

Racial and ethnic disparities in healthcare costs and outcomes of cigarette smoking in USA: 2008–2019

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ABSTRACT

Background In 2023, President Biden issued an executive order requiring cost-benefit analyses for new regulations to account for distributional effects. To inform new tobacco regulations, we estimate for the first time racial and ethnic disparities in spending and outcomes associated with smoking.

Methods With the 2008–2019 Medical Expenditure Panel Survey linked to the National Health Interview Survey, $n=1\,180\,84$ adults-years, logit models estimate the per cent of the top 10 health conditions attributable to smoking. Two-part regression models estimate the share of and total annual healthcare spending attributable to smoking.

Results White adults had higher ever-smoked rates, but minority smoking adults had twice as much of their annual medical spending associated with smoking than white smoking adults, 25% vs 12% ($p<0.01$). minority adults who smoked had 41% ($p<0.05$) higher risks of multiple chronic conditions associated with smoking than white adults. While the share of white smoking adults trying to quit declined to 53% in 2019, this desire increased to 63% for minorities. From 2008–2016, smoking comprised 7.5% of the nation's spending for white adults and 10.7% for minorities ($p<0.05$). In 2017–2019, this declined to 2.5% of the nation's spending for white adults and 8.9% for minorities ($p<0.05$). For any new antitobacco regulation, the cost savings would be \$134 million per year for every 100 000 minorities averted from initiating smoking, 135% more than the \$57 million saved annually for 100 000 white adults averted.

Implications Minority adults may benefit substantially more from antitobacco regulations and past federal cost-benefit analyses would have overlooked this.

INTRODUCTION

The Family Smoking Prevention and Tobacco Control Act in 2009 allowed the Food and Drug Administration (FDA) to regulate cigarettes in the USA.¹ The primary motivation for regulation is to reduce the harm of smoking.² Each year, 480 000 people die prematurely from a smoking-attributed disease, making tobacco use the leading cause of preventable illness and death in the USA.³ The Centers for Disease Control and Prevention (CDC) estimated that the healthcare costs and lost productivity due to the harms of smoking is \$600 billion per year.⁴ Moreover, half of the adults who smoke admit they have tried to quit but cannot.⁵ In 2022, the FDA proposed plans for regulations that would establish a maximum nicotine level to help reduce the addictiveness of cigarettes.² The estimated impact would be to deter 33 million

WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ No research has yet examined racial and ethnic disparities in the medical costs of smoking.
- ⇒ This is important since as of April 2023 cost-benefit analyses required in the USA to pass antitobacco regulations must now include distributional analyses.

WHAT THIS STUDY ADDS

- ⇒ We show that even though minority adults have a lower ever-smoked rate than white adults and make more attempts to quit, their medical spending associated with smoking was twice as high, with a 41% higher rate of having multiple chronic conditions associated with smoking.
- ⇒ These disparities are continuing to increase over time.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ Our results indicate that the minority population will benefit much more than the white population under antitobacco regulations that reduce smoking, exemplifying the importance of agencies including such distributional analyses in their regulatory cost-benefit analyses.

people from smoking by 2100.⁶ To pass such wide-sweeping regulation requires the Office of Management and Budget (OMB) to demonstrate that the benefits of the regulation outweigh the costs. Such past cost-benefit analyses for various smoking regulations have spurred much debate and many court cases, particularly over how to measure lost pleasure for adults who became addicted by smoking underage.¹⁷

Surprisingly, a missing element in this debate has been a consideration of the racial and ethnic disparities in the medical costs and outcomes of smoking. On President Biden's first day of office in 2021, he issued a memo requiring OMB to work with agencies to develop new recommendations to modernise the OMB regulatory cost-benefit review process to 'promote public health and safety, economic growth, social welfare, racial justice, ...human dignity, equity, and the interests of future generations'.^{8,9} To implement this, on 6 April 2023, President Biden issued the Executive Order on Modernizing Regulatory Review, which states, 'Regulatory analysis, as practicable and appropriate, shall recognize distributive impacts and equity, to the extent permitted by law'.¹⁰ Going forward, when a federal agency wishes to issue a



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new regulation that impacts at least \$200 million in economic activity, it will present cost-benefit analyses to OMB that will now include analyses of the subpopulations particularly affected by the regulation. According to the proposed new OMB Circular A-4, the empirical evidence from these distributive analyses can then be used by agencies to justify selecting and implementing a regulatory option that might leave some net benefits on the table but confer a much bigger proportion of the benefits on disadvantaged communities.¹¹

Given the renewed national interest in regulating tobacco products, this Executive Order may take on added importance in tobacco regulation. To help shed light on the potential implications of the president's directive, in this study, we present, for the first time as far as we are aware, evidence of racial and ethnic disparities in the excess healthcare costs and outcomes associated with smoking. We also track the recent surge in the number of minority adults trying to quit smoking. Finally, we provide an update of the smoking literature's national estimates of the costs of smoking to year 2019.

DATA AND METHODS

To estimate the association between smoking and medical spending, we followed the CDC model of Xu *et al.*¹² The data come from the 2008–2019 Medical Expenditure Panel Survey (MEPS) Household Component, sponsored by the Agency for Healthcare Research and Quality (AHRQ). The MEPS sample consists of 2-year overlapping panels of households, selected annually from respondents to the National Health Interview Survey (NHIS), designed to yield nationally representative estimates of healthcare expenditures for the civilian, non-institutionalised population.¹³ We merged the subset of adults (age ≥ 18 years) from panels 12–24 in MEPS, not pregnant, to the adult sample of the 2006–2018 NHIS to obtain the smoking, drinking and body mass index variables for a subset of adults.¹⁴ Adults who smoked were classified as currently smoking if they were flagged as smoking in MEPS (if that was missing, they were flagged as smoking if they were currently smoking in NHIS). If not currently smoking, they were flagged as an adult who formerly smoked using the 'years since quitting' variable in the NHIS. We refer to an 'adult who ever-smoked' as a person who currently smokes or formerly smoked. To enable national estimates of this subsample, we performed a raking procedure (see online supplemental appendix methods). This resulted in a representative sample of 118 084 adult-years.

Medical spending was inflation-adjusted to 2019.¹⁵ A two-part expenditure model was used, with a first stage probit estimation of the impact of smoking interacted with race on any positive spending.¹⁶ The second stage was a Generalized Linear Model (with a gamma family) of the impact of smoking interacted with race on logged spending conditional on positive spending (see covariates and full specification in online supplemental appendix supplemental appendix tables 1 and 2).¹² We interacted ever-smoked with Non-Hispanic (NH) Black, Hispanic, NH Asian, and Other Race, with NH White as the omitted group. In a second regression, we alternatively combined these as 'Minority' interacted with smoking. 'Other Race' includes other NH races or multi-races, such as Native American. By 'White', we refer to NH white.

Total smoking attributable healthcare spending was projected by subtracting the predicted healthcare spending when simulating all adults as ever-smoked from their predicted spending when simulated as if they never smoked. This was then divided by the person's predicted annual spending to get the per cent

of spending attributable to smoking. The smoking attributable fraction of national spending was calculated by dividing the total smoking attributable healthcare spending by the total predicted spending for the entire population. All these predictions were then performed separately for the White and Minority populations. Differences in spending between Minorities and Whites were bootstrapped at 1000 replications to obtain CIs. These estimates were then aggregated to estimate the share of the nation's healthcare spending associated with smoking (see online supplemental Appendix Methods).

Covariates from the CDC model were used: eight age categories, sex, race, smoking, race interacted with smoking, marriage, education level, poverty level, uninsured, region, metro area, and year fixed effects, including behavioural variables such as alcohol consumption (non-drinker, current drinker, former or heavy drinker); body mass index; the extent to which respondent takes more risks than the average person (agree somewhat/strongly or uncertain/strongly disagree); and belief in own ability to overcome illness without medical help (agree somewhat/strongly or uncertain/strongly disagree).¹² We included controls for family size, hard labour (eg, construction) and retail work (covariates are defined fully in the online supplemental Appendix Methods).

To estimate the association between smoking and health outcomes, we used a logit model for each of the top 10 health conditions. AHRQ has selected 14 conditions in MEPS as 'priority conditions', based on their prevalence, expense or relevance to policy. We focus on the 10 most common priority conditions in the nation. All have been shown by the Surgeon General to be exacerbated by smoking.¹⁷ We regress each condition on race interacted with smoking. We additionally estimate the association between smoking and the probability of having 3 or more of the overall 14 conditions (see online supplemental Appendix Methods for regression details).

RESULTS

Disparities in smoker characteristics

In [table 1](#), over the period 2008–2019, the percentage of minority adults who were currently smoking was 17%, ranging from 7% for Asian adults to 20% for Black adults and 22% for Other Races, compared with 17% for White adults. Of the Minority adults 17% formerly smoked compared with 28% of White adults ($p < 0.01$). Overall, White and Other Race adults had the highest rate of having ever smoked, 45%. White adults smoked the most cigarettes per day, 14, compared with 9 for Minority adults ($p < 0.01$). Black adults had smoked for the most years, 25.8 years vs 24.7 years for White adults ($p < 0.01$). Even though Black adults smoked longer, Whites started smoking regularly underage (age < 18 years) more so than anyone else (23.4% vs 21.4% for Other Race, $p < 0.01$) (the current age limit of 21 years was implemented in December 2019). Thus, in general, while White adults had the highest rate of ever-smoked, smoked with the greatest intensity, and started more so underage, Black adults have smoked for more years.

DISPARITIES IN MEDICAL SPENDING

In the bottom panel of [table 1](#), compared with White never-smoking adults over the 12 years 2008–2019, White adults who smoked spent \$876 more on annual medical care ($876 = 7208 - 6332$). This excess of \$876 attributable to smoking amounted to 11.8% of the \$7208 yearly spending per White adult who smoked. In contrast, Minority adults who smoked spent much more associated with smoking, \$1509 ($p < 0.05$). This amounted to 24.9% of the \$6253 in annual spending per Minority adult

Table 1 Excess annual medical spending attributable to smoking: 2008–2019

| <i>Smoker characteristics</i> | All Adults | White Adults | All Minority Adults | Black Adults | Hispanic Adults | Asian Adults | Other Races |
|--|-----------------------|-----------------------|--------------------------|--------------------------|--------------------------|--------------------------|------------------------|
| Adults who formerly smoked | 24% | 28% | 17%*** | 17%*** | 18%*** | 12%*** | 23%*** |
| Adults who currently smoke | 17% | 17% | 15%*** | 20%*** | 12%*** | 7%*** | 22%*** |
| Adults who ever smoked | 41% | 45% | 32%*** | 37%*** | 30%*** | 19%*** | 45% |
| Cigarettes per day | 13 | 14 | 9*** | 10*** | 8*** | 8*** | 12*** |
| Adults who started smoking regularly under age 18 years | 19.7% | 23.4% | 12.7%*** | 13.5%*** | 13.3%*** | 5.6%*** | 21.4%*** |
| Years of smoking | 24.4 | 24.7 | 23.5*** | 25.8*** | 21.7*** | 21.4*** | 24.6 |
| Estimated annual medical spending | | | | | | | |
| Total spending per adult who ever smoked | \$6962 (6735–7189) | \$7208 (6939–7477) | \$6253*** (5859–6657) | \$6358*** (5769–6947) | \$6121*** (5343–6899) | \$4609*** (3739–5478) | \$7663 (6683–8642) |
| Total spending per adult who never smoked | \$5928 (5702–6154) | \$6332 (6054–6609) | \$4744*** (4496–4992) | \$5393*** (4956–5830) | \$4508*** (4175–4842) | \$3713*** (3310–4116) | \$5713 (4785–6640) |
| Difference | | | | | | | |
| Spending associated with smoking per smoking adult | \$1034 (734–1336) | \$876 (520–1233) | \$1509** (1034–1985) | \$965 (195–1735) | \$1613 (766–2460) | \$896 (–53–1844) | \$1950* (748–3153) |
| Percent of smoking adult's total spending associated with smoking | 15.6% (11.6–19.6) | 11.8% (7.0–16.5) | 24.9%*** (18.6–31.3) | 15.7% (4.7–26.7) | 27.4%*** (16.7–38.2) | 18.4% (0.5–36.2) | 26.6%** (12.4–40.8) |
| Notes: n=118084 adult-years, not pregnant. Smoking adults smoked more than 100 cigarettes in their lifetime. White=Non-Hispanic White. Minority=Hispanic, Black, Asian, and other non-Whites and multirace adults. 95% CIs in parentheses, bootstrapped with 1000 repetitions, controlling for clustering at the primary sampling units. Two-part estimation of spending by minority interacted with ever-smoked: Probit estimate of any positive spending followed by a Generalized Linear Model estimate of logged spending in 2019 dollars. Source: MEPS and NHIS. Minority different than Non-Hispanic White: ***p<0.01, **p<0.05, *p<0.1. MEPS, Medical Expenditure Panel Survey; NHIS, National Health Interview Survey. | | | | | | | |

who smoked, more than twice as much as the 11.8% for White adults who smoked ($p<0.01$). This was primarily driven by Hispanic and Other Race adults who smoked, where excess spending for smoking made up 27.4% ($p<0.01$) and 26.6% ($p<0.05$) of their annual expenditures per year, respectively. Black and Asian adults also had a greater per cent of spending than Whites associated with smoking, but the difference was not statistically significant. Next, we present the first stage of [table 1](#)'s two-part model: the probability that smoking makes one more apt to use any healthcare than no healthcare during the year (see online supplemental online supplemental appendix table 3). Compared with White adults who smoke, Black adults who smoke are 1.6 percentage points more apt to use healthcare attributable to smoking ($p<0.05$), and Hispanic adults are 3.1 ($p<0.01$) percentage points more likely than White adults.

Overall, the average adult who smoked in [table 1](#) spent \$1034 associated with smoking. This amount attributable to smoking varied considerably between former and current smokers. Adults who formerly smoked spent \$1197 per year associated with smoking, while adults who currently smoked spent \$767 per year associated with smoking ($p<0.05$) (see online supplemental online supplemental appendix table 4). However, this difference existed only among White adults, not among Minority adults. Next, the amount attributable to smoking also varied considerably if an adult started smoking underage. For them, the spending associated with smoking was \$1409 compared with only \$718 for those who started smoking after age 17 years ($p<0.01$) (see online supplemental online supplemental appendix table 5). This cost difference due to start age persisted among both White and Minority adults who smoked.

DISPARITIES IN OUTCOMES

Disparities in outcomes accompanied these disparities in spending. In [figure 1](#), we examined the association between ever-smoked and the top 10 health conditions. In all 10 conditions, smoking was associated with increased condition rates

compared with adults who never smoked ($p<0.01$). The most excessive rate was for heart disease, with 38.1% of the smoking adult's heart disease rate attributable to smoking. While there was no difference between Minority and White adults in heart disease attributable to smoking on average, Other Race did have the highest rate of heart disease attributable to smoking, 55.3% compared with 39.7% for white adults (not shown). Minority adults who smoked had statistically significant larger estimated excess outcome rates associated with smoking than White adults who smoked for five conditions: asthma, arthritis, cancer, heart attack and joint pain. The largest disparity was with asthma, with 35.2% of Minority adults who smoked having asthma associated with smoking compared with only 7.6% of White adults who smoked ($p<0.01$). Not shown, these disparities varied by race and ethnicity. For cancer, Black adults had the highest rate, 27.5%, attributable to smoking. Other Race adults had the highest rates attributable to smoking for joint pain (29.2%), heart disease (55.3%) and arthritis (54.9%). Hispanic adults had the highest rates attributable to smoking for heart attack (31.4%) and asthma (38.5%). Asian adults who smoke had the highest rates attributable to smoking for stroke (43.8%) and diabetes (23.2%).

Overall, smoking also impacted not just each of the top 10 conditions but the risk of having multiple conditions at once. While White adults who smoked had 23.7% of their probability of having multiple conditions associated with smoking, this increased by 41% to 33.5% for Minority adults who smoked ($p<0.01$). This held for each Minority race and ethnicity, peaking at 37.1% for Other Race (see online supplemental appendix figure 1).

DISPARITIES IN NATIONAL SPENDING

While [table 1](#) examined the spending on smoking per adult who smoked, [table 2](#) estimates the total national excess spending associated with smoking. Overall, the excess expenditures associated with adults who smoked amounted to 7.2% of annual

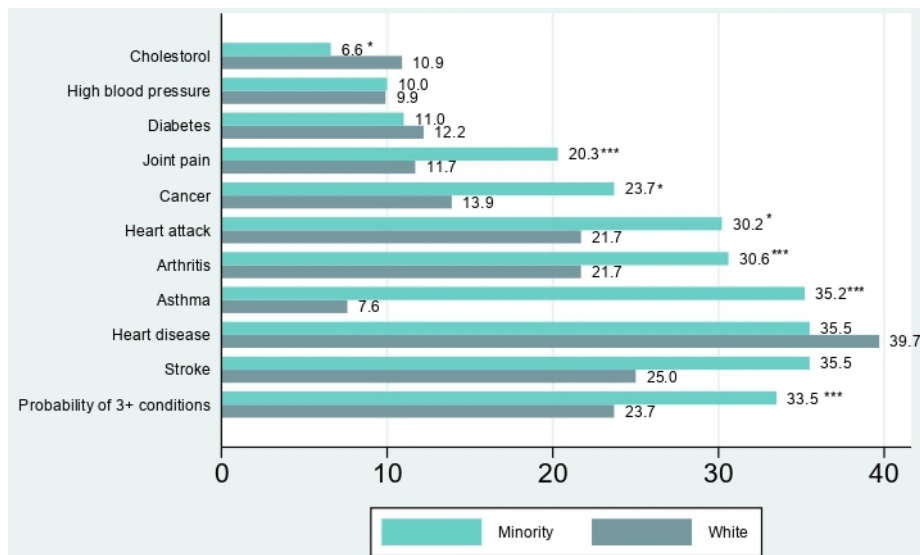


Figure 1 The percentage of healthcare conditions associated with smoking for adults who smoked: 2008–2019. Source: Medical Expenditure Panel Survey (MEPS) and National Health Interview Survey (NHIS). Notes: n=118 084 adult-years. Smoking=adults who smoked 100+ cigarettes in their lifetime. Logit estimates with bootstrapped SEs (1000 reps). White=Non-Hispanic White. All rates are significantly different than 0 at $p<0.01$. *** (***) (*) Minority rate differs from White rate at $p<0.01$, $p<0.05$ and $p<0.1$.

Table 2 The nation's share of healthcare spending associated with smoking: 2008–2019

| Share of nation's spending attributable to smoking | US population | White population | Minority population |
|--|---------------------|---------------------|-----------------------|
| Share of Total spending attributable to smoking | 7.2% (5.1–9.4) | 6.2% (3.7–8.8) | 10.2%** (7.2–13.4) |
| Share of population's | | | |
| Inpatient spending attributable to smoking | 12.0% (7.1–16.8) | 11.8% (5.9–17.8) | 12.3% (5.9–17.8) |
| Share of outpatient spending attributable to smoking | 6.1% (3.9–8.1) | 5.4% (2.8–7.9) | 8.2% (5.0–11.3) |
| Share of drug spending attributable to smoking | 8.5% (5.0–11.9) | 8.1% (3.9–12.3) | 9.7% (4.5–14.9) |
| Share of dental spending attributable to smoking | 3.2% (0.7–5.7) | 3.2% (0.2–6.2) | 3.1% (0.3–6.5) |
| Share of out-of-pocket attributable to smoking | 2.0% (-0.1–4.2) | 1.8% (-0.7–4.2) | 2.9% (-0.3–6.1) |
| Share of total spending attributable to smoking —paid by public programmes | 3.0% (2.2–3.9) | 2.5% (1.5–3.4) | 4.6%*** (3.2–6.1) |
| —due to those who quit or tried to quit smoking | 6.2% (4.4–7.3) | 5.6% (3.5–7.7) | 7.7% (5.2–10.2) |
| —due to those who started smoking under age 18 years | 4.6% (3.3–5.9) | 4.2% (2.7–5.8) | 5.8% (3.7–7.9) |
| —due to those who quit, tried to quit, or started under age 18 years | 7.1% (5.1–9.0) | 6.4% (4.1–8.8) | 8.9% (6.3–11.6) |

Notes: n=118 084 adult-years, representative of non-institutionalised, non-pregnant US population. Smoking adults smoked more than 100 cigarettes in their lifetime. White= Non-Hispanic White. Minority=Hispanic, Black, Asian, and other non-Whites and multirace adults. 95% CIs in parentheses, bootstrapped with 1000 repetitions, controlling for clustering at the primary sampling units. Two-part estimation of spending by minority interacted with ever-smoked: Probit estimate of any positive spending followed by a Generalized Linear Model estimate of logged spending in 2019 dollars. Source: MEPS and NHIS. Minority different than Non-Hispanic White: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
MEPS, Medical Expenditure Panel Survey; NHIS, National Health Interview Survey.

US medical expenditures by non-institutionalised adults not pregnant (upper panel of [table 2](#)). For the Minority population, 10.2% of their national spending was associated with excess expenditures by adults who smoked. This was 65% larger than the White population's 6.2% of the expenditure attributable to smoking ($p<0.05$). We also show this for all races, with the Hispanic population spending 11.0% ($p<0.10$) and the Other Race population spending 14.5% ($p<0.10$) of their annual healthcare expenditures on smoking-associated costs (see online supplemental appendix table 6).

From the middle panel of [table 2](#), we see that inpatient expenditures did not drive this disparity, since the White population had a slightly higher rate in inpatient expenditures associated with smoking, compared with the Minority population ($p=0.72$). The main disparity was in outpatient spending, with 8.2% in outpatient expenditures associated with smoking among Minorities, compared with 5.4% for the White population ($p=0.12$). Similarly, 9.7% of drug spending was associated with smoking among Minorities, compared with 8.1% for the White population ($p=0.57$), and 3.1% of dental expenditures for Minorities were associated with smoking, compared with 3.2% for the White population ($p=0.35$). Overall, 2.9% of out-of-pocket expenditures for Minorities were associated with smoking compared to 1.8% for the White population ($p=0.47$).

The bottom panel of [table 2](#) shows that overall, 3.0% of our national medical spending was attributable to smoking and paid by the federal government (Medicaid, Medicare, the Veterans Affairs, etc).

That is, the federal public programmes paid 42% (3.0/7.2) of the spending associated with smoking. This varied by race and ethnicity. Among White adults, 2.5% of national spending was associated with smoking and paid by the federal government, compared with 4.6% for the Minority population ($p<0.01$). That is, 40% (2.5/6.2) of the spending associated with smoking among White adults was paid by federal public programmes, compared with 45% (4.6/10.2) for Minority adults ($p<0.01$).

Table 3 Trends in the nation's share of healthcare spending associated with smoking: 2008–2016 vs 2017–2019

| Share of nation's spending attributable to smoking | US population | NH White population | Minority population |
|--|---------------------|----------------------|----------------------|
| 2008–2016 | 8.3% (5.8–10.8) | 7.5% (4.5–10.5) | 10.7% (7.6–13.8) |
| 2017–2019 (top quartile) | 4.2%** (0.9–7.6) | 2.5%** (-1.4–6.5) | 8.9%++ (3.6–14.2) |

Notes: 118084 adult-years. Bootstrapped (1000 reps). 95% CIs in parentheses, controlling for clustering at the primary sampling units. Smoking is current or former. NH=Non-Hispanic. Two-part estimation: Probit estimate of positive spending followed by a Generalized Linear Model estimate of logged spending. 2019 dollars. Source: MEPS and NHIS. Minority=Hispanic and Non-White adults. The late period differs from the early period. ** $p<0.01$, * $p<0.05$, $p<0.1$. Minority different than White: +++ $p<0.01$, ++ $p<0.05$, + $p<0.1$. MEPS, Medical Expenditure Panel Survey; NHIS, National Health Interview Survey.

Next, [table 2](#) examines the national spending attributable to certain adults who smoked. First, 6.2% of the nation's spending was associated with adults who tried to quit or did quit smoking. That is, 86% (6.2/7.2) of the spending associated with smoking was attributable to the 69.7% of smokers who wanted to quit or did quit. Second, 4.6% of the nation's spending was associated with those adults who started smoking regularly underage. Overall, 64% (4.6/7.2) of the national spending associated with smoking was attributable to the 20% of adults who started smoking under age 18 years. Combining these two groups, 34% of adults (83% of smokers) either tried to quit, did quit or started smoking underage. They were responsible for 7.1% of the nation's spending, or 98.6% (7.1/7.2) of all spending associated with smoking. These results were consistent across race and ethnicity, with no statistically significant differences.

RECENT INCREASES IN DISPARITIES IN SMOKING BEHAVIOUR

In [table 3](#), we see a widening disparity in the per cent of the population's spending attributable to smoking in the top quartile (2017–2019) compared with prior years. While the White population's spending associated with smoking declined from 7.5% to 2.5% from 2008–2016 to 2017–2019 ($p<0.05$), the Minority population's percentage remained relatively unchanged from 10.7% to 8.9% ($p=0.44$). That is, the gap between the White and Minority populations' per cent of spending on smoking doubled from 3.2 percentage points over 2008–2016 to 6.4 over 2017–2019 ($p<0.05$).

In [figure 2](#), over the latter part of the period 2008–2019, there was a sharp increase in the per cent of Minority adults who currently smoke who tried to quit in the past year or did quit (quitting defined as not smoking over the next 2 years), from 55% to 67% around 2012, compared with White smokers whose quit attempt rate decreased from 57% to 53% over the period. The Minority quit-attempt rate did not differ from the White rate in 2008 (60% vs 57%, $p=0.7$). However, by 2019 they differed, 63% for Minority adults who smoked versus 53% for White adults who smoked ($p<0.05$). All Minority races and ethnicities followed the general average minority pattern, increasing above the White rate over the period (see online supplemental appendix figure 2). Most of the increasing minority pattern in [figure 2](#) was driven by actual quits (see online supplemental appendix figure 3).¹¹ However, Black adults who currently smoke are more likely to try to quit but fail than all other adults who smoked (perhaps because of their higher rate of smoking menthol cigarettes, which are harder to quit).¹⁸

Finally, we see that the percentage of White adults who currently smoke and who started smoking regularly underage

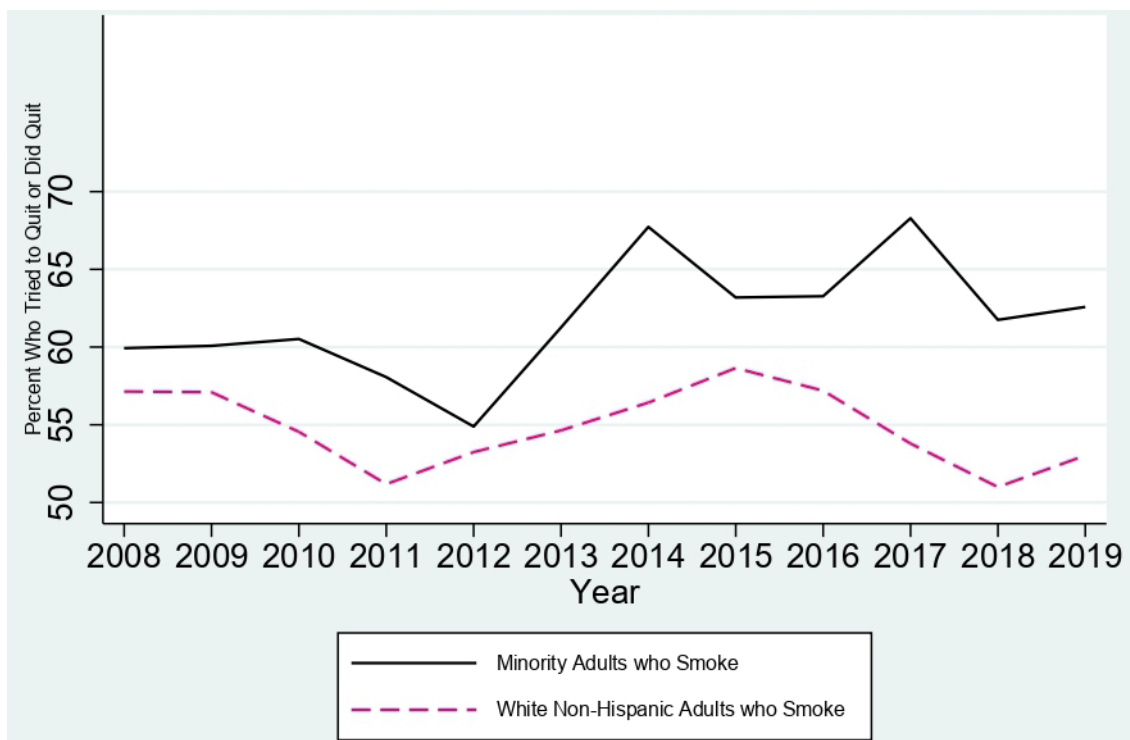


Figure 2 Percentage of smoking adults who tried to quit or did quit. Source: MEPS and NHIS. Notes: $n=9544$ adults currently smoking from NHIS, a year before MEPS. Two-year moving average of per cent of smoking adults not pregnant who stopped smoking cigarettes for more than 1 day in the past 12 months because they wanted to quit smoking, or did not smoke for the next 2 years in MEPS. MEPS, Medical Expenditure Panel Survey; NHIS, National Health Interview Survey.

has not changed much from 2008 to 2019, hovering above 50% (see online supplemental appendix figure 4).¹¹ However, for all Minority races, underage smoking has plummeted. For example, the percentage of current Black adults who smoke who started underage dropped by 50%, from 42% in 2009 to 21% in 2019.

DISCUSSION

This work provides an updated estimate of the national medical costs of smoking. Our 8.3% estimate of national spending attributable to smoking from 2008 to 2016 is consistent with the CDC's estimate¹⁹ of 8.7% for 2006–2010, and the Congressional Budget Office's (CBO)²⁰ estimate of 7% for 2000–2008. However, what is new is our finding that the rate declined to 4.2% for 2017–2019, reflecting the decline in smoking rates from 23% in 2000 to 14% in 2019. However, despite an even larger decline in smoking rates among Minority smokers, the percentage of national Minority healthcare spending associated with smoking has remained relatively stagnant over the last 20 years at about 9%–10%. As a result, the Minority population has not reaped very much in medical cost savings from the large reduction in the rate of smoking over the decades.

Our major contribution was to document racial and ethnic disparities in the spending attributable to smoking, something that has not been done before. While 6.2% of national spending was attributable to smoking among the White adult US population, it was 10.2% for the Minority population. This is despite that 45% of the White population ever-smoked (former and current smoking), compared with only 32% among the Minority population. If the Minority ever-smoking rate is simulated to be the same as the White rate, 45%, the percentage of Minority spending associated with smoking would increase from 10.2% to 14.3%. This is more than double the White percentage of spending associated with smoking. Moreover, such disparities are disproportionately borne by the federal budget, with 45% of the Minority smoking spending paid by the federal government, compared with only 40% for White smoking spending.

Why is smoking more costly among Minorities? Certainly, we have seen that Minority adults who smoke are 41% more likely to have three or more health conditions associated with smoking, compared with White adults who smoke. Whether this is in turn due to disparities in access (such as less frequent cancer screening and lab tests) is an open question for future research. What we do know is that Minority adults who smoke have recently shown greater interest in quitting smoking than White adults who smoke. We found that from 2008 to 2019, all of the increase in people trying to quit or actually quitting were Minority adults. With respect to smoking initiation, we also found that almost all of the decline in underage initiation of smoking was among Minorities.

Our results on distributional effects shed light on the potential benefits of President Biden's 6 April 2023 Executive Order on Modernising Regulatory Review, which states, 'Regulatory analysis, as practicable and appropriate, shall recognise distributive impacts and equity, to the extent permitted by law'.⁸ Going forward, when a federal agency wishes to issue a new regulation that impacts at least \$200 million in economic activity, it will present cost-benefit analyses to the Office of Information and Regulatory Affairs (OIRA) at OMB that will also now include analyses of the subpopulations particularly affected by the regulation. Traditionally, an agency will present three alternative scenarios to OIRA—its main proposal, one more stringent version of the regulation and one less stringent regulation. Each of these will now contain a distributional analysis. If they don't,

they will never be able to answer the question posed by OIRA Director Richard Revesz, 'Is it worth leaving some net benefits on the table in order to confer a much bigger proportion of the benefits on disadvantaged communities?'.²¹ The proposed new OMB Circular A-4, being revised for the first time since 2003, states, 'This interest may lead an agency to select a regulatory alternative with lower monetized net benefits over another with higher monetized net benefits because of the difference in how those net benefits are distributed in each alternative'.¹¹

The proposed Circular A-4 leaves it up to the agencies to decide what methods and demographic groups to use for these distributional analyses. While our research does not investigate a particular antitobacco regulation, it does indicate that if such regulation did reduce smoking, it could potentially have big distributional effects, with much larger medical cost savings accruing to Minority populations compared with the White population. In particular, we find that if a regulation averted 100 000 new people from initiating smoking, the cost savings would be \$134 million per year for 100 000 Minority adults averted from smoking, \$77 million (135%) more per year than the \$57 million saved per year for 100 000 White adults averted from smoking (see online supplemental appendix table 4). This would save the federal healthcare programmes \$83 million per year per 100 000 adults averted from smoking, \$60 million from Minority adults and \$23 million from White adults. Moreover, the increasingly strong impulse to quit smoking that we found among Minority adults who smoke over the last decade compared with White adults who smoke should be accounted for in cost-benefit analyses, since Minority adults who smoke may have less access to smoking cessation treatments compared with White adults. These findings would largely have gone unnoticed in past cost-benefit analyses and exemplify the importance of agencies including such distributional analyses.

Our spending estimates could possibly be biased if smoking is endogenous. For example, spending may be overestimated if smoking adults are more costly not because of smoking but due to, say, unobserved childhood adverse experiences or trauma that caused them to start smoking. Alternatively, it may be that adults who smoke are more apt to live in neighbourhoods with less access to medical care, so they spend less on healthcare. In the case where we do not observe these access issues, we would underestimate the impact of smoking. As a robustness check, in online supplemental appendix tables 7 and 8 we estimated the two-part spending model using an instrumental variables (IV) approach (also see the Appendix Methods section, 'Testing the Endogeneity of Smoking'). We found that we could reject the hypothesis that smoking is endogenous.

Finally, our paper addresses the main concern of a committee of prominent economists evaluating the FDA's cost-benefit analysis of graphic warning labels in 2014.²² The committee recommended that analyses should not account for the consumer surplus of adults who smoke who started smoking underage since they became addicted to cigarettes as children. The federal government should not be obligated to ascribe consumer surplus benefits to adults who began smoking underage.⁷ We bolster this ethics argument with additional economic evidence, showing that adults who started smoking regularly underage are almost twice as costly annually as those who started as adults (\$1409 vs \$718 per year in medical costs). That is, one adult who started smoking underage is equivalent in terms of excess annual healthcare costs to two adults who started smoking as adults. Moreover, 55% of their medical spending was paid by federal programmes. Thus, our research uncovers additional distributional effects beyond demographics—distributional effects for

groups that started smoking as children. This highlights the importance of agencies considering the multiple layers of the distributional effects of regulation.

Study limitations

We focused on cigarettes and did not include e-cigarettes and other tobacco products. About 4.6% of the population in 2021 used e-cigarettes. Moreover, our non-institutionalised data do not include the healthcare costs of smoking among the military and prison populations, nor nursing home spending. We did not analyse disparities in secondhand smoke, which future research should explore. We also did not examine disparities in the effect of smoking on longevity. The Congressional Budget Office (2012) estimates that smoking reduces life expectancy by 6–10 years.²⁰ Future research should examine a dynamic model of longevity and spending by race and ethnicity.

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