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Short communication

# Changes in urban and rural cigarette smoking and cannabis use from 2007 to 2017 in adults in the United States

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ABSTRACT

*Introduction:* Rural-urban differences in cigarette and cannabis use have traditionally shown higher levels of cigarette smoking in rural areas and of cannabis use in urban areas. To assess for changes in this pattern of use, we examined trends and prevalence of cigarette, cannabis, and co-use across urban-rural localities.

*Methods:* Urban-rural trends in current cigarette and/or cannabis use was evaluated using 11 cohorts (2007–2017) of the National Survey on Drug Use and Health (NSDUH; *N = 397,542*). We used logistic regressions to model cigarette and cannabis use over time, adjusting for demographics (age, gender, race/ethnicity, income, education), in addition to assessing patterns of cannabis use among cigarette smokers and nonsmokers.

*Results:* Despite decreases in cigarette smoking overall, between 2007 and 2017, the urban-rural disparity in cigarette smoking increased (AOR = 1.17), with less reduction in rural as compared to urban cigarette smokers. Cannabis use increased in general (AOR = 1.88 by 2017), with greater odds in urban than rural regions. Cannabis use increased more rapidly in non-cigarette smokers than smokers (AOR = 1.37 by 2017), with 219% greater odds of cannabis use in rural non-cigarette smokers in 2017 versus 2007.

*Conclusions:* Rurality remains an important risk factor for cigarette smoking in adults and the fastest-growing group of cannabis users is rural non-cigarette smokers; however, cannabis use is currently still more prevalent in urban areas. Improved reach and access to empirically-supported prevention and treatment, especially in rural areas, along with dissemination and enforcement of policy-level regulations, may mitigate disparities in cigarette use and slow the increase in rural cannabis use.

## 1. Introduction

Despite extensive reductions over the past five decades in cigarette smoking in the United States (US), tobacco use continues to be the leading preventable cause of death (Fenelon and Preston, 2012; Jha et al., 2013; Reitsma et al., 2017), with cigarettes being the most commonly used tobacco product (Hu et al., 2016). Prior work has documented geographic differences in the prevalence of cigarette smoking with higher rates in rural areas, especially the rural South and Midwest, even after accounting for socioeconomic status (Matthews et al., 2017). Moreover, recent work indicates that reductions in cigarette smoking are disproportionately due to reductions in smoking in urban regions and less so to declines in rural areas (Doogan et al., 2017), raising the question of whether urban-rural geographic disparities will become more pronounced over time.

Cannabis is the most commonly used Schedule 1 drug in the US and the majority of those who use cannabis also smoke cigarettes (Leatherdale et al., 2006; Richter et al., 2005; SAMHSA, 2013). Increases in cannabis use over the past two decades have coincided with reductions in perceived risk of use and state-level policies expanding medical and recreational access (Hasin et al., 2017; Martins et al., 2016; Okaneku et al., 2015; Pacek et al., 2015; Wen et al., 2015). With regard to co-use (i.e., current use of cigarettes and cannabis), cannabis use among tobacco users is increasing; whereas, tobacco use among cannabis users is on the decline (Schauer et al., 2015). However, the interplay between the rapidly changing cigarette and cannabis use landscapes across urban and rural regions is not well understood.

Our primary aim is to describe the changing trends from 2007 to 2017 in adults' cigarette smoking, cannabis use, and co-use across urban and rural regions using the National Survey on Drug Use and

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Health (NSDUH, 2019). Informed by prior findings, we hypothesized 1) higher prevalence of cigarettes use in rural areas and cannabis use in urban areas (Hasin et al., 2019; Matthews et al., 2017), 2) greater decreases in cigarette use in urban compared to rural areas (Doogan et al., 2017), 3) greater increases in cannabis use in urban than rural areas (Hasin et al., 2019), and 4) the greatest increase in cannabis use among urban cigarette smokers (Hasin et al., 2019; Schauer et al., 2015).

## 2. Methods

### 2.1. Study population

The dataset included those 18 years and older from the last 11 years (2007–2017) of the NSDUH, which are annual, cross-sectional surveys of non-institutionalized individuals in the 50 US states and the District of Columbia (SAMHSA, 2013). Each year, a nationally-representative multistage probability sample of household-dwelling individuals in the US is obtained. We used the NSDUH sampling weights to ensure that estimates were consistent with those provided by the US Census Bureau. Additional information on survey methods and sampling techniques can be found elsewhere (NSDUH, 2019).

### 2.2. Measures

The dependent variables were *current cigarette smoking* and *current cannabis use* as defined as consumption of at least one cigarette or use of cannabis (termed in the NSDUH as marijuana or hashish) in the past 30 days, respectively. Current co-use was defined as use of both cigarettes and cannabis within the past 30 days. The primary independent variables were *geographic locality* and *year* (NSDUH survey year). *Geographic locality* was determined using the Office of Management and Budget Rural-Urban Continuum Codes which provide county-level designation based on urbanization and adjacency to metro areas. The 2007–2014 surveys based urban/rural designation on the 2003 Rural-Urban Continuum Codes and 2015–2017 surveys used the updated 2013 codes. Those counties that did not include metro or micropolitan statistical areas and those that included labor market areas with fewer than 50,000 people were defined as rural. *Year* was an integer variable ranging from 2007 to 2017 with 2007 as the reference year. Age, race/ethnicity, income, education, and gender were included as covariates in all models. *Age* (18–34, 35–49, and 50 + year olds), *race/ethnicity* (non-Hispanic White, non-Hispanic Black, Hispanic, non-Hispanic other), income (< $20,000, $20,000-$49,999, $50,000-$74,999, > $74,999), education (some high school, high school graduate, some college, college graduate), and gender (female, male) were each coded categorically.

### 2.3. Statistical analyses

Statistical analyses were conducted in SAS 9.4 (SAS Institute, Cary, NC), via the SURVYEYFREQ and SURVEYLOGISTIC procedures which utilized the NSDUH-derived weight, stratum, and cluster variables. Logistic regressions, adjusted for age group, gender, income, education, and race/ethnicity, were conducted to estimate the odds of current cigarette smoking and cannabis use overall and by locality for the 2007–2017 period. Interactions between year and geographic locality were entered alongside main effects into each model and preserved in the model if significant. To assess the relationship between cigarette and cannabis co-use, current smoking status along with an interaction term for smoking status and locality were subsequently added to the model predicting current cannabis use.

## 3. Results

### 3.1. Descriptive results

The overall weighted sample ($N = 397,542$) was composed of 16% rurally-designated respondents. Sample characteristics across cohorts are presented in the Supplementary Materials Table 1. In general, rural compared to urban individuals were older ($p < 0.001$), in a lower income bracket ($p < 0.001$), and completed less formal education ($p < 0.001$). Both urban and rural subsamples had more females (52%) than males and the rural subsample comprised a higher proportion of non-Hispanic White individuals than the urban subsample ($p < 0.001$).

### 3.2. Cigarette use

Observed prevalence of current cigarette smoking declined from 25.8% in 2007 to 19.4% in 2017 (see Supplementary Table 2). In adjusted models, percentage of persons with current cigarette use decreased more slowly in rural areas as compared to urban ($p < 0.005$). In 2017, persons in urban areas had 15% lower odds (AOR = 0.85; 95% CI: 0.81-0.88; $p < 0.005$) of smoking cigarettes than in 2007. By comparison, persons in rural areas had only 8% lower odds of smoking cigarettes in 2017 than they had in 2007 (AOR = 0.92; 95% CI: 0.85-0.99; $p < 0.05$). By 2017, rural individuals had 18% greater odds of current cigarette smoking than urban individuals, after adjustment for age, race/ethnicity, income, education, and gender (AOR = 1.18; 95% CI = 1.14-1.21). The more rapid decline in urban than rural regions enhanced the urban-rural geographic disparity in cigarette smoking prevalence over the past decade (Fig. 1).

### 3.3. Cannabis use

In 2007, an estimated 5.6% of the adult population reported current cannabis use; by 2017, the observed prevalence had nearly doubled to 9.5% (see Supplementary Table 2). In adjusted effects models, the prevalence of current cannabis use increased linearly with year; by 2017, the adjusted odds of current cannabis use were 1.94 times greater than in 2007 (AOR = 1.94; 95% CI: 1.84–2.04; $p < 0.005$). Over the surveyed period, those in rural areas had lower odds of having used cannabis in the past 30 days compared to urban individuals (AOR = 0.71; 95% CI: 0.68-0.75; p < 0.005). We then examined whether the change in prevalence of cannabis use differed by geographic locality, and found that the difference in the rate of change between urban and rural cannabis use from 2007 to 2017 was not significant ($p = 0.08$, *ns*).

### 3.4. Cigarette and cannabis co-use

In 2017, 47.5% (95% CI: 45.6, 49.4; observed prevalence) of cannabis users reported current cigarette smoking compared to 66.4%

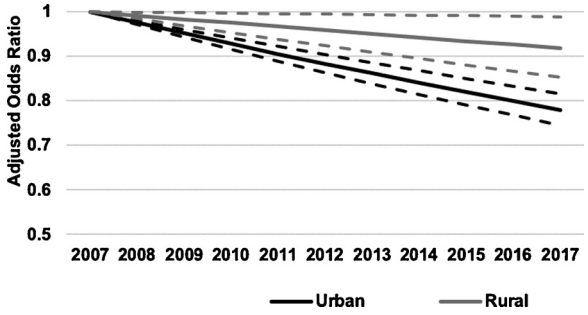


**Fig. 1.** Urban and rural changes in cigarette smoking from 2007 to 2017. Adjusted odds ratios (solid lines) and 95% confidence intervals (dotted lines) of current cigarette smoking relative to 2007 by geographic locality.

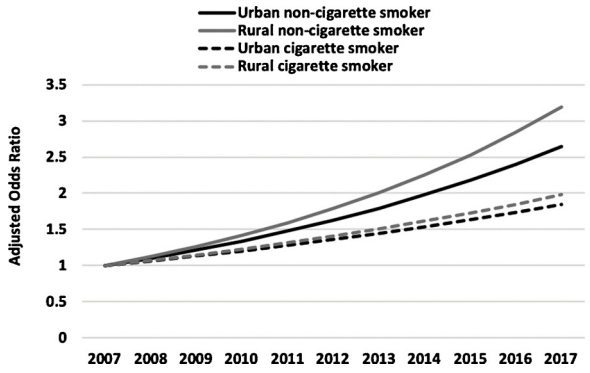


**Fig. 2.** Changes in cannabis use from 2007 to 2017 by locality and smoking status.
Change in adjusted odds of current cannabis use by urban (black) and rural (grey) locality and smoking status (smoker = dotted, nonsmoker = solid) relative to 2007.

(95% CI: 63.4–69.3; observed prevalence) in 2007 (see Supplementary Table 2). We added current cigarette smoking status and the interaction of smoking with year to the model to examine whether current cannabis use was moderated by concurrent cigarette use. The odds of cannabis use increased more rapidly among non-cigarette smokers than smokers (AOR = 1.37, 95% CI: 1.24–1.50, $p < 0.005$; see Fig. 2). Relative to 2007, cigarette smokers had 87% greater odds of using cannabis by 2017 (AOR = 1.87; 95% CI: 1.75–2.00, $p < 0.005$); whereas, non-cigarette smokers had 124% greater odds of currently using (AOR = 2.24; 95% CI: 2.12–2.36, $p < 0.005$). Across both cigarette smokers and nonsmokers, the greatest increase in relative odds of cannabis use was among rural non-cigarette smokers who had 219% greater odds of using cannabis in 2017 than in 2007 (AOR = 3.19; 95% CI: 2.56–3.98).

## 4. Discussion

Three primary findings emerged from this national study of US adults. First, the geographic disparity in cigarette smoking is increasing over time with a slower decline in cigarette use in rural versus urban cigarette smokers. Second, cannabis use is increasing in both urban and rural areas, with consistently higher prevalence in urban populations. Third, cannabis users are no longer predominantly concurrent cigarette smokers, with the prevalence of cannabis use increasing most rapidly in rural non-cigarette smokers.

Higher risk of cigarette smoking in rural regions is likely due to multiple factors including lower perceptions of risk of smoking (Weinstein et al., 2005), less access to prevention and cessation treatments (Carlson et al., 2012; Hutcheson et al., 2008), and more lenient tobacco control policies (York et al., 2010). Ongoing and future initiatives to increase access and reach of empirically-supported tobacco cessation treatments in the rural US may help to mitigate these disparities. Additionally, increased implementation and enforcement of tobacco control policies (e.g., increased tax rates, clean air laws) in rural areas may reduce disparities for vulnerable rural residents.

As hypothesized, the prevalence of current cannabis use is increasing across the US and is more prevalent in urban than rural regions with 9.8% of urban individuals reporting current cannabis use compared to 8.2% of rural individuals in 2017. Some of the largest urban areas are in states with the earliest changes in laws related to medical and/or recreational cannabis, which may be partially driving early increases in these urban areas (Hasin et al., 2019). Contrary to past findings that the majority of cannabis users are tobacco smokers, by 2017, only 47.5% of cannabis users also reported concurrent cigarette smoking. The reduction in prevalence of current cigarette smokers along with the rapidly increasing prevalence of cannabis use by non-cigarette smokers points to a forthcoming change in the tobacco and cannabis landscape.

Unexpectedly, the prevalence of current cannabis use is increasing more rapidly among non-cigarette smokers than smokers, which may be due, in part, to fewer Americans smoking cigarettes (Keyes et al., 2019; Kulik and Glantz, 2016). An additional possibility is that the increasing availability of cannabis products designed for other routes of administration (e.g., edible, vaped, etc.) may be leading to greater cannabis utilization in nonsmokers. In addition to increasing rates of cannabis use among non-cigarette smokers in general, the greatest demographic adjusted increase from 2007 to 2017 was among rural non-cigarette smokers (219%), followed by urban non-cigarette smokers (165%), rural cigarette smokers (98%), and urban cigarette smokers (85%). If this pattern persists, living in rural regions may become a risk factor for cannabis use. Targeted education, prevention, and treatment services may diminish the increases in cannabis use in rural areas. These interventions can be facilitated through the increased reach and acceptability of digital media and telehealth options in more remote parts of the US.

Limitations of the current study include that the analyses were restricted to conventional cigarettes, other tobacco and nicotine products (e.g., e-cigarettes) may show different patterns of use with regard to geographic locality and cannabis use. Second, the measures of cigarette use, cannabis use, and co-use in the NSDUH were selected to have comparable questions to define current use (i.e., past 30-day use). This measure does not include an estimate of the amount, frequency, or duration of use which could help to further define the inter-relationship between urban and rural use of cannabis and cigarettes. Third, the cross-sectional nature of the NSDUH precludes the examination of change in individual patterns of use, limiting the ability to differentiate between changes in cessation, initiation, and co-use of cannabis and cigarettes. Future investigations looking at moderators of effects, including demographic characteristics, and using longitudinal data are needed to more fully depict the potential public health impact of changes in urban and rural use of cannabis and cigarettes, to target specific subpopulations at the highest risk, and to determine what prevention and treatment strategies are likely to be most impactful.

In conclusion, living in a rural area continues to be a risk factor for cigarette smoking; whereas current cannabis use is more prevalent in urban areas and is increasingly common among non-cigarette smokers, with the fastest growth among rural non-cigarette smokers. The combination of higher prevalence of cigarette smoking in rural areas and the most rapid increases in cannabis use in rural non-cigarette smokers emphasizes a growing need to improve reach and access to empirically supported prevention and treatment in rural regions in addition to uniform dissemination and enforcement of policy-level regulations.

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## Contributors

Only the authors listed are responsible for the content and preparation of this manuscript. All authors contributed to the manuscript preparation and revisions and have approved of this manuscript.

## Declaration of Competing Interest

The authors of this paper have no conflicts of interest to declare.

## Appendix A. Supplementary data

Supplementary material related to this article can be found, in the

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