Cigarette Prices, Smoking, and the Poor: Implications of Recent Trends

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The remarkable decline in cigarette smoking over the past 40 years has been more marked in higher- than in lower-income persons, creating a sizeable income-based disparity. Contributors to the overall decline include increasing public awareness of the dangers of smoking, changing societal views about smoking, public health tobacco-control programs, and rising excise taxes on tobacco. The role of cigarette excise taxes, “passed through” to consumers as higher cigarette prices, remains both controversial and salient to income-based disparities in smoking participation.

Earlier studies from the United States and United Kingdom suggest that lower-income individuals are more sensitive than are higher-income individuals to cigarette pack prices, implying that, for a given increase in cigarette price, more lower- than higher-income individuals would stop smoking cigarettes. If this were so, then the substantial increases in cigarette pack prices of recent years should stop smoking cigarettes. If higher quit rates in response to rising cigarette prices, remains both controversial and salient to income-based disparities in smoking participation.

Yet observational studies from the United States and United Kingdom and other developed countries suggest that the gap in smoking participation between lower- and higher-income groups has not lessened and may be widening. Furthermore, a second grouping of econometric studies from the United States and United Kingdom and elsewhere have found that smokers in general and low-income smokers in particular may be relatively insensitive to cigarette pack prices. Thus, rising cigarette taxes may represent a particular burden for low-income persons who continue to smoke.

The contradictory nature of these 2 groupings of studies is striking and not satisfactorily explained. We therefore sought to examine the relationship between cigarette pack price and smoking participation to inform future tobacco-control policy aimed at lessening income-based disparities in smoking. We analyzed data from 1984 to 2004 drawn from the Behavioral Risk Factor Surveillance System (BRFSS), a large, nationally representative telephone survey that includes data on smoking participation among adults, and The Tax Burden on Tobacco, an annual compendium that includes cigarette tax and price data. In our analyses, we included data collected for 14 years before and 6 years after the tobacco Master Settlement Agreement (MSA) of 1998. Data from the period after the MSA has been limited in prior studies, yet this data may be helpful in reconciling the studies’ disparate findings—the dramatic rise in cigarette pack prices around the time of the MSA represents a natural experiment in the possible effects of price on smoking. Thus, we examined the adjusted relationship between price and smoking participation by income group (<25th percentile vs ≥25th percentile) and by time period (before vs after the MSA).

METHODS

The BRFSS is an ongoing collaborative project of the Centers for Disease Control and Prevention and US states and territories that is designed to collect uniform, state-specific data on preventive health practices and risk behaviors. The BRFSS telephone-administered questionnaire includes questions about key personal health behaviors. The BRFSS uses a multistage cluster design based on random-digit dialing to select a representative sample from each state’s noninstitutionalized civilian residents aged 18 years or older. Data from each state may be pooled to produce nationally representative estimates, but not all questions are asked by all states each year. Detailed survey information is available at http://www.cdc.gov/brfss/index.htm.

We used data from the 1984 through 2004 BRFSS surveys, including sociodemographics.
health behaviors and prices have used cigarette price as our key independent variable. Participants (0.28%) with reported smoking participation as the dependent variable. Participants (0.28%) with missing smoking data were excluded.

Some studies on the relationship between health behaviors and prices have used cigarette taxes, instead of total pack price, although this approach is controversial. Because of our interest in possible consequences of the MSA, which was associated with large increases in cigarette price but not cigarette taxes, we used cigarette price as our key independent variable. We used cigarette price in the state for the year preceding the year of data collection from the BRFSS (in constant 2004 dollars, adjusted for inflation according to the consumer price index). This information was obtained from the most recent volume of *The Tax Burden on Tobacco.* We used the cigarette pack price for the year before the data from the BRFSS survey, because smokers may take some time to respond to an increase in pack prices.

The covariates included were age in years; age sigmoid (to detect nonlinear relationships between smoking and age; age is the square of the deviation in age from the mean age to avoid collinearity with age variable); gender; race/ethnicity (categorized as non-Hispanic White, Hispanic, non-Hispanic Black, Other race, or Unknown); years of schooling (categorized as <9, 9–11, 12, 13–15, or ≥16 years completed); number of adults in the household; consumer price index; and household income. We also included dummy variables for each survey year (to adjust for national changes in information that pertained to smoking and attitudes toward smoking) and each state (to adjust for other state-level interventions, because state taxation is related to antismoking sentiment and smoking-related legislation).

In the BRFSS, income is coded as 1 of 6 to 8 ordered categories, with income categories being the same from year to year (although the distribution of persons in each category shifted toward higher categories each year). We converted the income categories into percentiles, assigning participants to the median percentile for the respective category for a given year. Thus, our income variable represented a relative measure of income in each year. We also included a Gini coefficient (a standardized measure of income inequality) for each year to adjust for the changing relative distribution of incomes by year. Participants with missing smoking (0.28%) and income (13.6%) data were excluded.

Because our focus was on the possible differential effect of cigarette pack price on smoking by income group and by time period, we conducted an initial analysis that included all participants with interaction terms between price and both income group (low income [lowest quartile] vs non–low, or high, income [all other quartiles]) and time period (before 1997 [pre-MSA] vs after [post-MSA]; 1997 was selected because this was the first year of a considerable price increase around the time of the MSA). Both interaction terms were statistically significant (P<.01), so we conducted 4 separate analyses stratified by income group and time period. We report the results of the logistic regression analyses as adjusted parameter estimates for the effects of price (together with the 95% confidence intervals [CIs]) as odds ratios, adjusted predicted marginal effects, and elasticities. The predicted marginal effect is the predicted probability of smoking at chosen levels of cigarette price, with other covariates set to their mean values for the included sample. The elasticity is the percentage change in the proportion of persons who smoke relative to the percentage change in cigarette price. Thus, an elasticity of −0.5 means that a 20% increase in price (from $2.00 to $2.40) is associated with a 10% decline in smoking participation (−0.10/0.20 = −0.50; i.e., smoking declines from 30% to 27%).

Because of ambiguities regarding the optimal analytic model, we explored several alternative approaches in a series of sensitivity analyses. These included using pack price at the year of the survey, lagged pack prices of up to 5 years before the survey, and cigarette tax instead of pack price. We also used cut points for income other than the 25th percentile and an analysis stratified by quartiles. In addition, we conducted an analysis that used year as a continuous variable and included an interaction term between price and year. An analysis that included interactions among all the key independent variables proved computationally prohibitive because of the large size of the data set and large number of variables.

RESULTS

Figure 1 shows the trends in smoking participation by income quartile over the study period. Although smoking declined over the 20-year period, the gaps in smoking participation among the income groups have widened. The proportion of lower-income persons smoking in the earlier time period (1984–1996) was 27.7%, increasing to 28.6% for the time period 1997–2004; for higher-income persons, smoking declined from 23.9% to 21.6%.

Superimposed on the smoking participation data is the average cigarette pack price. Pack prices increased throughout the study period, with a more marked price increase around the time of the MSA. In the earlier time period, the average price per pack was $2.24 versus $3.67 more recently. Visually, these summary data suggest that smoking participation was declining dramatically before the MSA, especially for higher-income persons, with no evident additional impact of the post-MSA increase in prices.

Table 1 summarizes the results of the logistic regression analyses that examined the adjusted relationships between cigarette prices and smoking participation (full results are available from the authors). In the earlier time period, the association (reported as an adjusted probability) between price and smoking is significant for both income groups, with a larger elasticity in the lower-income group (−0.45 vs −0.22 for the higher-income group). In terms of the adjusted marginal analysis, as the cigarette pack price increased from less than $2 to more than $3 in the earlier time period, smoking participation declined from 26% to 20% in the lower-income group and from 22% to...
Note. Data from the 1984–2004 Behavioral Risk Factor Surveillance System surveys and The Tax Burden on Tobacco.


<table>
<thead>
<tr>
<th></th>
<th>Lowest Income Quartile, AOR (95% CI)</th>
<th>All Other Income Quartiles, AOR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proportion smoking 1984–1996</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total sample, no.</td>
<td>266,682</td>
<td>777,382</td>
</tr>
<tr>
<td>Cigarette pack price, $</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;2</td>
<td>0.26 (0.25, 0.27)</td>
<td>0.22 (0.21, 0.22)</td>
</tr>
<tr>
<td>2–2.99</td>
<td>0.24 (0.23, 0.24)</td>
<td>0.21 (0.21, 0.21)</td>
</tr>
<tr>
<td>3–3.99</td>
<td>0.20 (0.18, 0.22)</td>
<td>0.19 (0.18, 0.20)</td>
</tr>
<tr>
<td>&gt;4</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Elasticity</td>
<td>–0.45 (–0.67, –0.22)</td>
<td>–0.22 (–0.35, –0.10)</td>
</tr>
<tr>
<td><strong>Proportion smoking 1997–2004</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total sample, no.</td>
<td>262,023</td>
<td>1,001,578</td>
</tr>
<tr>
<td>Cigarette pack price, $</td>
<td></td>
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</tr>
<tr>
<td>&lt;2</td>
<td>0.28 (0.25, 0.30)</td>
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</tr>
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<td>0.25 (0.23, 0.27)</td>
<td>0.18 (0.17, 0.19)</td>
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<tr>
<td>Elasticity</td>
<td>–0.14 (–0.36, 0.06)</td>
<td>–0.07 (–0.18, 0.05)</td>
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</table>

Notes. AOR = adjusted odds ratio; CI = confidence interval; NA = not applicable. Proportion smoking and elasticities (percentage change in the proportion of persons who smoke relative to the percentage change in cigarette price) were derived from logistic regression analyses adjusted for age, gender, race/ethnicity, education, number of adults in household, household income percentile, Gini coefficient, year, and state. Cigarette pack prices were gathered from The Tax Burden on Tobacco.

19% in the higher-income group. The adjusted odds ratio [AOR] for a 1-cent increase in cigarette pack price was 0.997 (95% CI=0.996, 0.998) for the lower-income group and 0.999 (95% CI=0.998, 0.999) for the higher-income group. In the later time period, the relationship between price and smoking was not statistically significant in the lower-income group (AOR=0.999; 95% CI=0.999, 1.00; $P=0.203$) or in the higher-income group (AOR=1.000; 95% CI=0.999, 1.000; $P=0.238$).

The sensitivity analyses produced results similar to those presented here; the analyses that used cigarette pack tax instead of cigarette pack price revealed greater differences between the 2 time periods. In the earlier time period, the elasticity for lower-income persons was $-0.07$ (95% CI=$-0.15$, 0.01; $P=0.08$), and for higher-income persons it was $-0.06$ (95% CI=$-0.10$, –0.01; $P=0.018$). In the more recent time period, the elasticity for lower-income persons was 0.00 (95% CI=$-0.07$, 0.07; $P=0.981$) and $-0.04$ (95% CI=$-0.07$, 0.00; $P=0.057$) for higher-income persons.

**DISCUSSION**

Our findings, which are based on analyses of nationally representative data collected before and after the 1998 MSA, suggest a
dramatic decline in the effect of cigarette pack prices on smoking participation in both lower- and higher-income individuals. These findings, in turn, suggest that cigarette excise taxation may have become an ineffectual public health tobacco-control policy in the post-MSA era.

In the period before the MSA (1985–1996), we found a statistically significant and public health policy–relevant effect of cigarette pack price on smoking, an effect that was greater for lower-income than for higher-income adults. Both findings are consistent with most prior studies that involved US samples from the era before the MSA. A single prior study of pre-MSA data reported no significant effect of cigarette pack price on smoking participation, but the wide confidence intervals around the point estimates in that study overlap with those observed here and elsewhere.

The post-MSA findings suggest a dramatic drop in price sensitivity for both lower- and higher-income persons. These findings are consistent with the only prior study that included post-MSA data. It is possible that we failed to detect an effect of cigarette pack price on smoking participation because the delay in impact of an increase in cigarette pack price may be longer than the 1-year lag we employed in our main analyses. However, analyses (not shown) that used pack price lags of up to 5 years produced similar results.

The reasons for the apparent declining price sensitivity of adult smokers are unclear. The declining sensitivity may reflect an outgrowth of the overall decline in smoking among US adults. According to National Health Interview Survey data, the prevalence of smoking in US adults has dropped from 42% in 1965 to 21% in 2004. With progressively lower smoking participation, remaining smokers are likely to be selectively more addicted to cigarettes than are smokers from earlier time periods and, thus, more insensitive to cigarette prices.

Regardless of such speculation, our findings suggest cigarette excise taxes may have become an increasingly ineffectual approach to tobacco control in the post-MSA era and have not helped reduce income-based disparities in smoking participation. The smoking participation gap may even be widening. In this context, increasing cigarette excise taxes appear to impose a particular burden on low-income persons who continue to smoke, and the burden for low-income persons may be quite significant. For example, at current prices, 2-pack-per-day smokers in a single low-income household may spend 25% or more of their income on cigarettes. To avoid aggravating this inequity, we believe public health tobacco-control measures other than increases in cigarette taxes, such as programs aimed at lessening barriers to quitting faced by low-income smokers, should be emphasized.

Limitations

This study has several limitations. The BRFSS included data only on adults aged 18 years or older, so we cannot comment on temporal trends in smoking and price sensitivity among adolescents, an important subgroup. The BRFSS data are also based upon participant self-report. There is likely some underreporting of smoking participation because of perceived social stigma, which may vary to unknown degrees by income level, by state, and over time. However, underreporting of smoking participation is unlikely to be as significant a problem as is the underreporting of cigarette consumption (e.g., number of cigarettes smoked per day). BRFSS data no longer include consumption data. Additionally, although smokers may reduce cigarette consumption in response to cigarette pack price, they may make offsetting health-threatening behavior changes, such as switching to higher tar and nicotine cigarettes. Thus, smoking participation is the key smoking behavior to address.

Further biases may have occurred, because rates of nonresponse to the BRFSS and its questions may differ by state, time period, income, and other sociodemographic factors. Also, the BRFSS is a telephone-based survey. People without telephones typically have low incomes and are thus more likely to smoke than those with telephones. Because of the way the BRFSS collects income data (restricted to household income in fixed income categories, with no adjustment for inflation), our treatment of income may have also produced some bias.

Finally, the pack prices derived from The Tax Burden on Tobacco are based on manufacturers’ listed retail prices. However, tobacco companies increasingly employ price-subsidizing promotions. Similarly, cigarette tax evasion and avoidance behaviors—such as switching from brand-name to generic cigarettes and purchasing cigarettes in adjoining states with lower taxes, on Indian reservations, from the Internet, or on the “black market” have become increasingly prevalent. Thus, the actual price consumers paid for cigarette packs in the more recent years of our BRFSS sample was often less than retail. Our finding of declining price sensitivity over time could, in part, stem from such bias. Stehr found that tax avoidance accounts for less than 10% of sales, so it is unlikely that avoidance accounts fully for the dramatic drop in price responsiveness we observed. The extent to which higher- and lower-income persons may differentially avoid paying retail prices is also debatable. However, it is noteworthy that the analysis that used taxes revealed a substantially lower elasticity for both income groups and also showed a decline in elasticity from the earlier to more recent time period, with possibly greater elasticity in the higher-income group.

Conclusions

The evidence suggests that increasing cigarette pack prices have not substantially contributed to reduction in disparities in smoking participation. Disparities may have increased as pack prices have increased. That the price of a product has risen despite an overall decline in demand for that product suggests that tobacco companies are responding, in part, to the demand from a remaining group of smokers who are price insensitive, probably because of addiction. This price-resistant group seems disproportionately concentrated among low-income persons. We believe that further significant increases in cigarette tax are likely to aggravate continuing inequities in our society, and through the economic burden associated with continued smoking participation of low-income persons, may result in other adverse health consequences. The evidence suggests that smoking participation declined significantly before the dramatic increase in prices (Figure 1). Thus, measures other than pricing are likely the major contributors to the decline in smoking participation. We conclude that such measures should continue to be strengthened. Additional efforts focused on those with low education and income levels should also be promoted to reduce the increasing disparity in smoking participation.
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Contributions

P. Franks originated the study, developed its design, conducted main analyses, and edited the article. A.F. Jerant developed the study design and had major responsibility for writing the article. J. P. Leigh developed the study design and had input into econometric modeling. D. Lee assisted with study design, assembled Behavioral Risk Factor Surveillance System data for analysis, and assisted with writing. A. Chien assisted with study design, assembled tobacco consumption data for analysis, and assisted with writing. I. Lewis and S. Lee assisted with study design, conducted literature review, and assisted with writing.

Human Participant Protection

Protocol approval was not required because the study used anonymous, publicly available data.

References

2. Leu RE. Anti-smoking publicity, taxation, and the impact of tobacco control program expenditures on ag-
3. Townsend J, Roderick P, Anderson LA. The effect of state cigarette tax increases on cigare-
35. Giovino GA, Schooley, MW, Zhu BP, et al. Surveil-

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Franks et al., Peer Reviewed | Research and Practice | 1877