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Changes in Multiple and Different Tobacco Product Use Behaviors in Women Before and During Pregnancy: An Analysis of Longitudinal Population Assessment of Tobacco and Health Data

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Abstract

Introduction: Changes in tobacco use behaviors among women with respect to pregnancy are expected to be significant and dynamic, with a strong desire for smoking cessation, diversification of tobacco products, and perceived relative safety on non-cigarette tobacco products. This study aims to illustrate how multiple and different tobacco use behaviors change before and during pregnancy.

Methods: Data were extracted from 864 pregnant, nationally representative U.S. women, who were prospectively followed with the Population Assessment of Tobacco and Health study between 2013 and 2017. Smoking statuses were defined based on the number and type of seven different tobacco products under current use. Differences in maternal characteristics were investigated in relation to tobacco-cessation statuses during pregnancy. Weighted percentages and 95% CIs were calculated.

Results: Only 50.4% of pre-pregnancy tobacco users achieved complete abstinence with varying rates of cessation, depending on the number and type of products used pre-pregnancy. The lowest cessation rates were observed among pre-pregnancy poly-tobacco users (23.3%) and conventional cigarette smokers (45.5%). During pregnancy, 11.3% and 2.8% of women reported smoking cigarettes and e-cigarettes, respectively. Persistent tobacco users during pregnancy were more likely to be white, older, and have non-private or no medical insurance (all $p < 0.05$).

Conclusions: This study demonstrates a widespread prenatal tobacco use and low rates of complete cessation in major subgroups of tobacco users. Current findings on the concurrent use of multiple products and non-cigarette tobacco products highlight the urgent need for further research and comprehensive public health intervention for smoking cessation during pregnancy.

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INTRODUCTION

Conventional cigarette smoking is the most significant modifiable causes of adverse birth outcomes in the U.S.¹ Although pregnancy is a strong motivation for women to quit smoking² and much effort has been made toward promoting smoking cessation during pregnancy,³ the actual decrease in prevalence has been minimal.⁴

Despite common perceptions on the relative safety of some non-cigarette tobacco products,⁵ especially e-cigarettes as compared with cigarettes during pregnancy,^{6–10} the literature consensus is that prenatal nicotine use poses a significant risk to the developing fetus regardless of the source product.^{11–17} Current research on prenatal tobacco use has been mainly focused on conventional cigarette smoking with only few studies describing how different tobacco use behaviors change with respect to pregnancy (i.e., pre-pregnancy cigarette and cigarillo smoking to exclusive e-cigarette use during pregnancy).^{18–20} With the strong motivation for smoking cessation and a wide variety of tobacco products, changes in pregnant women's smoking behaviors are expected to be dynamic and versatile.

Therefore, this study investigates: (1) how the pattern of tobacco use behavior changes (based on the number and type of products) in women before and during pregnancy and (2) how maternal characteristics differ between successful quitters and persistent tobacco users. By analyzing a longitudinally collected, nationally representative sample and accounting for the use of multiple different tobacco products, this study aims to provide a more accurate understanding of pre-pregnancy and prenatal tobacco use behaviors.

METHODS

Study Sample

Data were extracted from Waves 1–4 of the Population Assessment of Tobacco and Health study, a nationally representative, longitudinal study of 32,320 U.S. adults on the patterns and changes of tobacco use behaviors and associated risk factors.²¹ Data were collected from 2013 (Wave 1) to 2017 (Wave 4).

Women who: (1) were followed for two consecutive waves, (2) were not pregnant at the prior wave, and (3) became pregnant at the following wave were identified and included in the final sample. For consistency, earlier waves are referred to as the “pre-pregnancy wave” and follow-up waves as the “pregnancy wave.”

Measures

The following tobacco products were investigated: cigarettes, e-cigarettes, cigarillo, hookah, cigars (traditional or filtered), smokeless tobacco, and snus. Tobacco use status was defined as “current” if the participant reported that she had: (1) ever used the product, (2) ever used it regularly, and (3) was currently using it every day or some days.²¹

Tobacco use behaviors were defined by the total number of products and the type of products used. The number of different tobacco products was classified into four levels: (1)

tobacco abstinence (zero products), single-tobacco use (one product), dual-tobacco use (two different products), or poly-tobacco use (three or more different products).

Statistical Analysis

Differences in maternal characteristics of the persistent prenatal tobacco users were investigated, including race/ethnicity, age, education, marital status, medical insurance coverage, familial income, and gestational trimester. Weighted percentages (WPs) and 95% CIs were calculated for the prevalence of each number and type category, cessation rates, and sociodemographic characteristics of persistent users using the “weights” package (version 1.0) in R, version 3.6.3.

This secondary analysis of publicly available data was exempt from IRB approval of Sanford Research.

RESULTS

A total of 864 participants (318 from Waves 1–2, 255 from Waves 2–3, and 291 from Waves 3–4) were identified. Changes in smoking statuses throughout the pre-pregnancy and pregnancy waves, by the number and the type of tobacco products, are summarized in Tables 1 and 2, respectively.

Before pregnancy, 23.7% (95% CI=20.8%, 26.5%) of women reported currently using tobacco products. After becoming pregnant, 50.4% (95% CI=44.2%, 55.0%) of pre-pregnancy tobacco users achieved complete tobacco abstinence. However, 12.6% (95% CI=10.4%, 14.9%) of women kept using tobacco products while they were pregnant: Cigarettes were the most common product (WP=11.3%, 95% CI=9.4%, 13.6%), followed by e-cigarettes (WP=2.8%, 95% CI=1.9%, 4.2%). The rates of complete abstinence during pregnancy were lowest among the pre-pregnancy poly-users (WP=23.3%, 95% CI=7.3%, 54.1%) and CC smokers (WP=45.5%, 95% CI=38.6%, 52.5%).

The sociodemographic characteristics of the pre-pregnancy tobacco users are described in Table 3. Compared with complete quitters, persistent cigarette smokers and e-cigarette users were more likely to be Caucasian, older, and have non-private or no medical insurance (all $p<0.05$). Persistent cigarette smoking was also associated with a lower level of educational attainment and a lower income when compared with complete abstinence ($p<0.05$), but persistent e-cigarette use did not show similar associations ($p>0.05$) (Table 3).

DISCUSSION

This study aimed to quantify the changes in tobacco use behaviors in women before and during pregnancy, accounting for multiple different tobacco products. With only 50.4% of pre-pregnancy tobacco users achieving complete abstinence, 12.6% of women remained persistent tobacco users during pregnancy. It was also found that older Caucasian women with a non-private or no medical insurance were more likely to keep using tobacco products during their pregnancy.

The results of this study are consistent with previous studies^{18,19} using two waves of Population Assessment of Tobacco and Health data, as the estimates on smoking behaviors and cessation rates across the waves showed consistent overlap. However, this study adds to the current literature in a number of ways. First, this study included a larger sample and incorporated more recently collected data. Furthermore, there has been an urgent need for up-to-date analysis, as tobacco use behaviors of reproductive-aged women have changed significantly in recent years.²² Lastly, this study also compared the sociodemographic characteristics of complete quitters and persistent users during pregnancy. Although the current study is consistent with the previously described characteristics of women who quit smoking cigarettes completely during pregnancy,^{23–27} findings on multiple and non-cigarette product use encourage current public health interventions and research to be more comprehensive on the multiple dimensions of prenatal smoking behaviors.

On the other hand, this study shows a significantly higher rate of prenatal cigarette smoking (11.3%, 95% CI=9.4%, 13.6%) compared with the birth certificate–based population prevalence of 7.2%.²⁸ Considering the questionable validity of vital statistics data on prenatal smoking,²⁹ this study may offer more accurate statistics on prenatal tobacco use behaviors, which demonstrates the need for more extensive interventions for smoking cessation among pregnant women.

Limitations

A major limitation of this study is its small sample size, even after merging multiple waves. It should be noted that some behaviors were extremely rarely reported, which may have resulted in an overestimation or underestimation of the true rates of such behaviors. It is also plausible that participants' smoking statuses may have changed after the survey, as the cumulative smoking cessation rate increases as pregnancy advances.²⁷ Lastly, there is a strong possibility of under-reporting due to social stigma, guilt, and shame associated with smoking,³⁰ possibly leading to an overestimation of cessation rates. However, with a reduced chance of recall bias from its longitudinal survey design, this study may provide more reliable and current estimates of women's preconception and prenatal tobacco use behaviors than other surveys tied to pregnancy.³¹

CONCLUSIONS

Prenatal tobacco use behaviors are becoming more diverse, and more substantial changes are expected to come. This study demonstrates widespread preconception and prenatal tobacco use and varying patterns of change, calling for future research to broaden their scope into various tobacco products and concurrent use of multiple products, and demonstrating the need for more comprehensive public health interventions for tobacco cessation during pregnancy.

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Table 1.

Changes of Tobacco Use in Women Before and During Pregnancy, U.S, 2013–2017, by the Number of Tobacco Products

| Pre-pregnancy | During pregnancy | | | | |
|--------------------|--------------------|--------------------|------------------|------------------|-------------------|
| | Abstinence (N=682) | Single-use (N=146) | Dual-use (N=30) | Poly-use (N=6) | Total (N=864) |
| Abstinence (N=531) | 99.0 (98.0, 99.5) | 0.5 (0.2, 1.6) | 0.3 (0.1, 0.9) | 0.1 (0.0, 0.6) | 76.0 (72.7, 78.9) |
| Single-use (N=241) | 52.7 (45.2, 59.9) | 40.9 (34.0, 48.2) | 6.2 (3.0, 12.3) | 0.3 (0.0, 2.0) | 17.9 (15.4, 20.7) |
| Dual-use (N=77) | 43.1 (31.1, 55.9) | 41.6 (29.5, 54.7) | 13.6 (6.6, 26.1) | 1.7 (0.4, 7.0) | 5.2 (4.0, 6.7) |
| Poly-use (N=15) | 23.3 (7.3, 54.1) | 29.7 (10.7, 59.7) | 32.1 (9.9, 67.1) | 14.8 (1.8, 63.0) | 1.0 (0.6, 1.6) |
| Total (N=864) | 87.0 (84.7, 89.1) | 10.3 (8.5, 12.4) | 2.3 (1.5, 3.6) | 0.4 (0.2, 1.0) | 100.0 |

Notes: Single-use: reported current use of only 1 tobacco product; dual-use: reported current use of 2 different tobacco products; poly-use: reported current use of 3 or more different tobacco products. Statistics represent weighted percentage (95% CI). N indicates unweighted frequency of each row or column.

Table 2.

Changes of Tobacco Use in Women Before and During Pregnancy, U.S, 2013–2017, by the Type of Product

| Type of product | Pre-pregnancy prevalence | | During-pregnancy prevalence | | Cessation rate |
|------------------------|--------------------------|-------------------|-----------------------------|-------------------|-------------------|
| | N | WP (95% CI) | N | WP (95% CI) | WP (95% CI) |
| Conventional cigarette | 273 | 19.6 (16.9, 22.6) | 167 | 11.3 (9.4, 13.6) | 45.5 (38.6, 52.5) |
| E-cigarette | 87 | 6.1 (4.8, 7.8) | 35 | 2.8 (1.9, 4.2) | 76.2 (63.3, 85.6) |
| Hookah | 30 | 1.9 (1.3, 2.7) | 5 | 0.3 (0.1, 0.8) | 93.0 (61.3, 99.1) |
| Cigarillo | 29 | 1.7 (1.2, 2.5) | 9 | 0.7 (0.3, 1.6) | 85.2 (58.0, 96.0) |
| Any cigar | 17 | 1.1 (0.6, 2.0) | 4 | 0.2 (0.1, 0.7) | 94.8 (65.5, 99.4) |
| Smokeless | 8 | 0.6 (0.3, 1.4) | 7 | 0.5 (0.2, 1.1) | 64.3 (17.8, 93.8) |
| Snus | 1 | 0.1 (0.0, 0.5) | 2 | 0.1 (0.0, 0.5) | NA |
| Any tobacco | 333 | 23.7 (20.8, 26.5) | 182 | 12.6 (10.4, 14.9) | 50.4 (44.2, 55.0) |

Note: Pre- and during-pregnancy prevalence of tobacco products was cross-sectionally calculated with weighted percentages (WPs) and 95% CIs (without regards to the changes in status). Cessation rates were based on the number of pre-pregnancy users who reported complete cessation of the respective product during pregnancy.

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Table 3.

Characteristics of Pre-Pregnancy Tobacco Users, Stratified by During-Pregnancy Smoking Cessation Status and the Type of Tobacco Product Under Use, U.S., 2013–2017

| Variable | Complete quitters (N=162) | Persistent users (N=171) | |
|------------------------------|---------------------------|---------------------------------------|--------------------------|
| | | Conventional cigarette smoker (N=159) | E-cigarette users (N=29) |
| Number of products | | | |
| Single-product | – | 78.8 (72.4, 85.3) | 33.8 (16.2, 57.3) |
| Dual-product | – | 18.8 (12.7, 25.0) | 57.5 (34.5, 77.6) |
| Poly-product | – | 2.3 (0.0, 4.7) | 8.8 (2.3, 28.6) |
| Race/Ethnicity | | | |
| White | 60.0 (51.1, 68.3) | 80.1 (72.9, 85.7) | 83.2 (62.7, 29.8) |
| Black | 13.9 (9.3, 20.3) | 8.8 (5.1, 14.8) | 7.0 (1.3, 29.8) |
| Hispanic | 21.6 (15.2, 29.8) | 7.1 (4.1, 12.1) | 4.2 (0.9, 17.4) |
| Other | 4.5 (2.1, 9.5) | 4.0 (2.1, 7.3) | 5.6 (1.2, 22.0) |
| Age, years | | | |
| 18–24 | 41.5 (33.4, 48.7) | 30.4 (23.1, 37.6) | 16.7 (7.5, 33.0) |
| 25–34 | 54.5 (46.7, 62.2) | 57.7 (49.9, 65.4) | 58.1 (33.1, 79.5) |
| 35–54 | 4.5 (1.3, 7.7) | 11.9 (6.9, 17.0) | 25.2 (7.6, 57.9) |
| Marital status | | | |
| Married | 41.6 (32.7, 51.0) | 36.0 (28.5, 43.6) | 46.0 (23.6, 70.1) |
| Widowed, divorced, separated | 38.8 (30.7, 47.5) | 48.3 (40.4, 56.2) | 33.9 (16.9, 56.4) |
| Never married | 19.7 (13.9, 27.0) | 15.7 (10.0, 21.4) | 20.1 (6.6, 47.2) |
| Educational attainment | | | |
| Less than high school | 5.4 (2.9, 9.8) | 13.9 (9.2, 20.2) | 9.3 (3.1, 24.7) |
| GED/High school graduate | 8.7 (4.9, 15.0) | 14.7 (9.1, 22.8) | 4.1 (0.5, 27.0) |
| Associate degree | 23.5 (17.1, 31.5) | 32.5 (24.1, 42.7) | 31.8 (11.4, 62.8) |
| Bachelor or above | 62.4 (53.6, 70.4) | 38.8 (30.3, 48.0) | 54.8 (29.9, 77.50) |
| Medical insurance | | | |
| Private | 57.3 (49.6, 65.0) | 31.2 (23.5, 40.1) | 42.1 (22.0, 65.3) |
| Public | 19.9 (13.7, 26.1) | 38.9 (30.2, 48.5) | 46.6 (24.0, 70.8) |
| Other | 4.9 (1.5, 8.2) | 4.1 (1.8, 9.1) | 4.7 (0.6, 29.9) |
| None | 17.9 (11.9, 23.9) | 25.7 (18.9, 34.0) | 6.5 (1.9, 20.0) |
| Familial income | | | |
| <\$10,000 | 24.7 (18.1, 32.7) | 27.4 (20.5, 35.6) | 25.0 (11.1, 47.1) |
| \$10,000–\$24,999 | 20.0 (14.1, 27.6) | 33.6 (24.6, 43.9) | 33.5 (12.0, 64.9) |
| \$25,000–\$49,999 | 18.2 (12.6, 25.6) | 24.2 (17.3, 32.8) | 26.3 (10.9, 50.8) |
| \$50,000–\$100,000 | 21.8 (14.1, 32.1) | 10.7 (6.0, 18.3) | 15.3 (4.5, 40.9) |
| >\$100,000 | 15.3 (9.4, 24.1) | 4.1 (1.5, 10.7) | – |
| Pregnancy trimester | | | |
| First | 22.2 (14.9, 31.8) | 22.6 (15.6, 31.5) | 25.9 (10.1, 52.2) |
| Second | 34.5 (26.5, 43.4) | 46.1 (36.9, 55.6) | 42.0 (20.0, 67.7) |
| Third | 43.3 (34.4, 52.7) | 31.3 (23.5, 40.3) | 32.1 (14.2, 57.5) |

Note: Boldface indicates statistically significant differences between persistent users and complete quitters ($p < 0.05$). *P*-values are calculated from weighted chi-squared tests. Statistics represent valid, weighted percentages (95% CIs). Due to dual- or poly-use, the number of persistent users (N=171) is rightfully exceeded by the sum of the number of CC smokers (N=159) and EC users (N=29).

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