Changes in the Number of Smokers by State Before and after the US Epidemic

Yiyang Tian[1,*] and Ruoyu Ying[2]
[1]*Department of Letters and Science, University of California, Davis, U.S.A.*
[2]*Department of Computing, University of Technology Sydney, Sydney, Australia*
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Abstract: Against the backdrop of the global COVID-19 pandemic, significant changes have occurred in people's lifestyles and behavioral patterns, including variations in tobacco use. This study employs descriptive statistical analysis and regression analysis to explore trends in tobacco use among different age groups in the United States before and during the pandemic, as well as the influencing factors. The research covers descriptive statistics on tobacco use rates among individuals aged 12 - 17, 18 - 25, and 26+ for the periods 2018 - 2019 and 2021 - 2022, comparing changes and disparities across states and age groups. Regression models are constructed to analyze the impact of time dummy variables, state, and age on tobacco use rates. The findings indicate a decline in tobacco use rates across all age groups during the pandemic, with varying degrees of reduction and distinct influencing factors among different age groups. This study provides evidence for understanding the pandemic's impact on tobacco use behavior and offers insights for formulating more effective tobacco control policies.

1 INTRODUCTION

In the field of global public health, tobacco use has long been a critical issue of concern. Smoking is closely linked to the development of severe diseases such as lung cancer and cardiovascular conditions, posing a persistent threat to population health. According to the World Health Organization, smoking causes over 8 million deaths annually worldwide, including approximately 1.2 million non-smokers who die from secondhand smoke exposure. With increasing public health awareness and the implementation of tobacco control policies globally, smoking rates have shown a gradual decline over the past few decades. However, individual smoking behavior remains dynamically influenced by complex social and environmental factors.

The COVID-19 pandemic, which emerged in early 2020 as one of the most severe global public health crises of the century, has profoundly disrupted societal production and daily life. During the pandemic, measures such as social distancing, economic shutdowns, fear of infection, and abrupt changes in daily routines created a unique high-stress environment. In this context, smoking - a complex habit with both physiological dependence and psychological regulation functions - inevitably experiences multifaceted influences. From a psychological perspective, pandemic-induced anxiety and depression may have driven some individuals to increase smoking frequency as a coping mechanism. A 2020 survey by the American Psychological Association found that 40% of respondents reported increased smoking during the early pandemic, with the 18 - 34 age group showing a 52% increase. However, from a behavioral restriction standpoint, measures such as the closure of public spaces, tightened tobacco retail controls, and reduced social smoking opportunities due to remote work objectively constrained smoking behavior. This dual dynamic of "stress-driven increase" and "environmentally constrained decrease" led to significant individual variability in smoking behavior during the pandemic.

The United States, as one of the hardest-hit countries, exhibits notable regional heterogeneity among states in terms of pandemic response strategies, economic structures, demographic distributions, and tobacco control policy strictness. For instance, New York implemented strict lockdowns and closed all indoor public spaces as early as March 2020, while Texas lifted restrictions

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relatively early in 2021. Such differences resulted in varying levels of pandemic pressure, economic disruption, and behavioral constraints across states, leading to complex and diverse patterns in smoking behavior changes. Some industrial states saw 15% - 20 % fluctuations in smoking rates due to soaring unemployment and the closure of social venues, while states with a high concentration of tech industries, such as California, experienced smaller changes (around 5%) owing to widespread remote work and a younger demographic. Given this complexity, existing research lacks a systematic explanatory framework, necessitating in-depth comparative analysis.

This study addresses the dual mechanisms of pandemic impact on smoking behavior and the significant socioeconomic and policy differences across U.S. states. It aims to comprehensively analyze dynamic changes in smoking rates across states from 2018 - 2019 (pre-pandemic) to 2021 - 2022 (during and post-pandemic). The research focuses on three core dimensions: (1) using panel data models to precisely depict smoking rate trends across states by age, gender, and education level; (2) employing spatial econometric methods to identify regional clustering effects in smoking behavior changes; and (3) constructing structural equation models to explore the interaction mechanisms among pandemic control intensity, economic fluctuations, demographic characteristics, and pre-existing tobacco control policies. The study seeks to answer: Which states experienced significant changes in smoking rates during the pandemic? How do these changes quantitatively relate to state-level policy variables and socioeconomic indicators? What lasting effects did temporary environmental changes during the pandemic have on long-term smoking behavior patterns?

Theoretical contributions of this study include expanding traditional smoking behavior research, which primarily focuses on individual psychological factors, by incorporating macro-level public health events into the analytical framework. Through multi-level data integration, the study reveals the complex pathways through which major social crises influence addictive behaviors. The proposed theory enriches the situational factors theory in health behavior studies, offering new analytical dimensions for understanding individual decision-making during emergencies.

Practically, the findings will inform state-specific tobacco control policies in the U.S. For states with significant increases in smoking rates (e.g., Rust Belt industrial states), targeted interventions such as psychological support for the unemployed and community-based cessation programs are recommended. For states with notable declines (e.g., West Coast regions), successful strategies like "remote work smoking control" and "health communication for younger demographics" can be replicated elsewhere. Importantly, the regional difference analysis framework developed in this study can serve as a methodological reference for other countries assessing smoking behavior changes during public health crises and formulating tailored intervention strategies, thereby contributing to multi-objective collaborative governance systems.

2 LITERATURE REVIEW

2.1 Domestic Literature Review

Research on smoking behavior in China has evolved in stages, reflecting shifting public health priorities. Early studies focused on establishing the link between smoking and diseases, laying a scientific foundation for understanding smoking hazards. Liu Xiaoyan's (2018) 10-year cohort study in Xuanwei City provided large-scale evidence that smokers' lung cancer mortality was 3.2 times higher than non-smokers, solidifying smoking as a primary risk factor. Xiao Junling's (2020) cross-sectional survey of 10,000+ residents in Jiayuguan City further demonstrated that smokers faced 47% higher respiratory disease risks and 32% higher cardiovascular risks, establishing dose-response relationships between smoking and chronic diseases.

Post-2010, studies began examining sociodemographic disparities. Kang Guorong et al. (2015) revealed urban-rural divides in smoking rates (28.7% rural vs. 21.3% urban) and health literacy gaps (22 percentage points), incorporating socioeconomic status into smoking behavior models. Li Shanpeng and Qi Fei (2018) highlighted policy effects, showing that smoking bans reduced daily cigarette consumption from 16.2 to 13.5 in Qingdao. Li Zhongyou et al. (2018) tracked gender disparities over 25 years in Guangxi, with male smoking rates declining from 58.3% (1991) to 52.7% (2015) while female rates remained low (3.2% - 4.1%).

Recent studies emphasize targeted interventions. Lei Chunping (2012) identified peer influence (coefficient 0.63) and family environment (0.48) as key factors for youth smoking. Wang Zhao et al. (2011) classified college smokers into social (37.2%) and stress-relief (28.9%) types, informing tailored campus programs. Zheng Bao (2011) found policy perception gaps: smokers' support for public smoking

bans (68%) lagged behind non-smokers' (89%), but 72% desired cessation services, guiding local policy adjustments.

Domestically, research has progressed from biological foundations (disease links) to sociological explanations (group difference) to public health applications (precision strategies). While establishing an "individual-behavior-policy" framework, gaps remain in studying pandemic impacts and emerging products like e-cigarettes.

2.2 International Literature Review

Global research employs multidisciplinary approaches. Van Gucht et al. (2010) used behavioral diaries to show how social contexts and moods affect smoking patterns. Stang et al. (2000) quantified smoking's contribution to COPD. Noonan et al. (2015) mapped woodsmoke exposure risks using GIS, while Hall (2004) analyzed smoke hazards in fire disasters.

Haenszel et al. (1956) pioneered U.S. smoking pattern analyses. Shopland et al. (1996) identified higher smoking rates in Southern/Midwestern states, linking regional culture to behavior. Jamal et al. (2015) tracked 2005 - 2014 trends, showing faster declines among men and variations by race/education.

2.3 Literature Critique

Existing studies lack dynamic cross-regional comparisons, especially regarding pandemic impacts. International work underanalyzes state-level differences during COVID-19, neglecting policy-economic-psychological interactions. Methodologically, traditional surveys dominate, with limited causal inference. This study addresses these gaps by integrating multi-source data and causal methods to examine U.S. state-level smoking changes, offering theoretical and practical advancements for tobacco control.

3 METHODOLOGY

This study combines descriptive statistics and regression analysis to investigate pre-/post-pandemic tobacco use trends among U.S. age groups.

Descriptive statistics- compare 2018 - 2019 and 2021 - 2022 tobacco use rates across ages (12 - 17, 18 - 25, 26+) and states, calculating changes to identify pandemic effects.

Regression analysis -models tobacco use rates (dependent variable) against time dummies (0=pre-pandemic, 1=pandemic), controlling for state and age. Coefficient significance tests determine pandemic impacts, while R2 evaluates model fit. This reveals underlying mechanisms behind trend shifts.

4 RESULTS

4.1 Descriptive Statistical Analyses

This section explores changes in tobacco use trends before and after the epidemic with the help of descriptive statistical analyses of data on tobacco use rates by age from 2018 to 2019 and from 2021 to 2022.

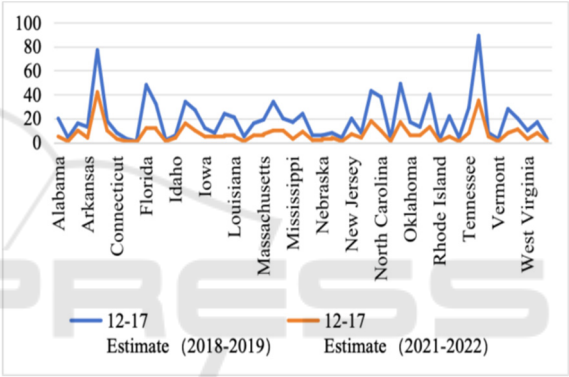

Figure 1: Changes in tobacco use among 12-17 year olds before and after the epidemic

Figure 1 shows that in the 12- to 17-year-old age group, the overall trend in the data shows a general decline in tobacco use in this age group during the epidemic, with estimates of tobacco use in Alabama ranging from 20 in 2018-2019 to 5 in 2021-2022, a decline of 15, and in California from 77 to 42, a decline of 35. California, on the other hand, dropped from 77 to 42, a decline of 35. Such a downward trend was demonstrated in several states, suggesting that tobacco use in this age group was controlled to some extent during the epidemic. In terms of regional distribution, there was a relatively large difference in tobacco use rates between states, with several states like Alaska having a relatively low estimated value of tobacco use before the epidemic of only 4, while California had a relatively high rate of 77. This difference persisted during the epidemic, reflecting the different foundations of youth tobacco prevention and control, as well as their effectiveness, in different regions.

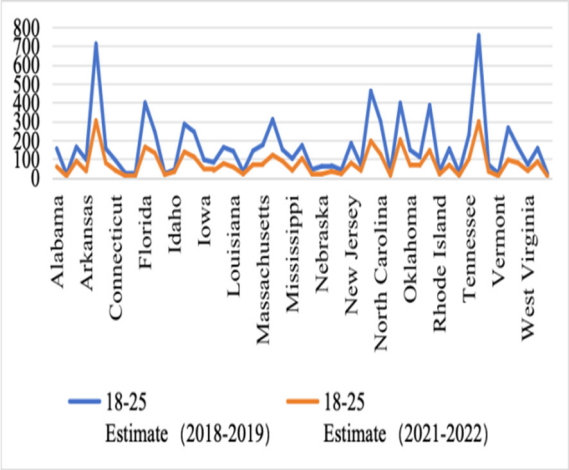

Figure 2: Changes in tobacco use among 18-25 year 25-year-olds before and after the epidemic

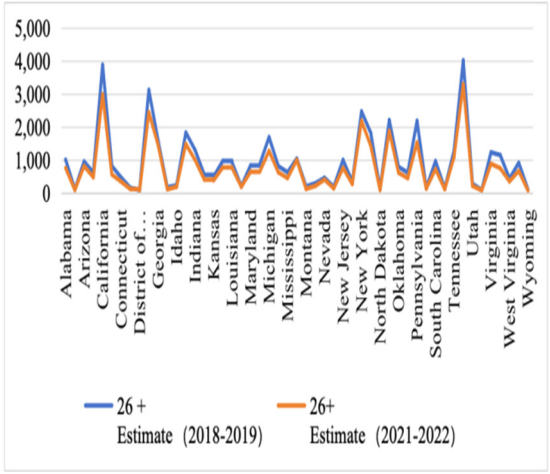

Figure 3: Changes in tobacco use among people aged 26+ before and after the epidemic

As can be seen in Figure 2, in the 18 to 25 age group, tobacco use rates in this age group showed the same decline during the epidemic, for example, in Alabama, where the rate of tobacco use decreased by 96 from 155 in 2018-2019 to 59 in 2021-2022, and in Texas, where the rate decreased from 756 to 299, a decline of 457, with different There is some variation in usage rates between states. Before the epidemic, Florida had a tobacco use rate of 399 compared to 23 in Hawaii, and during the epidemic, it dropped to 164 in Florida and 17 in Hawaii, and this difference between states has a key impact on the overall tobacco use trend, with this age group experiencing limited socialisation and lifestyle changes during the epidemic, which may be a key factor contributing to the decline in tobacco use rates.

Figure 3 shows that in the 26 and over age group, there was a decline in tobacco use during the epidemic for people aged 26 and over, for example, Alabama dropped from 1012 to 762, a decrease of 250, and New York dropped from 2469 to 2183, a decrease of 286, although the overall trend was downward, although the differences in use between different states were more striking, with states like Texas had a high estimate of tobacco use of 4,015 before the epidemic, while Vermont had only 97, and during the epidemic, Texas dropped to 3,293, and Vermont dropped to 86, a difference that reflects the impact of different states' social environments, levels of economic development, and tobacco control policies on the tobacco use behaviors of the adult population.

Comparison of the three age groups shows that tobacco use declined in all age groups during the epidemic, but the magnitude of the decline and the trend of change varied, with a more pronounced decline in the 12- to 17-year-old age group, which may be related to the strengthening of health promotion and education in schools during the epidemic, and the restriction of the scope of activities of students, etc., and a larger decline in the 18- to 25-year-old age group, where changes in lifestyle and social patterns had a greater impact on their tobacco use behaviour. The decline in the 18-25 age group is also relatively large, with changes in the pace of life and socialisation patterns having a greater impact on their tobacco use behaviour. 26 and older age groups, although also declining, are experiencing a smaller decline due to the relative stability of this group's lifestyles. Economically developed regions may see more pronounced declines in tobacco use because of strict prevention and control measures and high levels of health awareness, while states with higher levels of tobacco industry dependence have seen relatively smaller declines.

4.2 Regression Results

4.2.1 12-17 Year

Table 1: Tobacco use among 12-17 year olds

Regression Statistics	Value
Multiple R	0.8417
R Square	0.7085
Adjusted R Square	0.6646
Standard Error	7.0690
Observations	56

Table 2: Estimated regression coefficients and test results for tobacco use among 12-17 year olds

Coefficients	Standard Error	t Stat	P-value	Lower 95 per cent	Upper 95 per cent	Lower 95.0 per cent	Upper 95.0 per cent
Intercept	3.7394	6.3194	1.0284	16.1349	31.1270	16.1349	31.1270
After	4.4763	-3.6222	0.0007	-25.2310	-7.1976	-25.2310	-7.1976
Treated	0.2400	-0.1377	0.8906	-0.5152	0.4491	-0.5152	0.4491
Interaction Term (After*Treated)	0.2864	0.0208	0.9835	-0.5667	0.5786	-0.5667	0.5786

The results of the analyses in Table 1 and Table 2 show that, after controlling for the effects of the different states, the coefficient of the time dummy variable "After" in the 12 to 17 year olds shows a specific characteristic, with a coefficient of -16.2143, which means that in 2021 to 2022, the rate of tobacco use in the 12 to 17 year olds declined in comparison to the rate in 2018 to 2019. 2018 to 2019 is decreasing, as can be seen from the p-value of 0.0007; the coefficient is statistically significant, indicating that the epidemic has had a relatively very prominent effect on the use of tobacco in this age group. During the epidemic, this age group's exposure to tobacco may have been reduced due to the restriction of the scope of activities of young people and the strengthening of health education in schools, which led to a decrease in the rate of tobacco use. Moreover, Treated and Interaction Term are not significant in Table 1 and Table 2, suggesting that "state" as a control variable may have a weaker effect on tobacco use, and the main effect is due to the time dummy variable "After". After".

4.2.2 18-25 Years

Table 3: Tobacco use among 18-25 year olds

Regression Statistics	Value
Multiple R	0.9733
R Square	0.9474
Adjusted R Square	0.9347
Standard Error	23.9077
Observations	56

Table 4: Estimated regression coefficients and test results for tobacco use among 18-25 year olds

Coefficients	Coefficient Values	Standard Error	t Stat	P-value	Lower 95 per cent	Upper 95 per cent	Lower 95.0 per cent	Upper 95.0 per cent
Intercept	148.8768	10.8210	13.6836	2.1829	127.0232	170.7304	127.0232	170.7303
After	-133.8214	12.9327	-10.3475	3.4105	-159.9722	-107.6706	-159.9723	-107.6705
Treated	0.369643	0.61817	0.5980	0.5523	-0.8662	1.6055	-0.8662	1.6055
Interaction Term (After*Treated)	-0.5982	0.7380	-0.8106	0.4218	-2.0792	0.8828	-2.0792	0.8828

As can be seen from Table 3 and Table 4, the coefficient of the time dummy variable "After" is -133.8214 for the age group of 18 to 25 years old, which indicates that during the epidemic period, the tobacco use rate of this age group decreased compared with that before the epidemic. In addition, the p-value of this coefficient is 3.4105, which is much smaller than the common level of 0.05, and this change is statistically significant, which confirms that the epidemic has had a strong impact on the tobacco use behaviour of people aged 17 to 25. During the epidemic, there was a significant change in the way 18-25 year olds socialised, with an increase in online activities and a decrease in offline gatherings, which may have led to a corresponding decrease in tobacco use behaviours that were often seen in social situations, resulting in a significant decrease in tobacco use.

4.2.3 26 Years and Over

Table 5: Tobacco use among people aged 26 and over

Regression Statistics	Value
Multiple R	0.9733
R Square	0.9474
Adjusted R Square	0.9347
Standard Error	23.9077
Observations	56

Table 6: Estimated regression coefficients and test results for tobacco use among 26-year-olds

Coefficients	Coefficient Values	Standard Error	t Stat	P-value	Lower 95 per cent	Upper 95 per cent	Lower 95.0 per cent	Upper 95.0 per cent
Intercept	148.8769	10.8800	13.6836	2.1828	127.0232	170.7303	127.0232	170.7303
After	-133.8214	12.9327	-10.3476	3.4105	-159.972	-107.6705	-159.972	-107.6706
Treated	0.3696	0.6181	0.5980	0.5523	-0.8662	1.6055	-0.8662	1.6055
Interaction Term (After*Treated)	-0.5982	0.7380	-0.8106	0.4218	-2.0792	0.8827	-2.0792	0.8828

The analyses in Table 5 and Table 6 show that the coefficient of the time dummy variable "After" is -133.8214 for the age group of 26 and above, which also shows a decrease in tobacco use during the epidemic, and its p-value is 3.4105, which means that the epidemic has also had a certain impact on this age group. The coefficient of "After" is -133.8214, which also shows a decrease in tobacco use during the epidemic, with a p-value of 3.4105. During the epidemic, people in this age group may have reduced their tobacco consumption due to many factors such as changes in their work patterns and the implementation of controls in public places, which led to a decrease in the rate of tobacco use. Although the social and life patterns of people aged 26 and above are relatively more stable, the changes in the overall social environment brought about by the epidemic still have an undeniable impact on their tobacco use behaviour. Although the social and lifestyle patterns of people aged 26 and over are more stable, the changes in the social environment brought about by the epidemic have had a significant impact on their tobacco use behaviour.

Regression analyses clearly show that the epidemic had a strong impact on tobacco use trends in different age groups, and that tobacco use declined in all age groups during the epidemic. Although the magnitude of the decline and the factors influencing it varied by age group, it is undeniable that the epidemic, as a powerful external variable, reshaped people's lives and consumption patterns, and ultimately had a negligible effect on tobacco use behaviour. use behaviours.

5 CONCLUSION

This study focuses on the changes in tobacco use trends among different age groups before and after the epidemic, using regression analyses to deeply analyse the impact of time variables and factors such as different states and ages on tobacco use, and the results show that the epidemic had an impact on the use of tobacco among people aged 12-17, 17-25, and 26 and older, and that tobacco use among all age groups showed a declining trend during the epidemic. The results show that the epidemic had an impact on tobacco use among 12 to 17, 17 to 25, and 26-year-olds and older, and that tobacco use among all age groups decreased during the epidemic.

This result gives insights into many aspects. From the perspective of public health, the preventive and control measures implemented during the epidemic, such as social restriction and control of public places, have to a certain extent limited the access to and use of tobacco, resulting in a reduction in the rate of tobacco use among people of all ages, which provides new ideas and references for the subsequent formulation of tobacco control policies, such as making reference to the effective control model during the epidemic, strengthening the regulation of youth smoking behaviour, and restricting smoking

behaviour in public places. This provides new ideas and references for the subsequent formulation of tobacco control policies, for example, by referring to the control model that worked well during the epidemic, strengthening the regulation of youth smoking behaviour, and restricting smoking behaviour in public places.

However, it is also important to note the limitations of this study in that the model, although it takes into account factors such as time and state, may have an impact on tobacco use as well as other variables that were not included, such as changes in economic conditions, shifts in cultural attitudes, etc., and that the data from the study only covered two specific periods, making it difficult to fully reflect changes in tobacco use trends over time.

Future research can broaden the scope of data, incorporate more influencing factors, and construct a more complete model to gain a more comprehensive understanding of the changing patterns of tobacco use behaviours, provide a solid theoretical basis and data support for the development of more effective tobacco control strategies, and promote public health.

AUTHORS CONTRIBUTION

All the authors contributed equally and their names were listed in alphabetical order.

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