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Socioeconomic status and cigarette expenditure among U.S. households: Results from 2010-2015 Consumer Expenditure Survey

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ABSTRACT

Objectives: To examine (1) the association between household socioeconomic status (SES) and whether a household spends money on cigarettes, and (2) socioeconomic variations in percentage of total household expenditure spent on cigarettes among smoking households.

Methods: We used data from six consecutive years, 2010-2015, of the Consumer Expenditure Interview Survey. The interviews involved a structured questionnaire to collect data on household income, demographics, and a complete range of expenditures including expenditure on cigarettes. Households that reported cigarette expenditure in the previous three months were distinguished as smoking households. SES indicators employed in this study were education and occupation of the head of household and household poverty status. Logistic regression was used to assess the association of household smoking status with SES. Linear regression was used to assess the association of cigarette expenditure as a percentage of total household expenditure with SES. The analysis sample size was 39,218.

Results: Overall, 17.4% of households reported expenditure on cigarettes. Among smoking households, the average quarterly expenditure on cigarettes in constant 2015 dollars was $458.1 and the average cigarette expenditure as a percentage of total household expenditure was 5.6%. Multivariable regression results showed that poorer households, those headed by a person with a lower level of education or lower occupational status were more likely to report cigarette expenditure and had a higher cigarette expenditure as a percentage of total household expenditure ($p < 0.001$ for all of the stated associations).

Conclusion: Lower SES households are more likely to spend money on cigarettes and spend a larger percentage of their total expenditure on cigarettes. We recommend enhanced efforts in increasing cigarette taxation, anti-smoking mass media campaigns, and smoking bans in public places, which are effective in reducing smoking among low SES smokers.

Strengths and limitations of this study:

- We used a national household survey representing the entire U.S. civilian noninstitutional population that involved a structured questionnaire to collect data on household income, demographics, and a complete range of expenditures.
- Conclusions are based on data from six consecutive years of national and comprehensive expenditure data with relatively high response rates and large sample sizes.
- The cross-sectional design does not allow for inferences about the effect of socioeconomic status on whether a household spends money on cigarettes or percent of household expenditure spent on cigarettes among smoking households.
- Very high-income households are less likely to respond to the survey as households in the CES were linked to zip-code level average income, however non-response rates were not associated with income over most of the income distribution.

INTRODUCTION

Smoking cigarettes not only causes numerous health conditions,[1] but also is associated with deleterious financial consequences and a lowered standard of living. For example, smokers compared to non-smokers are more likely to experience financial stress, defined as events such as going without meals or not being able to pay rent.[2] Similarly, among smokers, higher cigarette expenditure is associated with a higher probability of experiencing financial stress.[3] Furthermore, smokers who spend more on cigarettes are more likely to report "smoking-induced deprivation", measured by asking smokers whether "money … spent on cigarettes resulted in not having enough money for household essentials such as food." [3 4] There is also evidence that quitting smoking is associated with a subsequent reduction in the probability of experiencing financial stress[5 6] and an increased level of prosperity.[5]

One of the strong and persistent determinants of smoking behavior in developed countries is socioeconomic status (SES). [7-12] For example, in the United States (U.S.), in 2015, smoking prevalence among adults living below poverty line was nearly twice that of those at or above poverty line (26.1% versus 13.9%). Similarly, smoking prevalence among individuals aged 25 years or older ranged from 34.1% in persons with a high school diploma to 16.6% in those with an associate degree to only 3.6% in those with a graduate degree. [9]

While there are numerous studies documenting the association between SES and smoking behavior, very little has been published on the association between SES and expenditure on cigarettes. An expenditure study conducted in Australia used data from a sample of 6,892 households and showed that those with a lower SES were more likely to report tobacco expenditure.[13] The odds of tobacco expenditure was 2.3 times greater among households headed by a person with no educational qualification than a university degree and 1.4 times greater

among households headed by a person with a blue-collar occupation than a professional occupation. Furthermore, among smoking households, those with a lower SES spent more of their funds on tobacco. Percent of total household expenditure spent on tobacco was 46% higher among households headed by a person with no educational qualification than a university degree and 38% higher among households headed by a person with a blue-collar occupation than a professional occupation. A different study of 1,144 households in Sri Lanka revealed that while higher income households spent more on tobacco products, they had a lower tobacco expenditure as a percentage of total household expenditure.[14] Similar results were reported in a study conducted in the Russian Federation, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan,[15] and another in Morocco.[16] We do not know of any studies in the U.S. that examine SES as a determinant of whether a household spends money on cigarettes and how much of the total household expenditure is spent on cigarettes. Our aim was to use data from the Consumer Expenditure Survey (CES) in the U.S. to examine (1) the association between household SES and whether a household reports cigarette expenditure, and (2) SES variations in percentage of total household expenditure spent on cigarettes among smoking households.

METHODS

Data

We used data from the CES, which is conducted by the U.S. Census Bureau under contract with the Bureau of Labor Statistics.[17] The CES is a national household survey representing the entire U.S. civilian noninstitutional population. The CES uses a cluster sampling design where primary sampling units are small clusters of counties grouped together into geographic entities. The sampling frame within the primary sampling units is the Census Bureau's Master Address File, which contains residential addresses identified in the 2010 census. Approximately 6,900

households at the identified addresses are interviewed each quarter of the year. Each household is interviewed every three months over four calendar quarters. After the fourth interview, the household is dropped from the survey and replaced by a new sample. The response rates varied from the highest of 74.5% in 2010 to the lowest of 64.2% in 2015.[18] The interviews' duration was about 60 minutes and they were primarily conducted in person using a structured questionnaire to collect data on household income, demographics, and a complete range of expenditure items. We appended data from the third quarter data collection (i.e., July, August, and September) of six consecutive years, 2010-2015, with a total sample size of 39,806 households. We did not use the first quarter data because the expenditure report of some of the participants pertained to the previous calendar year. Our sensitivity analyses revealed that using data from the second and fourth quarter yields very similar results as we report in this article. We excluded from the analysis 588 households, i.e., 1.5% of the total number of households, for which there was a missing value for one or more study variables except income. While the amount of missing data was negligible and not likely to have biased the results, we note that households with missing data were more likely to be of a higher SES background and report cigarette expenditure. The study sample size was 39,218. No source of funding was used to conduct this study. Ethical approval was not needed for this study as we used secondary data that are publically available by the U.S. Bureau of Statistics.

Measurement of smoking status of households and cigarette expenditure as a percentage of total household expenditure

The head of household was asked: "since the first of the reference month [three months prior to the interview], have you or any members of your household purchased cigarettes?" An affirmative answer indicated a smoking household. The head of a smoking household was asked:

"What is the usual weekly expense for cigarettes?" Weekly cigarette expenditure amounts were converted to quarterly amounts by the Census Bureau to match the timeframe for the reporting of most other household expenditures items. We converted nominal expenditure amounts to constant 2015 dollars using all-item consumer price index to account for inflation.[19 20] For smoking households, we computed cigarette expenditure as a percentage of total expenditure including expenditure on items such as food, alcoholic beverages, tobacco and smoking supplies, housing, apparel, transportation, health care, entertainment, and personal care.

Measurement of SES and other covariates

We employed three SES indicators: household poverty status, education, and occupation of head of household. We defined poverty status as the ratio of household income to poverty threshold for a given family size and composition for each survey year.[21] Regression-based multiple imputation was used by the Census Bureau to replace missing household income data.[22] We categorized education of the head of household into four groups as follows: less than high school, high school graduate, some college or associate degree, and Bachelor's or higher degree. We categorized occupation of the head of household into five groups as follows: manager and professional; administrative support, technician, sales; service, including protective and private household service; blue-collar, including machine and transportation operator, handler, laborer, mechanic, and construction worker; other occupations; and not in the labor force.

Other covariates used in the models were as follows: race/ethnicity of head of household, categorized as non-Hispanic White, non-Hispanic Black, Hispanic, and other; household size; number of males aged 16 and over in the household; and survey year.

Statistical analysis

The unit of analysis in this study was the household. U.S. Department of Labor provides sampling weights for each CES. These weights were computed based on the probability of selection of a household, household non-response, and national household distribution of age, race, and region.[17] In order to combine six years of surveys, we created a unified weight by multiplying the original weight in a given survey to the ratio of the sample size for that survey and the sum of samples sizes of all six surveys.[23] We used this unified weight for the computation of all point estimates and in all analyses.

The U.S. Department of Labor also provides 44 replicate weights for standard error estimation.[17] Researchers are instructed to use these replicate weights to construct 44 subsamples from the original sample data and thereby generate 44 separate estimates for each statistic. These estimates are then used to approximate standard errors based on the standard formula for computing sample standard deviation. We used this data-dependent method of estimating standard errors which is especially useful when data is generated through a multi-stage sampling design and where, to preserve respondent anonymity, complete information on sample clusters or strata is not made available to researchers as is the case in CES.[24]

We first conducted preliminary analyses to assess the bivariate associations of household smoking status and cigarette expenditure as a percentage of total household expenditure with covariates. Subsequently, we used logistic regression to assess the association of household smoking status and SES indicators. We also used multivariable linear regression to assess the association of cigarette expenditure as a percentage of total household expenditure with SES indicators. In regression analyses, we used the natural log transformation for cigarette expenditure as a percentage of total household expenditure as this variable had a highly positively skewed distribution. Covariates whose *p*-values were greater than 0.1 in the bivariate

models were not included in the multivariable models. We used Stata version 14.1 for all analyses.[25]

RESULTS

Sample characteristics and bivariate associations

Table 1 provides weighted sample characteristics and bivariate associations between the covariates and the outcomes. Overall, 17.4% of households reported expenditure on cigarettes. Among smoking households, the average quarterly expenditure on cigarettes in constant 2015 dollars was $458.1 and the average cigarette expenditure as a percentage of total household expenditure was 5.6%. About 14.6% of the households lived below the poverty threshold and 38.4% of the heads of households did not report a level of education beyond high school graduation. About 25.5% of the households were headed by a person holding a managerial or professional occupation, 16.8% by a person with an administrative occupation, 12.9% by a person holding a service occupation, and 10.4% by a person in a blue-collar occupation. The percentage of non-Hispanic Whites, non-Hispanic Blacks, and Hispanics were 69.1, 12.5, and 12.7%, respectively.

At the bivariate level, poorer households, those headed by a person with a lower level of education, and those headed by a person with a lower occupational status (such as blue-collar, service, or administrative compared to managerial or professional occupations) had a higher probability of being a smoking household. For example, while 22.1% of households below poverty reported cigarette expenditure, only 13.2% of those at or above 300% of poverty threshold did so. Similarly, while the percentage of smoking households was 22.6 among households headed by a person who did not complete high school, that percentage was only 8.2 among households headed by a college graduate. Furthermore, while 25.5% of household headed

by a blue-collar person reported cigarette expenditure, only 11.7% of those headed by a person in a managerial or professional occupation did so.

Bivariate results also showed that poorer households, those headed by a person with a lower level of education or lower occupational status had a higher percentage of their total expenditure devoted to cigarette expenditure.

Table 1. Weighted sample characteristics, bivariate association of smoking status of households and covariates (n = 39,218), and bivariate association of cigarette expenditure and covariates among smoking household (n = 6,559)

Covariates	% in sample	% smoking household (*p-value* for χ^{2} [a])	Cigarette expenditure as % of total expenditure (*p-value* for χ^{2} [a])
Total sample		17.35	5.56
Poverty status		($p < 0.001$)	($p < 0.001$)
< 100%	14.63	22.07	7.74
100%≥ and < 200%	21.38	19.47	6.64
200%≥ and < 300%	30.55	18.20	5.00
≥ 300%	33.44	13.15	3.63
Education		($p < 0.001$)	($p < 0.001$)
Less than high school	13.06	22.62	7.60
High school graduate	25.37	23.66	5.98
Some college or associate degree	31.09	18.93	4.98
Bachelor's or higher degree	30.47	8.22	3.48
Occupation		($p < 0.001$)	($p < 0.001$)
Manager and professional	25.48	11.72	3.64
Administrative support	16.78	18.67	4.63
Service	12.91	19.51	5.38
Blue-collar	10.44	25.46	5.44
Other Occupations	0.80	13.92	4.28
Not in the labor force	33.59	17.68	7.16
Race/ethnicity		($p < 0.001$)	($p < 0.001$)
Non-Hispanic White	69.09	19.06	5.69
Non-Hispanic Black	12.52	16.76	5.94
Hispanic	12.71	10.97	4.28
Other	5.68	12.04	4.36
Household size		($p < 0.001$)	($p < 0.001$)
1	29.51	15.13	7.20
2	32.15	17.57	5.41
3	15.22	20.13	4.94
4+	23.11	18.03	4.44
Number of males aged 16 +		($p < 0.001$)	($p < 0.001$)
0	22.81	14.34	6.56
1	63.85	17.22	5.46

2+	13.34	23.13	4.82
Year		(p = 0.009)	(p = 0.281)
2010	16.97	18.53	5.93
2011	16.00	18.81	5.56
2012	16.55	17.06	5.29
2013	16.7	16.41	5.48
2014	16.77	16.31	5.39
2015	17.01	17.01	5.62

a *P*-values for the bivariate association of covariates and each of the three outcomes using 44 replicate weights.

Multivariable analyses

Table 2 shows adjusted odds ratios for the association of being a smoking household and SES indicators. Poorer households, those headed by a person with a lower level of education or lower occupational status were more likely to report cigarette expenditure ($p < 0.001$ for poverty, education, and occupation). The odds of being a smoking household was 91% larger among households in poverty than those whose income was at or above 300% of poverty threshold. Similarly, households headed by a person who did not complete high school had 3.4 times the odds of being a smoking household than those headed by a person with at least a Bachelor's degree. Furthermore, the odds of being a smoking household was 46% larger among households headed by a blue-collar worker than those headed by a person in a managerial or professional occupation. Race/ethnicity was associated with smoking status ($p < 0.001$) such that the odds of being a smoking household were largest among households headed by a non-Hispanic White person and lowest among those headed by a Hispanic individual. Larger households and those with more males 16 years or older had higher odds of reporting cigarette expenditure ($p < 0.001$ for both household size and number of males 16 years or older). Finally, there was some evidence that odds of being a smoking household were greater in 2010 and 2011 than in later years ($p = 0.037$).

Table 2 also shows the results of the regression of the natural logarithm of cigarette expenditure as a percentage of total household expenditure on SES and other covariates. Poorer households, those headed by a person with a lower level of education or a lower occupational status had a higher cigarette expenditure as a percentage of total household expenditure. Percent spent on cigarettes was 77% ($e^{0.57}$x100 – 100) higher among households in poverty compared to those with an income at or above 300% of poverty threshold. Similarly, percent spent on cigarettes was 82% ($e^{0.60}$x100 – 100) higher among households headed by a person who did not complete high school than those headed by a person with at least a Bachelor's degree. Furthermore, percent spent on cigarettes was 19% ($e^{0.17}$x100 – 100) higher among households headed by a person with a blue-collar occupation than those headed by a person in a managerial or professional occupation. Race/ethnicity was associated with percent spent on cigarettes such that households headed by a non-Hispanic White person had the highest and those headed by a Hispanic individual had the lowest percent spent on cigarettes ($p < 0.001$). Larger households and those with a smaller number of males 16 years or older had a lower percentage spent on cigarettes ($p < 0.001$ for household size and $p = 0.018$ for number of males 16 years or older).

Table 2: Multivariable results[a] for the association of smoking status of household and cigarette expenditure as a percentage of total household expenditure with socioeconomic status indicators and other covariates

Covariates	Probability of being a smoking household (n = 39,218)		Cigarette expenditure as a % of household expenditure (n = 6,559)	
	Adjusted OR (95% CI)	*p*-value	Adjusted $\hat{\beta}$ (95% CI)	*p*-value
Poverty status		<0.001		<0.001
< 100%	1.91 (1.66, 2.21)		0.57 (0.50, 0.64)	
100%≥ and < 200%	1.48 (1.30, 1.67)		0.47 (0.40, 0.55)	
200%≥ and < 300%	1.27 (1.19, 1.37)		0.27 (0.21, 0.33)	
≥ 300%	1.00		0.00	
Education		<0.001		<0.001
Less than high school	3.40 (2.95, 3.93)		0.60 (0.51, 0.69)	
High school graduate	3.04 (2.73, 3.37)		0.44 (0.36, 0.52)	
Some college or associate degree	2.34 (2.13, 2.57)		0.27 (0.20, 0.34)	
Bachelor's or higher degree	1.00		0.00	
Occupation		<0.001		<0.001
Manager and professional	1.00		0.00	

Administrative support	1.20 (1.09, 1.32)		0.05 (-0.02, 0.12)	
Service	1.20 (1.09, 1.33)		0.12 (0.04, 0.20)	
Blue-collar	1.46 (1.27, 1.67)		0.17 (0.07, 0.26)	
Other Occupations	0.68 (0.45, 1.04)		-0.08 (-0.34, 0.19)	
Not in the labor force	0.90 (0.81, 1.01)		0.23 (0.17, 0.29)	
Race/ethnicity		<0.001		<0.001
Non-Hispanic White	1.00		0.00	
Non-Hispanic Black	0.67 (0.59, 0.76)		-0.17 (-0.25, -0.10)	
Hispanic	0.32 (0.28, 0.36)		-0.54 (-0.63, -0.45)	
Other	0.59 (0.51, 0.68)		-0.31 (-0.41, -0.21)	
Household size		<0.001		<0.001
1	1.00		0.00	
2	1.23 (1.10, 1.37)		-0.19 (-0.24, -0.14)	
3	1.40 (1.26, 1.55)		-0.32 (-0.38, -0.25)	
4+	1.15 (1.03, 1.29)		-0.49 (-0.54, -0.43)	
Number of males aged 16 +		<0.001		0.0178
0	1.00		0.00	
1	1.33 (1.23, 1.44)		0.05 (-0.00, 0.11)	
2+	1.88 (1.70, 2.09)		0.12 (0.04, 0.20)	
Year		0.037		--
2010	1.00		--	
2011	1.02 (0.93, 1.11)		--	
2012	0.92 (0.83, 1.00)		--	
2013	0.88 (0.78, 0.99)		--	
2014	0.88 (0.79, 0.98)		--	
2015	0.95 (0.85, 1.06)		--	

[a] All odds ratios (OR) from logistic analysis and regression coefficients ($\hat{\beta}$) from linear regression analyses are adjusted for the effect of all covariates in the model.

DISCUSSION

In this study, we used data from six consecutive years of the U.S. CES and found that lower SES households not only are more likely to spend money on cigarettes but also spend a larger portion of their total household expenditure on cigarettes. Our results were consistent with the findings from other countries, although these findings pertained to the general category of tobacco expenditure and not specifically to cigarette expenditure.[13-16]

We also found that larger households, households with more males aged 16+ years, and households headed by a non-Hispanic white person compared to others had a higher probability

of reporting cigarette expenditure and spent a larger percentage of their total household expenditure on cigarettes. None of these covariates, except number of males in the household, have been previously investigated in regards to tobacco expenditure. Our finding about number of males in the household was consistent with a study that was conducted in the New Independent States.[15]

A strength of this work was its use of six consecutive years of national and comprehensive expenditure data with relatively high response rates and large sample sizes. The validity of the CES data has been investigated by comparing them with National Income and Product Accounts data.[26] While this comparison was not specifically done for cigarette expenditure, the findings showed that most of the large categories of consumption were measured well in the CES, as the ratio to the National Income and Accounts statistics was close to one and has not declined notably over time. [26] The major weakness of the study is that, as it is the case with all cross-sectional analyses, it does not allow inferences about causality. It is plausible that poorer households headed by a person with a low level of formal education are more likely to have one or more smokers in the household and spend money on cigarettes. The effect of SES on smoking has been extensively studied.[7 27-31] It is also plausible that households that spend money on cigarettes and have higher health care expenditures due to smoking are more likely to have reduced income and experience downward socioeconomic mobility. However, to our knowledge, the effect of smoking on downward mobility has not been studied. Another weakness of this work is that, as reported in a study where households in the CES were linked to zip-code level average income, the very high income households are less likely to respond to the survey.[32] However, non-response rates were not associated with income over most of the income distribution.[32]

In light of our finding that lower SES households are more likely to include a smoker and spend relatively more on cigarettes, we recommend tobacco control policies that are effective in reducing smoking among lower SES groups. Increasing taxation on cigarettes is the most effective policy for reducing smoking among all segments of the population. In fact, many studies have shown that increasing the price of cigarettes results in a larger decrease in smoking prevalence among lower income and occupational groups than others.[7 33 34] This policy, however, is likely to negatively affect the finances of low income smokers who fail to quit or reduce smoking. To address this problem, part or all of the revenues from increased taxation can be used to fund evidence-based smoking cessation programs[35] for these smokers. There is also evidence that anti-smoking mass media campaigns are effective in reducing smoking prevalence[36 37] and increasing cessation rates[38] among low SES smokers. Finally, there is some evidence that bans on smoking in public places are effective in reducing smoking prevalence and consumption among lower SES smokes[39 40] and across all socioeconomic groups.[41]

Contributorship statement: Mohammad Siahpush contributed to the following aspects of the work: conception, design, data acquisition, data analysis, interpretation of data, drafting, and critical revision. Paraskevi Farazi contributed to the following aspects of the work: conception, data analysis, interpretation of data, and critical revision. Shannon Maloney contributed to the following aspects of the work: conception, data analysis, interpretation of data, and critical revision. Danae Dinkel contributed to the following aspects of the work: conception, data analysis, interpretation of data, and critical revision. Minh Nguyen contributed to the following aspects of the work: design, data analysis, interpretation of data, drafting, and critical revision. Gopal Singh contributed to the following aspects of the work: conception, data analysis, and

critical revision. All authors approve the final version as submitted. All authors are accountable for all aspects of the work.

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Socioeconomic status and cigarette expenditure among U.S. households: Results from 2010-2015 Consumer Expenditure Survey

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ABSTRACT

Objectives: To examine (1) the association between household socioeconomic status (SES) and whether a household spends money on cigarettes, and (2) socioeconomic variations in percentage of total household expenditure spent on cigarettes among smoking households.

Methods: We used data from six consecutive years, 2010-2015, of the Consumer Expenditure Interview Survey. The interviews involved a structured questionnaire to collect data on household income, demographics, and a complete range of expenditures including expenditure on cigarettes. Households that reported cigarette expenditure in the previous three months were distinguished as smoking households. SES indicators employed in this study were education and occupation of the head of household and household poverty status. Logistic regression was used to assess the association of household smoking status with SES. Linear regression was used to assess the association of cigarette expenditure as a percentage of total household expenditure with SES. The analysis sample size was 39,218.

Results: Overall, 17.4% of households reported expenditure on cigarettes. Among smoking households, the average quarterly expenditure on cigarettes in constant 2015 dollars was $458.1 and the average cigarette expenditure as a percentage of total household expenditure was 5.6%. Multivariable regression results showed that poorer households, those headed by a person with a lower level of education or lower occupational status were more likely to report cigarette expenditure and had a higher cigarette expenditure as a percentage of total household expenditure ($p < 0.001$ for all of the stated associations).

Conclusion: Lower SES households are more likely to spend money on cigarettes and spend a larger percentage of their total expenditure on cigarettes. We recommend enhanced efforts in increasing cigarette taxation, anti-smoking mass media campaigns, and smoking bans in public places, which are effective in reducing smoking among low SES smokers.

Strengths and limitations of this study:

- We used a national household survey representing the entire U.S. civilian noninstitutional population that involved a structured questionnaire to collect data on household income, demographics, and a complete range of expenditures.
- Conclusions are based on data from six consecutive years of national and comprehensive expenditure data with relatively high response rates and large sample sizes.
- The cross-sectional design does not allow for inferences about the effect of socioeconomic status on whether a household spends money on cigarettes or percent of household expenditure spent on cigarettes among smoking households.

INTRODUCTION

Smoking cigarettes not only causes numerous health conditions,[1] but also is associated with deleterious financial consequences and a lowered standard of living. For example, smokers compared to non-smokers are more likely to experience financial stress, defined as events such as going without meals or not being able to pay rent.[2] Similarly, among smokers, higher cigarette expenditure is associated with a higher probability of experiencing financial stress.[3] Furthermore, smokers who spend more on cigarettes are more likely to report "smoking-induced deprivation", measured by asking smokers whether "money … spent on cigarettes resulted in not having enough money for household essentials such as food." [3 4] There is also evidence that quitting smoking is associated with a subsequent reduction in the probability of experiencing financial stress[5 6] and an increased level of prosperity.[5]

One of the strong and persistent determinants of smoking behavior in developed countries is socioeconomic status (SES). [7-12] For example, in the United States (U.S.), in 2015, smoking prevalence among adults living below poverty line was nearly twice that of those at or above poverty line (26.1% versus 13.9%). Similarly, smoking prevalence among individuals aged 25 years or older ranged from 34.1% in persons with a high school diploma to 16.6% in those with an associate degree to only 3.6% in those with a graduate degree. [9]

While there are numerous studies documenting the association between SES and smoking behavior, very little has been published on the association between SES and expenditure on cigarettes. Whereas the primary implication of studies of the SES determinants of smoking pertains to the deleterious health effects of smoking and health inequalities, the primary implication of studies of cigarette expenditure relates to the financial burden of smoking.[3 13-15] An expenditure study conducted in Australia used data from a sample of 6,892 households and

showed that those with a lower SES were more likely to report tobacco expenditure.[16] The odds of tobacco expenditure were 2.3 times greater among households headed by a person with no educational qualification than a university degree and 1.4 times greater among households headed by a person with a blue-collar occupation than a professional occupation. Furthermore, among smoking households, those with a lower SES spent more of their funds on tobacco. Percent of total household expenditure spent on tobacco was 46% higher among households headed by a person with no educational qualification than a university degree and 38% higher among households headed by a person with a blue-collar occupation than a professional occupation. A different study of 1,144 households in Sri Lanka revealed that while higher income households spent more on tobacco products, they had a lower tobacco expenditure as a percentage of total household expenditure.[13] Similar results were reported in a study conducted in the Russian Federation, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan,[15] and another in Morocco.[14] Finally, a study of 748 smokers in the U.S. showed that lower income households spent a higher percentage of their household income on cigarettes.[17] We do not know of any other published studies in the U.S. that examine SES as a determinant of whether a household spends money on cigarettes and how much of the total household expenditure is spent on cigarettes. Our aim was to use data from the Consumer Expenditure Survey (CES) in the U.S. to examine (1) the association between household SES and whether a household reports cigarette expenditure, and (2) SES variations in percentage of total household expenditure spent on cigarettes among smoking households.

METHODS

Data

We used data from the CES, which is conducted by the U.S. Census Bureau under contract with the Bureau of Labor Statistics.[18] The CES is a national household survey representing the entire U.S. civilian noninstitutional population. The CES uses a cluster sampling design where primary sampling units (PSUs) are small clusters of counties grouped together into geographic entities. The sampling frame within the primary sampling units is the Census Bureau's Master Address File, which contains residential addresses identified in the 2010 census. Approximately 6,900 households at the identified addresses are interviewed each quarter of the year. Each household is interviewed every three months over four calendar quarters. After the fourth interview, the household is dropped from the survey and replaced by a new sample. The response rates varied from the highest of 74.5% in 2010 to the lowest of 64.2% in 2015.[19] The interviews' duration was about 60 minutes and they were primarily conducted in person using a structured questionnaire to collect data on household income, demographics, and a complete range of expenditure items. We appended data from the third quarter data collection (i.e., July, August, and September) of six consecutive years, 2010-2015, with a total sample size of 39,806 households. We did not use the first quarter data because the expenditure report of some of the participants pertained to the previous calendar year. Our sensitivity analyses revealed that using data from the second and fourth quarter yields very similar results as we report in this article. We excluded from the analysis 588 households, i.e., 1.5% of the total number of households, for which there was a missing value for one or more study variables except income. While the amount of missing data was negligible and not likely to have biased the results, we note that households with missing data were more likely to be of a higher SES background and report cigarette expenditure. The study sample size was 39,218. No source of funding was used to

conduct this study. Ethical approval was not needed for this study as we used secondary data that are publically available by the U.S. Bureau of Statistics.

Measurement of smoking status of households and cigarette expenditure as a percentage of total household expenditure

The head of household, who is defined as the primary person who rents or owns the home of the household,[20] was asked: "since the first of the reference month [three months prior to the interview], have you or any members of your household purchased cigarettes?" An affirmative answer indicated a smoking household. The head of a smoking household was asked: "What is the usual weekly expense for cigarettes?" Weekly cigarette expenditure amounts were converted to quarterly amounts by the Census Bureau to match the timeframe for the reporting of most other household expenditures items. We converted nominal expenditure amounts to constant 2015 dollars using all-item consumer price index to account for inflation.[21 22] For smoking households, we computed cigarette expenditure as a percentage of total expenditure including expenditure on items such as food, alcoholic beverages, tobacco and smoking supplies, housing, apparel, transportation, health care, entertainment, and personal care.

Measurement of SES and other covariates

We employed three SES indicators: household poverty status, education, and occupation of head of household. We defined poverty status as the ratio of household income to poverty threshold for a given family size and composition for each survey year.[23] Regression-based multiple imputation was used by the Census Bureau to replace missing household income data.[24] We categorized education of the head of household into four groups as follows: less than high school, high school graduate, some college or associate degree, and Bachelor's or higher degree. We categorized occupation of the head of household into five groups as follows: manager and

professional; administrative support, technician, sales; service, including protective and private household service; blue-collar, including machine and transportation operator, handler, laborer, mechanic, and construction worker; other occupations; and not in the labor force.

Other covariates used in the models were as follows: race/ethnicity of head of household, categorized as non-Hispanic White, non-Hispanic Black, Hispanic, and other; household size; number of males aged 16 and over in the household; and survey year.

Statistical analysis

The unit of analysis in this study was the household. U.S. Department of Labor provides sampling weights for each CES survey quarter. These weights were computed based on the probability of selection of a household, household non-response, and national household distribution of age, race, and region.[18] In order to combine six years of surveys, we created a unified weight by multiplying the original weight in a given survey to the ratio of the sample size for that survey and the sum of samples sizes of all six surveys.[25] We used this unified weight for the computation of all point estimates and in all analyses.

The U.S. Department of Labor also provides 44 replicate samples with accompanying sampling weights for standard error estimation.[18] Using replicate samples to estimate a standard error involves computing a statistic for subsets of the full study sample and examining the variability of the statistic over the subsets.[26] In essence, this method allows a single sample to simulate multiple samples. Replicate samples were constructed using the "balanced repeated replication" method where the sampled PSUs were divided into 44 strata and the households within each stratum were randomly divided into two half samples. CES uses a 44x44 Hadamard matrix to create the replicates in a "balanced" way.[27] Once the subsamples were formed, survey weights were computed for each subsample using the method described above for the weights for

each CES survey quarter. Subsequently, 44 different estimates of a statistic were generated using only one half-sample per stratum. These estimates were then used to approximate standard errors based on the formula for computing sample standard deviation:

$$\sigma_{\hat{\theta}} = \sqrt{\frac{1}{44}\sum_{r=1}^{44}(\hat{\theta}_r - \hat{\theta})^2}$$

where $\hat{\theta}$ is the estimated statistic based on the full sample, $\sigma_{\hat{\theta}}$ is the standard error of $\hat{\theta}$, and $\hat{\theta}_r$ is the rth replicate estimate of $\hat{\theta}$. We used this data-dependent method of estimating standard errors which is especially useful when data is generated through a multi-stage sampling design and where, to preserve respondent anonymity, complete information on sample clusters or strata is not made available to researchers as is the case in CES.[28]

We first conducted preliminary analyses to assess the bivariable associations of household smoking status and cigarette expenditure as a percentage of total household expenditure with each predictor. Subsequently, we used logistic regression to assess the association of household smoking status and SES indicators. We also used multivariable linear ordinary least squares regression to assess the association of cigarette expenditure as a percentage of total household expenditure with SES indicators. In linear regression analyses, we used the natural log transformation for cigarette expenditure as a percentage of total household expenditure as this variable had a highly positively skewed distribution. We checked for the normality of residuals and multicollinearity and found no violation of these ordinary least squares regression assumptions in the multivariable model. In relation to the issue of multicollinearity, we note that the associations between poverty status and education (Kendall's tau-b=0.34), poverty status and occupation (Cramer's V = 0.27), and education and occupation (Cramer's V = 0.27) were moderate. Covariates whose *p*-values were greater than 0.1 in the

bivariable models were not included in the multivariable models. When the outcome is a log-transformed variable in a regression equation, the interpretation of the regression coefficients can be derived as follows. An equation with a log-transformed variable and two covariates X_1 and X_2 can be written as:

$$\ln(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2$$

Suppose,

$$\ln(Y_1) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \quad \text{(Equation 1)}$$

$$\ln(Y_2) = \beta_0 + \beta_1 (X_1 + 1) + \beta_2 X_2 \quad \text{(Equation 2)}$$

Subtracting Equation 1 from Equation 2 gives:

$$\beta_1 = \ln(Y_2) - \ln(Y_1)$$

which can be expressed as:

$$e^{\beta_1} = 1 + \frac{Y_2 - Y_1}{Y_1}$$

It follows that a one unit increase in X_1 is associated with "$e^{\beta_1} * 100 - 100$" percentage change in Y, controlling for all other covariates. We used Stata version 14.1 for all analyses.[29]

RESULTS

Sample characteristics and bivariable associations

Table 1 provides weighted sample characteristics and bivariable associations between the covariates and the outcomes. Overall, 17.4% of households reported expenditure on cigarettes. Among smoking households, the mean quarterly expenditure on cigarettes in constant 2015 dollars was $458.1 and the mean cigarette expenditure as a percentage of total household expenditure was 5.6%. About 14.6% of the households lived below the poverty threshold and 38.4% of the heads of households did not report a level of education beyond high school graduation. About 25.5% of the households were headed by a person holding a managerial or

professional occupation, 16.8% by a person with an administrative occupation, 12.9% by a person holding a service occupation, and 10.4% by a person in a blue-collar occupation. The percentage of non-Hispanic Whites, non-Hispanic Blacks, and Hispanics were 69.1, 12.5, and 12.7%, respectively.

At the bivariable level, poorer households, those headed by a person with a lower level of education, and those headed by a person with a lower occupational status (such as blue-collar, service, or administrative compared to managerial or professional occupations) had a higher probability of being a smoking household. For example, while 22.1% of households below poverty reported cigarette expenditure, only 13.2% of those at or above 300% of poverty threshold did so. Similarly, while the percentage of smoking households was 22.6 among households headed by a person who did not complete high school, that percentage was only 8.2 among households headed by a college graduate. Furthermore, while 25.5% of household headed by a blue-collar person reported cigarette expenditure, only 11.7% of those headed by a person in a managerial or professional occupation did so.

Bivariable results also provide strong evidence that poorer households, those headed by a person with a lower level of education or lower occupational status had a higher percentage of their total expenditure devoted to cigarette expenditure.

Table 1. Weighted sample characteristics, bivariable association of smoking status of households and covariates (n = 39,218), and bivariable association of cigarette expenditure and covariates among smoking household (n = 6,559)

Covariates	% in sample	% smoking household (*p-value* for χ^{2} [a])	Cigarette expenditure as % of total expenditure (*p-value* for χ^{2} [a])
Total sample		17.35	5.56
Poverty status		($p < 0.001$)	($p < 0.001$)
< 100%	14.63	22.07	7.74
100%≥ and < 200%	21.38	19.47	6.64
200%≥ and < 300%	30.55	18.20	5.00
≥ 300%	33.44	13.15	3.63
Education		($p < 0.001$)	($p < 0.001$)

Less than high school	13.06	22.62	7.60
High school graduate	25.37	23.66	5.98
Some college or associate degree	31.09	18.93	4.98
Bachelor's or higher degree	30.47	8.22	3.48
Occupation		($p < 0.001$)	($p < 0.001$)
Manager and professional	25.48	11.72	3.64
Administrative support	16.78	18.67	4.63
Service	12.91	19.51	5.38
Blue-collar	10.44	25.46	5.44
Other Occupations	0.80	13.92	4.28
Not in the labor force	33.59	17.68	7.16
Race/ethnicity		($p < 0.001$)	($p < 0.001$)
Non-Hispanic White	69.09	19.06	5.69
Non-Hispanic Black	12.52	16.76	5.94
Hispanic	12.71	10.97	4.28
Other	5.68	12.04	4.36
Household size		($p < 0.001$)	($p < 0.001$)
1	29.51	15.13	7.20
2	32.15	17.57	5.41
3	15.22	20.13	4.94
4+	23.11	18.03	4.44
Number of males aged 16 +		($p < 0.001$)	($p < 0.001$)
0	22.81	14.34	6.56
1	63.85	17.22	5.46
2+	13.34	23.13	4.82
Year		($p = 0.009$)	($p = 0.281$)
2010	16.97	18.53	5.93
2011	16.00	18.81	5.56
2012	16.55	17.06	5.29
2013	16.7	16.41	5.48
2014	16.77	16.31	5.39
2015	17.01	17.01	5.62

[a] *P*-values for the bivariable association of covariates and each of the three outcomes using 44 replicate weights.

Multivariable analyses

Table 2 shows adjusted odds ratios for the association of being a smoking household and SES indicators. Poorer households, those headed by a person with a lower level of education or lower occupational status were more likely to report cigarette expenditure ($p < 0.001$ for poverty, education, and occupation). The odds of being a smoking household were 91% larger among households in poverty than those whose income was at or above 300% of poverty threshold.

Similarly, households headed by a person who did not complete high school had 3.4 times the odds of being a smoking household than those headed by a person with at least a Bachelor's degree. Furthermore, the odds of being a smoking household were 46% larger among households headed by a blue-collar worker than those headed by a person in a managerial or professional occupation. Race/ethnicity was associated with smoking status ($p < 0.001$) such that the odds of being a smoking household were largest among households headed by a non-Hispanic White person and lowest among those headed by a Hispanic individual. Larger households and those with more males 16 years or older had higher odds of reporting cigarette expenditure ($p < 0.001$ for both household size and number of males 16 years or older). Finally, there was some evidence that odds of being a smoking household were greater in 2010 and 2011 than in later years ($p = 0.037$).

Table 2 also shows the results of the regression of the natural logarithm of cigarette expenditure as a percentage of total household expenditure on SES and other covariates. Poorer households, those headed by a person with a lower level of education or a lower occupational status had a higher cigarette expenditure as a percentage of total household expenditure. Percent spent on cigarettes was 77% ($e^{0.57}*100 - 100$) higher among households in poverty compared to those with an income at or above 300% of poverty threshold. Similarly, percent spent on cigarettes was 82% ($e^{0.60}*100 - 100$) higher among households headed by a person who did not complete high school than those headed by a person with at least a Bachelor's degree. Furthermore, percent spent on cigarettes was 19% ($e^{0.17}*100 - 100$) higher among households headed by a person with a blue-collar occupation than those headed by a person in a managerial or professional occupation. Race/ethnicity was associated with percent spent on cigarettes such that households headed by a non-Hispanic White person had the highest and those headed by a

Hispanic individual had the lowest percent spent on cigarettes ($p < 0.001$). Larger households and those with a smaller number of males 16 years or older had a lower percentage spent on cigarettes ($p < 0.001$ for household size and $p = 0.018$ for number of males 16 years or older).

Table 2: Multivariable results[a] for the association of smoking status of household and cigarette expenditure as a percentage of total household expenditure with socioeconomic status indicators and other covariates

Covariates	Probability of being a smoking household (n = 39,218)		Cigarette expenditure as a % of household expenditure (n = 6,559)	
	Adjusted OR (95% CI)	*p*-value	Adjusted $\hat{\beta}$ (95% CI)	*p*-value
Poverty status		<0.001		<0.001
< 100%	1.91 (1.66, 2.21)		0.57 (0.50, 0.64)	
100%≥ and < 200%	1.48 (1.30, 1.67)		0.47 (0.40, 0.55)	
200%≥ and < 300%	1.27 (1.19, 1.37)		0.27 (0.21, 0.33)	
≥ 300%	1.00		0.00	
Education		<0.001		<0.001
Less than high school	3.40 (2.95, 3.93)		0.60 (0.51, 0.69)	
High school graduate	3.04 (2.73, 3.37)		0.44 (0.36, 0.52)	
Some college or associate degree	2.34 (2.13, 2.57)		0.27 (0.20, 0.34)	
Bachelor's or higher degree	1.00		0.00	
Occupation		<0.001		<0.001
Manager and professional	1.00		0.00	
Administrative support	1.20 (1.09, 1.32)		0.05 (-0.02, 0.12)	
Service	1.20 (1.09, 1.33)		0.12 (0.04, 0.20)	
Blue-collar	1.46 (1.27, 1.67)		0.17 (0.07, 0.26)	
Other Occupations	0.68 (0.45, 1.04)		-0.08 (-0.34, 0.19)	
Not in the labor force	0.90 (0.81, 1.01)		0.23 (0.17, 0.29)	
Race/ethnicity		<0.001		<0.001
Non-Hispanic White	1.00		0.00	
Non-Hispanic Black	0.67 (0.59, 0.76)		-0.17 (-0.25, -0.10)	
Hispanic	0.32 (0.28, 0.36)		-0.54 (-0.63, -0.45)	
Other	0.59 (0.51, 0.68)		-0.31 (-0.41, -0.21)	
Household size		<0.001		<0.001
1	1.00		0.00	
2	1.23 (1.10, 1.37)		-0.19 (-0.24, -0.14)	
3	1.40 (1.26, 1.55)		-0.32 (-0.38, -0.25)	
4+	1.15 (1.03, 1.29)		-0.49 (-0.54, -0.43)	
Number of males aged 16 +		<0.001		0.0178
0	1.00		0.00	
1	1.33 (1.23, 1.44)		0.05 (-0.00, 0.11)	
2+	1.88 (1.70, 2.09)		0.12 (0.04, 0.20)	
Year		0.037		--
2010	1.00		--	
2011	1.02 (0.93, 1.11)		--	
2012	0.92 (0.83, 1.00)		--	
2013	0.88 (0.78, 0.99)		--	

2014	0.88 (0.79, 0.98)	--
2015	0.95 (0.85, 1.06)	--

[a] All odds ratios (OR) from logistic analysis and regression coefficients ($\hat{\beta}$) from linear regression analyses are adjusted for the effect of all covariates in the model.

DISCUSSION

In this study, we used data from six consecutive years of the U.S. CES and found that lower SES households not only are more likely to spend money on cigarettes but also spend a larger portion of their total household expenditure on cigarettes. Our results were consistent with a previous report in the U.S.[17] and the findings from other countries, although these findings pertained to the general category of tobacco expenditure and not specifically to cigarette expenditure.[13-16]

We also found that larger households, households with more males aged 16+ years, and households headed by a non-Hispanic white person compared to others had a higher probability of reporting cigarette expenditure and spent a larger percentage of their total household expenditure on cigarettes. None of these covariates, except number of males in the household, have been previously investigated in regards to tobacco expenditure. Our finding about number of males in the household was consistent with a study that was conducted in the New Independent States.[15]

A strength of this work was its use of six consecutive years of national and comprehensive expenditure data with relatively high response rates and large sample sizes. The validity of the CES data has been investigated by comparing them with National Income and Product Accounts data.[30] While this comparison was not specifically done for cigarette expenditure, the findings showed that most of the large categories of consumption were measured well in the CES, as the ratio to the National Income and Accounts statistics was close to one and has not declined

notably over time. [30] The major weakness of the study is that, as it is the case with all cross-sectional analyses, it does not allow inferences about causality. It is plausible that poorer households headed by a person with a low level of formal education are more likely to have one or more smokers in the household and spend money on cigarettes. The effect of SES on smoking has been extensively studied.[7 31-35] It is also plausible that households that spend money on cigarettes and have higher health care expenditures due to smoking are more likely to have reduced income and experience downward socioeconomic mobility. However, to our knowledge, the effect of smoking on downward mobility has not been studied. Another weakness of this work is that, as reported in a study where households in the CES were linked to zip-code level average income, the very high income households are less likely to respond to the survey.[36] However, non-response rates were not associated with income over most of the income distribution.[36]

Cigarette expenditure may contribute to financial deprivation and lower standards of living, which in turn can lead to unfavorable smoking behaviors and outcomes.[3 4 37-39] For example, financial stress is associated with a lower probability of smoking cessation among smokers and a higher probability of relapse among ex-smokers.[37] Moreover, while smokers with financial stress are more likely to have an interest in quitting, they are less likely to make a quit attempt or succeed in quitting.[40] In light of our finding that lower SES households are more likely to include a smoker and spend relatively more on cigarettes, we recommend tobacco control policies that are effective in reducing smoking among lower SES groups. Increasing taxation on cigarettes is the most effective policy for reducing smoking among all segments of the population. In fact, many studies have shown that increasing the price of cigarettes results in a larger decrease in smoking prevalence among lower income and occupational groups than

others.[7 41 42] This policy, however, is likely to negatively affect the finances of low income smokers who fail to quit or reduce smoking. To address this problem, part or all of the revenues from increased taxation can be used to fund evidence-based smoking cessation programs[43] for these smokers. Moreover, there is evidence that the effectiveness of increased taxation can be undermined by the availability of cheap tobacco and that changing the tobacco tax structure for cheap tobacco may promote quitting among low income groups.[44 45] In addition to increasing taxation, there is evidence that anti-smoking mass media campaigns are also effective in reducing smoking prevalence[46 47] and increasing cessation rates[48] among low SES smokers. Furthermore, it has been reported that plain packaging of and featuring large health warning labels on cigarette packs are associated with reduced positive brand image and intention to purchase cigarettes among socioeoconomically disadvantaged smokers.[49] Finally, there is some evidence that bans on smoking in public places are effective in reducing smoking prevalence and consumption among lower SES smokers[50 51] and across all socioeconomic groups.[52]

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and critical revision. All authors approve the final version as submitted. All authors are accountable for all aspects of the work.

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

Page #		Item No	Recommendation
1-2	**Title and abstract**	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
			(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
	Introduction		
3	Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
4	Objectives	3	State specific objectives, including any prespecified hypotheses
	Methods		
5	Study design	4	Present key elements of study design early in the paper
5	Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
5	Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants
6-7	Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
5	Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
5	Bias	9	Describe any efforts to address potential sources of bias
5	Study size	10	Explain how the study size was arrived at
6-7	Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
7-9	Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
			(*b*) Describe any methods used to examine subgroups and interactions
			(*c*) Explain how missing data were addressed
			(*d*) If applicable, describe analytical methods taking account of sampling strategy
			(*e*) Describe any sensitivity analyses
	Results		
5, 9	Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
			(b) Give reasons for non-participation at each stage
			(c) Consider use of a flow diagram
9-10	Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
			(b) Indicate number of participants with missing data for each variable of interest
10-13	Outcome data	15*	Report numbers of outcome events or summary measures
13	Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear

			which confounders were adjusted for and why they were included
			(*b*) Report category boundaries when continuous variables were categorized
			(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
	Discussion		
14	Key results	18	Summarise key results with reference to study objectives
14	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
14-15	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
14-15	Generalisability	21	Discuss the generalisability (external validity) of the study results
	Other information		
17	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Socioeconomic status and cigarette expenditure among U.S. households: Results from 2010-2015 Consumer Expenditure Survey

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Socioeconomic status and cigarette expenditure among U.S. households: Results from 2010-2015 Consumer Expenditure Survey

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ABSTRACT

Objectives: To examine (1) the association between household socioeconomic status (SES) and whether a household spends money on cigarettes, and (2) socioeconomic variations in proportion of total household expenditure spent on cigarettes among smoking households.

Methods: We pooled data from six consecutive years, 2010-2015, of the Consumer Expenditure Interview Survey. The interviews involved a structured questionnaire to collect data on household income, demographics, and a complete range of expenditures including expenditure on cigarettes. Households that reported cigarette expenditure in the previous three months were distinguished as smoking households. SES indicators employed in this study were education and occupation of the head of household and household poverty status. Binary logistic regression was used to assess the association of household smoking status with SES. Fractional logistic regression was used to assess the association of cigarette expenditure as a proportion of total household expenditure with SES. The analysis sample size was 39,218.

Results: Overall, 17.4% of households reported expenditure on cigarettes. Among smoking households, the average quarterly expenditure on cigarettes in constant 2015 dollars was $458.1 and the average cigarette expenditure as a percentage of total household expenditure was 5.6%. Multivariable regression results showed that poorer households, those headed by a person with a lower level of education or lower occupational status were more likely to report cigarette expenditure and had a higher cigarette expenditure as a proportion of total household expenditure ($p < 0.001$ for all of the stated associations).

Conclusion: Lower SES households are more likely to spend money on cigarettes and spend a larger proportion of their total expenditure on cigarettes. We recommend enhanced efforts in increasing cigarette taxation, anti-smoking mass media campaigns, and smoking bans in public places, which are effective in reducing smoking among low SES smokers.

Strengths and limitations of this study:

- We used a national household survey representing the entire U.S. civilian noninstitutional population that involved a structured questionnaire to collect data on household income, demographics, and a complete range of expenditures.
- Conclusions are based on data from six consecutive years of national and comprehensive expenditure data with relatively high response rates and large sample sizes.
- The cross-sectional design does not allow for inferences about the effect of socioeconomic status on whether a household spends money on cigarettes or percent of household expenditure spent on cigarettes among smoking households.

INTRODUCTION

Smoking cigarettes not only causes numerous health conditions,[1] but also is associated with deleterious financial consequences and a lowered standard of living. For example, smokers compared to non-smokers are more likely to experience financial stress, defined as events such as going without meals or not being able to pay rent.[2] Similarly, among smokers, higher cigarette expenditure is associated with a higher probability of experiencing financial stress.[3] Furthermore, smokers who spend more on cigarettes are more likely to report "smoking-induced deprivation", measured by asking smokers whether "money … spent on cigarettes resulted in not having enough money for household essentials such as food." [3 4] There is also evidence that quitting smoking is associated with a subsequent reduction in the probability of experiencing financial stress[5 6] and an increased level of prosperity.[5]

One of the strong and persistent determinants of smoking behavior in developed countries is socioeconomic status (SES). [7-12] For example, in the United States (U.S.), in 2015, smoking prevalence among adults living below the poverty line was nearly twice that of those at or above the poverty line (26.1% versus 13.9%). Similarly, smoking prevalence among individuals aged 25 years or older ranged from 34.1% in persons with a high school diploma to 16.6% in those with an associate degree to only 3.6% in those with a graduate degree. [9]

There are numerous studies documenting the association between SES and smoking behavior. Less has been published on the association between SES and expenditure on cigarettes. Whereas the primary implication of studies of the SES determinants of smoking pertains to the deleterious health effects of smoking and health inequalities, the primary implication of studies of cigarette expenditure relates to the financial burden of smoking.[3 13-15] An expenditure study conducted in Australia used data from a sample of 6,892 households and showed that those with

a lower SES were more likely to report tobacco expenditure.[16] The odds of tobacco expenditure were 2.3 times greater among households headed by a person with no educational qualification than a university degree and 1.4 times greater among households headed by a person with a blue-collar occupation than a professional occupation. Furthermore, among smoking households, those with a lower SES spent a higher proportion of their funds on tobacco. Percent of total household expenditure spent on tobacco was 46% higher among households headed by a person with no educational qualification than a university degree and 38% higher among households headed by a person with a blue-collar occupation than a professional occupation. A different study of 1,144 households in Sri Lanka revealed that while higher income households spent more on tobacco products, they had a lower tobacco expenditure as a percentage of total household expenditure.[13] Similar results were reported in a study conducted in the Russian Federation, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan,[15] and another in Morocco.[14] Finally, a study of 748 smokers in the U.S. showed that lower income households spent a higher percentage of their household income on cigarettes.[17] This study did not assess the association of other commonly used indicators of SES (e.g. education and occupation) with cigarette expenditure. Furthermore, the study did not adjust for the effect of possible confounders in assessing the relationship between income and percent of income spent on cigarettes. Finally, the study did not measure cigarette expenditure directly; instead, it was estimated indirectly by asking respondents how many cigarettes they smoked each day and the price they paid for their last pack of cigarettes. Our aim was to address these shortcomings. We used data from the Consumer Expenditure Survey (CES) in the U.S. to examine (1) the association between household SES and whether a household reports cigarette expenditure, and (2) SES variations in proportion of total household expenditure spent on cigarettes among smoking households.

METHODS

Data

We used data from the CES, which is conducted by the U.S. Census Bureau under contract with the Bureau of Labor Statistics.[18] The CES is a national household survey representing the entire U.S. civilian noninstitutional population. The CES uses a cluster sampling design where primary sampling units (PSUs) are small clusters of counties grouped together into geographic entities. The sampling frame within the primary sampling units is the Census Bureau's Master Address File, which contains residential addresses identified in the 2010 census. Approximately 6,900 households at the identified addresses are interviewed each quarter of the year. Each household is interviewed every three months over four calendar quarters. After the fourth interview, the household is dropped from the survey and replaced by a new sample. The response rates varied from the highest of 74.5% in 2010 to the lowest of 64.2% in 2015.[19] The interviews' duration was about 60 minutes and they were primarily conducted in person using a structured questionnaire to collect data on household income, demographics, and a complete range of expenditure items. We appended data from the third quarter data collection (i.e., July, August, and September) of six consecutive years, 2010-2015, with a total sample size of 39,806 households. We did not use the first quarter data because the expenditure report of some of the participants pertained to the previous calendar year. Our sensitivity analyses revealed that using data from the second and fourth quarter yields very similar results as we report in this article. We excluded from the analysis 588 households, i.e., 1.5% of the total number of households, for which there was a missing value for one or more study variables except income. While the amount of missing data was negligible and not likely to have biased the results, we note that households with missing data were more likely to be of a higher SES background and report

cigarette expenditure. The final sample size for the analysis was 39,218. Ethical approval was not needed for this study as we used secondary data that are publically available by the U.S. Bureau of Statistics.

Measurement of smoking status of households and cigarette expenditure as a proportion of total household expenditure

The head of household, who is the first person mentioned by a respondent to be the one who owns or rents the home of the household, [20 21] was asked: "since the first of the reference month [three months prior to the interview], have you or any members of your household purchased cigarettes?" An affirmative answer indicated a smoking household. The head of a smoking household was asked: "What is the usual weekly expense for cigarettes?" Weekly cigarette expenditure amounts were converted to quarterly amounts by the Census Bureau to match the timeframe for the reporting of most other household expenditures items. We converted nominal expenditure amounts to constant 2015 dollars using the commonly used all-items consumer price index to account for inflation.[22 23] For smoking households, we computed cigarette expenditure as a proportion of total expenditure including expenditure on items such as food, alcoholic beverages, tobacco and smoking supplies, housing, apparel, transportation, health care, entertainment, and personal care.

Measurement of SES and other covariates

We employed three SES indicators: household poverty status, education, and occupation of head of household. We defined poverty status as the ratio of household income to poverty threshold for a given family size and composition for each survey year.[24] Regression-based multiple imputation was used by the Census Bureau to replace missing household income data.[25] We categorized education of the head of household into four groups as follows: less than high

school, high school graduate, some college or associate degree, and Bachelor's or higher degree. We categorized occupation of the head of household into five groups as follows: manager and professional; administrative support, technician, sales; service, including cleaning and building service, health service, food and beverage preparation, and protective and private household service; blue-collar, including machine and transportation operator, handler, laborer, mechanic, and construction worker; other occupations; and not in the labor force.

Other covariates used in the models were as follows: race/ethnicity of head of household, categorized as non-Hispanic White, non-Hispanic Black, Hispanic, and other; household size; number of males aged 16 and over in the household; number of females aged 16 and over in the household; and survey year.

Statistical analysis

The unit of analysis in this study was the household. U.S. Department of Labor provides sampling weights for each CES survey quarter. These weights were computed based on the probability of selection of a household, household non-response, and national household distribution of age, race, and region.[18] In order to combine six years of surveys, we created a unified weight by multiplying the original weight in a given survey to the ratio of the sample size for that survey and the sum of samples sizes of all six surveys.[26] We used this unified weight for the computation of all point estimates and in all analyses.

The U.S. Department of Labor also provides 44 replicate samples with accompanying sampling weights for standard error estimation.[18] Using replicate samples to estimate a standard error involves computing a statistic for subsets of the full study sample and examining the variability of the statistic over the subsets.[27] In essence, this method allows a single sample to simulate multiple samples. Replicate samples were constructed using the "balanced repeated

replication" method where the sampled PSUs were divided into 44 strata and the households within each stratum were randomly divided into two half samples. CES uses a 44x44 Hadamard matrix to create the replicates in a "balanced" way.[28] Once the subsamples were formed, survey weights were computed for each subsample using the method described above for the weights for each CES survey quarter. Subsequently, 44 different estimates of a statistic were generated using only one half-sample per stratum. These estimates were then used to approximate standard errors based on the formula for computing sample standard deviation:

$$\sigma_{\hat{\theta}} = \sqrt{\frac{1}{44}\sum_{r=1}^{44}(\hat{\theta}_r - \hat{\theta})^2}$$

where $\hat{\theta}$ is the estimated statistic based on the full sample, $\sigma_{\hat{\theta}}$ is the standard error of $\hat{\theta}$, and $\hat{\theta}_r$ is the rth replicate estimate of $\hat{\theta}$. We used this data-dependent method of estimating standard errors which is especially useful when data is generated through a multi-stage sampling design and where, to preserve respondent anonymity, complete information on sample clusters or strata is not made available to researchers as is the case in CES.[29]

We first conducted preliminary analyses to assess the bivariable associations of household smoking status and cigarette expenditure as a proportion of total household expenditure with each predictor. Subsequently, we used binary response logistic regression to assess the association of household smoking status and SES indicators. We also used fractional response logistic regression to assess the association of cigarette expenditure as a proportion of total household expenditure with SES indicators.[30-32] Fractional models are suitable for doubly bounded continuous variables such as proportions. The results of these models can be presented as relative proportion ratios.[30] We checked for the normality of residuals and multicollinearity and found no violation of these ordinary least squares regression assumptions in the

multivariable model. In relation to the issue of multicollinearity, we note that the associations between poverty status and education (Kendall's tau-b=0.34), poverty status and occupation (Cramer's V = 0.27), and education and occupation (Cramer's V = 0.27) were moderate. Furthermore, the largest change in a standard error comparing bivariable and multivariable regression results was 29.3% and pertained to the dummy variable comparing households in poverty with those at or above 300% of poverty line in the binary response logistic regression. Covariates whose *p*-values were greater than 0.1 in the bivariable models were not included in the multivariable models. We used Stata version 14.1 for all analyses.[33]

RESULTS

Sample characteristics and bivariable associations

Table 1 provides weighted sample characteristics and bivariable associations between the covariates and the outcomes. Overall, 17.4% of households reported expenditure on cigarettes. Among smoking households, the mean quarterly expenditure on cigarettes in constant 2015 dollars was $458.1 and the mean cigarette expenditure as a percentage of total household expenditure was 5.6%. About 14.6% of the households lived below the poverty threshold and 38.4% of the heads of households did not report a level of education beyond high school graduation. About 25.5% of the households were headed by a person holding a managerial or professional occupation, 16.8% by a person with an administrative occupation, 12.9% by a person holding a service occupation, and 10.4% by a person in a blue-collar occupation. The percentage of non-Hispanic Whites, non-Hispanic Blacks, and Hispanics were 69.1, 12.5, and 12.7%, respectively. Table 1 also shows that compared with all households, smoking household had a higher percentage from lower SES backgrounds.

At the bivariable level, poorer households, those headed by a person with a lower level of education, and those headed by a person with a lower occupational status (such as blue-collar, service, or administrative compared to managerial or professional occupations) had a higher probability of being a smoking household. For example, while 22.1% of households below poverty reported cigarette expenditure, only 13.2% of those at or above 300% of poverty threshold did so. Similarly, while the percentage of smoking households was 22.6 among households headed by a person who did not complete high school, that percentage was only 8.2 among households headed by a college graduate. Furthermore, while 25.5% of household headed by a blue-collar person reported cigarette expenditure, only 11.7% of those headed by a person in a managerial or professional occupation did so.

Bivariable results also provide strong evidence that poorer households, those headed by a person with a lower level of education or lower occupational status had a higher percentage of their total expenditure devoted to cigarette expenditure.

Table 1. Weighted sample characteristics, bivariable association of smoking status of households and covariates (n = 39,218), and bivariable association of cigarette expenditure and covariates among smoking household (n = 6,559)

Covariates	% in full sample (% among smoking households)	% smoking household and 95% CI (*p-value* for χ^{2} [a])	Cigarette expenditure as % of total expenditure and 95% CI (*p-value* for χ^{2} [a])
Total sample		17.35	5.56 (5.37, 5.74)
Poverty status		($p < 0.001$)	($p < 0.001$)
< 100%	14.63 (18.61)	22.07 (20.45, 23.77)	7.74 (7.28, 8.20)
100%≥ and < 200%	21.38 (24.00)	19.47 (18.31, 20.68)	6.64 (6.33, 6.95)
200%≥ and < 300%	30.55 (32.05)	18.20 (17.27, 19.17)	5.00 (4.78, 5.23)
≥ 300%	33.44 (25.35)	13.15 (12.18, 14.18)	3.63 (3.46, 3.79)
Education		($p < 0.001$)	($p < 0.001$)
Less than high school	13.06 (17.03)	22.62 (20.92, 24.41)	7.60 (7.21, 7.99)
High school graduate	25.37 (34.60)	23.66 (22.45, 24.91)	5.98 (5.69, 6.27)
Some college or associate degree	31.09 (33.93)	18.93 (17.90, 20.01)	4.98 (4.74, 5.21)
Bachelor's or higher degree	30.47 (14.44)	8.22 (7.64, 8.85)	3.48 (3.28, 3.68)
Occupation		($p < 0.001$)	($p < 0.001$)
Manager and professional	25.48 (17.21)	11.72 (10.85, 12.65)	3.64 (3.43, 3.84)
Administrative support	16.78 (18.06)	18.67 (17.24, 20.20)	4.63 (4.43, 4.84)

Service	12.91 (14.52)	19.51 (18.17, 20.92)	5.38 (5.41, 5.73)
Blue-collar	10.44 (15.33)	25.46 (23.31, 27.74)	5.44 (5.09, 5.78)
Other Occupations	0.80 (0.64)	13.92 (9.88, 19.26)	4.28 (3.14, 5.41)
Not in the labor force	33.59 (34.20)	17.68 (16.93, 18.46)	7.16 (6.83, 7.49)
Race/ethnicity		($p < 0.001$)	($p < 0.001$)
Non-Hispanic White	69.09 (75.92)	19.06 (18.17, 19.99)	5.69 (5.50, 5.89)
Non-Hispanic Black	12.52 (12.09)	16.76 (15.13, 18.52)	5.94 (5.38, 6.50)
Hispanic	12.71 (8.04)	10.97 (9.84, 12.22)	4.28 (3.79, 4.78)
Other	5.68 (3.94)	12.04 (10.56, 13.70)	4.36 (3.85, 4.86)
Household size		($p < 0.001$)	($p < 0.001$)
1	29.51 (25.75)	15.13 (14.31, 16.00)	7.20 (6.85, 7.56)
2	32.15 (32.57)	17.57 (16.33, 18.89)	5.41 (5.16, 5.65)
3	15.22 (17.67)	20.13 (18.92, 21.40)	4.94 (4.61, 5.27)
4+	23.11 (24.02)	18.03 (16.96, 19.15)	4.44 (4.18, 4.70)
Number of males aged 16 +		($p < 0.001$)	($p < 0.001$)
0	22.81 (18.85)	14.34 (13.40, 15.34)	6.56 (6.16, 6.97)
1	63.85 (63.36)	17.22 (16.35, 18.12)	5.46 (5.27, 5.66)
2+	13.34 (17.78)	23.13 (21.90, 24.41)	4.82 (4.52, 5.12)
Number of females aged 16 +		($p < 0.001$)	($p < 0.001$)
0	16.38 (18.54)	19.63 (18.42, 20.91)	6.83 (6.47, 7.19)
1	68.47 (63.51)	16.09 (15.25, 16.96)	5.39 (5.19, 5.59)
2+	15.15 (17.95)	20.56 (19.23, 21.95)	4.82 (4.46, 5.19)
Year		($p = 0.009$)	($p = 0.190$)
2010	16.97 (18.13)	18.53 (17.20, 19.94)	5.93 (5.65, 6.22)
2011	16.00 (17.35)	18.81 (17.44, 20.26)	5.56 (5.27, 5.86)
2012	16.55 (16.27)	17.06 (15.78, 18.42)	5.29 (4.98, 5.61)
2013	16.70 (15.80)	16.41 (15.18, 17.73)	5.48 (5.08, 5.89)
2014	16.77 (15.77)	16.31 (15.14, 17.55)	5.39 (5.02, 5.76)
2015	17.01 (16.68)	17.01 (15.80, 18.30)	5.62 (5.21, 6.03)

[a] *P*-values for the bivariable association of covariates and each of the three outcomes using 44 replicate weights.

Multivariable analyses

Table 2 shows adjusted odds ratios and 95% confidence intervals (CI) for the association of being a smoking household and SES indicators. Poorer households, those headed by a person with a lower level of education or lower occupational status were more likely to report cigarette expenditure ($p < 0.001$ for poverty, education, and occupation). The odds ratio comparing households in poverty with those above 300% of poverty threshold was 1.86 (95% CI: 1.61, 2.16). Similarly, the odds ratio comparing households headed by a person who did not complete

high school with those headed by a person with at least a Bachelor's degree was 3.37 (95% CI: 2.92, 3.89). Furthermore, the odds ratio comparing households headed by a blue-collar worker with those headed by a person in a managerial or professional occupation was 1.45 (95% CI: 1.26, 1.66). Race/ethnicity was associated with smoking status ($p < 0.001$) such that the odds of being a smoking household were largest among households headed by a non-Hispanic White person and lowest among those headed by a Hispanic individual. Larger households ($p < 0.001$), those with more males 16 years or older ($p < 0.001$), and those with fewer females 16 years or older ($p = 0.036$) had higher odds of reporting cigarette expenditure. Finally, there was some evidence that the odds of being a smoking household were greater in 2010 and 2011 than in later years ($p = 0.036$).

Table 2 also shows the results of the fractional logit regression for modelling the association of cigarette expenditure as a proportion of total household expenditure with SES and other covariates, among smoking households. Poorer households, those headed by a person with a lower level of education or a lower occupational status had a higher cigarette expenditure as a proportion of total household expenditure. The relative proportion ratio comparing households in poverty with those above 300% of poverty threshold was 1.74 (95% CI: 1.62, 1.87). Similarly, the relative proportion ratio comparing households headed by a person who did not complete high school with those headed by a person with at least a Bachelor's degree was 1.80 (95% CI: 1.65, 1.96). Furthermore, the relative proportion ratio comparing households headed by a blue-collar worker with those headed by a person in a managerial or professional occupation was 1.16 (95% CI: 1.06, 1.27). Race/ethnicity was associated with proportion spent on cigarettes such that households headed by a non-Hispanic White person had the highest and those headed by a

Hispanic individual had the lowest proportion spent on cigarettes ($p < 0.001$). Larger households had a lower proportion spent on cigarettes ($p < 0.001$).

Table 2: Multivariable results[a] for the association of smoking status of household and cigarette expenditure as a proportion of total household expenditure with socioeconomic status indicators and other covariates

Covariates	Odds of being a smoking household (n = 39,218)		Cigarette expenditure as a proportion of household expenditure (n = 6,559)	
	Adjusted odds ratios (95% CI)	*p*-value	Adjusted relative proportion ratios (95% CI)	*p*-value
Poverty status		<0.001		<0.001
< 100%	1.86 (1.61, 2.16)		1.74 (1.62, 1.87)	
100%≥ and < 200%	1.46 (1.29, 1.65)		1.57 (1.46 , 1.69)	
200%≥ and < 300%	1.26 (1.18, 1.35)		1.28 (1.21, 1.36)	
≥ 300%	1.00		1.00	
Education		<0.001		<0.001
Less than high school	3.37 (2.92, 3.89)		1.80 (1.65, 1.96)	
High school graduate	3.02 (2.72, 3.35)		1.50 (1.37, 1.63)	
Some college or associate degree	2.31 (2.11, 2.54)		1.28 (1.18, 1.39)	
Bachelor's or higher degree	1.00		1.00	
Occupation		<0.001		<0.001
Manager and professional	1.00		1.00	
Administrative support	1.20 (1.09, 1.32)		1.05 (0.97, 1.14)	
Service	1.20 (1.09, 1.33)		1.16 (1.07, 1.26)	
Blue-collar	1.45 (1.26, 1.66)		1.16 (1.06, 1.27)	
Other Occupations	0.68 (0.44, 1.04)		0.90 (0.71, 1.13)	
Not in the labor force	0.92 (0.82, 1.03)		1.33 (1.25, 1.41)	
Race/ethnicity		<0.001		<0.001
Non-Hispanic White	1.00		1.00	
Non-Hispanic Black	0.65 (0.57, 0.46)		0.88 (0.81, 0.95)	
Hispanic	0.31 (0.78, 0.35)		0.68 (0.60, 0.77)	
Other	0.58 (0.50, 0.68)		0.80 (0.71, 0.90)	
Household size		<0.001		<0.001
1	1.00		1.00	
2	1.45 (1.28, 1.65)		0.82 (0.75, 0.89)	
3	1.62 (1.41, 1.86)		0.74 (0.66, 0.82)	
4+	1.32 (1.13, 1.54)		0.61 (0.54, 0.68)	
Number of males aged 16 +		<0.001		0.085
0	1.00		1.00	
1	1.17 (1.06, 1.29)		1.04 (0.95, 1.13)	
2+	1.60 (1.40, 2.09)		1.11 (0.99, 1.24)	
Number of females aged 16 +		0.036		0.867
0	1.00		1.00	

1	0.73 (0.65, 0.83)	0.99 (0.90, 1.09)	
2+	0.92 (0.80, 1.05)	1.01 (0.88, 1.16)	
Year	0.036		--
2010	1.00	--	
2011	1.02 (0.93, 1.11)	--	
2012	0.92 (0.83, 1.00)	--	
2013	0.88 (0.78, 0.99)	--	
2014	0.88 (0.79, 0.98)	--	
2015	0.95 (0.85, 1.06)	--	

[a] All odds ratios (OR) from logistic analysis and regression coefficients ($\hat{\beta}$) from linear regression analyses are adjusted for the effect of all covariates in the model.

DISCUSSION

In this study, we pooled data from six consecutive years of the U.S. CES and found that lower SES households not only are more likely to spend money on cigarettes but also spend a larger portion of their total household expenditure on cigarettes. Our results were consistent with a previous report in the U.S.[17] and the findings from other countries, although these findings pertained to the general category of tobacco expenditure and not specifically to cigarette expenditure.[13-16]

We also found that larger households and households headed by a non-Hispanic white person compared to others had a higher probability of reporting cigarette expenditure and spent a larger proportion of their total household expenditure on cigarettes. Furthermore, households with a larger number of males aged 16+ years and those with fewer females aged 16+ years had a higher probability of reporting cigarette expenditure. None of these covariates, except number of males and females in the household, have been previously investigated in regards to tobacco expenditure. Our findings about number of males and females were not consistent with a study that was conducted in the Russian Federation, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, and Tajikistan,[15] where number of males was positively and number of females was negatively associated with tobacco expenditure as a share of total household expenditure.

A strength of this work was its use of six consecutive years of national and comprehensive expenditure data with relatively high response rates and large sample sizes. The validity of the CES data has been investigated by comparing them with National Income and Product Accounts data.[34] While this comparison was not specifically done for cigarette expenditure, the findings showed that most of the large categories of consumption were measured well in the CES, as the ratio to the National Income and Accounts statistics was close to one and has not declined notably over time. [34] The major weakness of the study is that, as it is the case with all cross-sectional analyses, it does not allow causal inferences. It is plausible that poorer households headed by a person with a low level of formal education are more likely to have one or more smokers in the household and spend money on cigarettes. The effect of SES on smoking has been extensively studied.[7 35-39] It is also plausible that households that spend money on cigarettes and have higher health care expenditures due to smoking are more likely to have reduced income and experience downward socioeconomic mobility. However, to our knowledge, the effect of smoking on downward mobility has not been studied. Another weakness of this work is that, as reported in a study where households in the CES were linked to zip-code level average income, the very high income households are less likely to respond to the survey.[40] However, non-response rates were not associated with income over most of the income distribution.[40] Finally, we note that we did not have a reliable variable for survey mode to include in the analyses. Telephone surveys are associated with underreporting of smoking[41 42] and based on the extent to which survey mode is associated with SES, the results of this study could be biased.

Cigarette expenditure may contribute to financial deprivation and lower standards of living, which in turn can lead to unfavorable smoking behaviors and outcomes.[3 4 43-45] For

example, financial stress is associated with a lower probability of smoking cessation among smokers and a higher probability of relapse among ex-smokers.[43] Moreover, while smokers with financial stress are more likely to have an interest in quitting, they are less likely to make a quit attempt or succeed in quitting.[46] In light of our finding that lower SES households are more likely to include a smoker and spend relatively more on cigarettes, we recommend tobacco control policies that are effective in reducing smoking among lower SES groups. Increasing taxation on cigarettes is the most effective policy for reducing smoking among all segments of the population. In fact, many studies have shown that increasing the price of cigarettes results in a larger decrease in smoking prevalence among lower income and occupational groups than others.[7 47 48] This policy, however, is likely to negatively affect the finances of low income smokers who fail to quit or reduce smoking. To address this problem, part or all of the revenues from increased taxation can be used to fund evidence-based smoking cessation programs[49] for these smokers. Moreover, there is evidence that the effectiveness of increased taxation can be undermined by the availability of cheap tobacco and that changing the tobacco tax structure for cheap tobacco may promote quitting among low income groups.[50 51] In addition to increasing taxation, there is evidence that anti-smoking mass media campaigns are also effective in reducing smoking prevalence[52 53] and increasing cessation rates[54] among low SES smokers. Furthermore, it has been reported that plain packaging of and featuring large health warning labels on cigarette packs are associated with reduced positive brand image and intention to purchase cigarettes among socioeconomically disadvantaged smokers.[55] Finally, there is some evidence that bans on smoking in public places are effective in reducing smoking prevalence and consumption among lower SES smokers[56 57] and across all socioeconomic groups.[58]

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

Page #		Item No	Recommendation
1-2	**Title and abstract**	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
			(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
	Introduction		
3	Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
4	Objectives	3	State specific objectives, including any prespecified hypotheses
	Methods		
5	Study design	4	Present key elements of study design early in the paper
5	Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
5	Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants
6-7	Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
5	Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
5	Bias	9	Describe any efforts to address potential sources of bias
5	Study size	10	Explain how the study size was arrived at
6-7	Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
7-9	Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
			(*b*) Describe any methods used to examine subgroups and interactions
5			(*c*) Explain how missing data were addressed
			(*d*) If applicable, describe analytical methods taking account of sampling strategy
8			(*e*) Describe any sensitivity analyses
	Results		
5, 9	Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
			(b) Give reasons for non-participation at each stage
			(c) Consider use of a flow diagram
9-10	Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
			(b) Indicate number of participants with missing data for each variable of interest
10-13	Outcome data	15*	Report numbers of outcome events or summary measures
13	Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear

			which confounders were adjusted for and why they were included
			(*b*) Report category boundaries when continuous variables were categorized
			(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
	Discussion		
14	Key results	18	Summarise key results with reference to study objectives
15	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
14-15	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
14-15	Generalisability	21	Discuss the generalisability (external validity) of the study results
	Other information		
18	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Socioeconomic status and cigarette expenditure among U.S. households: Results from 2010-2015 Consumer Expenditure Survey

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Socioeconomic status and cigarette expenditure among U.S. households: Results from 2010-2015 Consumer Expenditure Survey

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ABSTRACT

Objectives: To examine (1) the association between household socioeconomic status (SES) and whether a household spends money on cigarettes, and (2) socioeconomic variations in proportion of total household expenditure spent on cigarettes among smoking households.

Methods: We pooled data from six consecutive years, 2010-2015, of the Consumer Expenditure Interview Survey. The interviews involved a structured questionnaire about household income, demographics, and expenditures including expenditure on cigarettes. Households that reported cigarette expenditure in the previous three months were distinguished as smoking households. SES indicators were household poverty status, education, and occupation of the head of household. Logistic regression was used to assess the association of household smoking status with SES. Fractional logistic regression was used to assess the association of cigarette expenditure as a proportion of total household expenditure with SES. The analysis sample size was 39,218.

Results: The probability of spending money on cigarettes was higher among lower SES households. Households in poverty compared with those above 300% of poverty threshold had 1.86 (95% CI: 1.61, 2.16), households headed by a person with less than high school education compared with those headed by a person with at least a bachelor's degree had 3.37 (95% CI: 2.92, 3.89), and households headed by a blue-collar work compared with those headed by a person in a managerial occupation had 1.45 (95% CI: 1.26, 1.66) higher odds of spending money on cigarettes. Similarly, the proportion of total household expenditure spent on cigarettes was higher among lower SES smoking households.

Conclusion: Lower SES households are more likely to spend money on cigarettes and spend a larger proportion of their total expenditure on cigarettes. We recommend strategies effective in reducing smoking among low SES smokers.

Strengths and limitations of this study:

- We used a national household survey representing the entire U.S. civilian noninstitutional population that involved a structured questionnaire to collect data on household income, demographics, and a complete range of expenditures.
- Conclusions are based on data from six consecutive years of national and comprehensive expenditure data with relatively high response rates and large sample sizes.
- The cross-sectional design does not allow for causal inferences about the relationship between socioeconomic status and whether a household spends money on cigarettes or percent of household expenditure spent on cigarettes among smoking households.

INTRODUCTION

Smoking cigarettes not only causes numerous health conditions,[1] but also is associated with deleterious financial consequences and a lowered standard of living. For example, smokers compared to non-smokers are more likely to experience financial stress, defined as events such as going without meals or not being able to pay rent.[2] Similarly, among smokers, higher cigarette expenditure is associated with a higher probability of experiencing financial stress.[3] Furthermore, smokers who spend more on cigarettes are more likely to report "smoking-induced deprivation", measured by asking smokers whether "money … spent on cigarettes resulted in not having enough money for household essentials such as food." [3 4] There is also evidence that quitting smoking is associated with a subsequent reduction in the probability of experiencing financial stress[5 6] and an increased level of prosperity.[5]

One of the strong and persistent determinants of smoking behavior in developed countries is socioeconomic status (SES). [7-12] For example, in the United States (U.S.), in 2015, smoking prevalence among adults living below the poverty line was nearly twice that of those at or above the poverty line (26.1% versus 13.9%). Similarly, smoking prevalence among individuals aged 25 years or older ranged from 34.1% in persons with a high school diploma to 16.6% in those with an associate degree to only 3.6% in those with a graduate degree. [9]

There are numerous studies documenting the association between SES and smoking behavior. Less has been published on the association between SES and expenditure on cigarettes. Whereas the primary implication of studies of the SES determinants of smoking pertains to the deleterious health effects of smoking and health inequalities, the primary implication of studies of cigarette expenditure relates to the financial burden of smoking.[3 13-15] An expenditure study conducted in Australia used data from a sample of 6,892 households and showed that those with

a lower SES were more likely to report tobacco expenditure.[16] The odds of tobacco expenditure were 2.3 times greater among households headed by a person with no educational qualification than a university degree and 1.4 times greater among households headed by a person with a blue-collar occupation than a professional occupation. Furthermore, among smoking households, those with a lower SES spent a higher proportion of their funds on tobacco. Percent of total household expenditure spent on tobacco was 46% higher among households headed by a person with no educational qualification than a university degree and 38% higher among households headed by a person with a blue-collar occupation than a professional occupation. A different study of 1,144 households in Sri Lanka revealed that while higher income households spent more on tobacco products, they had a lower tobacco expenditure as a percentage of total household expenditure.[13] Similar results were reported in a study conducted in the Russian Federation, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan,[15] and another in Morocco.[14] Finally, a study of 748 smokers in the U.S. showed that lower income households spent a higher percentage of their household income on cigarettes.[17] This study did not assess the association of other commonly used indicators of SES (e.g. education and occupation) with cigarette expenditure. Furthermore, the study did not adjust for the effect of possible confounders in assessing the relationship between income and percent of income spent on cigarettes. Finally, the study did not measure cigarette expenditure directly; instead, it was estimated indirectly by asking respondents how many cigarettes they smoked each day and the price they paid for their last pack of cigarettes. Our aim was to address these shortcomings. We used data from the Consumer Expenditure Survey (CES) in the U.S. to examine (1) the association between household SES and whether a household reports cigarette expenditure, and (2) SES variations in proportion of total household expenditure spent on cigarettes among smoking households.

METHODS

Data

We used data from the CES, which is conducted by the U.S. Census Bureau under contract with the Bureau of Labor Statistics.[18] The CES is a national household survey representing the entire U.S. civilian noninstitutional population. The CES uses a cluster sampling design where primary sampling units (PSUs) are small clusters of counties grouped together into geographic entities. The sampling frame within the primary sampling units is the Census Bureau's Master Address File, which contains residential addresses identified in the 2010 census. Approximately 6,900 households at the identified addresses are interviewed each quarter of the year. Each household is interviewed every three months over four calendar quarters. After the fourth interview, the household is dropped from the survey and replaced by a new sample. The response rates varied from the highest of 74.5% in 2010 to the lowest of 64.2% in 2015.[19] The interviews' duration was about 60 minutes and they were primarily conducted in person using a structured questionnaire to collect data on household income, demographics, and a complete range of expenditure items. We appended data from the third quarter data collection (i.e., July, August, and September) of six consecutive years, 2010-2015, with a total sample size of 39,806 households. Each household appears only once in the pooled dataset. We did not use the first quarter data because the expenditure report of some of the participants pertained to the previous calendar year. Our sensitivity analyses revealed that using data from the second and fourth quarter yields very similar results as we report in this article. We excluded from the analysis 588 households, i.e., 1.5% of the total number of households, for which there was a missing value for one or more study variables except income. While the amount of missing data was negligible and not likely to have biased the results, we note that households with missing data were more likely

to be of a higher SES background and report cigarette expenditure. The final sample size for the analysis was 39,218. Ethical approval was not needed for this study as we used secondary data that are publically available by the U.S. Bureau of Statistics.

Measurement of smoking status of households and cigarette expenditure as a proportion of total household expenditure

The head of household, who is the first person mentioned by a respondent to be the one who owns or rents the home of the household, [20 21] was asked: "since the first of the reference month [three months prior to the interview], have you or any members of your household purchased cigarettes?" An affirmative answer indicated a smoking household. The head of a smoking household was asked: "What is the usual weekly expense for cigarettes?" Weekly cigarette expenditure amounts were converted to quarterly amounts by the Census Bureau to match the timeframe for the reporting of most other household expenditures items. We converted nominal expenditure amounts to constant 2015 dollars using the commonly used all-items consumer price index to account for inflation.[22 23] For smoking households, we computed cigarette expenditure as a proportion of total expenditure including expenditure on items such as food, alcoholic beverages, tobacco and smoking supplies, housing, apparel, transportation, health care, entertainment, and personal care.

Measurement of SES and other covariates

We employed three SES indicators: household poverty status, education, and occupation of head of household. We defined poverty status as the ratio of household income to poverty threshold for a given family size and composition for each survey year.[24] Regression-based multiple imputation was used by the Census Bureau to replace missing household income data.[25] We categorized education of the head of household into four groups as follows: less than high

school, high school graduate, some college or associate degree, and Bachelor's or higher degree. We categorized occupation of the head of household into five groups as follows: manager and professional; administrative support, technician, sales; service, including cleaning and building service, health service, food and beverage preparation, and protective and private household service; blue-collar, including machine and transportation operator, handler, laborer, mechanic, and construction worker; other occupations; and not in the labor force.

Other covariates used in the models were as follows: race/ethnicity of head of household, categorized as non-Hispanic White, non-Hispanic Black, Hispanic, and other; household size; number of males aged 16 and over in the household; number of females aged 16 and over in the household; and survey year.

Statistical analysis

The unit of analysis in this study was the household. U.S. Department of Labor provides sampling weights for each CES survey quarter. These weights were computed based on the probability of selection of a household, household non-response, and national household distribution of age, race, and region.[18] In order to combine six years of surveys, we created an adjusted weight by multiplying the original weight in a given survey to the ratio of the sample size for that survey and the sum of samples sizes of all six surveys.[26] We used this adjusted weight for the computation of all point estimates and in all analyses.

The U.S. Department of Labor also provides 44 replicate samples with accompanying sampling weights for standard error estimation.[18] Using replicate samples to estimate a standard error involves computing a statistic for subsets of the full study sample and examining the variability of the statistic over the subsets.[27] In essence, this method allows a single sample to simulate multiple samples. Replicate samples were constructed using the "balanced repeated

replication" method where the sampled PSUs were divided into 44 strata and the households within each stratum were randomly divided into two half samples. CES uses a 44x44 Hadamard matrix to create the replicates in a "balanced" way.[28] Once the subsamples were formed, survey weights were computed for each subsample using the method described above for the weights for each CES survey quarter. Subsequently, 44 different estimates of a statistic were generated using only one half-sample per stratum. These estimates were then used to approximate standard errors based on the formula for computing sample standard deviation:

$$\sigma_{\hat{\theta}} = \sqrt{\frac{1}{44}\sum_{r=1}^{44}(\hat{\theta}_r - \hat{\theta})^2}$$

where $\hat{\theta}$ is the estimated statistic based on the full sample, $\sigma_{\hat{\theta}}$ is the standard error of $\hat{\theta}$, and $\hat{\theta}_r$ is the rth replicate estimate of $\hat{\theta}$. We used this data-dependent method of estimating standard errors which is especially useful when data is generated through a multi-stage sampling design and where, to preserve respondent anonymity, complete information on sample clusters or strata is not made available to researchers as is the case in CES.[29]

We first conducted preliminary analyses to assess the bivariable associations of household smoking status and cigarette expenditure as a proportion of total household expenditure with each predictor. Subsequently, we used binary response logistic regression to assess the association of household smoking status and SES indicators. We also used fractional response logistic regression to assess the association of cigarette expenditure as a proportion of total household expenditure with SES indicators.[30-32] Fractional models are suitable for doubly bounded continuous variables such as proportions. The results of these models can be presented as relative proportion ratios.[30] We checked for the normality of residuals and multicollinearity and found no violation of these ordinary least squares regression assumptions in the

multivariable model. In relation to the issue of multicollinearity, we note that the associations between poverty status and education (Kendall's tau-b=0.34), poverty status and occupation (Cramer's V = 0.27), and education and occupation (Cramer's V = 0.27) were moderate. Furthermore, the largest change in a standard error comparing bivariable and multivariable regression results was 29.3% and pertained to the dummy variable comparing households in poverty with those at or above 300% of poverty line in the binary response logistic regression. Covariates whose *p*-values were greater than 0.1 in the bivariable models were not included in the multivariable models. We used Stata version 14.1 for all analyses.[33]

Patient and public involvement

Patients and public were not involved.

RESULTS

Sample characteristics and bivariable associations

Table 1 provides weighted sample characteristics and bivariable associations between the covariates and the outcomes. Overall, 17.4% of households reported expenditure on cigarettes. Among smoking households, the mean quarterly expenditure on cigarettes in constant 2015 dollars was $458 and the mean cigarette expenditure as a percentage of total household expenditure was 5.6%. About 14.6% of the households lived below the poverty threshold and 38.5% of the heads of households did not report a level of education beyond high school graduation. About 25.5% of the households were headed by a person holding a managerial or professional occupation, 16.8% by a person with an administrative occupation, 12.9% by a person holding a service occupation, and 10.4% by a person in a blue-collar occupation. The percentage of non-Hispanic Whites, non-Hispanic Blacks, and Hispanics were 69.1, 12.5, and

12.7%, respectively. Table 1 also shows that compared with all households, smoking household had a higher percentage from lower SES backgrounds.

At the bivariable level, poorer households, those headed by a person with a lower level of education, and those headed by a person with a lower occupational status (such as blue-collar, service, or administrative compared to managerial or professional occupations) had a higher probability of being a smoking household. For example, while 22.1% of households below poverty reported cigarette expenditure, only 13.2% of those at or above 300% of poverty threshold did so. Similarly, while the percentage of smoking households was 22.6 among households headed by a person who did not complete high school, that percentage was only 8.2 among households headed by a college graduate. Furthermore, while 25.5% of household headed by a blue-collar person reported cigarette expenditure, only 11.7% of those headed by a person in a managerial or professional occupation did so.

Bivariable results also provide strong evidence that poorer households, those headed by a person with a lower level of education or lower occupational status had a higher percentage of their total expenditure devoted to cigarette expenditure.

Table 1. Weighted sample characteristics, bivariable association of smoking status of households and covariates (n = 39,218), and bivariable association of cigarette expenditure and covariates among smoking household (n = 6,559)

Covariates	% in full sample (% among smoking households)	% smoking household and 95% CI (*p-value* for χ^{2} [a])	Cigarette expenditure as % of total expenditure and 95% CI (*p-value* for χ^{2} [a])
Total sample		17.4	5.6 (5.4, 5.7)
Poverty status[b]		($p < 0.001$)	($p < 0.001$)
< 100%	14.6 (18.6)	22.1 (20.5, 23.8)	7.7 (7.3, 8.2)
100%≥ and < 200%	21.4 (24.0)	19.5 (18.3, 20.7)	6.6 (6.3, 7.0)
200%≥ and < 300%	30.6 (32.1)	18.2 (17.3, 19.2)	5.0 (4.8, 5.2)
≥ 300%	33.4 (25.4)	13.2 (12.2, 14.2)	3.6 (3.5, 3.8)
Education		($p < 0.001$)	($p < 0.001$)
Less than high school	13.1 (17.0)	22.6 (20.9, 24.4)	7.6 (7.2, 8.0)
High school graduate	25.4 (34.6)	23.7 (22.5, 24.9)	6.0 (5.7, 6.3)
Some college or associate degree	31.1 (33.9)	18.9 (17.9, 20.0)	5.0 (4.7, 5.2)

Bachelor's or higher degree	30.5 (14.4)	8.2 (7.6, 8.9)	3.5 (3.3, 3.7)
Occupation		($p < 0.001$)	($p < 0.001$)
Manager and professional	25.5 (17.2)	11.7 (10.9, 12.7)	3.6 (3.4, 3.8)
Administrative support	16.8 (18.1)	18.7 (17.2, 20.2)	4.6 (4.4, 4.8)
Service	12.9 (14.5)	19.5 (18.2, 20.9)	5.4 (5.4, 5.7)
Blue-collar	10.4 (15.3)	25.5 (23.3, 27.7)	5.4 (5.1, 5.8)
Other Occupations	0.8 (0.6)	13.9 (9.9, 19.3)	4.3 (3.1, 5.4)
Not in the labor force	33.6 (34.2)	17.7 (16.9, 18.5)	7.2 (6.8, 7.5)
Race/ethnicity		($p < 0.001$)	($p < 0.001$)
Non-Hispanic White	69.1 (75.9)	19.1 (18.2, 20.0)	5.7 (5.5, 5.9)
Non-Hispanic Black	12.5 (12.1)	16.7 (15.1, 18.5)	5.9 (5.4, 6.5)
Hispanic	12.7 (8.0)	11.0 (9.8, 12.2)	4.3 (3.8, 4.8)
Other	5.7 (3.9)	12.0 (10.6, 13.7)	4.4 (3.9, 4.9)
Household size		($p < 0.001$)	($p < 0.001$)
1	29.5 (25.8)	15.1 (14.3, 16.0)	7.2 (6.9, 7.6)
2	32.2 (32.6)	17.6 (16.3, 18.9)	5.4 (5.2, 5.7)
3	15.2 (17.7)	20.1 (18.9, 21.4)	4.9 (4.6, 5.3)
4+	23.1 (24.0)	18.0 (17.0, 19.2)	4.4 (4.2, 4.7)
Number of males aged 16 +		($p < 0.001$)	($p < 0.001$)
0	22.8 (18.9)	14.3 (13.4, 15.3)	6.6 (6.2, 7.0)
1	63.9 (63.4)	17.2 (16.4, 18.1)	5.5 (5.3, 5.7)
2+	13.3 (17.8)	23.1 (21.9, 24.4)	4.8 (4.5, 5.1)
Number of females aged 16 +		($p < 0.001$)	($p < 0.001$)
0	16.4 (18.5)	19.6 (18.4, 20.9)	6.8 (6.5, 7.2)
1	68.5 (63.5)	16.1 (15.3, 17.0)	5.4 (5.2, 5.6)
2+	15.2 (18.0)	20.6 (19.2, 22.0)	4.8 (4.5, 5.2)
Year		($p = 0.009$)	($p = 0.190$)
2010	17.0 (18.1)	18.5 (17.2, 19.9)	5.9 (5.7, 6.2)
2011	16.0 (17.4)	18.8 (17.4, 20.3)	5.6 (5.3, 5.9)
2012	16.6 (16.3)	17.1 (15.8, 18.4)	5.3 (5.0, 5.6)
2013	16.7 (15.8)	16.4 (15.2, 17.7)	5.5 (5.1, 5.9)
2014	16.8 (15.8)	16.3 (15.1, 17.6)	5.4 (5.0, 5.8)
2015	17.0 (16.7)	17.0 (15.8, 18.3)	5.6 (5.2, 6.0)

[a] *P*-values for the bivariable association of covariates and each of the three outcomes using 44 replicate weights.
[b] Higher percentages indicate higher relative income.

Multivariable analyses

Table 2 shows adjusted odds ratios (OR) and 95% confidence intervals (CI) for the association of being a smoking household and SES indicators. Poorer households, those headed by a person with a lower level of education or lower occupational status were more likely to report cigarette expenditure ($p < 0.001$ for poverty, education, and occupation). The odds ratio

comparing households in poverty with those above 300% of poverty threshold was 1.86 (95% CI: 1.61, 2.16). Similarly, the odds ratio comparing households headed by a person who did not complete high school with those headed by a person with at least a Bachelor's degree was 3.37 (95% CI: 2.92, 3.89). Furthermore, the odds ratio comparing households headed by a blue-collar worker with those headed by a person in a managerial or professional occupation was 1.45 (95% CI: 1.26, 1.66). Race/ethnicity was associated with smoking status ($p < 0.001$) such that the odds of being a smoking household were largest among households headed by a non-Hispanic White person and lowest among those headed by a Hispanic individual. Larger households ($p < 0.001$), those with more males 16 years or older ($p < 0.001$), and those with fewer females 16 years or older ($p = 0.036$) had higher odds of reporting cigarette expenditure. Finally, there was some evidence that the odds of being a smoking household were greater in 2010 and 2011 than in later years ($p = 0.036$).

Table 2 also shows the results of the fractional logit regression for modelling the association of cigarette expenditure as a proportion of total household expenditure with SES and other covariates, among smoking households. Poorer households, those headed by a person with a lower level of education or a lower occupational status had a higher cigarette expenditure as a proportion of total household expenditure. The relative proportion ratio comparing households in poverty with those above 300% of poverty threshold was 1.74 (95% CI: 1.62, 1.87). Similarly, the relative proportion ratio comparing households headed by a person who did not complete high school with those headed by a person with at least a Bachelor's degree was 1.80 (95% CI: 1.65, 1.96). Furthermore, the relative proportion ratio comparing households headed by a blue-collar worker with those headed by a person in a managerial or professional occupation was 1.16 (95% CI: 1.06, 1.27). Race/ethnicity was associated with proportion spent on cigarettes such that

households headed by a non-Hispanic White person had the highest and those headed by a Hispanic individual had the lowest proportion spent on cigarettes ($p < 0.001$). Larger households had a lower proportion spent on cigarettes ($p < 0.001$).

Table 2: Multivariable results[a] for the association of smoking status of household and cigarette expenditure as a proportion of total household expenditure with socioeconomic status indicators and other covariates

Covariates	Odds of being a smoking Household (n = 39,218)		Cigarette expenditure as a proportion of household expenditure (n = 6,559)	
	Adjusted odds ratios (95% CI)	*p*-value	Adjusted relative proportion ratios (95% CI)	*p*-value
Poverty status		<0.001		<0.001
< 100%	1.86 (1.61, 2.16)		1.74 (1.62, 1.87)	
100%≥ and < 200%	1.46 (1.29, 1.65)		1.57 (1.46, 1.69)	
200%≥ and < 300%	1.26 (1.18, 1.35)		1.28 (1.21, 1.36)	
≥ 300%	1.00		1.00	
Education		<0.001		<0.001
Less than high school	3.37 (2.92, 3.89)		1.80 (1.65, 1.96)	
High school graduate	3.02 (2.72, 3.35)		1.50 (1.37, 1.63)	
Some college or associate degree	2.31 (2.11, 2.54)		1.28 (1.18, 1.39)	
Bachelor's or higher degree	1.00		1.00	
Occupation		<0.001		<0.001
Manager and professional	1.00		1.00	
Administrative support	1.20 (1.09, 1.32)		1.05 (0.97, 1.14)	
Service	1.20 (1.09, 1.33)		1.16 (1.07, 1.26)	
Blue-collar	1.45 (1.26, 1.66)		1.16 (1.06, 1.27)	
Other Occupations	0.68 (0.44, 1.04)		0.90 (0.71, 1.13)	
Not in the labor force	0.92 (0.82, 1.03)		1.33 (1.25, 1.41)	
Race/ethnicity		<0.001		<0.001
Non-Hispanic White	1.00		1.00	
Non-Hispanic Black	0.65 (0.57, 0.46)		0.88 (0.81, 0.95)	
Hispanic	0.31 (0.78, 0.35)		0.68 (0.60, 0.77)	
Other	0.58 (0.50, 0.68)		0.80 (0.71, 0.90)	
Household size		<0.001		<0.001
1	1.00		1.00	
2	1.45 (1.28, 1.65)		0.82 (0.75, 0.89)	
3	1.62 (1.41, 1.86)		0.74 (0.66, 0.82)	
4+	1.32 (1.13, 1.54)		0.61 (0.54, 0.68)	
Number of males aged 16 +		<0.001		0.085
0	1.00		1.00	
1	1.17 (1.06, 1.29)		1.04 (0.95, 1.13)	
2+	1.60 (1.40, 2.09)		1.11 (0.99, 1.24)	
Number of females aged 16 +		0.036		0.867
0	1.00		1.00	

1	0.73 (0.65, 0.83)	0.99 (0.90, 1.09)	
2+	0.92 (0.80, 1.05)	1.01 (0.88, 1.16)	
Year	0.036		--
2010	1.00	--	
2011	1.02 (0.93, 1.11)	--	
2012	0.92 (0.83, 1.00)	--	
2013	0.88 (0.78, 0.99)	--	
2014	0.88 (0.79, 0.98)	--	
2015	0.95 (0.85, 1.06)	--	

[a] All odds ratios (OR) from logistic analysis and regression coefficients ($\hat{\beta}$) from linear regression analyses are adjusted for the effect of all covariates in the model.

DISCUSSION

In this study, we pooled data from six consecutive years of the U.S. CES and found that lower SES households not only are more likely to spend money on cigarettes but also spend a larger portion of their total household expenditure on cigarettes. Our results were consistent with a previous report in the U.S.[17] and the findings from other countries, although these findings pertained to the general category of tobacco expenditure and not specifically to cigarette expenditure.[13-16]

We also found that larger households and households headed by a non-Hispanic white person compared to others had a higher probability of reporting cigarette expenditure and spent a larger proportion of their total household expenditure on cigarettes. Furthermore, households with a larger number of males aged 16+ years and those with fewer females aged 16+ years had a higher probability of reporting cigarette expenditure. None of these covariates, except number of males and females in the household, have been previously investigated in regard to tobacco expenditure. Our findings about number of males and females were not consistent with a study that was conducted in the Russian Federation, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, and Tajikistan,[15] where number of males was positively and number of females was negatively associated with tobacco expenditure as a share of total household expenditure.

A strength of this work was its use of six consecutive years of national and comprehensive expenditure data with relatively high response rates and large sample sizes. The validity of the CES data has been investigated by comparing them with National Income and Product Accounts data.[34] While this comparison was not specifically done for cigarette expenditure, the findings showed that most of the large categories of consumption were measured well in the CES, as the ratio to the National Income and Accounts statistics was close to one and has not declined notably over time. [34] The major weakness of the study is that, as it is the case with all cross-sectional analyses, it does not allow causal inferences. It is plausible that poorer households headed by a person with a low level of formal education are more likely to have one or more smokers in the household and spend money on cigarettes. The effect of SES on smoking has been extensively studied.[7 35-39] It is also plausible that households that spend money on cigarettes and have higher health care expenditures due to smoking are more likely to have reduced income and experience downward socioeconomic mobility. However, to our knowledge, the effect of smoking on downward mobility has not been studied. Another weakness of this work is that, as reported in a study where households in the CES were linked to zip-code level average income, the very high income households are less likely to respond to the survey.[40] However, non-response rates were not associated with income over most of the income distribution.[40] Finally, we note that we did not have a reliable variable for survey mode to include in the analyses. Telephone surveys are associated with underreporting of smoking[41 42] and based on the extent to which survey mode is associated with SES, the results of this study could be biased.

Cigarette expenditure may contribute to financial deprivation and lower standards of living, which in turn can lead to unfavorable smoking behaviors and outcomes.[3 4 43-45] For

example, financial stress is associated with a lower probability of smoking cessation among smokers and a higher probability of relapse among ex-smokers.[43] Moreover, while smokers with financial stress are more likely to have an interest in quitting, they are less likely to make a quit attempt or succeed in quitting.[46] In light of our finding that lower SES households are more likely to include a smoker and spend relatively more on cigarettes, we recommend tobacco control policies that are effective in reducing smoking among lower SES groups. Increasing taxation on cigarettes is the most effective policy for reducing smoking among all segments of the population. In fact, many studies have shown that increasing the price of cigarettes results in a larger decrease in smoking prevalence among lower income and occupational groups than others.[7 47 48] This policy, however, is likely to negatively affect the finances of low income smokers who fail to quit or reduce smoking. To address this problem, part or all of the revenues from increased taxation can be used to fund evidence-based smoking cessation programs[49] for these smokers. Moreover, there is evidence that the effectiveness of increased taxation can be undermined by the availability of cheap tobacco and that changing the tobacco tax structure for cheap tobacco may promote quitting among low income groups.[50 51] In addition to increasing taxation, there is evidence that anti-smoking mass media campaigns are also effective in reducing smoking prevalence[52 53] and increasing cessation rates[54] among low SES smokers. Furthermore, it has been reported that plain packaging of and featuring large health warning labels on cigarette packs are associated with reduced positive brand image and intention to purchase cigarettes among socioeconomically disadvantaged smokers.[55] Finally, there is some evidence that bans on smoking in public places are effective in reducing smoking prevalence and consumption among lower SES smokers[56 57] and across all socioeconomic groups.[58]

Contributorship statement: Mohammad Siahpush contributed to the following aspects of the work: conception, design, data acquisition, using Stata for data analysis, interpretation of data, drafting, and critical revision. Paraskevi Farazi contributed to the following aspects of the work: conception, data analysis, interpretation of data, and critical revision. Shannon Maloney contributed to the following aspects of the work: conception, data analysis, interpretation of data, and critical revision. Danae Dinkel contributed to the following aspects of the work: conception, data analysis, interpretation of data, and critical revision. Minh Nguyen contributed to the following aspects of the work: design, data analysis, interpretation of data, drafting, and critical revision. Gopal Singh contributed to the following aspects of the work: conception, data analysis, and critical revision. All authors approve the final version as submitted. All authors are accountable for all aspects of the work.

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Data sharing statement: No additional data available.

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

Page #		Item No	Recommendation
1-2	**Title and abstract**	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
			(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
	Introduction		
3	Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
4	Objectives	3	State specific objectives, including any prespecified hypotheses
	Methods		
5	Study design	4	Present key elements of study design early in the paper
5	Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
5	Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants
6-7	Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
5	Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
5	Bias	9	Describe any efforts to address potential sources of bias
5	Study size	10	Explain how the study size was arrived at
6-7	Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
7-9	Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
			(*b*) Describe any methods used to examine subgroups and interactions
5			(*c*) Explain how missing data were addressed
			(*d*) If applicable, describe analytical methods taking account of sampling strategy
9			(*e*) Describe any sensitivity analyses
	Results		
9-10	Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
			(b) Give reasons for non-participation at each stage
			(c) Consider use of a flow diagram
9-10	Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
			(b) Indicate number of participants with missing data for each variable of interest
11-13	Outcome data	15*	Report numbers of outcome events or summary measures
11-13	Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear

			which confounders were adjusted for and why they were included
			(*b*) Report category boundaries when continuous variables were categorized
			(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
	Discussion		
14	Key results	18	Summarise key results with reference to study objectives
15	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
15-16	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
15-16	Generalisability	21	Discuss the generalisability (external validity) of the study results
	Other information		
17	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.