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Smoking and Cellular Telephone Use Among Pregnant Women Seeking Prenatal Care: Opportunities for Intervention

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Abstract

Objectives—Although smoking during pregnancy is associated with poor pregnancy outcomes, many women continue to smoke throughout pregnancy. Behavioral interventions for smoking cessation yield modest benefits, particularly in lower socioeconomic groups. Pharmacotherapy, a first-line option for smoking cessation, has not shown clear benefits for pregnant smokers, partly due to limited adherence. We evaluated the feasibility of conducting a pharmacotherapy trial for smoking cessation in pregnant women, using text messaging to enhance medication adherence.

Methods—We surveyed 724 predominantly minority pregnant women to examine the prevalence and correlates of smoking and the use of cellular telephones and text messaging.

Results—Nearly 18% of the respondents were current smokers, with a majority (67.7%) expressing interest in participating in a smoking cessation trial. Only about 6% of women with a smoking history ever received nicotine dependence treatment. Smokers were significantly more likely to be depressed than non-smokers. The vast majority of respondents (92.1%) owned cell phones, with 93.2% having an unlimited text-messaging plan.

Conclusions—These data support the feasibility of conducting a pharmacotherapy smoking cessation trial and using text messaging to enhance medication adherence in a predominantly minority population of pregnant smokers.

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Keywords

Smoking during pregnancy; Pharmacotherapy trial; Text messaging; Cellular telephone use; depression

Introduction

Numerous studies have shown negative health consequences of cigarette smoking during pregnancy for both mothers and fetuses, including an elevated risk of spontaneous abortion, placenta previa, placental abruption, preterm birth, stillbirth, fetal growth restriction, low birth weight, and sudden infant death syndrome (1). Despite these risks, up to 17.6% of women in the United States smoke during pregnancy (2,3). Many of the behavioral interventions and medications for smoking cessation have modest effects in pregnant women (4–6) and certain medications have been untested in this population. Previous research with pregnant smokers has suggested that poor medication adherence may be an important barrier to effective treatment (7–9).

Women from low socio-economic groups are more likely to smoke during pregnancy and smoking rates are persistently higher in inner-city communities (10,11). Among low-income pregnant women, stress and depression are obstacles to quitting smoking (12–14). To help low-income pregnant women quit smoking, treatment must be accessible and effective and it must address the factors that prevent women from quitting.

Technological innovation offers a new method to increase medication adherence and deliver behavioral interventions for smoking cessation. Smoking cessation interventions using cellular telephones have shown success in pregnant women (15). Such interventions for smoking cessation offer the promise of reaching low-income women because of the high rate of cell phone ownership in this population (16). Also, medications such as bupropion have emerged as potential treatments for smoking cessation in pregnant women and are currently prescribed to treat depression (17,18). Because the most effective smoking cessation treatments combine behavioral interventions with medication (19), a treatment program that utilizes both approaches may be most effective.

We surveyed low-income pregnant women in prenatal clinics at the University of Pennsylvania Health System (Penn) and Temple University Health System (Temple) in Philadelphia to explore the potential implementation of a combined smoking cessation intervention. We queried respondents about their smoking habits, interest in nicotine dependence treatment, cell phone use, and demographic factors. We aimed to determine the prevalence of smoking in the population of low-income pregnant women in the Philadelphia area, describe the population of smokers, determine whether pregnant smokers would be interested in a smoking cessation program using a cell phone intervention and medication, and characterized women’s cell phone use to determine the feasibility of implementing the smoking cessation program.

Materials and Methods

Procedures

We surveyed 500 pregnant women receiving prenatal care at the Dickens Women's Health Center at the Hospital of the University of Pennsylvania and 224 women at obstetrics clinics at Temple University Health System (Main and Episcopal Hospitals). Both sites provide free treatment for low-income pregnant women. Women were recruited while waiting to be seen for a routine clinic visit and asked whether they would complete an anonymous survey about their smoking habits and cell phone usage. The Institutional Review Boards at each of the institutions approved the study protocol, which accorded with the Declaration of Helsinki. Interested subjects at Penn gave verbal consent to participate and received a $5 cash payment to complete the survey. Interested subjects at Temple gave written consent and were not paid to participate. Prior to completing the survey, subjects received a summary of the study aims and a description of a hypothetical trial of a medication for smoking cessation. The proposed treatment was described as combining an approved smoking cessation medication and a cell phone text messaging intervention.

Measures

Participants were given a printed survey, created by the researchers, to complete independently. Questions were formatted as multiple choice or write-in description. The survey contained four sections—the first section elicited demographic data [age, race, years of education (the inclusion of which occurred after the study was initiated, resulting in missing data for one-third of subjects)] and clinical information (weeks of gestation, number of lifetime pregnancies, number of children, and the presence of clinical diagnoses of diabetes and hypertension). The information assessed the factors associated with smoking in this population. The second section asked about smoking habits (past or current smoking, numbers of cigarettes smoked per day, prior smoking cessation treatment received, and current interest in the hypothetical treatment described to them). This section estimated the prevalence of smoking and whether smokers would be interested in smoking cessation treatment that used a medication and a cell phone intervention. The third section queried the women on their cell phone usage (type of plan, presence and type of text messaging plan, extent of usage of text messaging, and service interruptions) and Internet access. This section assessed the feasibility of using a cell phone intervention. The fourth section asked women whether they had ever been diagnosed with depression and taken medication for depression for at least 2 weeks, and, if so, whether they stopped taking the medication upon learning of the pregnancy). It included the 9-item depression module (PHQ-9) from the Patient Health Questionnaire, which makes criteria-based diagnoses of major depression and other depression (20). This section estimated the rate of depression and determined whether pregnant smokers were already taking medication for depression.

Data Analysis

Statistical analyses were conducted using SPSS for Windows, Version 19. Descriptive analyses included means and standard deviations for continuous variables and frequencies for categorical variables. We compared current smokers, past smokers, and never smokers on demographic, clinical, and cell phone use characteristics. Women were identified as

current smokers if they endorsed current daily smoking, regular smoking despite having cut down, or smoking once in a while. Current smokers were asked the average number of cigarettes that they smoked daily. Due to the low frequency of Caucasian, Asian, and Latina racial/ethnic groups, we dichotomized race/ethnicity as African American vs. Non-African American. We used PHQ-9 scores to differentiate Major Depression, “other depression,”and “no depression” based on the methods described by Kroenke et al. (20).

We used a chi-square test to examine discrete variables and analysis of variance to test group differences on continuous variables, with Tukey’sHSD test*a posteriori*. Statistical significance was set at alpha=0.05.Although we considered using regression analysis to control the type I error rate, because this was a hypothesis-generating study, we chose to limit the analyses to univariate tests for ease of interpretation.

Results

Demographics

The sample was predominantly (79.0%) African American (Table 1). Participants’ mean age was 24.4 years (*SD*=5.4) and they completed 12.3 (*SD*=1.8) years of school. The women reported having had a mean of 2.7 (*SD*=1.9) pregnancies (including the present one) and a mean of 1.3 living children (*SD*=1.4). A healthcare provider had diagnosed 5.1% of the women with hypertension and 5.3% with diabetes mellitus (Table 1).

Smoking Habits

Almost one-fifth (17.8%) of respondents reported current smoking and 10.4% smoked >5 cigarettes/day. A substantial proportion of women (20.1%) reported a past history of smoking. A greater percentage of women at Temple than Penn were current or past smokers [$\chi^2_{(2)}$=29.84, p<0.001]. Only 6.3% of past or current smokers reported having ever received smoking cessation treatment. The majority (67.7%) of current smokers expressed interest in participating in a proposed study of a medication and counseling for smoking cessation (Table 2).

Depression

A medical provider had diagnosed 18.9% of respondents with depression; of this group, 50.9% reported taking an antidepressant medication for at least two weeks (Table 3). The vast majority of women taking an antidepressant medication (94.2%) reported having stopped it because of their pregnancy. Based on PHQ-9 scores, 35.1% of women were currently depressed (11.9% with major depression and 23.2% with other depression).Current smokers were most likely to have been clinically diagnosed with depression [$\chi^2_{(1)}$=27.11, p<0.001] and to have the highest PHQ-9 scores, reflecting current depression [$\chi^2_{(4)}$=34.88, p<0.001] (Table 3).

Cell Phone Usage

As shown in Table 4, the vast majority of women (N=626 or 92.1%) owned a cell phone, though 25.6% reported that they had experienced an interruption to their telephone service. Nearly all of the women with cell phones (93.2%) reported having an unlimited text-

messaging plan. In addition, 85.0% of survey respondents reported having wireless Internet access (Table 4).

Correlates of Smoking

The relationships between smoking status and other variables are shown in Table 5. There were differences as a function of smoking group (never/past/current smoking) on a number of demographic and clinical characteristics. Maternal age differed significantly by smoking status [$F_{(2,719)}$=10.37, p<0.001]: current smokers were significantly older than never smokers (p<0.001), but not past smokers (p=0.24). Smoking status was also associated with years of education [$F_{(2,481)}$=4.49, p=0.012]: current smokers completed significantly fewer years of school than never smokers (p=0.009). Smoking status also differed by race [$\chi^2_{(2)}$=32.09, p<0.001], with a greater representation of African Americans among current smokers than past smokers [$\chi^2_{(1)}$=4.29, p=0.038], but not never smokers [$\chi^2_{(1)}$=2.43, p=0.12].

The number of children that a woman had differed by smoking status [$F_{(2,717)}$=17.43, p<0.001]. Current smokers had significantly more children than both past smokers (p<0.001) and never smokers (p<0.001). The prevalence of a depression diagnosis made by a healthcare provider also differed significantly by smoking behavior [$\chi^2_{(2)}$=28.19, p<0.001], such that current smokers were more likely to have been diagnosed with depression than never smokers [$\chi^2_{(1)}$=36.32, p<0.001] but not past smokers [$\chi^2_{(1)}$=3.33, p=0.068]. Similarly, the distribution of subjects diagnosed with depression based on the PHQ-9 differed significantly by smoking behavior [$\chi^2_{(4)}$=35.55, p<0.001]. Unlike healthcare providers' diagnoses, the proportion of current smokers diagnosed with depression by the PHQ was significantly greater than that of both never smokers [$\chi^2_{(1)}$=33.31, p<0.001] and past smokers [$\chi^2_{(1)}$=16.77, p< 0.001].

Finally, the percentage of cell phone owners differed significantly by smoking group [$\chi^2_{(2)}$=15.21, p<0.001].Current smokers were significantly less likely to own a cell phone than past smokers [$\chi^2_{(1)}$=8.35, p=0.004] or never smokers [$\chi^2_{(1)}$=12.90, p< 0.001]. However, smoking status was not associated with either the number of text messages sent [F(2,634)=1.52, p=0.22] or received [F(2,631)=0.87, p=0.42] (Table 5).

Discussion

We surveyed pregnant women seeking care at two major urban medical centers to examine the feasibility of conducting a smoking cessation medication trial using a cell phone intervention. We found that17.8% of the women reported current smoking and, importantly, more than two-thirds of them (67.7%) were interested in participating in such a smoking cessation treatment. We also found that, of the women who reported smoking, only 6.3% reported ever receiving any kind of smoking cessation treatment. This underscores the need for smoking cessation treatments to be made more available to pregnant women. Many barriers to smoking cessation exist for pregnant women (21) who, although often aware of the dangers of smoking during pregnancy (22), may be ashamed to seek treatment (23).

We also found that over 92% of respondents owned a cell phone, a higher rate of cell phone ownership than expected. Although smokers were less likely than never smokers to own a cell phone, smokers nonetheless had a very high rate of cell phone ownership (> 83%), indicating that a cell phone-based intervention would be feasible with this population. Also, among phone owners, on all measures of cell phone usage, including the number of text messages sent and received, the three smoking groups did not differ significantly, further suggesting that the difference is cell phone ownership between smokers and non-smokers is not a serious limitation to the implementation of cell phone interventions. A possible limitation in implementing a cell phone smoking cessation intervention in this population is the high rate of service interruptions. However, participants in a study could be provided with phones or a prepaid service card to prevent frequent outages in service. Overall, these findings support the feasibility of implementing a cell phone intervention in this patient population. The use of a cell phone intervention to augment in-person treatment contacts could reduce the stigma that pregnant smokers may experience. This, in turn, could increase their willingness to seek smoking cessation treatment.

In addition to supporting the feasibility of a smoking cessation trial involving medication and a cell phone intervention, we found that smoking status was associated with a number of demographic and other features. African Americans were more likely to be current smokers than past smokers, suggesting that these women are most at risk to continue smoking throughout their pregnancy, highlighting the need to target this population with efforts to promote smoking cessation. Past smokers were older than non-smokers and current smokers were older than both of the other groups. These findings contrast with national data showing that young adults (aged 18–25) are the group with the highest rate current of current tobacco use (3). One possible explanation for this finding is that older women are more likely to be experienced mothers (i.e., having borne more children than either past smokers or never smokers) and may have been less likely to quit for the health of their child, based on having already delivered a child while still smoking; this theory is supported by previous research (11). We also found that current and past smokers had significantly fewer years of education than never smokers, consistent with population data (3).

Because pregnant smokers are more likely than non-smokers to be diagnosed with depression (24), we also examined the prevalence of depression among low-income pregnant women in the Philadelphia area. Based on PHQ-9 scores, current smokers were more likely to be depressed than either past smokers or never smokers. Smokers accounted for about 37% of depressed respondents, despite comprising only about 18% of respondents. This, combined with the fact that depression is a strong predictor of continued smoking, indicates that the design and implementation of smoking cessation treatments for pregnant women must take depression into account (25–27). The high rate of co-occurring smoking and depression in this patient population suggests that bupropion, a medication that has proven efficacious for smoking cessation and depression treatment, may have a unique role in pregnant smokers.

The study has several limitations. First, the participants were primarily minority women, so the findings may not be relevant to other populations of pregnant women. However, socioeconomically disadvantaged populations have higher rates of smoking than the general

population (3), and minority populations have different barriers to smoking cessation and lower success rates than the general population (21). Thus, smoking cessation treatments should be designed specifically to treat this population of pregnant women. These findings are relevant to efforts to address disparities in the access to effective care among minority groups. A second limitation of the study is that it relies solely on self-reported information, which for socially undesirable behavior (e.g., smoking during pregnancy) may lead to underreporting of that behavior. Conversely, socially desirable features (e.g., phone ownership) may have been over reported. Finally, because the survey was modified after the study was initiated, to include questions about education and the diagnosis of depression by a medical professional, data were missing for some of the measures.

The data presented here support the call for greater availability of smoking cessation treatments for pregnant women and support the feasibility of using a cell phone intervention, either as a treatment or to enhance treatment adherence. More broadly, these findings support the feasibility of using a cell phone intervention to reach minority populations to promote health behaviors. New methods of communication and improved technologies could help to address the disparities in smoking rates and access to treatment for minority populations. Finally, the data underscore the need to incorporate the assessment and treatment of depression in the context of nicotine dependence treatment in this population. Rigorous tests of empirically based interventions for nicotine dependence in pregnant smokers may offer new approaches to reduce the rate of smoking, particularly in minority women.

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Table 1

Demographic and Clinical Features of Sample [Mean (SD) or Percentage]

Variable	UPenn (N=500)	Temple (N=224)	Overall (N=724)
Age	24.6 (5.5)	24.1 (5.1)	24.4 (5.4)
Race			
African American	87.4%	60.3%	79.0%
Non-African American	12.6%	39.7%	21.0%
Education (yr)	(N=385) 12.9 (1.9)	(N=102) 11.6 (1.4)	(N=487) 12.3 (1.8)
Number of Pregnancies	2.7 (1.9)	3.2 (2.1)	2.7 (1.9)
Number of Children	1.2 (1.4)	1.5 (1.5)	1.3 (1.4)
Diabetes Mellitus			
Yes	6.8%	1.8%	5.3%
No	93.2%	98.2%	94.7%
Hypertension			
Yes	3.2%	9.4%	5.1%
No	96.8%	90.6%	94.9%

Table 2

Smoking Behavior

Variable	UPenn (N=500)	Temple (N=222)	Overall (N=722)
Smoking Status			
Current Smoker	13.8%	27.0%	17.8%
Past Smoker	17.8%	25.2%	20.1%
Never Smoked	68.4%	47.7%	62.0%
Currently Smokes ≥5 Cigarettes/Day	7.6%	16.2%	10.4%
Ever Received Treatment to Stop Smoking	7.1%	5.2%	6.3%
Interested in Treatment to Stop Smoking	63.8%	72.1%	67.7%

Table 3

Depression Measures by Study Site

Variable	UPenn	Temple	Overall
Diagnosed with Depression	(N=389)	(N=151)	(N=540)
Yes	17.0%	23.8%	18.9%
No	83.0%	76.1%	81.1%
Medication for Depression	(N=389)	(N=151)	(N=540)
Yes	9.0%	11.3%	9.6%
No	91.0%	88.7%	90.4%
Stopped Medication Due to Pregnancy	(N=387)	(N=151)	(N=538)
Yes	7.8%	12.6%	9.1%
No	92.2%	87.4%	90.9%
Depression Based on PHQ-9	(N=481)	(N=217)	(N=698)
Yes	29.9%	46.5%	35.1%
No	70.1%	53.5%	64.9%

PHQ-9 = 9-item depression module from the Patient Health Questionnaire

Table 4

Cellular Telephone Ownership and Usage by Study Site [% or Mean (SD)]

Variable	UPenn	Temple	Overall
Own a Cell Phone	(N=500)	(N=223)	(N=723)
Yes	469 (93.8%)	197 (88.3%)	666 (92.1%)
No	31 (6.2%)	26 (11.7%)	57 (7.9%)
Number of Messages Sent/Week	(N=465)	(N=174)	(N=638)
	192.7 (499.6)	277.2 (909.0)	200.41 (507.9)
Number of Messages Received/	(N=464)	(N=172)	(N=636)
	197.1 (519.2)	290.6 (920.5)	226.7 (661.6)
Cell Phone Plan Type	(N=471)	(N=195)	(N=666)
Prepaid	25.1%	31.8%	27.0%
Family Plan	41.2%	31.3%	38.3%
Separate Contract	31.0%	28.2%	30.2%
Do not know	2.7%	8.7%	4.5%
Cell Service Interruption	(N=472)	(N=154)	(N=626)
Yes	28.4%	33.1%	25.6%
No	71.6%	66.9%	60.9%
Text Messaging Plan Type	(N=469)	(N=197)	(N=666)
Unlimited	94.7%	89.8%	93.2%
Limited	2.6%	3.0%	2.7%
Pay per message	1.5%	2.0%	1.7%
Cannot send	0.0%	0.1%	0.3%
Do not know	1.1%	4.6%	2.1%
Wireless Internet Access	(N=478)	(N=168)	(N=646)
Yes	87.2%	78.6%	85.0%
No	12.8%	21.4%	15.0%

Table 5

Demographic, Clinical and Cellular Telephone Use Characteristics by Smoking Status

Variable	Current Smokers (N=129)	Past Smokers (N=145)	Never Smokers (N=448)	Test Statistic (df)	p-value
Age (yr)	26.1 (5.4)	25.0 (5.0)	23.7 (5.3)	$F_{(2, 719)} = 10.37$	0.001
Education (yr)	11.8 (1.8)	12.2 (1.6)	12.5 (1.9)	$F_{(2, 481)} = 4.49$	0.012
Number of Children	1.9 (1.8)	1.3 (1.3)	1.1 (1.3)	$F_{(2, 722)} = 19.86$	<0.001
Race	AA: 77.5% Non-AA: 22.5%	AA: 66.2% Non-AA: 33.8%	AA: 83.5% Non-AA: 16.5%	$\chi^2_{(2)} = 19.86$	<0.001
Depression (Based on PHQ-9 Score)	MD: 25.0% OD: 30.6% None: 44.4%	MD: 9.2% OD: 24.1% None: 66.7%	MD: 9.0% OD: 20.9% None: 70.1%	$\chi^2_{(4)} = 35.55$	<0.001
Cell Phone Ownership	83.7%	94.5%	93.7%	$\chi^2_{(2)} = 15.21$	<0.001
Number of Text Messages Sent	120.5 (198.7)	208.1 (657.1)	218.2 (505.9)	$F_{(2, 634)} = 1.52$	0.22
Number of Text Messages Received	147.7 (274.7)	217.1 (717.2)	225.8 (519.0)	$F_{(2, 631)} = 0.87$	0.42

AA = African American, PHQ-9 = 9-item depression module from the Patient Health Questionnaire, MD = Major depression, OD = Other depression