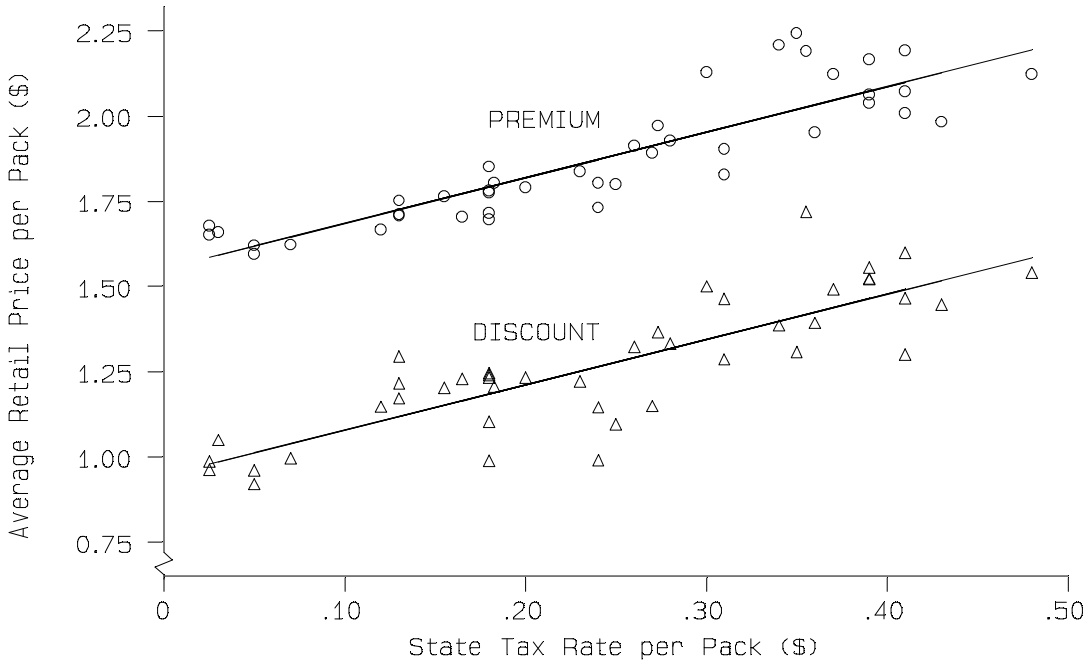
Figure 2 shows how premium-brand and discount cigarette prices varied in relation to state cigarette excise tax rates among the metropolitan areas in our study. The least squares regression lines in the Figure (with standard errors in parentheses) were:

PREMIUM PRICE = 1.552 + 1.336 ∗ TAX RATE $R^2 = 0.79$
(0.030) (0.109)

DISCOUNT PRICE = 0.945 + 1.332 ∗ TAX RATE $R^2 = 0.70$
(0.037) (0.135)

**Fig. 2. Premium-Brand and Discount Cigarette Prices in Relation to State Tax Rates, November 1992.**




## DISCUSSION

Our results confirm previous reports [6–8] that price-responsiveness of smoking varies inversely with age. Our estimate of -0.831 (standard error 0.402) for the price elasticity of smoking "some days" or "every day" among 15-to-17-year-olds (Table 1) is consistent with a recent estimate of -0.675 (range, -0.376 to -0.923) for the price elasticity of smoking within the past thirty days among students in eighth, tenth and twelfth grades [9]. Likewise, our estimated participation price elasticity of -0.524 (st. err. 0.258) for 18-to-20-year-olds accords with estimates in the range of -0.520 to -0.536 for college students' use of cigarettes within the past thirty days [10]. Public health policy needs to consider the impact of price increases on the number of experimenting smokers, and not just the number of young people who smoke every day.

Our findings suggest that nicotine addiction is acquired and reinforced over an extended time period, starting in the teenage years and continuing at least through the mid-to-late twenties. Each successive age group in our cross-sectional analysis gives us a different snapshot along this continuum of increasing addiction. In a young experimenter, whose "stock of addictive capital" is relatively low, an increase in price can result in an abrupt, permanent shift to a new, non-smoking lifetime trajectory [11–13]. As the smoker's addictive stock grows, however, an increase in price is more likely to cause only a marginal reduction in the number smoked. At the youngest ages, the impact of a change in price may also be amplified by bandwagon effects.

We observed that family income was inversely related to cigarette consumption (Table 1). Others [14,15] have reported smoking to be an inferior good. When both premium-brand and discount prices were independent variables in the same equation, we found that discount prices were positively related to consumption (Table 3). For the majority of young smokers who consume premium brands [2], this finding indicates that discount brands are gross substitutes for premium brands. Still, it is possible that for some low-income youth, deep-discount and generic cigarettes are Giffen goods.

Some authors [16] have suggested that the apparent deterrent effect of higher prices on youth smoking may actually reflect the influence of other, hard-to-measure factors that may be correlated with price. In particular, they posit that states with stronger anti-smoking sentiment are more likely to raise cigarette taxes. Since state taxes apply equally to all cigarettes sold (Figure 2), such a theory would require that youth smoking be inversely related to the prices of both premium and discount brands, a prediction that runs counter to our findings (Table 3).

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