Tobacco and nicotine delivery product use in a national sample of pregnant women

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ABSTRACT

Monitoring use of tobacco products among pregnant women is a public health priority, yet few studies in U.S. national samples have been reported on this topic. We examined prevalence and correlates of using cigarettes, e-cigarettes, and other tobacco/nicotine delivery products in a U.S. national sample of pregnant women. Data were obtained from all pregnant women (≥18 years) in the first wave of the Population Assessment of Tobacco and Health (PATH, 2013–2014) Study ($N = 388$). Prevalence of current and prior use of tobacco/nicotine products was examined overall and among current cigarette smokers. Multiple logistic regression was used to examine correlates of use of cigarettes, e-cigarettes, hookah and cigars. Overall prevalence was highest for cigarettes (13.8%), followed by e-cigarettes (4.9%), hookah (2.5%) and cigars (2.3%), and below 1% for all other products. Prevalence of using other tobacco products is much higher among current smokers than the general population, with e-cigarettes (28.5%) most prevalent followed by cigars (14.0%), hookah (12.4%), smokeless (4.7%), snus (4.6%), and pipes (2.1%). Sociodemographic characteristics (poverty, low educational attainment, White race) and past-year externalizing psychiatric symptoms were correlated with current cigarette smoking. In turn, current cigarette smoking and past year illicit drug use were correlated with using e-cigarettes, hookah, and cigars. These results underscore that tobacco/nicotine use during pregnancy extends beyond cigarettes. The results also suggest that use of these other products should be included in routine clinical screening on tobacco use, and the need for more intensive tobacco control and regulatory strategies targeting pregnant women.

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1. Introduction

Examining prevalence of use of tobacco (e.g., conventional cigarettes, hookah) and other nicotine delivery systems (e.g., electronic cigarettes, dissolvables) in pregnant women is critically important. Pregnant women represent a highly vulnerable population in whom exposure to the byproducts of combusted tobacco as well as nicotine are toxic to both mother and fetus (Thompson et al., 2009). For example, tobacco cigarette smoking and maternal use of smokeless tobacco are associated with comparable increases in the risk of preterm birth, still-birth, and neonatal apnea (U.S. Department of Health and Human Services, 2014). Nicotine exposure in utero is neurotoxic while also impairing lung development in both first- and second-generation offspring, presumably through epigenetic mechanisms (Leslie, 2013).

Although surveillance systems such as the Pregnancy Risk Assessment Monitoring System (PRAMS) permit some level of monitoring of prevalence of tobacco cigarette smoking before, during, and after pregnancy (Tong et al., 2013), there are limitations. PRAMS is a state-level tool that does not include nationally representative samples, only queries respondents about conventional cigarettes, and is only administered with women who have delivered a live infant. To our knowledge, the most recent examination of tobacco cigarette smoking during pregnancy in a large U.S. national sample used the 2002–2009 National

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Survey on Drug Use and Health (NSDUH) Restricted-Data Analysis System (R-DAS), where month-specific cigarette smoking prevalence estimates were reported among pregnant women aged 12–44 years (Alshaarawy and Anthony, 2015). Prevalence was approximately 25% during Months 1–2 of pregnancy, 17.6% during Month 3, between 13.1%–14.6% during Months 4–8, and 11.3% during Month 9. Although the report provides informative data regarding smoking prevalence and changes during the course of pregnancy starting before the end of the first trimester, it did not examine prevalence of non-cigarette tobacco or nicotine product use. To our knowledge, only two reports have examined prevalence of non-cigarette tobacco and nicotine product use among pregnant women drawn from a nationally representative sample (Brown et al., 2016; Syamlal et al., 2016). However, these reports aggregated use across products to form a single measure of past month tobacco use. Thus an updated estimate of tobacco cigarette smoking prevalence, along with prevalence of other tobacco and nicotine delivery product use, is needed to address this gap.

The purpose of the present study was to obtain prevalence estimates across a relatively broad list of commercially available tobacco and nicotine delivery products among pregnant women drawn from a U.S. nationally representative sample. We were particularly interested in the prevalence of e-cigarette use, which was excluded from the NSDUH survey used in each of the three studies described above. Studies conducted using other nationally representative surveys show substantial increases in e-cigarette use in the general U.S. adult and youth populations (e.g., National Health Interview Survey [NHIS; Singh et al., 2016], National Youth Tobacco Survey [NYTS; Arrazola et al., 2014]), including women of reproductive age [King et al., 2015]). The present study characterizes prevalence and examines correlates of the use of tobacco cigarettes, e-cigarettes, hookah, cigars (i.e., traditional cigars, filtered cigars, cigarillos), smokeless tobacco (i.e., moist snuff, dip, spit, or chewing tobacco), pipe, snus, and dissolvable tobacco.

2. Method

2.1. Data source

Data were drawn from the Public Use File of the first wave (2013–2014) of the Population Assessment of Tobacco and Health (PATH) Study, a household-based, nationally representative, longitudinal cohort study of 45,971 youth (aged 12–17 years) and adults in the U.S. non-institutionalized population. Data were collected from September 12, 2013, through December 15, 2014. Weighting procedures adjusted for varying selection probabilities and differential non-response rates, while appropriately accounting for the complex study design. The overall weighted response rate was 74.0%. For additional details on adult sampling and weighting procedures, see Kasza et al. (2017). Analyses in the current study were restricted to a subsample of 388 adult women (aged ≥18 years) who reported being pregnant at the time they completed the survey.

2.2. Measures

We obtained data on respondents' age, race/ethnicity, education, U.S. census region, and poverty status. Age was defined as a continuous variable ≥18 years. Race/ethnicity was defined in terms of four categories: White, Black, Hispanic or Other. The Other category encompassed respondents of races other than White or Black, and respondents who endorsed more than one race. Education was defined in terms of four categories: Less than high school/GED, high school graduate, some college/associate's degree, and bachelors/advanced degree. U.S. census regions included the Northeast, Midwest, South, and West. Poverty status was defined as living below versus at or above the U.S. federal poverty line, which was based on annual household income and current Health and Human Services poverty guidelines.

We defined psychiatric status in terms of respondents' scores on two of the four subscales of the GAIN Short Screener (GAIN-SS; Dennis et al., 2013). More specifically, we were interested in respondents' scores on the subscales reflecting possible internalizing psychiatric disorders and possible externalizing psychiatric disorders. Regarding internalizing disorders, depressive symptomatology is a well-established risk factor for tobacco use across the lifespan (Audrain-McGovern et al., 2009). Regarding externalizing disorders, the symptoms assessed on this subscale can be conceptualized as reflecting impulsivity, which is associated with cigarette smoking in both pregnant women (White et al., 2014) and non-pregnant women of reproductive age (Chivers et al., 2016). On each subscale, participants earned one point for each item that they endorsed experiencing within the past year (range = 0–4 for internalizing and 0–5 for externalizing). Thus higher scores on each subscale indicate more past-year symptoms.

Gestational age was defined as the number of weeks pregnant a respondent reported at the time of survey completion. In order to better interpret the logistic regression parameters, gestational age was recoded such that a one-unit increase in gestational age is equivalent to a 4-week period.

Respondents were identified as current smokers, former smokers, or never-smokers. Current smokers were defined as respondents who (a) reported smoking ≥100 lifetime cigarettes and smoking every day or some days at the time of survey completion (i.e., current established smokers), or (b) did not report smoking ≥100 lifetime cigarettes but were smoking every day or some days at the time of survey completion (i.e., current experimental smokers). Former smokers were defined as respondents who (a) reported smoking ≥100 lifetime cigarettes but not smoking at all at the time of survey completion (i.e., former established smokers), or (b) reported previously smoking but not ≥100 lifetime cigarettes and were not smoking at all at the time of survey completion (i.e., former experimental smokers). Never-smokers were respondents who reported no lifetime or current tobacco cigarette use.

Prevalence of current, former, or never-use was also obtained for the following products: e-cigarettes, hookah, traditional cigars, filtered cigars, cigarillos, smokeless tobacco (i.e., moist snuff, dip, spit, or chewing tobacco), pipe, snus, and dissolvable tobacco. Traditional cigars, filtered cigars, and cigarillos were combined to form an aggregate "any cigar" category. For all products, current users were defined as respondents who (a) reported having ever used the product fairly regularly and using some days or every day now (i.e., current established users), or (b) reported using the product previously but not fairly regularly and using some days or every day now (i.e., current experimental users). Former users were defined as respondents who (a) reported having ever used the product fairly regularly but not using at all now (i.e., former established users), or (b) reported using the product previously but not fairly regularly and not using at all now (i.e., former experimental users). Never-users were respondents who reported no lifetime or current use of the product in question.

Alcohol use was defined as any alcohol consumption within the past year. Illicit drug use was defined as using at least one of the following substances in the past year: marijuana, cocaine or crack, prescription drugs such as painkillers or sedatives used without a prescription, stimulants like methamphetamine or speed, or any other drugs such as heroin, inhalants, solvents, or hallucinogens.

2.3. Statistical methods

Frequencies and percentages (weighted to account for the complex sampling scheme) were generated across all respondents aged ≥18 years of age who endorsed being pregnant at the time they completed the survey. Frequencies and weighted percentages of current, former, and never-use of all tobacco and nicotine delivery products examined in this report were evaluated overall and separately within groups defined by tobacco cigarette smoking status (i.e., current,

former, and never-smokers). For those products where overall prevalence was >1%, we also examined the frequency of product use. These products included (a) conventional tobacco cigarettes, (b) e-cigarettes, (c) hookah, and (d) any cigar. For tobacco cigarettes, frequency of use is presented in terms of both mean days used in the past 30 days and mean cigarettes smoked per day. For e-cigarettes and any cigar, we present only mean days used in the past 30 days as sample sizes were sufficiently small to generate reliable estimates for the latter measure of frequency. Because the PATH survey includes slightly different questions pertaining to the frequency of hookah use, these data are presented in terms of the proportion of current hookah users who endorsed using hookah weekly, monthly, every couple of months, or about once per year.

Logistic regression was used to examine correlates of current use of the above products for which overall prevalence was >1%. The regression for each outcome involved two steps. First, we used simple logistic regression to examine associations between the variables described above with the outcome. Second, any independent variables that were significantly associated with the outcome were included in a multiple logistic regression model to determine which variables remained significantly associated with the outcome after controlling for the presence of others. Odds ratios (95% CIs) were estimated for both the simple and multiple logistic regression analyses. Unadjusted odds ratios (ORs) represent the odds of currently using a particular tobacco or nicotine delivery product without controlling for the other independent variables. Adjusted odds ratios (AORs) represent the odds of using the product in question adjusting for all other variables remaining in the final model.

All analyses were conducted using SAS 9.4 software (SAS Institute, Cary, NC) and statistical significance across all tests was defined as p < 0.05 (2-tailed). Missing data on any variable resulted in case-wise deletion of that respondent.

3. Results

3.1. Sample characteristics

Respondent characteristics are displayed in Table 1. The majority of pregnant women included in the subsample were between 18 and 34 years of age, and with an average gestational age of approximately 21 weeks (95% CI = 29.1, 42.8). Slightly over half of the respondents were White, and over 80% of respondents graduated high school. Comparable proportions of respondents were represented across the four Census regions, although slightly higher and lower proportions resided in the South and Northeast, respectively. Slightly over half of respondents lived at or above the federal poverty line, and the majority endorsed alcohol but not illicit drug use during the past year. On average, respondents reported few symptoms reflecting the potential presence of either an internalizing or externalizing psychiatric disorder.

3.2. Prevalence of use of tobacco and other nicotine delivery products

Table 2 shows overall prevalence of current-, former- and never-use of all eight tobacco/nicotine delivery products, as well as prevalence of use of each product within groups defined by tobacco cigarette smoking status. We used the published suppression guidelines for various CDC studies to designate those prevalence estimates that may be statistically unreliable (Klein et al., 2002). Briefly, these guidelines specify that estimates are considered statistically unreliable and should be suppressed if the denominator is based on <50 sample cases, or the relative standard error (i.e., SE/Prevalence) of the estimate is >30%. As the former criterion was not met in any case, we present all prevalence estimates and use a ¶ symbol to designate those cases where (SE/Prevalence) * 100 is >30%.

Overall, conventional tobacco cigarettes were the most commonly used product with a 13.8% (n = 100, 95% CI = 10.5, 17.1) prevalence. Following tobacco cigarettes, the next most commonly used products

Table 1
Sociodemographics, substance use, psychiatric status, and gestational age among pregnant women (n = 388, weighted % = 4.43, 95% CI = 3.8, 5.1) — Population Assessment of Health and Tobacco (PATH) study, United States, 2013–2014.

	Prevalence Weighted % (95% CI)
Age	
18–24 years	35.9 (29.1, 42.8)
25–34 years	53.2 (45.7, 60.4)
35–54 years	10.9 (6.0, 15.8)
Race/ethnicity[a]	
White	55.0 (48.4, 61.6)
Black	11.9 (7.9, 15.8)
Hispanic	23.3 (18.0, 28.6)
Other	9.8 (4.3, 15.3)
Education level	
< High school/GED	16.7 (11.4, 21.9)
High school graduate	21.7 (16.2, 27.3)
Some college/associate's degree	33.7 (28.1, 39.3)
Bachelor's/advanced degree	27.9 (21.2, 34.6)
U.S. census region	
West	24.8 (18.1, 31.4)
Northeast	14.6 (8.9, 20.2)
Midwest	25.2 (18.8, 31.7)
South	35.4 (28.9, 42.0)
Poverty status[b]	
Below poverty level	42.9 (35.5, 50.3)
At or above poverty level	57.1 (49.7, 64.5)
Alcohol use[c]	
Past year alcohol use	55.6 (48.0, 63.1)
Illicit drug use[d]	
Past year illicit drug use	15.8 (10.9, 20.6)
M (95% CI)	
Psychiatric status[e]	
Internalizing	0.6 (0.4, 0.7)
Externalizing	1.2 (1.0, 1.4)
Gestational age (weeks)	20.9 (19.7, 22.2)

[a] The four racial/ethnicity categories (White, Black, Other, Hispanic) are mutually exclusive; persons identifying as Hispanic are categorized as such, regardless of race, "Other" includes non-Hispanic persons of two or more races and persons belonging to racial groups other than non-Hispanic White or non-Hispanic Black.
[b] Based on reported family income and poverty thresholds published by the U.S. Department of Health and Human Services.
[c] Self-reported alcohol use within the past year.
[d] Use of at least one of the following illicit drugs within the past year: marijuana, cocaine or crack, prescription drugs such as painkillers or sedatives used without a prescription, stimulants like methamphetamine or speed, or any other drugs such as heroin, inhalants, solvents, or hallucinogens.
[e] Represents the average number of symptoms experienced in the past year reflecting a possible internalizing or externalizing psychiatric disorder (score ranges 0 to 4 and 0 to 5, respectively), as measured by the Gain Short Screener (GAIN-SS).

in the sample overall were e-cigarettes (n = 34, weighted % = 4.9%, 95% CI = 3.2, 6.6), hookah (n = 20, weighted % = 2.5%, 95% CI = 1.3, 3.8), and any cigar (n = 18, weighted % = 2.3%, 95% CI = 1.0, 3.5). Prevalence was <1.0% for all of the remaining products (pipe, dissolvables, smokeless, and snus).

Over 40% of pregnant women who smoke conventional tobacco cigarettes also use other non-cigarette tobacco or nicotine delivery products (weighted % = 40.9%, 95% CI = 31.0, 50.7). Hence, ordering product use from most to least prevalent among current tobacco cigarette smokers produces a pattern that is generally similar to that observed in the total sample overall albeit with higher absolute prevalence estimates. More specifically, prevalence of current use of non-cigarette tobacco or nicotine delivery products among the current tobacco cigarette smokers was highest for e-cigarettes (n = 27, weighted % = 28.5%, 95% CI = 19.7, 37.3), followed by any cigar (n = 15, weighted % = 14.0%, 95% CI = 6.4, 21.6), hookah (n = 14, weighted % = 12.4%, 95% CI = 5.4, 19.4). Less than three women used smokeless tobacco, snus, pipes, or dissolvables.

Table 2

Prevalence of use of conventional tobacco cigarettes[a] and other tobacco and nicotine delivery products[b] among pregnant women overall and across three categories of tobacco cigarette smoking status: current smoker, former smoker, and never-smoker—Population Assessment of Health and Tobacco (PATH) study, United States, 2013–2014.

	Overall (n = 388)	Current smokers (n = 100)	Former smokers (n = 173)	Never smokers (n = 114)
	Weighted % (95% CI)	Weighted % (95% CI)	Weighted % (95% CI)	Weighted % (95% CI)
Tobacco cigarettes				
Current smoker	13.8 (10.5, 17.1)	100.0 (0.0)	–	–
Former smoker	42.8 (35.6, 50.1)	–	100.0 (0.0)	–
Never smoker	43.3 (35.9, 50.8)	–	–	100.0 (0.0)
E-cigarettes				
Current user	4.9 (3.2, 6.6)	28.5 (19.7, 37.3)	2.3 (0.4, 4.2)[¶]	–
Former user	18.4 (14.1, 22.6)	44.5 (33.1, 56.0)	28.0 (21.0, 35.0)	0.6 (0.0, 1.4)[¶]
Never user	76.7 (72.2, 81.2)	27.0 (17.1, 36.8)	69.7 (62.1, 77.3)	99.4 (98.6, 100.0)
Hookah				
Current user	2.5 (1.3, 3.8)	12.4 (5.4, 19.4)	1.1 (0.1, 2.1)[¶]	0.7 (0.0, 1.9)[¶]
Former user	27.3 (21.9, 32.6)	30.5 (19.2, 41.8)	42.9 (33.7, 52.1)	10.4 (5.6, 15.2)
Never user	70.2 (64.7, 75.7)	57.1 (45.3, 68.8)	56.0 (46.9, 65.1)	88.9 (83.8, 93.9)
Any cigar[c]				
Current user	2.3 (1.0, 3.5)	14.0 (6.4, 21.6)	0.8 (0.0, 1.7)[¶]	–
Former user	35.3 (28.0, 42.5)	48.0 (37.3, 58.6)	56.6 (45.8, 67.4)	10.7 (2.9, 18.4)
Never user	62.5 (55.1, 69.9)	38.0 (27.5, 48.6)	42.6 (31.7, 53.6)	89.3 (81.6, 97.1)
Smokeless				
Current user	0.6 (0.0, 1.4)[¶]	4.7 (0.0, 10.0)	–	–
Former user	3.7 (2.0, 5.5)	9.6 (2.4, 16.8)[¶]	5.7 (2.5, 8.8)	–
Never user	95.6 (93.7, 97.5)	85.7 (76.7, 94.7)	94.3 (91.2, 97.5)	100.0 (100.0, 100.0)
Snus				
Current user	0.6 (0.0, 1.4)[¶]	4.6 (0.0, 10.0)[¶]	–	–
Former user	3.0 (1.5, 4.4)	5.6 (0.6, 10.5)[¶]	5.2 (2.4, 8.0)	–
Never user	96.4 (94.8, 98.0)	89.8 (82.7, 96.9)	94.8 (92.0, 97.6)	100.0 (100.0, 100.0)
Pipe				
Current user	0.4 (0.0, 0.8)[¶]	2.1 (0.0, 5.2)[¶]	0.2 (0.0, 0.6)[¶]	–
Former user	5.7 (3.4, 8.0)	14.0 (6.1, 21.8)	8.5 (4.3, 12.7)	0.4 (0.0, 1.3)[¶]
Never user	93.9 (91.5, 96.2)	83.9 (75.7, 92.1)	91.3 (87.1, 95.5)	99.6 (98.7, 100.0)
Dissolvable				
Current user	0.1 (0.0, 0.3)[¶]	0.8 (0.0, 2.3)[¶]	–	–
Former user	0.1 (0.0, 0.3)[¶]	–	0.2 (0.0, 0.7)	–
Never user	99.8 (99.5, 100.0)	99.2 (97.7, 100.0)	99.8 (99.3, 100.0)	100.0 (100.0, 100.0)

  [a] For tobacco cigarette smoking, categories of use were (a) Current smoker = self-reported smoking ≥100 lifetime cigarettes and smoking every day or some days now, OR self-reported smoking <100 lifetime cigarettes and smoking every day or some days now, (b) Former smoker = self-reported smoking ≥100 lifetime cigarettes and not smoking at all now, OR self-reported smoking <100 lifetime cigarettes and not smoking at all now, and (c) Never smoker = self-reported no lifetime or current cigarette smoking. Smoking status could not be determined for one woman.

  [b] For all other non-cigarette tobacco/nicotine-delivery products, categories of use were (a) Current user = has ever used the product fairly regularly and using every day some days now, OR has used the product but not regularly and using every day or some days now, (b) Former user = has ever used the product fairly regularly but is not using at all now, OR has used the product but not regularly and is not using at all now, and (c) Never user = has never used the product fairly regularly and is not using at all now.

  [c] Any cigar includes traditional cigars, filtered cigars, and/or cigarillo. All prevalence estimates weighted to reflect the sampling design and, thus, are estimates of the non-institutionalized United States population.

  [¶] Represents estimates for which (SE/Estimate) ∗ 100 > 30%.

Among former and never-smokers, prevalence of current use of other non-cigarette tobacco or nicotine delivery products was uniformly low. The only products for which prevalence of current use exceeded 1.0% among former smokers were e-cigarettes (n = 7, weighted % = 2.3%, 95% CI = 0.4, 4.2) and hookah (n = 4, weighted % = 1.1%, 95% CI = 0.1, 2.1). Among never-smokers, prevalence of current use across all products examined was zero with the exception of hookah, with reported use by two women (weighted % = 0.7%, 95% CI = 0.0, 1.9).

3.3. Frequency of use of tobacco and other nicotine delivery products

Among conventional tobacco cigarette smokers, the mean number of days used in the past 30 days was 26.0 (95% CI = 24.5, 27.6), with women smoking an average of 10.9 cigarettes per day (95% CI = 9.0, 12.8). Among those currently using e-cigarettes, the mean number of days of vaping in the past month was 13.1 (95% CI = 7.0, 19.1). Among cigar users, the mean number of days of smoking in the past month was 12.7 (95% CI = 3.6, 21.8). Finally, among hookah users, 8.6% of women reported smoking weekly (95% CI = 0.1, 17.2), 8.4% reported smoking monthly (95% CI = 0.0, 17.6), 40.1% reported smoking every couple months (95% CI = 23.0, 57.3), and 42.8% reported smoking about once per year (95% CI = 26.0, 59.6).

3.4. Multiple logistic regression modeling

Table 3 shows the results of the simple and multiple logistic regression analyses for current tobacco cigarette smoking. Four variables remained significant in the final model: race/ethnicity, educational attainment, poverty status and externalizing scores on the GAIN-SS. More specifically, White's, Blacks, and those endorsing Other race/ethnicity had higher odds of smoking relative to Hispanics (AORs = 5.55, 2.53, and 4.61, respectively). In addition, those with less than a high school degree or GED, high school graduates, and those with some college/associates degree had higher odds of smoking relative to those with a Bachelor's degree (AORs = 10.61, 3.90, and 3.00, respectively). Similarly, those living below the poverty line had nearly three-fold higher odds of smoking relative to those living at or above the poverty line (AOR = 2.94). Regarding psychiatric status, odds of current cigarette smoking increased by 87% for every one additional symptom that respondents endorsed experiencing in the past year on the GAIN-SS externalizing subscale.

As fewer variables remained significant in the multiple logistic regression analyses for the other non-cigarette tobacco/nicotine products, Table 4 shows the results of the multiple logistic regression analyses only for current use of e-cigarettes (left), any cigar (middle), and

Table 3
Simple and multiple logistic regression analyses predicting any current tobacco cigarette smoking[a] among pregnant women (aged ≥18 years) (n = 388)—Population Assessment of Health and Tobacco (PATH) study, United States, 2013–2014.

	Simple logistic regression		p	Multiple logistic regression		p
	Main effects			Main effects[g]		
	OR	(95% CI)		AOR	(95% CI)	
Age group (years)			0.12			
18–24	Ref. group					
25–34	0.58	(0.34, 0.99)				
35–54	0.89	(0.34, 2.30)				
Race/ethnicity[b]			0.04			<0.01
White	3.16	(1.43, 6.99)		5.55	(2.07, 14.91)	
Black	2.49	(0.83, 7.47)		2.53	(0.87, 7.30)	
Other	2.00	(0.59, 6.84)		4.61	(1.00, 21.18)	
Hispanic	Ref. group			Ref. group		
Education level			<0.0001			<0.01
< High school/GED	16.67	(5.33, 49.97)		10.61	(2.45, 45.87)	
High school graduate	7.96	(2.29, 27.66)		3.90	(0.87, 17.46)	
Some college/associates degree	5.20	(1.47, 18.37)		3.00	(0.74, 12.23)	
Bachelor's/advanced degree	Ref. group			Ref. group		
Poverty status[c]			<0.0001			<0.05
Below poverty level	4.93	(2.38, 10.20)		2.94	(1.09, 7.96)	
At or above poverty level	Ref. group			Ref. group		
Alcohol use[d]						
Past year alcohol use	1.01	(0.57, 1.79)	0.98			
Illicit drug use[e]						
Past year illicit drug use	3.21	(1.55, 6.64)	<0.01			
Region			0.42			
West	Ref. group					
Northeast	1.89	(0.55, 6.43)				
South	2.13	(0.88, 5.18)				
Midwest	1.74	(0.72, 4.22)				
Psychiatric status[f]						
Externalizing	1.85	(1.45, 2.36)	<0.0001	1.87	(1.25, 2.78)	<0.01
Internalizing	1.71	(1.38, 2.12)	<0.0001			
Gestational age (4-week interval)	0.96	(0.84, 1.09)	0.19			

[a] Defined as self-reported smoking ≥100 lifetime cigarettes and smoking every day or some days now, or self-reported smoking <100 lifetime cigarettes and smoking every day or some days now.

[b] The four racial/ethnicity categories (White, Black, Other, Hispanic) are mutually exclusive; persons identifying as Hispanic are categorized as such, regardless of race, "Other" includes non-Hispanic persons of two or more races and persons belonging to racial groups other than non-Hispanic White or non-Hispanic Black.

[c] Based on reported family income and poverty thresholds published by the U.S. Department of Health and Human Services.

[d] Self-reported alcohol use within the past year.

[e] Use of at least one of the following illicit drugs within the past year: marijuana, cocaine or crack, prescription drugs such as painkillers or sedatives used without a prescription, stimulants like methamphetamine or speed, or any other drugs such as heroin, inhalants, solvents, or hallucinogens.

[f] Represents the average number of symptoms experienced in the past year reflecting a possible internalizing or externalizing psychiatric disorder (score ranges 0 to 4 and 0 to 5, respectively), as measured by the Gain Short Screener (GAIN-SS).

[g] n for final model = 357 due to missing values.

hookah (right). Only those variables that remained significant in the final model are displayed in the Table. With respect to e-cigarette use, only current tobacco cigarette smoking and past year illicit drug use remained significant in the final model. More specifically, the odds of e-cigarette use were 28-fold higher among current tobacco cigarette smokers relative to former smokers. In addition, odds of e-cigarette use were almost four-fold higher among those who reported using illicit drugs at least once in the past year compared to those who either never used these products or used them more than a year prior to the survey.

Table 4
Multiple logistic regression analyses predicting any e-cigarette use, any cigar use, and any hookah use among pregnant women (aged ≥18 years) (n = 388)—Population Assessment of Health and Tobacco (PATH) study, United States, 2013–2014.

	Any e-cigarette use		Any cigar use		Any hookah use	
	Main effects[c]		Main effects[d]		Main effects[e]	
	AOR	(95% CI)	AOR	(95% CI)	AOR	(95% CI)
Current cigarette smoking[a]						
Yes vs no	28.02	(9.95, 78.92)	26.23	(5.84, 117.73)	9.94	(2.96, 50.05)
Illicit drug use[b]						
Past year illicit drug use	3.84	(1.49, 9.90)	22.77	(5.19, 99.91)	5.29	(1.41, 19.79)
Gestational age (4-week interval)					0.76	(0.58, 1.00)

[a] Defined as self-reported smoking ≥100 lifetime cigarettes and smoking every day or some days now, or self-reported smoking <100 lifetime cigarettes and smoking every day or some days now.

[b] Use of at least one of the following illicit drugs with in the past year: marijuana, cocaine or crack, prescriptions drugs such as painkillers or sedatives used without a prescription, stimulants like methamphetamine or speed, or any other drugs such as heroin, inhalants, solvents, or hallucinogens.

[c] n for final model = 387 due to missing values.

[d] n for final model = 385 due to missing values.

[e] n for final model = 384 due to missing values.

As with e-cigarette use, only current tobacco cigarette smoking and use of illicit drugs remained in the final model predicting current use of any cigar, with the odds of cigar use being 26-fold higher among current tobacco cigarette smokers relative to former smokers, and almost 23-fold higher among those using illicit drugs within the past year compared to those who either never used illicit drugs or used them more than a year ago.

With respect to current hookah use, those variables that remained in the final model included current tobacco cigarette smoking, past year use of illicit drugs, and gestational age. More specifically, the odds of hookah use were almost 10-fold higher among current smokers relative to a combined group including former and never-smokers. Odds of hookah use were also 5-fold higher among those who reported using illicit drugs in the past year compared to never users and those who used illicit drugs more than a year ago. Lastly, the odds of hookah use decreased by 24% for each four additional weeks of gestational age.

4. Discussion

The present report was conducted to evaluate the prevalence and correlates of using conventional tobacco cigarettes, e-cigarettes, and other tobacco and nicotine delivery products in a U.S. national sample of pregnant women. Our findings indicating a 13.8% maternal smoking prevalence among women whose average gestational age was 20.9 weeks (5–6 months) is consistent with an earlier study using 2002–2009 NSDUH data reporting maternal smoking prevalence between 13.1% and 14.6% during months 4–8 of pregnancy (Alshaarawy and Anthony, 2015). Considered together, these data indicate minimal progress in reducing cigarette smoking during pregnancy over the past decade. Clearly, renewed tobacco control and regulatory efforts targeting this population are sorely needed, although it must be recognized that smoking risk is not equivalent across all subgroups of pregnant women. More specifically, the results of the multiple logistic regression analyses indicated that odds of current tobacco cigarette smoking were significantly higher among women who were White, had lower educational attainment, were living below the federal poverty level, and endorsed more symptoms indicative of a past year externalizing psychiatric disorder. Efforts to reduce smoking among pregnant women should therefore include developing more intensive or targeted health communication and cessation interventions keeping in mind those characteristics that heighten vulnerability to smoking during pregnancy.

One context where there appears to be missed opportunities for tobacco use interventions is at obstetrical clinics. The present results certainly underscore the importance of screening for use of tobacco and nicotine delivery products beyond conventional tobacco cigarettes, especially among those who endorse current smoking. Regarding acting on screening information, only an estimated 6% of providers arrange for cessation-focused follow-up visits with pregnant women who report being conventional cigarette smokers, citing a lack of time as the primary obstacle to engaging patients in cessation efforts (Coleman-Cowger et al., 2014). Modifying systems of care to foster greater practitioner engagement surrounding cigarette smoking and use of other tobacco and nicotine delivery products may be an important step towards reducing smoking during pregnancy. Additionally, control and regulatory efforts to increase health care provider awareness and promote more consistent messaging surrounding prevalence and risks of using other non-cigarette tobacco products during pregnancy will also be important. Lastly, clinics and hospitals should consider moving evidence-based treatments for pregnant tobacco users into routine care (Chamberlain et al., 2013; Higgins and Solomon, 2016).

Following conventional tobacco cigarettes, e-cigarettes were the second most commonly used product, with an overall prevalence of approximately 5% and prevalence within current tobacco cigarette smokers nearly six-fold higher at 28.5%. In contrast, prevalence of e-cigarette use among former and never-smokers was 2.3% and 0%,

respectively, although the former may not represent a statistically reliable estimate. Considered together, these data present a mixed picture. On the one hand, the low and zero prevalence of e-cigarette use among former and never-smokers is encouraging. On the other hand, the fact that nearly one third of current tobacco cigarette smokers also use e-cigarettes, a product for which nicotine levels and nicotine-related impurities have been shown to vary across brands (England et al., 2015), may be of concern if it results in a greater level of nicotine exposure during pregnancy. Alternatively, if e-cigarette use among pregnant smokers signals interest in smoking cessation, this could be leveraged to reduce the risk of nicotine exposure in this group (Chivers et al., 2016). However, considering that a higher proportion of current tobacco cigarette smokers were former e-cigarette users (44.5%) than current e-cigarette users (28.5%) whether pregnant smokers use e-cigarettes to reduce or quit smoking is unclear. Although the effects of dual tobacco cigarette plus e-cigarette use on maternal and fetal health remain unknown, the neurotoxic effects of nicotine on the fetus are well established, thereby validating concerns about adverse effects of nicotine exposure from multiple sources on maternal and fetal health outcomes.

Overall prevalence of other non-cigarette tobacco or nicotine delivery product use in U.S. pregnant women exceeded 1% only for cigars and hookah. However, as with e-cigarettes, prevalence ranged between five- and seven-fold higher among tobacco cigarette smokers relative to overall prevalence, and both tobacco cigarette smoking and illicit drug use significantly increased the odds of cigar and hookah use in the multiple logistic regression analyses. The risk for alternative tobacco product use conferred by conventional cigarette smoking highlights the need for additional counseling (e.g., by obstetricians at prenatal visits) surrounding tobacco use whenever pregnant women endorse smoking conventional cigarettes. Additionally, broad regulatory actions for the general population that decrease the prevalence of dual/poly tobacco product use, restrict marketing of all tobacco and nicotine delivery products to vulnerable groups, and increase health communication about the effects of tobacco and nicotine delivery products may have an important and specific impact on maternal and fetal health (Vijayaraghavan et al., 2016).

In contrast to tobacco cigarette smokers, never-smokers reported zero use across all products examined except hookah. This finding is consistent with research showing that young adults perceive hookah as less addictive and easier to quit than tobacco cigarettes (Akl et al., 2015). Importantly research indicates that the amount of smoke inhaled during a 30–60 min hookah session can equal that produced by 100 or more cigarettes (Maziak et al., 2008), and long-term hookah use is associated with the development of cancer, cardiovascular disease, and decreased pulmonary functioning (Lopez et al., 2017). Moreover, there are 54 case reports in the medical literature of acute carbon monoxide (CO) poisoning related to hookah smoking, suggesting that hookah likely poses acute risks for pregnant women as such high quantities of CO would be particularly harmful during pregnancy (Retzky, 2017). Clearly the message that hookah poses adverse health risks comparable to those of tobacco cigarettes will be important to convey to all reproductive-aged women as opposed to smokers alone such that use can be discontinued immediately should these women learn that they are pregnant or are planning to become pregnant.

The present study has several limitations that merit mention. First, the study used a cross-sectional research design, which precludes examining changes in the odds of tobacco/nicotine delivery product use within non-pregnant women of reproductive age who subsequently become pregnant. Examining longitudinal predictors of sustaining tobacco product use upon becoming pregnant will become possible when future waves of PATH data are released. Second, adolescents were excluded from the present sample thereby potentially limiting generality to pregnant adolescents. Third, PATH survey items were administered in the context of a semi-structured interview and respondents' self-reported tobacco use status was not biochemically verified which could potentially lead to underreporting of use. Finally, cell sizes were relatively

small for some categories of tobacco product use, resulting in some prevalence estimes for which (SE/Estimate) ∗ 100 exceeded 30%, thereby suggesting that these estimates may be statistically unreliable. This limitation applies in particular to prevalence estimates for smokeless, snus, pipes, and dissolvables, both overall and within current tobacco cigarette smokers. In addition, prevalence of e-cigarette and hookah use within former and never smokers were also identified as statistically unreliable, which should be taken into account in considering these results. These limitations notwithstanding, the present study contributes new knowledge regarding prevalence and correlates of tobacco and nicotine delivery product use among U.S. pregnant women, while also identifying potential tobacco control and regulatory strategies to prevent or reduce tobacco/nicotine delivery product use in this highly vulnerable population.

Conflicts of interest

None to declare.

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