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Joint and Independent Effects of E-cigarette and Traditional Cigarette Use on Preterm Birth among Women with a Recent Singleton Live Birth, PRAMS 2016-2017

By

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Master of Public Health

Epidemiology

Lauren Christiansen-Lindquist, PhD, MPH

Committee Chair

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Abstract

Joint and Independent Effects of E-cigarette and Traditional Cigarette Use on Preterm Birth among Women with a Recent Singleton Live Birth, PRAMS 2016-2017

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Radhika Prakash Asrani

Introduction: With the introduction of e-cigarettes in 2006, tobacco and nicotine use during pregnancy now includes both traditional cigarettes and e-cigarettes. While the association between traditional cigarette use and preterm birth is well established, little is known about the association between the use of e-cigarettes during pregnancy and preterm birth. The purpose of this study is to estimate the joint and independent effects of e-cigarette and traditional cigarette use on preterm birth, using data from the 2016-17 Pregnancy Risk Assessment Monitoring System (PRAMS).

Methods: This study includes PRAMS respondents from all participating sites whose pregnancies resulted in a live singleton birth between 2016 and 2017 (n = 56,455). Both e-cigarette and traditional cigarette use in the last 3 months of pregnancy were ascertained via self-report, and preterm birth (live birth occurring prior to 37 completed weeks' gestation) was ascertained via birth certificates. We estimated the independent and joint effects of both e-cigarettes and traditional cigarettes on preterm birth, while controlling for maternal demographic and pregnancy characteristics.

Results: The prevalence of both traditional and e-cigarettes in the last three months of pregnancy was low, with 7.6% of women reporting only using traditional cigarettes, 0.4% reporting only using e-cigarettes, and 0.7% of women reporting dual use of both e-cigarettes and traditional cigarettes. Women who exclusively used either e-cigarettes or traditional cigarettes had an increased prevalence of preterm birth compared to non-users, with prevalence ratios of 1.29 (95% CI: 0.77, 2.16) and 1.28 (95% CI: 1.08, 1.50), respectively. Dual users had a decreased prevalence of preterm birth compared to non-users (PR = 0.83 95% CI: 0.51, 1.34).

Conclusions: This study suggests that the effect of e-cigarette use on preterm birth is similar to that of traditional cigarette use, though the estimate for e-cigarettes is less precise due to a much smaller sample size. The finding that women who used both e-cigarettes and traditional cigarettes did not have an increased prevalence of preterm birth should be interpreted with caution as this might be due to bias. Healthcare providers should counsel pregnant patients on the risks of both traditional and e-cigarette use.

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Background

Preterm birth, defined as spontaneous deliveries occurring before 37 completed weeks' gestation is a relatively common pregnancy outcome that can be caused by many different factors. The body of literature examining the risk factors of preterm birth has grown over the last three decades and has established that precursors to preterm birth vary by gestational age as well as by social and environmental factors. While the focus of this paper is to study the association between e-cigarettes and preterm birth, we will begin with a brief overview of the literature on risk factors for preterm birth, with a focus on the effect of smoking on preterm birth.

Risk Factors for Preterm Birth

In 2017, the preterm birth rate for women across all age groups in the United States was 9.93% (3.8 million preterm births).[1] Several factors affect preterm birth, and these include maternal characteristics as well as lifestyle, genetic, contextual, and environmental factors.[2] Infections such as HIV, syphilis, urinary tract infections, and underlying maternal chronic medical conditions such as diabetes, anemia, and thyroid disease put women at an increased risk of preterm birth.[3]

History of previous preterm birth is a significant risk factor which is likely driven by the interaction of genetic and environmental risk factors.[4] The risk of preterm birth among women with a history of preterm birth was nearly four times that of those among women without such a history.[5] Younger and older maternal age, multiple gestations, and short inter-pregnancy intervals are other maternal risk factors. Preterm births occurring to women aged <19 years

accounted for nearly 24% of all preterm births and those occurring among women aged >40 years accounted for approximately 36% of all preterm births; women in these age groups represented 8% and 3% of all births, respectively.[1] Furthermore, births occurring among younger women, are also characterized by shorter inter-pregnancy intervals.[6] Nearly 35% of pregnancies among women aged <20 years followed an inter-pregnancy interval of less than 18 months.[1] Maternal pre-pregnancy obesity and BMI < 18.5 are other risk factors for premature births. [7,8,5]

Non-Hispanic black women have the highest rate of preterm birth (13.3%) as compared to non-Hispanic white women (9.0%).[1] Non- Hispanic black women experience higher levels of stress due to institutional racism, discriminatory access to resources, and neighborhood level determinants of deprivation such as residential segregation, all of which put them at a greater risk of preterm birth.[9] The social environment can influence susceptibility to diseases and this effect may vary by individual level behaviors and characteristics. Highly disadvantaged neighborhoods are characterized by higher levels of crime, reduced access to care, poor quality of housing, air pollution, lack of access to healthy food, and higher rates of alcohol, drug and tobacco consumption.[10] Smoking, when combined with these other individual and environmental stressors, may contribute to an elevated preterm birth risk. [11,12]

Association between Smoking and Preterm Birth

Smoking-related causes of preterm birth include spontaneous preterm labor, preterm premature rupture of the membranes, and antepartum bleeding.[13] In 2017, 6.9% of women reported smoking tobacco during pregnancy.[1] Smoking was more common in the first trimester

(6.7%) than in the second (5.8%) or third (5.5%).[1] The prevalence of smoking also differed by maternal race and ethnicity, where 10.1% of non-Hispanic white women smoked during pregnancy, followed by 5.6% of non-Hispanic black women and 1.8% of Hispanic women.[1] Smoking also varied by age, with the highest prevalence among women aged 20-24 years (9.9%) and women <20 years (8.2%).[1] Women aged 35-39 years (4.4.%) and 40-54 years (4.4.%) reported lower smoking rates. Overall, the rate of smoking among pregnant women in 2017 declined by 4% from 2016.[1] In 2016, the prevalence of smoking during pregnancy varied by state – with 25.1% in West Virginia to 16.5% in Montana.[14] Women who had completed high school education, but had not completed college reported the highest prevalence of smoking during pregnancy (12.2%) followed by women with less than a high school education (11.7%).[14]

Smoking during pregnancy has also been associated with multiparity, unemployment, psychiatric and depressive symptoms, being socio-economically disadvantaged, and alcohol and drug use. [15,16,17,18] Depressed women are four times more likely to smoke during pregnancy.[19] Young women start smoking for several reasons and these include: trying to appear modern and affluent and to fit in with social networks.[20] It's suggested that unpleasant symptoms associated with nicotine withdrawal could be stronger for pregnant women, therefore making smoking cessation more challenging. [21,22]

Several studies have examined the effect of smoking on birth outcomes, with preterm birth being the primary focus; however, studies have also examined the effect of smoking on low birth weight (LBW) and small for gestational age (SGA). A meta-analysis of studies that assessed the association between maternal smoking (any vs. none) and preterm birth reported a pooled odds ratio of 1.27 (95% confidence interval, 1.21-1.33).[23] Not only is there an

association between any smoking and the risk of preterm birth, but there is also a dose-response relationship between maternal smoking and preterm birth risk at low to moderate levels of smoking.[24,23] The effect is more pronounced among women who smoke at least 10 cigarettes a day, resulting in very preterm birth (<32 weeks gestation).[24] Some studies find that preterm delivery is associated with daily smoking, but not with non-daily smoking.[25] Overall, a review of the literature shows that smoking during pregnancy increases the likelihood of preterm birth, with odds ratios ranging between 0.78 and 1.85 after adjustment for factors such as maternal age, education, source of payment, race and ethnicity, marital status, income and parity.[26,25,27,28] In some cases, the association did not hold after control of all relevant covariates.[29] In studies of women who smoked during a previous pregnancy, but quit before a subsequent pregnancy, researchers observed a reduction in the likelihood of preterm birth in the second pregnancy.[30] No significant evidence of interaction between race and smoking patterns in preterm birth risk was noted.[28,11] Lastly, the odds of preterm birth were lower if smoking cessation occurred early in the pregnancy (first trimester) versus in the last trimester.[26]

Existing Evidence on E-Cigarettes

In recent years, tobacco and nicotine use during pregnancy has extended beyond cigarettes to include e-cigarettes. According to the FDA, e-cigarettes or electronic nicotine delivery systems (ENDS) are non-combustible tobacco products that use an e-liquid that may contain nicotine. The liquid is heated to create an aerosol that is inhaled by the user. E-cigarettes were introduced in the US in 2006, and have since gained popularity, particularly

among youth.[31] E-cigarettes have been marketed as "healthier" alternatives to conventional cigarettes[32] as the e-liquids have been found to contain fewer toxicants and carcinogens.[33] For this reason, they may be misconstrued as safe to use during pregnancy.

Data obtained from the Population Assessment of Tobacco and Health (PATH) study in 2013-2014 indicated that prevalence of using other tobacco products among pregnant women (N = 388) was higher among current smokers compared to the general population, with 28.5% of current smokers using e-cigarettes followed by cigars (14.0%), hookah (12.4%), smokeless (4.7%), snus (4.6%), and pipes (2.1%).[34] While factors such as poverty, lower educational attainment, and white race were found to be correlated with smoking cigarettes, a study by Kurti et.al found that cigarette smoking and illicit drug use were also correlated with using e-cigarettes, hookah and cigars.[34] The study finds that the odds of e-cigarette use among pregnant women was 28 times higher among current cigarette smokers compared to non-smokers (AOR: 28.02 95% CI: 9.95, 78.92). Another study using the same dataset evaluated the prevalence of multiple product use during pregnancy and found that overall prevalence of any tobacco use during pregnancy was 15.7%, with the most prevalent tobacco products being cigarettes alone (52.2%, 95% CI = 40.9% to 63.6%), cigarettes plus e-cigarettes (15.8%, 95% CI = 8.7% to 23.0%), and e-cigarettes alone (6.0%, 95% CI = 0.5% to 11.5%).[35]

A qualitative investigation among pregnant women found that women viewed e-cigarettes as a harm reduction or cessation strategy during pregnancy.[36] Inconsistencies in messaging from healthcare providers were also noted, where some doctors were not concerned about their patients smoking e-cigarettes, while other providers advocated for smoking 1-2 traditional cigarettes a day in lieu of e-cigarettes.[36] A recent systematic review of

the literature on ENDS use during pregnancy found 96 manuscripts published between 2007 and 2018, however none of these evaluated the effect of e-cigarettes on reproductive outcomes.[33]

While the association between traditional cigarette use and preterm birth is well established, and it is known that e-cigarette use is associated with traditional cigarette use, little is known about the association between the use of e-cigarettes during pregnancy and preterm birth. This study aims to fill this gap in the literature by evaluating the joint and independent effects of e-cigarette and traditional cigarette use on preterm birth using 2016-2017 data from the Pregnancy Risk Assessment Monitoring System (PRAMS).

Introduction

With the introduction of e-cigarettes in 2006, tobacco and nicotine use during pregnancy now includes both traditional cigarettes and e-cigarettes. E-cigarettes or electronic nicotine delivery systems (ENDS) are non-combustible tobacco products that use an e-liquid that may contain nicotine. E-cigarettes have been promoted as "healthier" alternatives to conventional cigarettes[32] and for this reason, they may be misconstrued as safe to use during pregnancy. Qualitative studies have found that pregnant women receive inconsistent guidance from healthcare providers on the use of e-cigarettes during pregnancy, wherein some providers have not advised against the use of e-cigarettes, leading them to be viewed as a harm reduction or cessation strategy during pregnancy.[36]

A recent study examined the prevalence of e-cigarette use during pregnancy in the US using data from the 2016 Pregnancy Risk Assessment Monitoring System (PRAMS). The prevalence of e-cigarette use in the last 3 months of pregnancy was 1.2% in a total sample of 33,964 women, with 0.5% of women exclusively smoking e-cigarettes and 0.7% of women using both e-cigarettes and traditional cigarettes.[37] The prevalence of e-cigarette use varied by state, with West Virginia reporting the highest prevalence at 4.4.%. Among women who reported using e-cigarettes during pregnancy, most (43.2%) reported using e-cigarettes ≤1 day/week, while 30.5% reported using e-cigarettes more than once per day. White women were more likely to use e-cigarettes (AOR=4.68, 95% CI=2.91, 7.54) than Black women, as were women with lower (vs. higher) levels of education. As for traditional cigarette use, 7.7% of women reported only smoking traditional cigarettes in the last trimester of pregnancy and 7.0% of

women exclusively smoked traditional cigarettes in the last trimester of their pregnancy. A small percentage (0.8%) of women were dual users of both e-cigarettes and traditional cigarettes.

Since e-cigarettes are relatively new, little is known about their effect on birth outcomes. However, the association between traditional cigarette smoking and preterm birth is well established. A meta-analysis of studies that assessed the association between maternal smoking (any vs. none) and preterm birth reported a pooled odds ratio of 1.27 (95% confidence interval, 1.21-1.33).[23] Given that cigarette smoking during pregnancy increases the likelihood of preterm birth, and that there is some overlap between traditional cigarette and e-cigarette use, it is important to know whether e-cigarette use carries similar risks. The purpose of this study is to estimate the joint and independent effects of e-cigarette and traditional cigarette use on preterm birth, using data from the 2016-17 Pregnancy Risk Assessment Monitoring System (PRAMS).

Methods

Study data were obtained from the Pregnancy Risk Assessment Monitoring System (PRAMS) for 2016 and 2017. PRAMS is a surveillance project of the Centers for Disease Control and Prevention (CDC) which collects state-specific, population-based data on maternal attitudes and experiences before, during, and shortly after a pregnancy that resulted in a live birth. PRAMS sites currently cover approximately 83% of all US births.[38] Sampled women receive a mailed questionnaire packet, with telephone follow-up for non-responders. Select birth certificate elements are linked to participants' questionnaire responses. This study includes data from the PRAMS Phase 8 questionnaire (2016-2017) as this was the first phase to include questions on e-cigarette use. This project was classified as non-human subjects research by Emory University and did not require IRB review.

The study population includes PRAMS respondents from all participating sites from 2016-2017 who had a singleton live birth with a gestational age between 20 and 42 completed weeks' gestation.

Preterm birth was defined as a live birth occurring prior to 37 completed weeks' gestation. The gestational age was reported on the birth certificate and is calculated from the first day of the Last Menstrual Period (LMP) for all states.

To ascertain both e-cigarette and traditional cigarette use during pregnancy, participants were asked whether they used each of these during the past two years. If they responded affirmatively, they were asked whether they used each of these during the last 3 months of pregnancy.

In order to evaluate the independent and joint effects of e-cigarette and traditional cigarette use, we compared the three different smoking categories (dual use; e-cigarette use only; and traditional cigarette use only) to non-users. BMI, race and ethnicity, and gestational diabetes were assessed as potential effect modifiers. Confounders were selected *a priori* using a causal diagram (Figure 1), and included maternal age, area of residence (rural vs. urban), marital status, method of payment, and adequacy of prenatal care utilization as measured by the Kotlechuck index which accounts for both the timing of prenatal care initiation as well as the total number of prenatal care visits. Maternal race, area of residence, level of education, marital status, previous preterm birth, and mode of payment were sourced from the birth certificate.

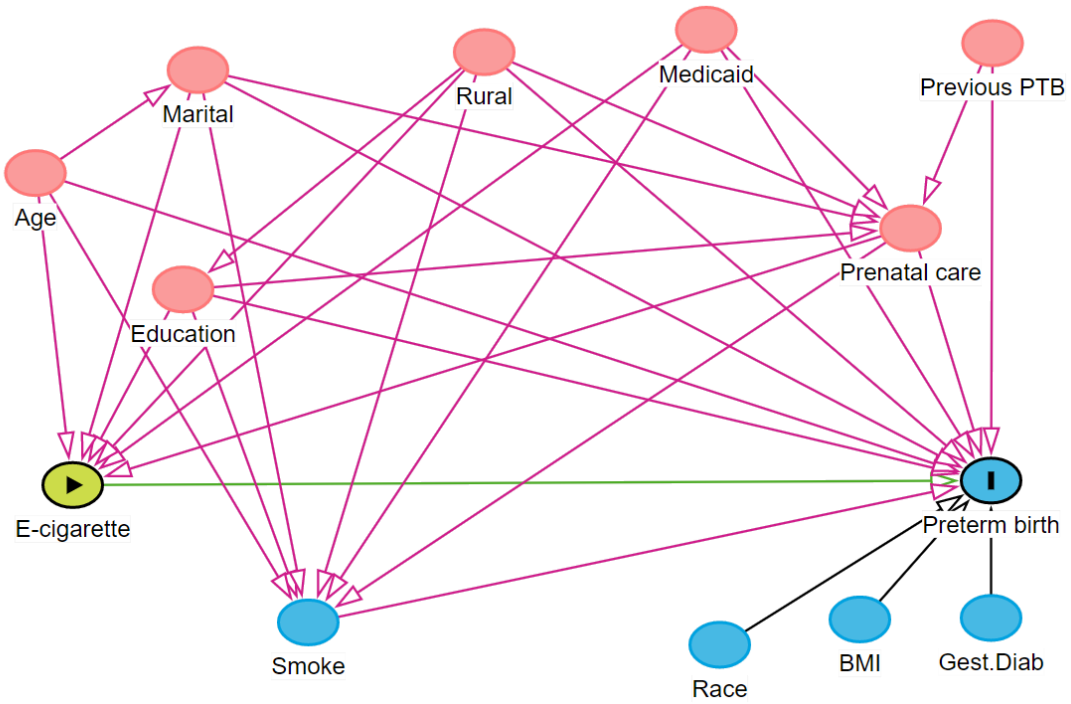

Figure 1. Conceptual Directed Acyclic Diagram (DAG) showing the hypothesized association between e-cigarettes and preterm birth, controlling for age, education, marital status, area type, prenatal care, and Medicaid. Potential effect modifiers are smoking, race, BMI, and gestational diabetes.

All analyses were conducted using SUDAAN to account for the complex survey design; PROC RLOGIST and predicted marginals were used to estimate prevalence ratios. A collinearity assessment was conducted prior to conducting multivariable analyses.

Results

In 2016 and 2017, a total of 67,821 PRAMS participants had a singleton live birth. The analytic sample excludes women with missing values for e-cigarette use (n = 1,246, 2%) or preterm birth (n = 8,538, 13%).

In our study sample of 56,455 mothers, 56.5% identified as non-Hispanic white, 20.3% as Hispanic, and 13.3% as non-Hispanic Black (**Table 1**). Most mothers had some college education (64.2%), were married (62.9%), and were 30-34 years old (29.9%). Nearly 80% of mothers resided in urban areas. Approximately half (47%) of women received adequate prenatal care as measured by the Kotelchuck Index. Most deliveries were paid by private insurance (60.3%), followed by Medicaid (39.7%).

The prevalence of e-cigarette use in the last 3 months of pregnancy was 1% (n = 605). Compared to non-uses, e-cigarette users were younger, had lower educational attainment, and were more likely to be unmarried, White, live in an urban area, have inadequate prenatal care, and to have used Medicaid as a source of payment for their delivery. There were no differences between e-cigarette users and non-users on the prevalence of gestational diabetes, previous preterm birth, and pre-pregnancy BMI.

The prevalence of traditional cigarette use was 7.6% (n = 4884); with 0.7% (n = 391) of women reporting dual use of e-cigarettes and cigarettes. The distribution of e-cigarette and traditional cigarette use, and their overlap, is shown in Figure 2.

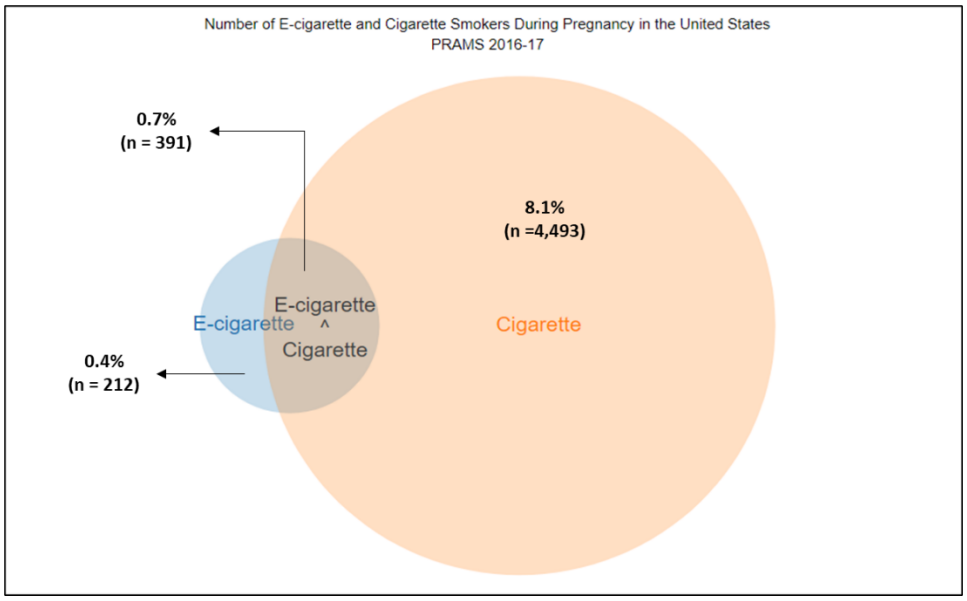

Figure 2. Number of E-Cigarette and Cigarette Smokers During Pregnancy in the United States, PRAMS 2016-17

The prevalence of preterm birth was 9.8% (n = 9826), with 11.2% (140) of e-cigarette users experiencing preterm birth, compared to 9.8% of non-users. The prevalence of preterm birth also differed by traditional cigarette use, with 13.3% of traditional cigarette smokers experiencing a preterm birth compared to 9.5% of non-smokers. Preterm birth was most common among women under the age of 19, Non-Hispanic Black women, as well as women who were unmarried, living in rural areas, with lower education attainment, and those receiving Medicaid. (**Table 1**)

The prevalence of preterm birth among dual users was 0.83 (95% CI: 0.51, 1.34) in comparison to those who do not use either e-cigarettes or traditional cigarettes, after adjusting

for all covariates (**Table 2**). Women who only used e-cigarettes had a 29% higher prevalence of preterm birth compared to non-smokers (PR = 1.29, 95% CI: 0.77, 2.16). The prevalence of preterm birth among traditional cigarette users was 1.28 times (95% CI: 1.08, 1.50) that of non-smokers. Although we were interested in learning whether the association between e-cigarette use and preterm birth was modified by both BMI and maternal race/ethnicity, we were unable to do so given small sample sizes in some of these groups.

Discussion

This study builds on previous studies that evaluate the use of tobacco products among pregnant women, by highlighting the prevalence of e-cigarette use during pregnancy, its dual use with traditional cigarettes and its effects on preterm birth in a large population-based sample in the United States. Prevalence of e-cigarette use during pregnancy was lower than traditional cigarette use, and was more common among Non-Hispanic White women, those who were unmarried, had lower levels of education, and those who relied on Medicaid as a mode of payment for their pregnancy.

Women who used only e-cigarettes or traditional cigarettes had an increased prevalence of preterm birth compared to non-users, with prevalence ratios of 1.29 (95% CI: 0.77, 2.16) and 1.28 (95% CI: 1.08, 1.50) respectively. Our findings are consistent with previous studies that examine the association between traditional cigarette use and preterm birth which report a pooled odds ratio of 1.27 (95% confidence interval, 1.21-1.33).[23] Although the estimate for the association between e-cigarette use and preterm birth is less precise due to a much smaller sample size, these findings suggest that the magnitude of the association between e-cigarette use and preterm birth is similar to that of traditional cigarette use. Additional research is needed to quantify the *risk* of preterm birth among e-cigarette users and should include a larger sample of women who exclusively used e-cigarettes.

Despite the increased risk of preterm birth observed in users of either e-cigarettes or traditional cigarettes, this association was not observed among dual users (PR = 0.83 95% CI: 0.51, 1.34). Given the known association between traditional cigarette use and preterm birth,

this finding is counterintuitive, but may be explained by issues related to sampling and/or measurement error. First, PRAMS only samples women who have experienced a live birth – these paradoxical findings could be due to bias attributable to the necessary exclusion of women who had stillbirths. If dual users are *more* likely to experience a stillbirth, they would no longer be at risk for preterm birth. This exclusion could artificially reduce the risk among dual users, thus making this exposure appear to be protective. Secondly, the intensity of smoking is another factor that could shed more light on the observed effects among dual users. It is unknown whether dual users had initiated e-cigarette use as a smoking cessation strategy to reduce traditional cigarette use.[34] Having additional information about the frequency of smoking for all users would be useful to better estimate this association.

These findings are subject to certain limitations. First, given that data are self-reported postpartum, the findings are subject to recall and social-desirability biases which could result in differential misclassification of e-cigarette and traditional cigarette use during pregnancy. Studies examining the validity of self-reported cigarette smoking during pregnancy using cotinine measurements indicate that nearly 21% of those with detectable cotinine were misclassified as non-smokers by self-report.[39] Further research is needed is needed to assess whether misclassification is differential by preterm birth status, or whether reporting of e-cigarette use follows similar patterns. Second, these estimates were obtained using data from 2016-2017, and do not reflect trends with newer e-cigarette products such as JUUL, which contain higher levels of nicotine that gained popularity towards the end of 2017.[40] Finally, due to the cross-sectional nature of this study, we cannot establish a casual link between e-cigarette use and preterm birth. However, given that the magnitude of the association between

e-cigarette use and preterm birth was nearly identical to that of traditional cigarette use, which has an established causal link, scrutiny on the use of e-cigarettes as a safer alternative to traditional cigarettes is warranted.

In summary, we found that the association between e-cigarette use and preterm birth is similar to that of traditional cigarette use. Future longitudinal studies with an adequate sample of both e-cigarette users as well as dual users of both e-cigarettes and traditional cigarettes are needed in order to better understand the relationship between these smoking patterns and preterm birth. At this time, it does not appear that e-cigarettes offer a safer alternative to traditional cigarette use when it comes to reducing the likelihood of preterm birth. Healthcare providers should counsel pregnant patients on the risks of both traditional and e-cigarette use, and should offer other alternatives to smoking cessation such as nicotine replacement therapy, counselling and educational messaging.[26,41,42]

Conclusion

Our study contributes to a growing literature on nicotine delivery product use during pregnancy and its effects on birth outcomes. This study demonstrates that e-cigarettes and cigarettes are being used in pregnancy which could contribute to increased risk of preterm birth. Studies find that quitting and quitting early in pregnancy have been associated with a reduced risk of preterm birth, even for high frequency cigarette smokers.[26] E-cigarette retail sites include claims related to health and smoking cessation, with 95% of retail sites claiming health benefits of e-cigarette use such as absence of tar or carcinogens in their products.[43] Previous studies indicate that healthcare providers learned about e-cigarettes from their patients, through advertisements and, the news media. [44] There is a need for training about the risks of e-cigarette use for health care providers so that they can appropriately counsel pregnant women and those of childbearing age. Healthcare providers should incorporate screening and counseling about both e-cigarettes and traditional cigarettes during antenatal visits.

Tables

Table 1. Characteristics of PRAMS Respondents, by Preterm Birth Status, 2016-17 [1]

Characteristic	Total[2] *N = 56,455* *n (%)*	Preterm birth (< 37 weeks) *n = 9,826* *n (%)*	Term birth (≥ 37 weeks) *n = 46,629* *n (%)*
Maternal Demographics			
Maternal Age			
<=17	782 (1.3)	179 (2.1)	603 (1.3)
18-19	2,052 (3.2)	386 (3.8)	1666 (3.2)
20-24	10,696 (18.4)	1856 (19.4)	8840 (18.3)
25-29	16,687 (29.3)	2711 (28.1)	13976 (29.5)
30-34	16,357 (29.9)	2695 (26.8)	13662 (30.2)
35-39	8,092 (14.6)	1588 (15.9)	6504 (14.4)
40+	1,788 (3.2)	410 (3.9)	1378 (3.2)
Current Marital Status			
Married	33,840 (62.9)	5307 (54.0)	28533 (63.9)
Not married	22,572 (37.1)	4503 (46.0)	18069 (36.1)
Education			
Graduate and higher	35,635 (64.2)	5764 (55.5)	29871 (65.1)
Highschool and lower	20,820 (35.8)	4062 (44.5)	16758 (34.9)
Maternal Race			
Non-Hispanic White	26,484 (56.5)	4357 (47.2)	22127 (57.5)
Non-Hispanic Black	9,754 (13.3)	1961 (19.8)	7793 (12.5)
Hispanic	11,436 (20.3)	2112 (23.4)	9324 (20.0)
Other	8,781 (9.9)	1396 (9.6)	7385 (10.0)
Area of Residence			
Urban	22,070 (79.1)	3935 (77.7)	18135 (79.2)
Rural	9,549 (20.9)	1461 (22.3)	8088 (20.8)
Pregnancy Characteristics			
Kotelchuck Index			
Inadequate	6,211 (11.6)	394 (3.9)	1648 (3.4)
Intermediate	5,850 (10.7)	3924 (42.0)	20850 (47.8)
Adequate	24,221 (47.0)	2279 (25.1)	11272 (25.6)
Adequate Plus	18,838 (30.7)	2715 (29.0)	10783 (23.2)
Mode of payment: Medicaid			
No	31,968 (60.3)	5086 (51.7)	26882 (61.3)
Yes	24,487 (39.7)	4740 (48.3)	19747 (38.7)
Smoking			
E-Cigarette Use in Last 3 Months of Pregnancy			
No	55,850 (99.0)	9686 (98.9)	46164 (99.0)
Yes	605 (1.0)	140 (1.1)	465 (1.0)
Traditional Cigarette Use in Last 3 Months of Pregnancy			
No	51,243 (92.4)	8609 (89.6)	42634 (92.7)
Yes	4,884 (7.6)	1155 (10.4)	3729 (7.3)

[1]Frequencies represent actual counts and percentages are weighted to account for sampling

[2]Values may not sum to total due to missing values

Table 2. Independent and joint effects of traditional cigarette and e-cigarette use during the last 3 months of pregnancy on preterm birth, PRAMS 2016-2017 [1,2]

	Prevalence Ratios	95% CI
E-cigarette and traditional cigarette use (Dual Users)	0.83	0.51, 1.34
E-cigarette use only	1.29	0.77, 2.16
Traditional cigarette use only	1.28	1.08, 1.50
Non-users *(Ref)*	1.00	

[1]*Adjusted for maternal age, race, education, area type, marital status, adequacy of prenatal care, and mode of payment (Medicaid)*
[2]*Analyses accounts for survey weights and sample design*

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