Declining trend in cigarette smoking among U.S. adults over 2008-2018: A decomposition analysis

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Abstract

Introduction: The association of smoking prevalence with socio-demographics and related disparities among U.S. adults are well documented. There is, however, limited information on what population characteristics contributed most to the significant decline in cigarette smoking levels in the recent past.

Method: The data were obtained from the nationally representative annual cross-sectional National Health Interview Surveys, 2008 and 2018, of U.S. adults (18+). We applied threefold Oaxaca-Blinder linear decomposition analysis of trends in cigarette smoking prevalence, initiation, and cessation into changes in population characteristics (composition effect), changes in individual smoking propensities by population characteristics (structure effect), and the interaction of the two (residual effect) to quantify specific contributions of different demographic and socio-economic characteristics of population (e.g., sex, age, race/ethnicity, education, marital status, employment status, health insurance coverage, family income, and region of residence) to the overall change in smoking rates.

Results: Decreases in smoking propensities regardless of the changes in population composition accounted for 68.4% of the reduction in overall smoking prevalence, 84.5% of the reduction in smoking initiation, and almost all the increase in successful smoking cessation. Reduction in smoking propensity among young adults (ages 18-24 years) and individuals with Medicaid coverage contributed most to the reduction in overall smoking prevalence. Reduction in smoking propensity among young adults with Medicaid coverage was the most significant factor in reducing smoking initiation. Non-Hispanic White smokers benefitted most from increase in successful smoking cessation.

Conclusion: Consistent reduction in smoking among U.S. adults by all major population characteristics in part reflects the success of active tobacco control interventions at national, state, and local levels. Disproportionately larger reduction in smoking propensities among the population sub-groups with initially higher smoking propensity compared to the national average accounted for most of the decline in cigarette smoking in the U.S. Persistence of higher-than-average smoking propensity and/or slowdown of the decline in smoking propensity can make the progress in smoking reduction inequitable. Strengthening of proven tobacco control measures with targeted intervention to induce smoking cessation among adult smokers is key to continued success in reducing smoking overall and remedying inequities in smoking and population health.

Introduction

Smoking is a major modifiable risk factor for non-communicable diseases. Smoking-related illnesses account for more than half a million deaths in the United States annually (GBD 2019). There has, however, been considerable progress in reducing cigarette smoking prevalence among U.S. adults by 67.7% over the past few decades (from 42.4% in 1965 to 13.7% in 2018) (NCHS, 2022). The decline in smoking prevalence at the aggregate level can broadly be viewed as an outcome of decline in smoking initiation among never smokers and increase in smoking cessation among ever smokers. Since 1965, former cigarette smoking prevalence increased moderately among all adults, a pattern that reflects relatively steady smoking cessation rate (USDHHS, 2020). Among young adults aged 18-24 years old, in contrast, former cigarette smoking prevalence declined since the late 1970s alongside remarkable decline in current cigarette smoking prevalence, which reflects decreasing cigarette smoking initiation (USDHHS, 2020).

The success of reduction in adult cigarette smoking has, however, been overshadowed by the growing concern that the burden of cigarette smoking, and its adverse health consequences are concentrated among low socio-economic status and disadvantaged population (Wang et al., 2018). The correlates of smoking initiation, cessation, prevalence, disparities, and their trends by age, sex, race/ethnicity, geography, and individual and household socio-economic status are well documented for U.S. adults (USDHHS, 2020; Drope et al, 2018; Garrett et al., 2015). There is, however, limited information on what population characteristics contributed most to the significant decline in cigarette smoking prevalence and initiation and increase in smoking cessation in the recent past.

The aggregate level smoking behavior can change over time through two mechanisms. First, the population composition may change towards the group that typically has lower or higher smoking propensities. Second, smoking propensity may change at different rates over time among different population subgroups that would be reflected in the convergence or divergence of smoking behavior among them. The residual change is attributable to the interaction of the above two mechanisms. The aim of this study is to partition the changes in cigarette smoking prevalence, smoking initiation and successful smoking cessation observed over 2008-2018 into these three components and identify which socio-demographic characteristics contributed most to the overall decline in smoking prevalence and which were sluggish.

From the policy perspective, while the compositional change may be driven by general macro-level changes (for example, educational policy change that encourages college education), the structural change in smoking propensities in different sub-groups can be directly influenced by tobacco control policy and related interventions. This decomposition analysis can aid us to understand the extent to which tobacco control policies can advance the goals of reduction of smoking prevalence in the overall population and in specific population sub-groups aimed at reducing smoking disparity.

Insight into the changing smoking propensities by population characteristics is necessary to measure differential progress in tobacco control. To the best of our knowledge there are no studies that examined the specific contribution of demographic and socio-economic factors in the declining trend in smoking prevalence over time in the U.S. This study can help inform policies aimed at accelerating the progress in reduction in overall smoking level while addressing smoking disparities and related health inequities.

Materials and Methods

Data source

This study used data from the 2008 and 2018 National Health Interview Survey (NHIS), an annual survey on health and behaviors (including tobacco use) of the civilian noninstitutionalized adult population aged 18 years and older in the United States. The NHIS is conducted in a computer-assisted face-to-face interview format by the National Center for Health Statistics and uses geographically clustered sampling techniques to generate a nationally representative sample (NCHS, 2019).

The total household response rate was 84.9% in 2008 and 64.2% in 2018. The Sample Adult response rate conditional on household participation in the survey was 74.2% in 2008 and 53.1% in 2018.[1,2] As these data are de-identified and publicly available, and the authors do not have access to any restricted or identifying information on the respondents, ethics approval was not required.

The NHIS Sample Adult component included 21,781 adults in 2008 and 25,417 adults in 2018. This study excluded respondents with missing data on smoking status (current, former, or never smoker) or any sociodemographic variable used in the analysis. Smoking status was missing in 256 observations (1.2%) in 2008 and 84 observations (0.3%) in 2018 data. Each population characteristic separately had missing values in less than 1% of the total sample, except for the family income status variable with missing values in 13.3% and 6.2% of total sample in 2008 and 2018 respectively. Altogether, the missing values accounted for loss of 3,212 observations (14.8% of total sample) in 2008 and 1,846 observations (7.3% of total sample) in 2018.

The final cross-sectional sample included 18,569 respondents in 2008 and 23,571 respondents in 2018 with an analytic pooled sample of 42,140 respondents for the analysis on the trend in smoking prevalence in the full sample of all adults (18 years and above). The trend in smoking initiation was analyzed based on the current smoking status among the young adult (18-24 years) sub-sample who were current or never smokers, with an analytic pooled sample size of 3,368. The trend in smoking cessation was analyzed based on recent successful smoking cessation among older adults (25 years and above) who were ever (current or former) smokers with an analytic pooled sample size of 7,729.

[1] Available from https://ftp.cdc.gov/pub/health_statistics/nchs/Dataset_Documentation/NHIS/2008/srvydesc.pdf Accessed November 7, 2022.
[2] Available from https://www.cdc.gov/nchs/hus/sources-definitions/nhis.htm Accessed November 7, 2022

Outcome variables

Current cigarette smoking status was coded 1 if the respondents reported to have smoked 100 or more cigarettes during their lifetime and answered “every day” or “some days” to the question “Do you NOW smoke cigarettes every day, some days or not at all?”. It was coded 0 otherwise.

Smoking initiation status was proxied by the current smoking status among young adults aged 18-24 years. It was coded 1 if a respondent was a current smoker according to the same definition as above and 0 otherwise. Former smokers were excluded from this sub-sample to focus on smoking initiation in isolation from smoking cessation. Recent evidence shows that the average age of smoking initiation (when people first try cigarettes or smoke regularly) has shifted from teens to young adulthood (ages 18-23 years), and that between 2002 and 2018, the proportion of young adults initiating smoking more than doubled (from 20.6% to 42.6%) (Barrington-Trimis et al., 2020). This shift in the average age of smoking initiation is linked to the minimum legal age to purchase cigarettes at age 18 introduced by most states over this period. It is, therefore, maintained throughout the analysis that the trend in smoking initiation is reflected in the current smoking status of young adults. The smoking initiation rate was thus measured by the ratio of the number of current smokers to the total number of current and never smokers among young adults.

Successful smoking cessation was measured by recent quit success among adult ever smokers aged 25 years and older. Recent quit success was defined as quitting smoking for six months or longer during the past year among former cigarette smokers who quit during the past year and current smokers who had smoked for at least two years (Creamer et al., 2019). The time span of smoking cessation was assessed by asking: “How long has it been since you quit smoking cigarettes?” to identify those former smokers who quit during the past year. Responses recorded in the dataset were less than 1 year, year values from 1 to 69 years, and 70+ years, and persons who answered “less than 1 year” and “1 year” were counted as quitting during the past year. To determine whether current smokers smoked for at least two years, time since initiation was measured by subtracting the age reported for when the person first started smoking regularly from the person’s current age. Recent successful smoking cessation rate was thus measured by the ratio of former smokers who quit for at least six months during the past year to the total number of these former smokers and the current smokers who had smoked for at least two years.

Population characteristics

This study included several sociodemographic variables in the model to decompose the changes in adult smoking prevalence, smoking initiation, and successful smoking cessation. The population characteristics that were available and comparable in both surveys in 2008 and 2018 were used as independent variables in the analysis, including sex (male and female), age group (18-24, 25-44, 45-64, and 65+), race/ethnicity (non-Hispanic White, non-Hispanic Black/African American, Asian, American Indian/Alaskan Natives (AI/AN), Hispanic, and multiracial), highest

level of education attained (below high school, high school diploma and below college, college graduate and above), marital status (married/living with partner and not married/living with partner), employment status (currently employed and not employed), health insurance coverage (uninsured, private insurance, Medicaid including dual eligible for Medicaid and Medicare, Medicare only, and other insurance), family income status relative to federal poverty level (FPL) (<100%, 100-200%, 200-400%, and >400%), and census region (northeast, midwest, south, and west). The details of these measures are provided in Appendix I.

As individuals cross the threshold age for high school graduation at approximately age 18 and they may not necessarily complete college education at the age interval 18-24, the cutoff between lower and higher educated persons among young adults was set at high school graduation level for the analysis on smoking initiation. For the analysis on smoking cessation among older adults aged 25 years and above, the highest level of education was classified as below high school, high school diploma and below college, and college and above based on the historically predominant pattern of educational inequalities in smoking among U.S. adults (de Walque, 2010; Pampel, 2009; Pierce et al., 1989).

Analytical framework

We applied threefold Kitagawa-Oaxaca-Blinder linear decomposition method to decompose the absolute reduction in smoking prevalence between 2008 (base year) and 2018 (reference year) into three effects in percentage point changes: shifts in population composition away from the sub-groups with relatively higher smoking propensities in the reference year (called 'composition effect'), reduction in smoking propensities keeping the population composition same as in the base year (called 'structure effect'), and the interaction of the changes in population composition and smoking propensities (called 'residual effect') (Kitagawa, 1955; Oaxaca, 1973; Blinder, 1973). The same method was applied to decompose the absolute reduction in smoking initiation and the absolute increase in smoking cessation. Throughout the rest of the paper, decrease in smoking prevalence and smoking initiation and increase in smoking cessation are interpreted as decrease in smoking propensity.

The relative contribution of a population characteristic to each type of effect was estimated by dividing the change in the outcome variable associated with the specific characteristic by the total change in the outcome variable due to the corresponding type of effect. All estimates were weighted by individual sample weights that account for the survey design and sample selection process. The statistical significance of the estimates was determined at 5% level. We reported a 95% confidence interval (CI) of the estimated contribution of each factor. Population characteristics identified with positive and statistically significant contributions were deemed to have accelerated the reduction in smoking prevalence while those with negative and statistically significant contributions had offsetting effect. The positive and the negative contributions add up to 100% of the total change under each type of effect.

The selection of the observation period over 2008-2018 was based on two considerations:

(1) The Family Smoking Prevention and Tobacco Control Act (TCA) was signed into law on June 22, 2009, that consolidated the federal regulation of the manufacture, distribution, and marketing of tobacco products under the authority of US Food and Drug Administration (FDA).[3] The baseline year 2008 covers the point of observation immediately preceding the enactment of the TCA and allows us to link the changes in smoking behavior at the population level from the base year to this landmark change in comprehensive tobacco control policy environment in the post-TCA era.
(2) The NHIS redesigned questionnaire and adjusted survey weights in 2019 which may render trend data non-comparable before and after the design. The preliminary evaluation by the National Center for Health Statistics suggests that the current smoking estimates for 2019 may have shifted upward by 0.5 percentage points due to methodological changes in survey weights.[4] Hence, 2018 was selected as the reference year allowing for a decade's interval wide enough for the decomposition of trend.

Previous research indicates that educational inequalities in adult smoking are generated by the combination of inequalities in initiation and quitting and that the inequalities in initiation play a larger role in generating the overall educational inequality in adult smoking prevalence (Maralani, 2013). In view of the potentially larger role of smoking initiation in driving changes in adult smoking prevalence, the decomposition was further broken down into two pathways: decrease in smoking initiation and increase in smoking cessation.

The technical details of the analytical framework are provided in Appendix II. All the statistical analyses were done using the *oaxaca* algorithm in STATA Version 17.0 MP-Parallel Edition (Jahn, 2008).

Results

Patterns and changes in smoking prevalence, initiation, and recent successful cessation

Cigarette smoking prevalence among U.S. adults (18 years and above) decreased from 20.6% to 13.7% (difference -6.9% points; P<0.001) between 2008 and 2018 (Table 1). Among young adults (18-24 years) who were never or current smokers, the percentage of current smokers decreased from 22.5% to 8.2% (difference -14.3% points; P<0.001) over the same period reflecting nearly two-thirds reduction in smoking initiation. The rate of recent successful smoking cessation among adults aged 25 years and above increased from 6.4% to 8.0% (difference 1.6% points; P=0.021). The substantial reduction in smoking initiation and moderate increase in recent successful smoking cessation indicate that the reduction in overall adult smoking prevalence was largely driven by the reduction in cigarette smoking initiation.

[3] Family Smoking Prevention and Tobacco Control and Federal Retirement Reform. Public Law 111-31—June 22, 2009. Available from https://www.govinfo.gov/content/pkg/PLAW-111publ31/pdf/PLAW-111publ31.pdf. Accessed November 7, 2022.
[4] National Center for Health Statistics (2020). "Preliminary evaluation of the impact of the 2019 National Health Interview Survey questionnaire redesign and weighting adjustments on Early Release Program estimates" from https://www.cdc.gov/nchs/data/nhis/earlyrelease/EReval202009-508.pdf . Accessed November 7, 2022.

Table 1 further reveals that smoking prevalence decreased across most population sub-groups among all adults with wide variation in the rates of absolute decrease. Those who did not experience any change in smoking prevalence include the elderly (65 years and older), AI/AN and multiracial persons, and Medicare recipients. These changes were accompanied by increasing proportions of the elderly population, Asian, AI/AN, Hispanic, and multiracial persons, college graduates, persons not married/living with partner, persons with Medicaid, Medicare, or other health insurance coverage, and persons in the highest income group (with family income above 400% of FPL). On the other hand, the proportions of the young and middle-aged individuals (18-24 and 25-44 years old), non-Hispanic White population, persons with education below college level, persons married/living with partner, those uninsured or covered with private health insurance, persons living in poverty (family income below 100% of FPL) or with family income at 200-400% of FPL, and residents in the midwest region decreased. The p-values of the differences in population proportions and smoking prevalence between 2008 and 2018 are provided in Table A1 in Appendix III.

Among young adults, smoking initiation decreased at statistically significant rates in most population sub-groups, except Asians, multiracial persons and individuals covered with other insurance. These changes were accompanied by increasing proportions of Hispanic and multiracial persons, high school graduates, persons not married/living with partner, persons covered with private or Medicaid health insurance, and persons in the highest income group with family income above 400% of the FPL. The proportions of non-Hispanic White individuals, persons with education below high school level, persons married/living with partner, uninsured, and persons with family income below FPL, declined. The p-values of the differences in population proportions and smoking initiation between 2008 and 2018 are provided in Table A2 in Appendix III.

Successful smoking cessation rate increased only among a few sub-groups—adults aged 25-44 years, non-Hispanic Whites, individuals with high school diploma but below college education, and currently employed persons while remaining steady among other sub-groups. Among older adult ever smokers, the population proportions of the elderly (65+ years old), Asians and multiracial persons, individuals with high school education and above, not married/living with partner, currently not employed, persons covered with Medicaid, Medicare or other insurance, and persons with family income just above the FPL (100-200% of FPL) increased. On the other hand, the proportions of adults aged 25-44 years, non-Hispanic White persons, individuals with less than high school education, married/living with partner, currently employed, uninsured and individuals covered with private insurance decreased. The p-values of the differences in population proportions and smoking initiation between 2008 and 2018 are provided in Table A3 in Appendix III.

Decomposition of reduction in adult cigarette smoking prevalence

The results of decomposition of the overall reduction in adult cigarette smoking prevalence presented in the first row in Table 2 indicate that the main contributor to the decrease in

smoking prevalence was the structure effect accounting for -5.0% points reduction (68.4% of the total reduction of -7.3% points). The composition effect contributed to -1.6% points reduction (22.1% of the total reduction of -7.3% points). The residual -0.69% points (9.4% of the overall reduction of -7.3% points) was due to the interaction of the changes in population composition and smoking propensities.

Panel A: Composition effect

The top three drivers in order of statistically significant percentage contribution to the total composition effect included increase in the proportion of adults with highest educational attainment at college level and above who had the lowest smoking propensity among all educational groups, increase in the proportion of the elderly (65 years and above) with relatively low smoking propensity among all adult age groups, and decrease in the proportion of non-Hispanic White persons with relatively high smoking propensity compared to the national average in the reference year. Among other sub-groups, increases in the proportions of Hispanic population and highest income group with family income above 400% of FPL, and decreases in the percentages of individuals with education below high school level, the uninsured, adults aged 25-44, adults aged 45-64, individuals with high school diploma and below college level education, lowest income group with family income below 100% of FPL, persons living in the midwest region contributed to the reduction in smoking prevalence. There were, however, offsetting contributions from decreases in the percentages of individuals covered by private insurance, young adults aged 18-24 years and individuals married/living with partner, and increases in the percentage of those covered by Medicaid.

Panel B: Structure effect

While all population-subgroups among U.S. adults experienced a decrease in smoking propensity, two major sub-groups experienced decrease at faster pace than others—young adults aged 18-24 years and persons with health insurance coverage from Medicaid. There were, however, offsetting contributions from the individuals covered by private insurance, the elderly, individuals with education at college level and above, and Hispanic persons who experienced moderate rate of absolute reduction in smoking propensity and decelerated the overall decrease. Had these groups experienced a similar rate of decrease to the positive contributors, the overall decline would have been much faster. The relative contributions of other population characteristics were not statistically significantly different from zero.

Panel C: Residual effect

The residual effect of changes in population composition and smoking propensities was largely driven by the elderly population, adults with highest educational attainment at college level and above, and Hispanic persons. The offsetting contributions came from the individuals covered by Medicaid and private insurance.

Decomposition of reduction in smoking initiation

The results of decomposition of the overall reduction in cigarette smoking initiation among young adults presented in the first row in Table 3 indicate that the main contributor to the

decrease in smoking initiation was the reduction in smoking propensities across all population sub-groups accounting for -12.7% points reduction (84.5% of the total reduction of -15.0% points). Compositional change contributed to -2.3% points reduction (15.3% of the total reduction of -15.0% points). The residual -0.02% points change (0.1% of the total reduction of -15.0% points) was due to the interaction of the changes in population composition and smoking propensities.

Panel A: Composition effect

The top three most important drivers in order of statistically significant percentage contribution to the total composition effect in reducing smoking initiation were decrease in the proportion of non-Hispanic White persons who had one of the highest smoking propensities among all racial/ethnic groups, decrease in the proportion of the married/living with partner young adults with higher smoking propensity than their counterparts, and increase in the proportion of Hispanic young adults with the lowest smoking propensity among all racial/ethnic groups in the reference year. Among other sub-groups, an increase in the proportion of the highest income group with family income above 400% of FPL with the lowest smoking propensity among all income groups contributed to the reduction in smoking initiation. No offsetting contributions were discerned to be statistically significant.

Panel B: Structure effect

While all population-subgroups among young adults experienced a decrease in smoking propensity, persons with health insurance coverage from Medicaid made the most significant contribution to the overall reduction due to the structure effect. There were, however, offsetting contributions from the individuals covered by private insurance, residents of the midwest region, and the Asians who experienced lowest rate of absolute reduction in smoking propensity in the respective population characteristic. The relative contributions of other population characteristics were not statistically significantly different from zero.

Panel C: Residual effect

The only statistically significant contribution to the overall interaction effect of changes in population composition and smoking propensities among young adults was found from individuals with private health insurance coverage which was largely offset by the negative contribution of those with Medicaid coverage. The overall interaction effect was, however, not statistically significant.

Decomposition of increase in recent successful smoking cessation

The results of decomposition of the moderate increase in overall recent successful smoking cessation among ever smokers aged 25 years and above presented in the first row in Table 4 indicate that the main contributor to the increase in smoking cessation was the structure effect accounting for almost all the total increase (1.63% points of overall 1.64% points). The contributions from composition and interaction effects were minimal and not statistically significant. As shown in Panel B of Table 4, the only population sub-group that made statistically

significant contribution to the increased cessation rate are the non-Hispanic White ever smokers.

Discussion

This study assessed contributions of various social, demographic, economic and geographic characteristics of the population to the reduction in cigarette smoking prevalence by about 7% points among U.S. adults between 2008 and 2018. Decreases in smoking propensities regardless of the changes in population composition accounted for 68.4% of the reduction in overall smoking prevalence, 84.5% of the reduction in smoking initiation, and almost all the increase in successful smoking cessation. Changes in population composition and its interaction with changing smoking propensities explained the rest.

The predominance of the structure effect in explaining the reduction in smoking prevalence is consistent with previous studies showing that changing propensities alone predict most of the observed decline in adult smoking prevalence (DeCicca and Kenkel, 2015; Mendez, Warner, and Courant, 1998). Nationwide tobacco control efforts, gaining momentum with the TCA enacted in 2009, may have contributed to the strong structure effect. The low level of contribution of the composition effect brings a big relief because addressing vulnerability (e.g., lower education, lower income, lack of insurance) at the population level takes fundamental social and economic improvement which is beyond the scope of tobacco control (Frieden, 2010). It also suggests that there is ample room for strengthening equitable tobacco control measures to speed up reduction in smoking prevalence in the vulnerable groups.

A closer look at the contribution of population characteristics to the structure effect indicates that young adults (ages 18-24 years) and individuals with Medicaid coverage were the major beneficiaries of the reduction in overall smoking prevalence. The significant reduction in smoking prevalence among young adults reflects decline in cigarette smoking initiation, which was largely driven by decrease in smoking propensity among young adults with Medicaid coverage. The progress in reduction in cigarette smoking among young adults was, however, accompanied by the uptake of e-cigarette use among youth with increasing availability of alternative nicotine delivery products diverting nicotine craving away from combustible cigarettes (Harrell et al., 2022; Bandi et al., 2021).

The decomposition of the trend in smoking behavior over 2008-2018 involves comparison of the smoking outcomes in 2008 with those at the end of the following decade in which the reforms of the Affordable Care ACT (ACA) took effect. The reform included expanded coverage of young adult family members under age 26 in the government-funded Medicaid program to support affordable health care beginning in 2010, state-based private coverage marketplaces since 2014, and in many states, income-based Medicaid expansion. It appears that the expansion of Medicaid coverage of young adults contributed to the remarkable progress in reducing smoking propensity among them driving down the overall smoking prevalence in the US adult population. This finding adds to the existing evidence base that the Medicaid provision

of comprehensive and preventive health services not only benefitted children from increased access to health care services, but also lifted them up leading to improved health, social and economic outcomes subsequently in their adulthood (Brown et al., 2015; Cohodes et al., 2014).

In contrast, the decomposition of the trend in successful smoking cessation rate suggests that Medicaid coverage did not make statistically significantly different contribution to increased successful cessation from other types of insurance or even lack of insurance coverage. This is despite ACA provisions implemented since 2014 that expanded eligibility for affordable health insurance coverage under Medicaid for people with limited income and resources and mandated comprehensive coverage for tobacco dependence treatments for most private health plans and new Medicaid beneficiaries in states with expanded Medicaid coverage (DeGiulio et al, 2016; Ku et al, 2016; Koma et al., 2017; Bailey et al., 2019; Maclean et al., 2019). This phenomenon might be linked to lack of stability and continuity of Medicaid coverage due to loss of eligibility among adults aged 26 years and older, which can be investigated further in future research (Ku, 2022).

Although the absolute increase in recent successful smoking cessation rate among the non-Hispanic White ever smokers was lower than that among non-Hispanic Black or Asian ever smokers, the overwhelmingly large proportion (74.3% in 2008, as shown in Table 1) of non-Hispanic White people among ever smoker population weighed most in the measurement of the progress in smoking cessation on average. The share of non-Hispanic White persons among ever smokers declined significantly over 2008-2018 while increasing or at least not decreasing for other racial/ethnic groups. Further investigation is necessary to identify the barriers of smoking cessation among the population sub-groups other than the non-Hispanic White group and gear tobacco control policy changes towards removing those barriers.

As of 2018, smoking prevalence among those with Medicaid coverage (23.5%) was still at a level comparable to the uninsured group (23.9%) and more than twice as high as the levels among those with private insurance or Medicare (Table 1). The rate of successful smoking cessation also continued to be the lowest among those covered by Medicaid. It suggests that there is ample room for stepping up efforts to reduce smoking propensity and improve smoking-related health outcomes among the underserved populations (e.g., lower income adults, rural residents, individuals with mental and physical disabilities) who are eligible for Medicaid and yet unable to share equal progress with the rest of the population. Medicaid expansion to increase coverage of smoking cessation is one plausible pathway to make significant contribution to eliminating the disparities in smoking-related and all-cause mortality.

Taken together, disproportionately larger reductions in smoking propensities among population sub-groups with initially higher smoking propensities compared to the national average accounted for most of the decline in overall smoking prevalence. The strengthening of proven tobacco control measures (e.g., education on the harms of smoking, increases in cigarette taxes, comprehensive prohibition of smoking in workplaces and other public spaces, mass media campaigns, restriction of marketing and advertising of tobacco products, mandatory

health warnings, cessation treatment programs, lawsuits won against tobacco industry and state funding for tobacco control programs) is key to continued success in reducing overall smoking prevalence while closing the smoking inequalities and related health disparities. Smoking explains a large part of the socioeconomic disparity in mortality from smoking-related diseases overall (62%), cardiovascular diseases (38%) and all-cause mortality (34%) in the U.S. (Glei et al., 2020). Therefore, reduction in smoking not only improves population health but also helps achieve health equity.

Contributions

The Kitagawa-Oaxaca-Blinder decomposition method has commonly been used to examine sources of disparities in smoking behaviors (Bauer et al., 2007; Chung et al., 2010; Dang, 2016; Amroussia et al., 2019; Chyderiotis et al., 2020). But it has not been applied to study trends in smoking prevalence until recently by Lahoti and Dixit (2021) to examine the sources of changes in smoking and smokeless tobacco use in India. The current study is the first to apply this method to examine the trend in smoking prevalence in the U.S.

Limitations

(1) This study focuses on only recent successful smoking cessation which is the most advanced stage of the progression of motivation and intention to quit smoking from pre-contemplation and contemplation to preparation and action where crucial interventions can be made to lead to the final stage, as the trans-theoretical model of change in human behavior suggests (Prochaska et al., 1992). The decomposition of smoking cessation behavior at all five stages remains to be the subject for future research.

(2) This study is limited to identifying the differential rates of progress in reducing smoking prevalence among major population sub-groups and does not explain the reasons for persistence of smoking disparities among them. For example, comprehensive smoke-free policies can benefit all individuals in the jurisdictions covered by the law irrespective of their socio-economic status, while protection from exposure to indoor secondhand smoke may depend on what type of housing people live in (Dinno and Glantz, 2009; USDHHS, 2006). Future research can address this gap based on individual level survey data that can be linked to local level variations in tobacco control policy environment as well as neighborhood characteristics. The NHIS data used for this study do not have local or state identifiers of respondents and hence do not allow for such spatial mapping in the broader social determinants of health framework.

(3) Mental health and sexual orientation are two important determinants of smoking status. These characteristics could not be included in the analysis due to the unavailability of these variables in the 2008 NHIS.

Conclusions

Consistent reduction in smoking among U.S. adults by all major population characteristics in part reflects the success of active tobacco control interventions at national, state, and local levels. Disproportionately larger reduction in smoking propensities among the population sub-groups with initially higher smoking propensity compared to the national average accounted for most of the decline in cigarette smoking in the U.S. Persistence of higher-than-average smoking propensity and/or slowdown of the decline in smoking propensity can make the progress in smoking reduction inequitable. Strengthening of proven tobacco control measures with targeted intervention to induce smoking cessation among adult smokers is key to continued success in reducing smoking overall and remedying inequities in smoking and population health.

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Table 1: Population proportion, smoking prevalence, initiation and cessation by US population characteristics, 2008 and 2018.

Population characteristics	All adults: Aged 18 years and above				Young adults: Aged 18-24 years				Ever smokers aged 25 and above			
	Proportion (%)		Smoking prevalence (%)		Proportion (%)		Smoking initiation (%)		Proportion (%)		Smoking cessation (%)	
	2008	2018	2008	2018	2008	2018	2008	2018	2008	2018	2008	2018
Overall	100.0	100.0	20.6	13.7	100.0	100.0	22.5	8.2	100.0	100.0	6.4	8.0
Sex												
Male	48.3	48.3	23.1	15.6	50.4	49.7	24.7	8.9	54.0	50.7	6.2	8.3
Female	51.7	51.7	18.3	12.0	49.6	50.3	20.2	7.6	46.0	49.3	6.7	7.3
Age group												
18-24	12.8	11.7	21.3	7.8	-	-	-	-				
25-44	36.3	34.4	23.7	16.5	-	-	-	-	49.1	45.7	7.0	10.0
45-64	34.3	33.3	22.6	16.3	-	-	-	-	42.5	40.5	5.8	5.2
65+	16.6	20.6	9.3	8.4	-	-	-	-	8.4	13.8	6.3	9.4
Race/Ethnicity												
Non-Hispanic White	68.7	63.2	22.0	15.0	60.9	52.2	26.1	11.4	74.3	69.1	6.8	8.6
Non-Hispanic Black	11.6	11.7	21.2	14.6	14.3	12.6	17.3	4.5	11.4	12.4	3.5	5.6
Asian only	4.5	6.1	9.8	7.1	4.8	6.2	10.0	5.5	2.1	3.2	5.9	10.5
American Indian/Alaskan Native	0.6	0.8	32.4	22.6	0.7	1.1	-	-	0.9	1.3	-	-
Hispanic	13.6	16.4	15.8	9.8	17.8	23.7	17.0	3.2	10.1	11.5	6.2	7.0
Multiracial	1.1	1.9	23.1	19.1	1.5	4.2	24.1	12.6	1.2	2.4	9.9	5.8
Highest level of education												
Below high school	15.3	11.4	27.3	20.3	-	-	-	-	19.2	16.0	4.8	3.1
High school diploma & below college	57.8	55.1	24.3	17.3	-	-	-	-	66.8	68.2	5.1	7.0
College and above	26.7	33.5	8.9	5.6	-	-	-	-	14.0	15.8	5.2	6.9
Below high school	-	-	-	-	19.1	12.0	26.1	11.1	19.1	15.9	4.8	3.1
High school and above	-	-	-	-	80.9	88.0	20.1	7.8	80.9	84.1	6.8	8.9

Population characteristics	All adults: Aged 18 years and above				Young adults: Aged 18-24 years				Young adults: Aged 18-24 years			
	Proportion (%)		Smoking prevalence (%)		Proportion (%)		Smoking initiation (%)		Proportion (%)		Smoking cessation (%)	
	2008	2018	2008	2018	2008	2018	2008	2018	2008	2018	2008	2018
Marital Status												
Married/Living with partner	61.9	60.0	18.9	12.5	23.6	16.4	27.2	15.2	61.3	56.6	6.4	8.3
Not married/living with partner	38.1	40.0	24.3	18.1	76.4	83.6	21.0	6.9	38.7	43.4	6.4	7.6
Employment status												
Currently employed	64.1	63.5	21.1	13.4	63.6	65.4	23.7	9.5	65.9	62.0	7.1	9.0
Not employed	35.9	36.5	19.9	14.3	36.4	34.6	20.3	5.8	34.1	38.0	5.2	6.4
Health insurance status												
Uninsured	15.5	10.4	32.8	23.9	28.3	14.1	31.3	12.5	23.3	17.4	4.2	6.2
Private insurance	55.7	53.6	17.6	10.8	56.1	64.7	15.8	6.9	50.7	42.7	8.1	9.7
Medicaid	7.3	11.3	35.4	23.5	10.7	17.4	35.0	8.7	11.4	18.7	3.9	5.4
Medicare only	15.4	17.6	11.2	10.0	-	-	-	-	9.3	13.4	6.1	8.1
Other insurance	4.8	6.7	21.7	15.6	4.4	3.6	24.0	13.1	5.3	7.8	6.3	8.5
Family income relative to FPL												
<100%	12.1	10.3	31.4	22.6	25.6	17.6	21.9	11.0	16.3	15.5	4.6	4.7
100-200%	16.5	17.3	26.9	19.4	21.0	21.8	29.8	8.8	19.4	23.6	4.8	5.8
200-400%	30.1	28.5	22.1	14.9	28.4	30.8	22.7	9.7	32.1	30.1	6.0	7.6
>400%	41.3	44.0	15.0	8.9	24.9	29.8	19.1	4.5	32.1	30.7	8.3	11.3
Region												
Northeast	17.1	17.3	18.8	12.5	15.4	13.7	22.9	9.1	15.8	15.9	6.8	9.5
Midwest	24.1	22.0	22.6	16.2	25.0	25.4	19.8	10.4	27.3	25.6	7.9	7.9
South	36.1	39.0	22.0	14.8	36.9	34.9	21.3	8.3	38.1	39.9	5.8	7.5
West	22.7	23.8	17.7	10.7	22.8	25.9	21.7	5.5	18.8	18.6	5.1	7.7

Note: FPL = Federal Poverty Level. Medicaid includes dual eligible for Medicaid and Medicare. Population proportion and smoking prevalence estimates were weighted by cross-sectional survey weights. Smoking prevalence, initiation, and cessation were suppressed in small samples that produced unstable estimates.

Table 2: Decomposition of the decrease in cigarette smoking prevalence among U.S. adults (aged 18+), 2008-2018.

Population characteristics	Panel A: Composition effect			Panel B: Structure effect			Panel C: Residual effect			Panel D: Overall	
	Change (% points)	95% CI	Contribution (%)	Change (% points)	95% CI	Contribution (%)	Change (% points)	95% CI	Contribution (%)	Total	(%)
Overall	-1.62	(-1.30 , -1.94)	100.0	-5.00	(-4.15 , -5.84)	100.0	-0.69	(-0.31 , -1.06)	100.0	-7.30	100.0
Sex											
Male	0.00	(0.02 , -0.02)	0.0	-0.16	(0.26 , -0.58)	3.3	0.00	(0.00 , 0.00)	0.0	-0.16	2.3
Female	0.00	(0.02 , -0.02)	0.0	0.17	(0.62 , -0.27)	-3.5	0.00	(0.00 , 0.00)	0.0	0.17	-2.4
Total	0.00	(0.05 , -0.05)	0.0	0.01	(0.04 , -0.02)	-0.2	0.00	(0.01 , -0.01)	0.0	0.01	-0.1
Age group											
18-24	0.08	(0.14 , 0.02)	-4.9	-0.65	(-0.36 , -0.94)	13.0	-0.07	(-0.01 , -0.12)	9.6	-0.64	8.7
25-44	-0.17	(-0.09 , -0.26)	10.6	-0.27	(0.35 , -0.89)	5.5	-0.02	(0.02 , -0.06)	2.7	-0.46	6.3
45-64	-0.10	(-0.02 , -0.17)	5.9	-0.08	(0.46 , -0.63)	1.7	0.00	(0.02 , -0.03)	0.5	-0.18	2.5
65+	-0.35	(-0.25 , -0.45)	21.7	1.31	(1.91 , 0.72)	-26.3	-0.33	(-0.18 , -0.49)	48.7	0.63	-8.6
Total	-0.54	(-0.35 , -0.72)	33.3	0.31	(0.79 , -0.17)	-6.2	-0.42	(-0.21 , -0.64)	61.5	-0.65	8.9
Race/Ethnicity											
Non-Hispanic White	-0.22	(-0.13 , -0.32)	13.9	-0.68	(1.08 , -2.44)	13.6	-0.06	(0.09 , -0.21)	8.4	-0.96	13.2
Non-Hispanic Black	0.00	(0.01 , -0.02)	0.1	0.11	(0.49 , -0.26)	-2.3	0.00	(0.01 , -0.01)	0.1	0.11	-1.5
Asian only	-0.02	(0.02 , -0.05)	1.2	0.18	(0.39 , -0.03)	-3.6	-0.05	(0.01 , -0.11)	7.2	0.11	-1.5
American Indian/Alaskan Native	0.01	(0.02 , -0.01)	-0.5	-0.05	(0.04 , -0.13)	0.9	0.02	(0.05 , -0.02)	-2.4	-0.02	0.3
Hispanic	-0.20	(-0.12 , -0.28)	12.1	0.59	(1.09 , 0.08)	-11.7	-0.09	(-0.01 , -0.18)	13.8	0.30	-4.0
Multiracial	0.03	(0.07 , 0.00)	-2.0	-0.02	(0.11 , -0.14)	0.3	0.01	(0.06 , -0.05)	-0.9	0.02	-0.3
Total	-0.40	(-0.27 , -0.53)	24.8	0.14	(2.50 , -2.22)	-2.8	-0.18	(-0.04 , -0.31)	26.2	-0.44	6.1
Highest level of education											
Below high school	-0.19	(-0.12 , -0.25)	11.5	-0.23	(0.01 , -0.47)	4.6	-0.08	(0.00 , -0.16)	11.7	-0.50	6.8
High school diploma & below college	-0.06	(-0.02 , -0.09)	3.5	-0.33	(0.40 , -1.05)	6.5	-0.01	(0.02 , -0.04)	1.7	-0.39	5.4
College and above	-0.45	(-0.35 , -0.55)	27.9	0.90	(1.41 , 0.38)	-17.9	-0.16	(-0.62 , -0.25)	22.8	0.29	-4.0
Total	-0.69	(-0.54 , -0.84)	42.9	0.34	(1.04 , -0.36)	-6.8	-0.25	(-0.09 , -0.41)	36.2	-0.60	8.3
Marital Status											
Married/Living with partner	0.04	(0.06 , 0.01)	-2.2	0.18	(0.77 , -0.40)	-3.7	0.01	(0.03 , -0.02)	-1.2	0.23	-3.1
Not married	0.04	(0.06 , 0.01)	-2.2	-0.12	(0.26 , -0.50)	2.4	0.01	(0.03 , -0.02)	-1.2	-0.08	1.1
Total	0.07	(0.11 , 0.03)	-4.4	0.06	(0.26 , -0.14)	-1.3	0.02	(0.07 , -0.04)	-2.4	0.15	-2.1
Employment status											
Currently employed	0.00	(0.01 , -0.01)	0.1	-0.44	(0.29 , -1.16)	8.7	-0.01	(0.01 , -0.03)	1.7	-0.45	6.2
Not employed	0.00	(0.01 , -0.01)	0.1	0.24	(0.65 , -0.16)	-4.9	-0.01	(0.01 , -0.03)	1.7	0.23	-3.2
Total	0.00	(0.02 , -0.03)	0.2	-0.19	(0.13 , -0.51)	3.9	-0.02	(0.02 , -0.07)	3.4	-0.22	3.0
Health insurance status											
Uninsured	-0.18	(-0.06 , -0.30)	11.1	-0.14	(0.16 , -0.44)	2.8	-0.08	(0.09 , -0.25)	11.4	-0.40	5.4
Private insurance	0.20	(0.28 , 0.12)	-12.4	1.51	(2.74 , 0.32)	-30.3	0.09	(0.17 , 0.01)	-13.3	1.81	-24.7
Medicaid	0.13	(0.21 , 0.06)	-8.1	-0.60	(-0.23 , -0.97)	12.0	0.21	(0.35 , 0.08)	-31.0	-0.26	3.5
Medicare only	0.00	(0.06 , -0.05)	-0.2	0.20	(0.72 , -0.32)	-4.0	-0.04	(0.06 , -0.14)	5.5	0.17	-2.3
Other insurance	-0.01	(0.03 , -0.04)	0.4	0.18	(0.38 , -0.02)	-3.6	-0.05	(0.01 , -0.12)	7.8	0.12	-1.6
Total	0.15	(0.36 , -0.07)	-9.2	1.15	(2.09 , 0.22)	-23.1	0.13	(0.45 , -0.19)	-19.6	1.44	-19.7
Family income relative to FPL											
<100%	-0.06	(-0.02 , -0.09)	3.5	0.07	(0.33 , -0.18)	-1.5	0.01	(0.06 , -0.03)	-1.8	0.03	-0.4
100-200%	0.01	(0.02 , -0.01)	-0.5	0.07	(0.41 , -0.27)	-1.4	0.00	(0.01 , -0.01)	0.3	0.08	-1.1
200-400%	0.01	(0.03 , -0.01)	-0.8	-0.23	(0.23 , -0.70)	4.7	-0.01	(0.01 , -0.04)	1.9	-0.23	3.2
>400%	-0.11	(-0.06 , -0.17)	6.9	-0.14	(0.63 , -0.91)	2.7	0.01	(0.06 , -0.04)	-1.2	-0.24	3.3
Total	-0.15	(-0.07 , -0.22)	9.0	-0.23	(0.44 , -0.89)	4.5	0.01	(0.08 , -0.01)	-0.8	-0.37	5.0
Region											
Northeast	0.00	(0.00 , -0.01)	0.2	0.00	(0.30 , -0.31)	0.1	0.00	(0.01 , -0.01)	0.0	-0.01	0.1
Midwest	-0.03	(-0.01 , -0.06)	2.0	0.29	(0.65 , -0.06)	-5.9	0.02	(0.06 , -0.01)	-3.5	0.28	-3.9
South	0.00	(0.01 , -0.01)	-0.1	-0.31	(0.20 , -0.81)	6.1	0.00	(0.01 , -0.01)	-0.4	-0.30	4.1
West	-0.02	(0.00 , -0.04)	1.2	-0.11	(0.25 , -0.47)	2.2	0.00	(0.02 , -0.01)	-0.6	-0.13	1.7
Total	-0.05	(-0.01 , -0.09)	3.3	-0.13	(0.12 , -0.38)	2.6	0.03	(0.08 , -0.01)	-4.5	-0.15	2.1
Constant				-6.46	(-3.75 -9.17)	129.4					

Table 3: Decomposition of the decrease in cigarette smoking initiation among young adults (aged 18-24), 2008-2018.

Population characteristics	Panel A: Composition effect			Panel B: Structure effect			Panel C: Residual effect			Panel D: Overall	
	Change (% point)	95% CI	Contribution (%)	Change (% point)	95% CI	Contribution (%)	Change (% point)	95% CI	Contribution (%)	Total	(%)
Overall	-2.31	(-0.98 , -2.99)	100.0	-12.72	(-9.55 , -15.90)	100.0	-0.02	(2.01 , -2.04)	100.0	-15.05	100.0
Sex											
Male	0.01	(0.08 , -0.07)	-0.2	-0.20	(1.22 , -1.63)	1.6	0.00	(0.02 , -0.02)	-7.1	-0.20	1.3
Female	0.01	(0.08 , -0.07)	-0.2	0.21	(1.67 , -1.26)	-1.6	0.00	(0.02 , -0.02)	-7.1	0.21	-1.4
Total	0.01	(0.16 , -0.14)	-0.4	0.01	(0.05 , -0.04)	0.0	0.00	(0.04 , -0.04)	-14.3	0.02	-0.1
Race/Ethnicity											
Non-Hispanic white	-0.39	(-0.07 , -0.72)	17.0	-0.95	(3.28 , -5.17)	7.4	-0.14	(0.50 , -0.79)	898.7	-1.48	9.9
Non-Hispanic Black	0.08	(0.21 , -0.05)	-3.4	0.50	(1.62 , -0.62)	-3.9	0.08	(0.30 , -0.13)	-522.6	0.66	-4.4
Asian only	0.02	(0.09 , -0.06)	-0.7	0.70	(1.32 , 0.08)	-5.5	-0.15	(0.09 , -0.39)	948.6	0.57	-3.8
American Indian/Alaskan Native	0.00	(0.04 , -0.04)	-0.1	-0.22	(0.15 , -0.58)	1.7	0.10	(0.30 , -0.11)	-595.4	-0.12	0.8
Hispanic	-0.28	(-0.06 , -0.50)	12.1	1.63	(3.53 , -0.27)	-12.8	-0.39	(0.12 , -0.90)	2457.4	0.96	-6.4
Multiracial	0.06	(0.19 , -0.08)	-2.4	-0.13	(0.65 , -0.91)	1.0	0.09	(0.60 , -0.42)	-543.1	0.01	-0.1
Total	-0.52	(-0.04 , -1.00)	22.4	1.54	(7.72 , -4.64)	-12.1	-0.42	(0.46 , -1.31)	2643.6	0.60	-4.0
Highest level of education											
Below high school	-0.11	(0.10 , -0.31)	4.6	0.03	(0.58 , -0.52)	-0.2	0.02	(0.34 , -0.30)	-111.2	-0.06	0.4
High school and above	-0.11	(0.10 , -0.31)	4.6	-0.22	(3.76 , -4.21)	1.7	0.02	(0.34 , -0.30)	-111.2	-0.31	2.1
Total	-0.21	(0.20 , -0.63)	9.2	-0.19	(3.25 , -3.63)	1.5	0.04	(0.68 , -0.61)	-222.4	-0.37	2.4
Marital Status											
Married/Living with partner	-0.23	(-0.01 , -0.44)	9.8	0.18	(0.82 , -0.46)	-1.4	0.09	(0.40 , -0.22)	-549.4	0.04	-0.3
Not married	-0.23	(-0.01 , -0.44)	9.8	-0.91	(2.26 , -4.08)	7.2	0.09	(0.40 , -0.22)	-549.4	-1.05	7.0
Total	-0.45	(-0.02 , -0.88)	19.6	-0.73	(1.81 , -3.26)	5.7	0.18	(0.79 , -0.44)	-1098.7	-1.00	6.7
Employment status											
Currently employed	0.02	(0.10 , -0.06)	-0.9	-0.48	(1.43 , -2.39)	3.8	0.01	(0.05 , -0.03)	-47.1	-0.45	3.0
Not employed	0.02	(0.10 , -0.06)	-0.9	0.25	(1.25 , -0.75)	-2.0	0.01	(0.05 , -0.03)	-47.1	0.28	-1.8
Total	0.04	(0.20 , -0.12)	-1.8	-0.23	(0.68 , -1.14)	1.8	0.02	(0.10 , -0.07)	-94.2	-0.17	1.1
Health insurance status											
Uninsured	-0.36	(0.26 , -0.98)	15.6	-0.16	(0.81 , -1.13)	1.2	-0.16	(0.80 , -1.12)	974.1	-0.67	4.5
Private insurance	-0.39	(0.00 , -0.77)	16.7	6.22	(10.12 , 2.32)	-48.9	-0.85	(-0.19 , -1.51)	5321.5	4.99	-33.1
Medicaid	-0.01	(0.25 , -0.26)	0.3	-2.32	(-0.86 , -3.79)	18.3	0.86	(1.51 , 0.21)	-5368.8	-1.47	9.8
Other insurance	-0.02	(0.08 , -0.13)	1.0	0.16	(0.57 , -0.25)	-1.3	0.06	(0.22 , -0.11)	-356.8	0.19	-1.3
Total	-0.78	(-0.04 , -1.51)	33.7	3.90	(7.88 , -0.07)	-30.7	-0.09	(1.27 , -1.46)	570.0	3.03	-20.2
Family income relative to FPL											
<100%	-0.20	(0.03 , -0.42)	8.5	0.66	(1.50 , -0.18)	-5.2	0.29	(0.67 , -0.10)	-1801.0	0.75	-5.0
100-200%	0.00	(0.02 , -0.02)	-0.1	-0.80	(0.44 , -2.04)	6.3	0.02	(0.15 , -0.11)	-147.6	-0.78	5.2
200-400%	0.02	(0.07 , -0.04)	-0.7	0.26	(1.77 , -1.24)	-2.1	-0.02	(0.08 , -0.11)	101.7	0.26	-1.8
>400%	-0.19	(0.01 , -0.38)	8.1	-0.28	(1.28 , -1.84)	2.2	0.05	(0.32 , -0.22)	-299.3	-0.42	2.8
Total	-0.36	(-0.02 , -0.71)	15.8	-0.16	(0.51 , -0.82)	1.2	0.34	(0.90 , -0.22)	-2146.2	-0.18	1.2
Region											
Northeast	0.00	(0.06 , -0.06)	0.0	-0.28	(0.65 , -1.20)	2.2	-0.04	(0.10 , -0.17)	226.7	-0.31	2.1
Midwest	0.00	(0.05 , -0.05)	-0.1	1.37	(2.73 , 0.01)	-10.8	-0.01	(0.19 , -0.21)	71.9	1.36	-9.1
South	0.00	(0.06 , -0.05)	-0.2	-0.88	(0.73 , -2.48)	6.9	-0.05	(0.09 , -0.20)	342.7	-0.93	6.2
West	-0.04	(0.06 , -0.15)	1.9	-0.20	(1.22 , -1.62)	1.6	0.03	(0.23 , -0.17)	-179.0	-0.22	1.4
Total	-0.04	(0.13 , -0.20)	1.6	0.02	(1.12 , -1.09)	-0.1	-0.07	(0.32 , -0.47)	462.3	-0.09	0.6
Constant				-16.88	(-8.12 , -25.65)	132.7					

Table 4: Decomposition of the increase in successful smoking cessation rate among U.S. adults (aged 25+), 2008-2018.

Population characteristics	Panel A: Composition effect			Panel B: Structure effect			Panel C: Residual effect			Panel D: Overal	
	Change (% point)	95% CI	Contribution (%)	Change (% point)	95% CI	Contribution (%)	Change (% point)	95% CI	Contribution (%)	Total	(%)
Overall	0.08	(0.51 , -0.36)	100.0	1.63	(3.00 , 0.26)	100.0	-0.07	(0.46 , -0.60)	100.0	1.64	100.0
Sex											
Male	0.00	(0.02 , -0.03)	-3.4	0.10	(0.88 , -0.67)	6.3	0.00	(0.03 , -0.03)	5.8	0.10	5.8
Female	0.00	(0.02 , -0.03)	-3.4	-0.08	(0.53 , -0.69)	-4.9	0.00	(0.03 , -0.03)	5.8	-0.09	-5.3
Total	-0.01	(0.04 , -0.05)	-6.7	0.02	(0.19 , -0.14)	1.3	-0.01	(0.05 , -0.07)	11.5	0.01	0.5
Age group											
25-44	-0.06	(0.02 , -0.14)	-75.5	0.63	(1.75 , -0.49)	38.5	0.05	(0.14 , -0.04)	-67.7	0.62	37.5
45-64	0.06	(0.15 , -0.02)	82.9	-0.72	(0.14 , -1.57)	-44.0	-0.04	(0.03 , -0.10)	56.4	-0.69	-42.2
65+	0.07	(0.20 , -0.06)	89.3	0.06	(0.52 , -0.41)	3.4	-0.02	(0.17 , -0.22)	34.0	0.10	6.2
Total	0.07	(0.31 , -0.16)	96.8	-0.03	(1.02 , -1.09)	-2.1	-0.02	(0.21 , -0.32)	22.7	0.02	1.5
Race/Ethnicity											
Non-Hispanic White	-0.10	(0.01 , -0.21)	-126.7	2.83	(5.32 , 0.35)	173.9	0.20	(0.40 , 0.00)	-293.3	2.94	179.3
Non-Hispanic Black	0.00	(0.02 , -0.03)	-4.6	0.42	(0.95 , -0.11)	25.9	-0.03	(0.04 , -0.10)	47.4	0.39	23.6
Asian only	0.01	(0.07 , -0.06)	9.4	0.11	(0.35 , -0.13)	6.8	-0.04	(0.06 , -0.14)	63.4	0.07	4.5
American Indian/Alaskan Native	-0.01	(0.01 , -0.02)	-10.6	-0.11	(0.04 , -0.26)	-6.7	0.03	(0.09 , -0.03)	-45.3	-0.09	-5.2
Hispanic	0.01	(0.05 , -0.03)	11.9	0.14	(0.68 , -0.40)	8.5	-0.01	(0.05 , -0.08)	21.3	0.13	8.1
Multiracial	-0.01	(0.04 , -0.06)	-8.6	-0.08	(0.13 , -0.29)	-4.8	0.04	(0.14 , -0.07)	-53.8	-0.05	-2.9
Total	-0.10	(0.04 , -0.24)	-129.2	3.32	(6.25 , 0.39)	203.6	0.18	(0.39 , -0.04)	-260.3	3.40	207.4
Highest level of education											
Below high school	0.14	(0.24 , 0.03)	181.1	-0.30	(0.11 , -0.71)	-18.6	-0.07	(0.03 , -0.18)	105.2	-0.24	-14.4
High school diploma & below college	-0.03	(0.02 , -0.08)	-41.3	0.32	(1.76 , -1.11)	19.9	-0.01	(0.04 , -0.06)	16.6	0.28	17.2
College and above	0.07	(0.17 , -0.04)	87.7	0.23	(0.79 , -0.33)	14.2	-0.02	(0.04 , -0.07)	28.4	0.28	17.0
Total	0.18	(0.35 , 0.00)	227.4	0.25	(1.36 , -0.85)	15.5	-0.10	(0.04 , -0.25)	150.2	0.32	19.8
Marital Status											
Married/Living with partner	0.02	(0.08 , -0.03)	32.2	-0.03	(0.75 , -0.80)	-1.6	0.00	(0.06 , -0.07)	3.2	0.00	-0.2
Not married	0.02	(0.08 , -0.03)	32.2	0.02	(0.61 , -0.57)	1.2	0.00	(0.06 , -0.07)	3.2	0.04	2.6
Total	0.05	(0.15 , -0.06)	64.4	-0.01	(0.18 , -0.20)	-0.4	0.00	(0.13 , -0.14)	6.4	0.04	2.4
Employment status											
Currently employed	-0.02	(0.04 , -0.07)	-21.6	0.11	(1.05 , -0.83)	6.7	0.01	(0.08 , -0.06)	-11.5	0.10	6.1
Not employed	-0.02	(0.04 , -0.07)	-21.6	-0.07	(0.50 , -0.63)	-4.0	0.01	(0.08 , -0.06)	-11.5	-0.07	-4.5
Total	-0.03	(0.08 , -0.14)	-43.2	0.04	(0.42 , -0.33)	2.6	0.02	(0.15 , -0.12)	-23.0	0.03	1.6
Health insurance status											
Uninsured	0.03	(0.16 , -0.10)	36.2	0.23	(0.72 , -0.27)	13.9	0.07	(0.24 , -0.09)	-108.5	0.33	20.1
Private insurance	-0.06	(0.12 , -0.24)	-77.3	-0.65	(0.53 , -1.82)	-39.7	-0.13	(0.11 , -0.37)	189.6	-0.84	-51.1
Medicaid	-0.02	(0.14 , -0.17)	-19.6	0.42	(0.98 , -0.13)	26.0	-0.16	(0.05 , -0.38)	240.4	0.24	14.9
Medicare only	0.01	(0.11 , -0.10)	7.4	-0.02	(0.51 , -0.56)	-1.5	0.01	(0.18 , -0.16)	-11.6	-0.01	-0.7
Other insurance	0.00	(0.08 , -0.08)	-4.7	-0.15	(0.16 , -0.45)	-8.9	0.05	(0.17 , -0.06)	-77.9	-0.10	-5.8
Total	-0.04	(0.30 , -0.39)	-58.0	-0.17	(0.77 , -1.10)	-10.2	-0.16	(0.32 , -0.64)	231.9	-0.37	-22.6
Family income relative to FPL											
<100%	0.01	(0.04 , -0.02)	11.1	-0.31	(0.15 , -0.78)	-19.2	-0.01	(0.03 , -0.05)	19.2	-0.32	-19.4
100-200%	-0.03	(0.04 , -0.10)	-40.2	-0.11	(0.41 , -0.62)	-6.5	0.02	(0.11 , -0.07)	-26.5	-0.12	-7.3
200-400%	0.01	(0.04 , -0.03)	8.0	0.15	(0.82 , -0.51)	9.3	0.01	(0.05 , -0.04)	-14.4	0.17	10.2
>400%	-0.03	(0.04 , -0.10)	-43.5	0.61	(1.53 , -0.32)	37.2	0.03	(0.09 , -0.04)	-40.1	0.60	36.6
Total	-0.05	(0.07 , -0.17)	-64.6	0.34	(0.80 , -0.12)	20.7	0.04	(0.19 , -0.10)	-61.7	0.33	20.2
Region											
Northeast	0.01	(0.03 , -0.02)	8.4	0.16	(0.64 , -0.32)	10.0	-0.01	(0.02 , -0.04)	9.9	0.16	10.0
Midwest	0.00	(0.01 , -0.01)	1.1	-0.44	(0.19 , -1.07)	-26.9	-0.01	(0.03 , -0.05)	16.0	-0.45	-27.4
South	0.00	(0.01 , -0.01)	-1.4	0.05	(0.89 , -0.78)	3.3	0.00	(0.01 , -0.01)	1.1	0.05	3.1
West	0.00	(0.02 , -0.01)	5.1	0.10	(0.57 , -0.38)	5.9	0.00	(0.02 , -0.02)	-4.7	0.10	6.3
Total	0.01	(0.05 , -0.03)	13.2	-0.12	(0.38 , -0.63)	-7.7	-0.02	(0.05 , -0.08)	22.4	-0.13	-7.9
Constant				-2.01	(1.74 , -5.77)	-123.4					

Appendix I: Description of population characteristics

The population characteristics that were available and comparable in both surveys in 2008 and 2018 were used as independent variables in the analysis, including sex (male and female), age group (18-24, 25-44, 45-64, and 65+), race/ethnicity (non-Hispanic White, non-Hispanic Black/African American, Hispanic, and other), highest level of education attained (below college and college or above), marital status (married/living with partner and not married), employment status (currently employed and not employed), health insurance coverage (uninsured and insured), family income status relative to federal poverty level (<100%, 100-200%, 200-400%, and >400%), and census region (northeast, midwest, south, and west). The details of these measures are provided in Appendix I.

The 'other' race/ethnic category included non-Hispanic Asian, non-Hispanic American Indian/Alaskan Native, and multiracial groups. These categories were not considered independently in the decomposition analysis in view of very low sample size (less than 200) of each race/ethnic category by age group (18-24 and 25 and above) and survey year producing unstable estimates.

The highest educational attainment below college level merged 0-12 years (no diploma), general educational development (GED) high school equivalency diploma, high school diploma, some college (no degree), and associate degree. The undergraduate and graduate degrees were merged into college and above level category. In marital status the 'not married' category included divorced/separated/widowed, and single/never married/not living with a partner.

The employment status was defined based on responses to two questions: (1) "What was [person]/were you doing last week?" and (2) "Have you ever held a job or worked at a business?". Adults who answered "working for pay at a job or business," "with a job or business but not at work," or "working, but not for pay, at a family-owned job or business" to the first question were classified as 'currently employed'. Adults who answered "looking for work" or "not working at a job or business and not looking for work" to the first question and subsequently answered "yes" to the second question were classified as 'previously employed'. Finally, adults who were "looking for work" or "not working at a job or business and not looking for work" based on the first question and answered "no" to the second question were classified as 'never employed'. The 'not employed' category in employment status included both the 'previously employed' and the 'never employed'.

Under the health insurance coverage status, the 'uninsured' category included adults who have not indicated that they are covered at the time of the interview under private health insurance, Medicare, Medicaid, Children's Health Insurance Program (CHIP), a state-sponsored health plan, other government programs, or military coverage. The 'insured' category included private coverage, Medicaid, Medicare only, and other coverage. Private coverage included adults who have any comprehensive private insurance plan (including health maintenance organizations and preferred provider organizations). Medicaid coverage status included adults aged less than

65 years who do not have private coverage but who have Medicaid or other state-sponsored health plans including CHIP; and adults aged 65 years and above who do not have any private coverage but have Medicare and Medicaid or other state-sponsored health plans including CHIP. Medicare only included adults aged 65 years and above who only have Medicare coverage. Other coverage included adults who do not have private insurance, Medicaid, or other public coverage, but who have any type of military coverage, coverage from other government programs, or Medicare. All four types of insurance were coded as one 'insured' category due to very low sample size (less than 200) of each insurance type in separate analysis of smoking initiation among young adults (18-24) and smoking cessation for older adult smokers (25 and above) producing unstable estimates.

The summary of the adult sample (18 years and above) by population characteristics and corresponding missing values are provided in Table A1.

Appendix II: Kitagawa-Oaxaca-Blinder linear decomposition

The smoking status of individuals is regressed on a set of individual characteristics for each year as follows:

$$s_{2008} = \beta_{2008,0} + \sum_i \beta_{2008,i} x_{2008,i} + \varepsilon_{2008} \quad (1)$$

$$s_{2018} = \beta_{2018,0} + \sum_i \beta_{2018,i} x_{2018,i} + \varepsilon_{2018} \quad (2)$$

where s_{2008} and s_{2018} denote current smoking status (1 if a current smoker and 0 otherwise), $x_{2008,i}$ and $x_{2018,i}$ denote the i-th population characteristic, $\beta_{2008,i}$ and $\beta_{2018,i}$ denote the regressions coefficients of the i-th characteristic, and ε_{2008} and ε_{2018} stand for the residual terms for the years 2008 and 2018 respectively.

Following Kitagawa-Oaxaca-Blinder linear decomposition method to decompose the change in smoking prevalence between 2008 and 2018 (Kitagawa, 1955; Oaxaca, 1973; Blinder, 1973), the change in smoking prevalence between 2008 and 2018 can be expressed as follows:

$$\begin{aligned}
\Delta s_{2008-2018} &= s_{2008} - s_{2018} \\
&= \sum_i \beta_{2018,i} \left(x_{2008,i} - x_{2018,i}\right) \\
&\quad + \left(\beta_{2008,0} - \beta_{2018,0}\right) + \sum_i x_{2008,i}\left(\beta_{2008,i} - \beta_{2018,i}\right) \\
&\quad + \sum_i \left(x_{2008,i} - x_{2018,i}\right)\left(\beta_{2008,i} - \beta_{2018,i}\right) \\
&= \Delta_C + \Delta_S + \Delta_I \qquad (3)
\end{aligned}$$

where $\Delta_C = \sum_i \beta_{2018,i} \left(x_{2008,i} - x_{2018,i}\right)$ denotes contribution due to changes in population characteristic or "composition effect" keeping the smoking propensity same as in the reference year 2018; $\Delta_S = \left(\beta_{2008,0} - \beta_{2018,0}\right) + \sum_i x_{2008,i}\left(\beta_{2008,i} - \beta_{2018,i}\right)$ denotes contribution due to changes in the propensities to smoke or the "structure effect" keeping the population composition unchanged at the base year 2008; and $\Delta_I = \sum_i \left(x_{2008,i} - x_{2018,i}\right)\left(\beta_{2008,i} - \beta_{2018,i}\right)$ accounts for the residual change or the "interaction effect" of compositional and structural changes.

We used the linear probability models, instead of logit model (which is more commonly used for binary outcomes), to estimate the effects of population characteristics on smoking status in view of two considerations: (i) This paper is concerned with the main sources of absolute reduction (in percentage points) in the level of smoking prevalence for decomposition of trend, as opposed to relative change (in percentages) which is relevant for decomposing inequality between two groups. Linear probability model provides direct estimates of absolute change. In contrast, the estimates from logit model (which is linear in the log of odds) cannot be directly interpreted in terms of absolute change. (ii) Estimates from linear probability models provide

close approximation to the effects on binary outcomes estimated from a logit model (Angrist and Pischke, 2008).

The detailed decomposition of equation (3) provided the absolute contributions of each characteristic. The relative contribution of each characteristic was estimated by dividing the absolute contribution of the characteristic by the total explained difference of the outcome variable between 2008 and 2018.

The decomposition of the declining trend in smoking prevalence can further be broken down into two pathways through which smoking prevalence can change: declining trend in smoking initiation and increasing trend in smoking cessation. To illustrate this decomposability, we considered the following individual-level relationship of smoking prevalence to the conditional probabilities of initiation and cessation (DeCicca et al, 2008):

$$Pr\{S_t = 1\} = Pr\{I_t = 1|S_{t-1} = 0\} \cdot Pr\{S_{t-1} = 0\} + (1 - Pr\{Q_t = 1|S_{t-1} = 1\}) \cdot Pr\{S_{t-1} = 1\} \quad (4)$$

where, Pr denotes probability, S_t denotes smoking status in year t, S_{t-1} denotes smoking status in past year t-1, I_t indicates smoking initiation status (equal to 1 if a nonsmoker in year t-1 initiates smoking in year t and 0 otherwise), and Q_t indicates smoking cessation status (1 if a smoker in year t-1 quits in year t and 0 otherwise).

Using empirical population fractions of smokers in year t (s_t), smokers in year t-1 (s_{t-1}), new smokers in year t (i_t), and quitters in year t (q_t), equation (4) can be rewritten as:

$$s_t = i_t\,(1 - s_{t-1}) + (1 - q_t)\,s_{t-1} \quad (5)$$

or current smoking prevalence in year t (s_t) is a weighted average of current smoking initiation rate (i_t) and the rate of failure to quit among smokers ($1 - q_t$). The weight of current smoking initiation rate is given by the fraction of nonsmokers from period *t-1* who were at risk of smoking initiation in the current year *t*, ($1 - s_{t-1}$). The weight of the failure to quit rate is given by the fraction of smokers in the previous period *t-1* who continued to smoke in *t-1* and are at risk of failure to quit in year t, (s_{t-1}).

The weight of smoking cessation is less among adolescents as there is relatively small fraction of smokers (s_{t-1}) among them who can potentially quit. In the same vein, the weight of smoking initiation is less among adults as initiation becomes less common among older people and the fraction of nonsmokers at risk of initiation, ($1 - s_{t-1}$), becomes relatively small. Thus, it is important to examine the decomposition in (5) separately for young adults (aged 18-24 years) and older adults (aged 25 years and above).

Equation (5) reveals that the change in smoking prevalence (s_t) between 2008 and 2018 can be explained by changes in smoking initiation and cessation rates between the two years, conditional on the past smoking prevalence of each group at risk of initiation and cessation failure. To put it formally,

$$\Delta s_{2008-2018} = s_{2008} - s_{2018}$$

$$= [i_{2008}(1 - s_{2007}) - i_{2018}(1 - s_{2017})] + [(1 - q_{2008})s_{2007} - (1 - q_{2018})s_{2017}] \quad (6)$$

As equation (6) shows, understanding the factors that contributed to the temporal trends in smoking initiation and smoking cessation separately is key to identifying which pathway the targeted interventions should follow in reducing smoking prevalence in different population sub-groups. This breakdown is also important in understanding how to reduce disparity while achieving the national target rate of smoking prevalence as it requires that population sub-groups that have higher smoking prevalence experience slower smoking initiation and faster smoking cessation. The decomposition analysis laid out in equations (1)-(3) for the trend in smoking prevalence was, therefore, repeated to the trends in smoking initiation and successful smoking cessation.

Appendix III: Supplementary Tables

Table A1: Population proportion (%) and smoking prevalence (%) by population characteristics of U.S. adults, 2008 and 2018.

Population characteristics	All adults: Aged 18 years and above							
	Proportion (%)				Smoking prevalence (%)			
	2008	2018	Change	P-value	2008	2018	Change	P-value
Overall	100.0	100.0			20.6	13.7	-6.9	<.001
Sex								
Male	48.3	48.3	0.0	0.955	23.1	15.6	-7.5	<.001
Female	51.7	51.7	0.0	0.955	18.3	12.0	-6.4	<.001
Age group								
18-24	12.8	11.7	-1.1	0.011	21.3	7.8	-13.5	<.001
25-44	36.3	34.4	-1.9	<.001	23.7	16.5	-7.3	<.001
45-64	34.3	33.3	-1.0	0.065	22.6	16.3	-6.3	<.001
65+	16.6	20.6	4.1	<.001	9.3	8.4	-0.8	0.189
Race/Ethnicity								
Non-Hispanic White	68.7	63.2	-5.5	<.001	22.0	15.0	-7.1	<.001
Non-Hispanic Black	11.6	11.7	0.1	0.730	21.2	14.6	-6.7	<.001
Asian only	4.5	6.1	1.6	<.001	9.8	7.1	-2.7	0.035
American Indian/Alaskan Native	0.6	0.8	0.2	0.015	32.4	22.6	-9.8	0.113
Hispanic	13.6	16.4	2.8	<.001	15.8	9.8	-6.0	<.001
Multiracial	1.1	1.9	0.8	<.001	23.1	19.1	-4.0	0.309
Highest level of education								
Below high school	15.3	11.4	-4.0	<.001	27.3	20.3	-7.0	<.001
High school diploma and below college	57.8	55.1	-2.8	<.001	24.3	17.3	-7.0	<.001
College and above	26.7	33.5	6.8	<.001	8.9	5.6	-3.3	<.001
Marital Status								
Married/Living with partner	61.9	60.0	-1.9	0.001	18.9	12.5	-6.4	<.001
Not married/living with partner	38.1	40.0	1.9	0.001	24.3	18.1	-6.2	<.001

Population characteristics	All adults: Aged 18 years and above							
	Proportion (%)				Smoking prevalence (%)			
	2008	2018	Change	P-value	2008	2018	Change	P-value
Employment status								
Currently employed	64.1	63.5	-0.6	0.286	21.1	13.4	-7.6	<.001
Not employed	35.9	36.5	0.6	0.286	19.9	14.3	-5.6	<.001
Health insurance status								
Uninsured	15.5	10.4	-5.1	<.001	32.8	23.9	-8.9	<.001
Private insurance	55.7	53.6	-2.1	<.001	17.6	10.8	-6.9	<.001
Medicaid	7.3	11.3	4.0	<.001	35.4	23.5	-11.9	<.001
Medicare only	15.4	17.6	2.2	<.001	11.2	10.0	-1.3	0.090
Other insurance	4.8	6.7	1.9	<.001	21.7	15.6	-6.1	0.001
Family income relative to FPL								
<100%	12.1	10.3	-1.8	<.001	31.4	22.6	-8.8	<.001
100-200%	16.5	17.3	0.7	0.118	26.9	19.4	-7.5	<.001
200-400%	30.1	28.5	-1.6	0.004	22.1	14.9	-7.2	<.001
>400%	41.3	44.0	2.7	<.001	15.0	8.9	-6.1	<.001
Region								
Northeast	17.1	17.3	0.3	0.456	18.8	12.5	-6.4	<.001
Midwest	24.1	22.0	-2.1	<.001	22.6	16.2	-6.4	<.001
South	36.1	39.0	2.9	0.117	22.0	14.8	-7.2	<.001
West	22.7	23.8	1.1	0.054	17.7	10.7	-7.1	<.001

Table A2: Population proportion and smoking initiation by population characteristics of U.S. young adults, 2008 and 2018.

Population characteristics	Young adults: Aged 18-24 years							
	Proportion (%)				Smoking initiation (%)			
	2008	2018	Change	P-value	2008	2018	Change	P-value
Overall	100.0	100.0			22.5	8.2	-14.3	<.001
Sex								
Male	50.4	49.7	-0.6	0.759	24.7	8.9	-15.8	<.001
Female	49.6	50.3	0.6	0.759	20.2	7.6	-12.7	<.001
Race/Ethnicity								
Non-Hispanic White	60.9	52.2	-8.7	<.001	26.1	11.4	-14.7	<.001
Non-Hispanic Black	14.3	12.6	-1.7	0.198	17.3	4.5	-12.8	<.001
Asian only	4.8	6.2	1.4	0.100	10.0	5.5	-4.4	0.237
American Indian/Alaskan Native	0.7	1.1	0.4	0.234	-	-	-	-
Hispanic	17.8	23.7	5.9	<.001	17.0	3.2	-13.8	<.001
Multiracial	1.5	4.2	2.7	<.001	24.1	12.6	-11.4	0.243
Highest level of education								
Below high school	19.1	12.0	-7.1	<.001	27.4	11.1	-16.3	<.001
High school and above	80.9	88.0	7.1	<.001	21.3	7.8	-13.5	<.001
Marital Status								
Married/Living with partner	23.6	16.4	-7.2	<.001	27.2	15.2	-11.9	<.001
Not married/living with partner	76.4	83.6	7.2	<.001	21.0	6.9	-14.2	<.001
Employment status								
Currently employed	63.6	65.4	1.8	0.356	23.7	9.5	-14.2	<.001
Not employed	36.4	34.6	-1.8	0.356	20.3	5.8	-14.5	<.001

Population characteristics	Young adults: Aged 18-24 years							
	Proportion (%)				Smoking initiation (%)			
	2008	2018	Change	P-value	2008	2018	Change	P-value
Health insurance status								
Uninsured	28.3	14.1	-14.2	<.001	31.3	12.5	-18.8	<.001
Private insurance	56.1	64.7	8.6	<.001	15.8	6.9	-8.9	<.001
Medicaid	10.7	17.4	6.7	<.001	35.0	8.7	-26.4	<.001
Medicare only	-	-	-	-	-	-	-	-
Other insurance	4.4	3.6	-0.8	0.274	24.0	13.1	-10.9	0.152
Family income relative to FPL								
<100%	25.6	17.6	-8.0	<.001	21.9	11.0	-10.9	<.001
100-200%	21.0	21.8	0.8	0.636	29.8	8.8	-21.1	<.001
200-400%	28.4	30.8	2.3	0.242	22.7	9.7	-13.0	<.001
>400%	24.9	29.8	4.9	0.016	19.1	4.5	-14.5	<.001
Region								
Northeast	15.4	13.7	-1.6	0.267	22.9	9.1	-13.8	0.001
Midwest	25.0	25.4	0.4	0.726	19.8	10.4	-9.4	<.001
South	36.9	34.9	-2.0	0.451	21.3	8.3	-13.0	<.001
West	22.8	25.9	3.2	0.143	21.7	5.5	-16.2	<.001

Table A3: Population proportion and smoking cessation by population characteristics of U.S. adult ever smokers, 2008 and 2018.

Population characteristics	Ever smokers aged 25 and above							
	Proportion (%)				Smoking cessation (%)			
	2008	2018	Change	P-value	2008	2018	Change	P-value
Overall	100.0	100.0			6.4	8.0	1.6	0.021
Sex								
Male	54.0	50.7	-3.2	0.196	6.2	8.3	2.1	0.053
Female	46.0	49.3	3.2	0.196	6.7	7.3	0.6	0.197
Age group								
25-44	49.1	45.7	-3.4	0.010	7.0	10.0	3.0	0.006
45-64	42.5	40.5	-1.9	0.143	5.8	5.2	-0.6	0.509
65+	8.4	13.8	5.4	<.001	6.3	9.4	3.1	0.071
Race/Ethnicity								
Non-Hispanic White	74.3	69.1	-5.2	<.001	6.8	8.6	1.8	0.026
Non-Hispanic Black	11.4	12.4	0.9	0.263	3.5	5.6	2.1	0.174
Asian only	2.1	3.2	1.1	0.009	5.9	10.5	4.6	0.228
American Indian/Alaskan Native	0.9	1.3	0.4	0.181	-	-	-	-
Hispanic	10.1	11.5	1.5	0.078	6.2	7.0	0.8	0.706
Multiracial	1.2	2.4	1.2	0.001	9.9	5.8	-4.1	0.391
Highest level of education								
Below high school	19.2	16.0	-3.2	0.002	4.8	3.1	-1.7	0.161
High school diploma and below college	66.8	68.2	1.5	0.245	5.1	7.0	1.9	0.015
College and above	14.0	15.8	1.8	0.062	5.2	6.9	1.7	0.232
Marital Status								
Married/Living with partner	61.3	56.6	-4.6	<.001	6.4	8.3	1.9	0.051
Not married/living with partner	38.7	43.4	4.6	<.001	6.4	7.6	1.1	0.206
Employment status								
Currently employed	65.9	62.0	-4.0	0.002	7.1	9.0	1.9	0.039
Not employed	34.1	38.0	4.0	0.002	5.2	6.4	1.2	0.200

Population characteristics	Ever smokers aged 25 and above							
	Proportion (%)				Smoking cessation (%)			
	2008	2018	Change	P-value	2008	2018	Change	P-value
Health insurance status								
Uninsured	23.3	17.4	-6.0	<.001	4.2	6.2	2.0	0.162
Private insurance	50.7	42.7	-8.0	<.001	8.1	9.7	1.6	0.155
Medicaid	11.4	18.7	7.3	<.001	3.9	5.4	1.6	0.251
Medicare only	9.3	13.4	4.2	<.001	6.1	8.1	2.0	0.250
Other insurance	5.3	7.8	2.5	<.001	6.3	8.5	2.1	0.357
Family income relative to FPL								
<100%	16.3	15.5	-0.8	0.398	4.6	4.7	0.1	0.958
100-200%	19.4	23.6	4.2	<.001	4.8	5.8	1.1	0.393
200-400%	32.1	30.1	-2.0	0.122	6.0	7.6	1.6	0.167
>400%	32.1	30.7	-1.4	0.287	8.3	11.3	3.0	0.051
Region								
Northeast	15.8	15.9	0.1	0.916	6.8	9.5	2.6	0.156
Midwest	27.3	25.6	-1.8	0.131	7.9	7.9	0.0	0.989
South	38.1	39.9	1.9	0.152	5.8	7.5	1.7	0.099
West	18.8	18.6	-0.2	0.840	5.1	7.7	2.6	0.073