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The Relationship of Childhood Trauma to Nicotine Dependence in Pregnant Smokers

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Abstract

Pregnant women with high levels of nicotine dependence are the least likely to quit smoking spontaneously during pregnancy or to benefit from smoking cessation interventions. In the general population, there is increasing evidence of a relationship between smoking, nicotine dependence, and exposure to childhood trauma. We examined the relationship of childhood trauma to several measures of nicotine dependence and evaluated whether this relationship was mediated by major depressive disorder or depressive symptom severity in pregnant smokers. Moderate to extreme levels of childhood trauma were significantly related to smoking within 5 minutes or less of waking, and to the Behavioral Choice-Melioration, Negative Reinforcement and Tolerance subscales of the Wisconsin Inventory of Smoking Dependence Motives (WISDM-68) scale. The relationships between childhood emotional abuse and the WISDM-68 Total and Negative Reinforcement subscale were partially mediated by depressive symptoms. Results suggest that childhood trauma may be a risk factor underlying nicotine dependence in pregnant smokers. Increased understanding of the relationship of affect regulation to smoking in individuals with childhood trauma histories may aid in the development of more effective treatments of nicotine dependence for this population of smokers.

Keywords

pregnant smokers; nicotine dependence; childhood trauma

Maternal smoking during pregnancy is an important public health issue. It is responsible for 20% or more of the incidence of low birth weight, a condition that is associated with neonatal, perinatal, and infant morbidity and mortality (Lieberman, Gremy, Lang, & Cohen, 1994; Vardavas et al., 2010). Women who continue to smoke are at increased risk for a number of adverse pregnancy outcomes including placental abruption, pre-term birth, stillbirth, sudden infant death syndrome, and spontaneous abortion (Cnattingius, 2004; Shah & Bracken, 2000). Smoking cessation during pregnancy is associated with a significant

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reduction in these risks (Lumley, Oliver, & Waters, 2000; Johansson, Dickman, Kramer, & Cnattingius, 2009).

It is especially important to understand factors that may contribute to nicotine dependence in pregnant smokers. Nicotine dependence, as defined by the Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV; American Psychiatric Association, 1994), is a cluster of cognitive, behavioral, and physiological symptoms, indicating use of tobacco despite the presence of tobacco-related problems. Nicotine dependence is characterized by tolerance, heavy tobacco use, withdrawal, compulsive use and relapse. Pregnant women with high levels of nicotine dependence are the least likely to quit spontaneously during pregnancy (Gilman, Breslau, Subramanian, Hitsman, & Koenen, 2008; Solomon & Quinn, 2004), or to benefit from smoking cessation interventions (Fiore et al., 2000). The plateau in quit rates among pregnant smokers may be largely due to the ineffectiveness of existing interventions in addressing nicotine dependence (Ershoff, Ashford, & Goldenberg, 2004). Greater understanding of factors associated with nicotine dependence in pregnant smokers might enable us to more effectively tailor psychosocial smoking cessation interventions for this population. The development of psychosocial interventions that would more effectively address nicotine dependence is especially critical given the lack of evidence for the safety and efficacy of smoking cessation medication in pregnant women (Fiore et al., 2008; Lumley et al., 2009).

One factor that has received little attention is the relationship between childhood trauma and nicotine dependence. In the general population, there is increasing evidence that exposure to trauma during childhood is predictive of smoking initiation and nicotine dependence. In a population-based sample of adolescents (Roberts, Fuemmeler, McClernon, & Beckham, 2008), childhood sexual and physical abuse increased risk for lifetime ever regular smoking (smoke at least one cigarette every day for 30 days). Among current smokers, childhood sexual and physical abuse was significantly related to number of cigarettes smoked per day and nicotine dependence as measured by the Fagerstrom Test of Nicotine Dependence (FTND), which characterizes nicotine dependence in terms of level of physical tolerance and withdrawal symptoms during abstinence (Heatherton, Kozlowski, Frecker, & Fagerström, 1991). In studies utilizing large population based cohorts, childhood sexual abuse significantly increased risk of DSM-IV (American Psychiatric Association, 2000) nicotine dependence. Risk of nicotine dependence increased with sexual abuse severity (Mamun et al., 2007; Nelson et al., 2002). Several studies have found evidence for a graded relationship between severity of trauma, current smoking, heavy smoking (20 or more cigarettes per day) and early smoking initiation (onset by 14 years old; Anda et al., 1999; Jun et al., 2008).

We are aware of only two studies that have examined the relationship of childhood trauma to smoking during pregnancy. Both studies, which involved large representative samples of women, found a graded association between cumulative childhood hardships and abuse, and elevated risk for smoking during pregnancy (Harville, Boynton-Jarrett, Power, & Hypponen, 2010; Chung et al., 2010).

It is important to consider the role that depression might play in the relationship between childhood trauma and nicotine dependence. Current models of addiction assign a central role

to negative reinforcement of drug taking behavior that occurs when negative affective states motivate drug use as a means of escaping and/or avoiding distress (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004; Stasiewicz & Maisto, 1993). Indeed, the most common explanation offered for the association between nicotine dependence and childhood trauma is that nicotine is being used to ameliorate negative affective states, trauma symptoms, and mental health disorders (Jun et al., 2008; Mamun et al., 2007; Nichols & Harlow, 2004; Roberts et al., 2008). There are numerous lines of evidence showing that early life stress impacts brain structure and function and results in dysregulation of the hypothalamic-pituitary-adrenal axis—the system that is primarily responsible for regulation of stress and emotion, and that such effects may lead to increased risk for the development of mood and anxiety disorders (Anda et al., 2006; Heim & Nemeroff, 2001; Widom, DuMont, & Czaja, 2007). Previous studies that have examined depression in analyses of the relationship between childhood trauma and smoking have found depression to have additive or independent effects on cigarette use and dependence (Acierno, Kilpatrick, Resnick, Saunders, & Best, 1996; Acierno et al., 2000; Roberts et al., 2008). Although it has been hypothesized that the association between childhood trauma and nicotine dependence may be due to use of nicotine to regulate negative affect that results from childhood abuse (Acierno et al., 2000; Anda et al., 1999; Jun et al., 2008; Mamun et al., 2007; Nichols & Harlow, 2004; Roberts et al., 2008), to our knowledge this hypothesis has not been directly tested. If smoking is used to ameliorate negative affective states that result from childhood trauma, then it could be hypothesized that depression might at least partially account for the trauma-nicotine dependence relationship. Given that persistent smoking during pregnancy is associated with low socioeconomic status (SES; Solomon & Quinn, 2004), and low SES is associated with risk of both MDD (Gilman, Kawachi, Fitzmaurice, & Buka, 2002) and childhood trauma (Zielinski, 2009), the evaluation of depression as a mediator of the childhood trauma-smoking relationship may be especially important in pregnant smokers.

This study focuses on a sample of pregnant women who were assessed for the presence of DSM-IV (American Psychiatric Association, 2000) mood disorders prior to entering a smoking cessation trial. Based on previous findings of a positive relationship between childhood trauma and nicotine dependence, we predicted that women who had experienced the greatest levels of childhood trauma would have the highest levels of nicotine dependence. Given the emphasis in the literature on both negative affective states and psychiatric disorders as potential pathways between abuse, smoking and nicotine dependence (Acierno et al., 2000; Anda et al., 1999; Jun et al., 2008; Mamun et al., 2007; Nichols & Harlow, 2004; Roberts et al., 2008), we tested the hypothesis that the relationship between childhood trauma and nicotine dependence would be mediated by both depression symptom severity and depressive disorder diagnoses.

Method

Participants and Procedures

The sample consisted of the first 201 pregnant smokers who were eligible and consented to participate in an intensive, 10-session smoking cessation intervention study. To be included in the sample, women also had to attend the baseline and first treatment visit, and complete

the childhood trauma measure. Additional information regarding the sample can be found in Cinciripini et al., 2010. In brief, participants were recruited from the Houston metropolitan area using radio, television and other forms of advertising. To be included in the trial women were required to be 16 years of age, 32 weeks pregnant, have smoked at least a puff or more during the past 7 days, have a telephone, and express a willingness to quit smoking during the study. Women were excluded if they were currently participating in psychotherapy or other smoking cessation treatment, had unstable medical conditions that would adversely affect attendance, or demonstrated psychological instability during the screening. Initially, 1,067 women telephoned and expressed interest in obtaining information about the study. At the initial telephone contact, women were told that the study was evaluating two counseling methods for helping pregnant women quit smoking—one that would focus on health concerns related to pregnancy and one that would focus on learning to manage negative mood. Women were also informed that they would receive 10 weekly counseling sessions that would last about an hour each and would be asked to attend long-term follow-up assessment visits at 3- and 6-months postpartum. Women were informed that if they were enrolled in the study, they would be compensated \$40 for each of the treatment sessions that they completed.

Six-hundred and fifty four women completed the preliminary telephone screen. Six hundred and eight women met the initial eligibility criteria and were invited to attend an in-person screening session. Two hundred seventy-five of these women attended the in-person screening session, during which the mood module of the Structured Clinical Interview for DSM-IV (SCID) Axis I Disorders (modified for Chronic Major and Double Depression; First, Spitzer, Gibbon, & Williams, 2001) was administered. Two hundred fifty of these women met eligibility criteria and consented to participate. Two hundred fifteen attended the first treatment visit at which time they were randomized to treatment groups (see Cinciripini et al., 2010 for study details). Because the measure of childhood trauma was added to the study protocol several months after study initiation, these data were not collected on the first 14 participants; thus, the final sample consisted of 201 women.

Measures

Demographic and Smoking-Related Characteristics—Information on demographics, socioeconomic status, gestational age, and smoking related variables were collected by structured interviews during the telephone screen and via a computer-administered questionnaire at the baseline session.

Childhood Trauma—The Childhood Trauma Questionnaire-Short Form (Bernstein, Ahluvalia, Pogge, & Handelsman, 1997; Bernstein & Fink, 1998) is a widely used 28-item self-report questionnaire that retrospectively assesses abuse and neglect that occurred in childhood, which was developed for administration to adolescents age 12 and older and to adults. It includes 5 scales that evaluate traumatic childhood experiences, including emotional, physical and sexual abuse, and emotional and physical neglect. Item responses are made on a 5-point Likert scale that assesses frequency of traumatic childhood events by asking for level of agreement with statements about childhood events (Never to Very Often True).

The CTQ has demonstrated acceptable to good reliability and validity in psychiatric, community, and substance using samples (Bernstein et al., 1997; Bernstein et al., 2003; Scher, Stein, Asmundson, McCreary, & Forde, 2001) and good convergent validity with clinician rated interviews and therapist ratings (Bernstein & Fink, 1998). Confirmatory factor analyses have consistently provided evidence for five distinct, yet intercorrelated factors across a variety of adolescent, adult and community samples (Bernstein et al., 2003; Scher et al., 2001; Thombs, Lewis, Bernstein, Medrano, & Hatch, 2007). Similar to previous studies (Bernstein et al., 2003; Scher et al., 2001), intercorrelations between subscales in the current study were significant $p < .001$, with high correlations between emotional and physical abuse (.68), emotional and physical neglect (.70) and lower correlations between sexual abuse and emotional (.28) and physical neglect (.33). (See Table 1) Cronbach's coefficient alpha for the five CTQ scales ranged from .96 for the Sexual Abuse scale to .76 for the Physical Neglect scale.

The relationship of nicotine dependence to the five types of trauma was evaluated using a categorical measure. CTQ cut scores were used to classify trauma severity based on sensitivity and specificity data derived from two validation samples (Bernstein & Fink, 1998). These scores delineate none to minimal, low to moderate, moderate to severe, and severe to extreme levels of maltreatment. To increase power to detect differences between trauma severity level categories, we collapsed scores into two categories for each type of trauma: 1) none to low levels of trauma (low level trauma group), and; 2) moderate to extreme levels of trauma (high level trauma group). We chose the moderate cut point to minimize the misidentification of nonmaltreatment cases, as this cut point has been shown to have a specificity of at least 95%, while still achieving high sensitivities ranging from 49% to 72% (Bernstein & Fink, 1998). Similar to previous studies (Anda et al., 1999; Jun et al., 2008), we created a variable assessing the total number of the five trauma categories (e.g., emotional, sexual, and physical abuse and emotional and physical neglect) that participants experienced at the moderate or greater level of severity. Creation of this variable allowed us to examine whether the experience of multiple types of trauma increased the risk for nicotine dependence, as has been found in previous studies (Anda et al., 1999; Jun et al., 2008).

Nicotine Dependence—Information about current smoking rate, pre-pregnancy smoking rate, and age of initiation of smoking was gathered at the baseline visit.

The FTND – Time to First Cigarette (Heatherton et al., 1991) is an item on the FTND, a widely used 6-item questionnaire that measures physical dimensions of nicotine dependence (Radzins et al., 2003). Most of the variation in the FTND scores is captured by two items, which include time to first cigarette after waking and number of cigarettes smoked per day (Heatherton, Kozlowski, Frecker, Rickert, & Robinson, 1989). Because the total FTND score is affected by current smoking rate and women who are pregnant frequently reduce their smoking rate upon learning of their pregnancies, we utilized the item that queries time to first cigarette as a measure of nicotine dependence. Individuals who self-report smoking within 5 minutes or less from waking have been found to significantly differ from those who smoke within 6 or more minutes in level of expired carbon monoxide, salivary cotinine, difficulty abstaining for one day, and cigarettes per day (Heatherton et al., 1989; Heatherton

et al., 1991). It has been shown to be a better predictor of abstinence at 1-week and 6-months than other measures of nicotine dependence (Baker et al., 2007). A categorical measure was created that consisted of two levels: 1) smoke in 5 minutes or less after waking, and; 2) smoke 6 minutes or later after waking.

The Wisconsin Inventory of Smoking Dependence Motives (WISDM-68; (Piper et al., 2004) is a theoretically based multi-dimensional measure that was developed to assess motivational factors underlying tobacco dependence. It consists of 13 subscales representing various motives for tobacco use, including Affiliative Attachment, Automaticity, Behavioral Choice-Melioration, Cognitive Enhancement, Craving, Cue Exposure-Associative, Loss of Control, Negative Reinforcement, Positive Reinforcement, Social-Environmental Goads, Taste and Sensory Properties, Tolerance, and Weight Control. All 13 subscales have been shown to have strong internal consistency across two samples and across gender and race (Piper et al., 2004). In the current sample, Cronbach's coefficient alpha was .94 for total scale and ranged from .80 for the Loss of Control and Tolerance subscales to .93 for the Taste and Sensory Process subscale. We chose to evaluate each of the 13 subscales for several reasons. Given that smoking for relief from negative affect has been suggested as an important explanatory factor for the childhood abuse-nicotine dependence relationship, we were especially interested in evaluating the Negative Reinforcement subscale. In addition, factor analyses of the WISDM-68 have primarily been conducted in non-psychiatrically disordered samples of middle-aged smokers (Piper et al., 2004; Piper et al., 2008). There is little information on how previous findings on the WISDM-68 might apply to this population of smokers who were early in their smoking careers and had high rates of MDD. Thus, we were concerned about making assumptions in regards to choosing specific subscales on which to focus, other than Negative Reinforcement.

Depression—Mood disorders were assessed at screening using the Mood Module of the Patient Edition of the SCID (First, Spitzer, Gibbon, & Williams, 1994). Level of depressive symptom severity was assessed at baseline using the Center for Epidemiologic Studies Depression Scale (CES-D). The CES-D is a 20-item self-report measure developed to assess depressive symptoms in community populations (Radloff, 1977).

Data Analytic Methods

Descriptive statistics, including means, standard deviations, and frequency distributions, were calculated for demographic, smoking, mood, and trauma variables. Bivariate correlations between demographic variables (age, weeks pregnant, education, marital status, employment status, and annual family income) and nicotine dependence measures (current smoking rate, pre-pregnancy smoking rate, age of initiation of smoking, smoking within 5 minutes or less from waking, and WISDM-68 Total) were examined to identify which, if any, demographic variables to include as covariates in later analyses, using a Bonferonni-adjusted alpha of 0.0014.

Pearson correlation was conducted to examine intercorrelations between CTQ subscales. The CTQ subscales were highly correlated. However, our sample size did not provide enough power (35%) to utilize multivariate logistic regression models to examine the

unique relationships of the CTQ subscales to the dichotomous measure of smoking within 5 minutes. Therefore, we chose to examine each type of trauma and the total number of trauma types experienced separately as predictors of nicotine dependence and smoking related variables, including smoking within 5 minutes or less of waking, pre-pregnancy and current smoking rates, age of onset of smoking, and WISDM-68 scales.

Multiple regression analyses were performed using SAS PROC REG (SAS institute, Inc., Cary, NC) when predicting smoking rates and age of onset outcome measures. Logistic regression was performed using SAS PROC LOGISTIC when predicting smoking within five minutes of waking. A critical p value of 0.05 was used for each regression analysis. Multivariate analysis of variance (MANOVA) was conducted with the WISDM-68, with each of the 13 subscale scores entered as a dependent variable. The overall type I error rate (α) was set at 0.05 for each MANOVA analysis. To control for the possible inflation of Type I error due to multiple testing, a Bonferroni adjustment was used resulting in a critical p -value of .002 for any of the individual scale comparisons to be considered significant. Many of the WISDM-68 subscales have been found to be substantially correlated (Piasecki, Piper, & Baker, 2010; Piper et al., 2004). Thus, significant findings on multiple subscales may not reflect unique effects. Given the theoretical importance that negative reinforcement (i.e., use of smoking to avoid negative affective states) has in explaining the childhood abuse-nicotine dependence relationship (Acierno et al., 2000; Anda et al., 1999; Jun et al., 2008; Mamun et al., 2007; Nichols & Harlow, 2004; Roberts et al., 2008), in instances of significant findings on multiple subscales that included WISDM-68 Negative Reinforcement, univariate follow-up regressions were repeated with trauma predicting individual subscale scores after controlling for the score on Negative Reinforcement. This approach allowed us to further explore the importance of the relationship of negative reinforcement dependence motives to childhood trauma, relative to other dependence motives represented on the WISDM-68 subscales. For univariate follow-up analyses to MANOVAs, Hedges' g (Hedges, 1981) was used to estimate effect size. Like Cohen's d , this statistic is based on the standardized mean difference approach, but it provides an unbiased estimate. Because number of abuse categories is a continuous variable, effect size measures based on mean difference or standardized mean difference (like d or g) are not appropriate. In this case, we provided a measure of proportion of variance explained by this variable.

In cases in which a trauma variable was a statistically significant predictor of a nicotine dependence variable, depression variables (baseline CES-D total score, lifetime MDD diagnosis, and current MDD diagnosis) were examined as potential mediators. Mediation was assessed following MacKinnon's approach (MacKinnon, 1994). In Step 1, the nicotine dependence measure was regressed on the trauma variable, which must have a significant effect. In Step 2, the depression variable, the hypothesized mediator in this case, was regressed on the trauma variable. Finally, in Step 3, the nicotine dependence variable was regressed on the trauma variable with the depression variable (i.e, hypothesized mediator) included in the same equation. In order to conclude there is a mediation effect, the trauma variable must be a significant predictor of the depression variable in Step 2 and the depression variable must be a significant predictor of the nicotine dependence variable when

controlling for the effect of the trauma variable in Step 3. A critical p value of 0.05 was used for each regression analysis. The significance of the mediated effect was tested by computing standard errors using Sobel's method (Sobel, 1982; Sobel, 1986) to perform Z-tests. Because issues related to scaling arise in the case of logistic regression with dichotomous outcomes (i.e. smoking within 5 minutes of waking) or mediators (i.e., MDD diagnosis), mediation effects must be adjusted and were computed following the method of MacKinnon (MacKinnon & Dwyer, 1993).

Results

Characteristics of Sample

Demographic and Smoking-Related Characteristics—Demographic and smoking-related characteristics of the sample are shown in Table 2. The average age was 25 years. Women were on average 20 weeks into their pregnancy. The majority of the sample was African-American; one-third of the sample was White. Sixty-eight percent of women had a high school degree or less, 50% were unemployed, and 54% had an annual family income of \$19,999 or less. Fifty-eight percent were not living with a partner, and only 19% were married. Sixty-five percent were receiving Medicaid or county health care. The average age at which the participants began smoking was 15.5 years. Women had reduced their smoking rate from an average of 16.5 cigarettes a day before they knew they were pregnant, to 10.6 cigarettes a day. The average FTND score was 3.4, which falls within the “low” level of nicotine dependence on this measure (Fagerstrom, Heatherton, & Kozlowski, 1990). Twenty-one percent of women endorsed smoking within 5 minutes of waking.

Identification of Covariates—Correlations between nicotine dependence and demographic variables are presented in Table 3. A demographic variable was included as a covariate in later analyses if it was significantly related to multiple nicotine dependence outcomes, using the Bonferroni-adjusted alpha of 0.0014. Categorical variables were dichotomized as follows: Race into white versus non-white; income into less than versus greater than \$20,000 per year; education into less than high school versus high school or higher; employment into employed/student versus homemaker or unemployed; living with partner into married and living with partner/not married and living with partner versus not married/not living with a partner. Race showed significant correlations with age of smoking onset ($r = -0.28, p < 0.001$) and total WISDM score ($r = 0.24, p < 0.001$). Other demographic variables were not significantly related to nicotine dependence measures. Thus, race was the only demographic variable included as a covariate in subsequent analyses.

Mood Disorder Diagnoses—Frequency and percentage of DSM-IV mood disorders are shown in Table 4. Seventy-seven percent of the sample had a lifetime history of MDD. Twenty-six percent of women were currently experiencing a major depressive episode (MDE) at the threshold level, and 13% were in partial remission of a MDE for a total of 39% who met criteria for MDD with current symptoms. Five percent of the sample had a lifetime history of bipolar disorder. Among the seven individuals (3.5% of the sample) who met criteria for current bipolar disorder, four were in a major depressive episode, and three were in manic, hypomanic or mixed episodes.

Rates of Childhood Trauma—When grouped, the percentage of the sample that endorsed experiencing high levels of trauma was as follows: 32% emotional abuse, 21% physical abuse, 33% sexual abuse, 34% emotional neglect, and 25% physical neglect. Forty-one percent of the sample had experienced no traumas at the high level. Fifty-nine percent of women in the sample had experienced at least one of the trauma categories at the high level. Twenty-one percent of the sample had experienced one type of trauma, 15% two traumas, 7% three traumas, 8% four traumas, and 8% had experienced all 5 types of trauma.

Relationship of Childhood Trauma to Nicotine Dependence

Results of logistic regression analyses predicting smoking within 5 minutes of waking from childhood trauma and number of trauma categories, controlling for race, are shown in Table 5. Smoking within 5 minutes of waking was significantly more likely in women who had experienced high levels of trauma than those who experienced low levels for each trauma category, except sexual abuse. Adjusted odds ratios ranged from ($OR = 2.69$; 95% CI 1.32, 5.47) for emotional abuse to ($OR = 2.08$, CI 1.03, 4.22) for emotional neglect. Number of categories of trauma was also significantly related to smoking within 5 minutes of waking (Wald = 4.94, $df = 1$, $p = .026$).

Daily smoking rate before learning of pregnancy, current smoking rate, and age of initiation of smoking were unrelated to trauma group for any of the trauma categories or to number of categories of trauma experienced.

MANOVA analyses, using the Wilks Lambda test for significance and controlling for race, showed statistically significant effects on WISDM-68 subscales for high levels of emotional abuse $F = 2.48$ (13, 183), $p = .004$, physical abuse $F = 1.81$ (13, 183), $p = .045$, and number of abuse categories $F = 1.80$ (13, 183), $p = .046$. MANOVA results were nonsignificant for sexual abuse, emotional neglect and physical neglect.

Using a critical p value of .002 to adjust for multiple tests, follow-up univariate tests of the effect of emotional abuse on 13 WISDM-68 subscales, controlling for race, indicated that high levels of emotional abuse significantly predicted the Behavioral Choice-Melioration $F = 10.27$ (1, 195), $p = .002$; Negative Reinforcement $F = 15.73$ (1, 195), $p = .0001$; and Tolerance $F = 9.89$ (1, 197), $p = .002$ subscales. White race was also a significant and positive predictor for Negative Reinforcement $F = 12.08$ (1, 195), $p = .0006$, but nonsignificant for Behavioral Choice-Melioration and Tolerance. Effect sizes on these univariate tests using Hedges' g were $g = 0.491$ for the relationship of high emotional abuse to Behavioral Choice-Melioration; $g = 0.482$ for Tolerance; $g = 0.608$ for Negative Reinforcement, indicating that effect sizes were in the medium range.

To further investigate the relative contribution of each of the three WISDM-68 subscales that were found to be significantly related to emotional abuse, Behavioral Choice-Melioration and Tolerance were tested in univariate models, controlling for Negative Reinforcement, as well as race. We chose to control for Negative Reinforcement given the central role that it has been given (i.e., use of smoking to avoid negative affective states) in explaining the childhood abuse-nicotine dependence relationship (Acierno et al., 2000; Anda et al., 1999; Jun et al., 2008; Mamun et al., 2007; Nichols & Harlow, 2004; Roberts et al.,

2008). In these univariate follow-up tests, high emotional abuse was no longer significantly predictive of the Behavioral Choice-Melioration or Tolerance subscales, suggesting that the relationships between emotional abuse and these WISDM subscales were significantly attenuated when accounting for the effects of Negative Reinforcement.

Follow-up univariate tests of the 13 WISDM-68 subscales for physical abuse, controlling for race, indicated that high physical abuse was significant only for the Negative Reinforcement subscale $F = 10.67$ (1, 195), $p = .001$. White race was also a significant and positive predictor in this model $F = 14.35$ (1, 195), $p = .0002$. Effect size for the relationship of high physical abuse to Negative Reinforcement using Hedges' g was $g = 0.561$.

Follow-up univariate tests for number of abuse categories, controlling for race were marginal for Negative Reinforcement $F = 9.30$ (1, 197), $p = .0026$. The adjusted $R^2 = 0.0377$, suggesting that approximately 4% of the variance in WISDM-68 Negative Reinforcement was accounted for by number of abuse categories. Univariate follow-up tests for number of abuse categories were nonsignificant for all other WISDM-68 subscales.

Do Depressive Symptoms Mediate the Childhood Trauma-Smoking Within 5 Minutes of Waking Relationship?

For tests of CES-D as a mediator of the relationship of emotional abuse, physical abuse, emotional neglect, physical neglect and number of trauma categories to smoking within 5 minutes of waking, criterion 2 was met (CES-D was related to all of the trauma variables), but criterion 3 was not met (CES-D was not related to smoking upon waking when controlling for childhood trauma), thus CES-D was not further evaluated as a mediator of these relationships.

Do Depressive Symptoms Mediate the Childhood Trauma-WISDM-68 Relationships?

Although emotional abuse was significantly related to several WISDM-68 subscales, because of the likelihood of collinearity among subscales, we chose to evaluate mediation utilizing only the WISDM-68 Total and Negative Reinforcement subscale. As seen in Tables 6 and 7, criteria for Step 1 (Emotional Abuse was related to WISDM-68 Total and WISDM-68 Negative Reinforcement), Step 2 (Emotional Abuse was related to CES-D), and Step 3 (CES-D was related to WISDM-68 Total and WISDM-68 Negative Reinforcement when controlling for Emotional Abuse) were met in tests of CES-D as a mediator of the relationships of emotional abuse with total WISDM-68 score and the WISDM-68 Negative Reinforcement subscale. To test the significance of the mediated effect of CES-D on the relationship between Emotional Abuse and the two WISDM-68 scales, we used computed standard errors using Sobel's method (Sobel, 1982; Sobel, 1986) to perform Z-tests. Z tests on the mediated effects' proportion of the total effect were significant for the WISDM-68 Total scale $Z = 1.98$, $p = .047$, and approached significance for the WISDM-68 Negative Reinforcement subscale $Z = 1.95$, $p = .051$. CES-D score accounted for 17% of the relationship between emotional abuse and total WISDM-68 scale and 14% of the relationship with the WISDM-68 Negative Reinforcement subscale. Criteria for steps 1 through 3 were met in tests of CES-D as a mediator of the relationships between physical abuse and total WISDM-68 and WISDM-68 Negative Reinforcement. However, Z tests on

the mediated effects' proportion of the total effect were nonsignificant for both WISDM-68 scales.

Does Presence of Lifetime or Current Major Depressive Disorder Mediate the Childhood Trauma-Smoking Within 5 Minutes of Waking or WISDM-68 Relationships?

Criterion 2 was not met (lifetime and current MDD were not related to the trauma categories) for tests of current and lifetime MDD as mediators of the relationship of emotional and physical abuse, emotional and physical neglect, and number of trauma categories to smoking within 5 minutes of waking; and tests of current and lifetime MDD as mediators of the relationship of emotional and physical abuse to WISDM-68 Total and Negative Reinforcement. Thus, MDD was not further evaluated as a mediator of these relationships.

Discussion

In the current study, we found evidence of a relationship between nicotine dependence and childhood trauma in pregnant smokers who were participating in a smoking cessation intervention trial. Each of the trauma categories was significantly related to smoking within 5 minutes of waking with the exception of sexual abuse. Women who had experienced high levels of emotional and physical abuse and neglect were 2 to 2.7 times more likely to smoke within 5 minutes, depending on the type of abuse. Given that time to first cigarette has been found to have the strongest predictive relationship to lapse and lapse-relapse latency following quit attempts compared to other measures of nicotine dependence (Baker et al., 2007), this finding suggests that history of childhood abuse may be a marker for relapse susceptibility and that such individuals may require more intensive or more targeted forms of smoking cessation interventions.

Sexual abuse was the only form of trauma that was unrelated to smoking within 5 minutes. This finding is inconsistent with previous studies in population-based samples showing childhood sexual abuse to be significantly related to number of cigarettes smoked per day, age of regular smoking onset (Anda et al., 1999; Jun et al., 2008; Nichols & Harlow, 2004; Roberts et al., 2008), and DSM-IV nicotine dependence (Hapke et al., 2005), and thus requires replication in future studies.

Several WISDM-68 subscales were related to childhood emotional abuse and physical abuse. The WISDM-68 was developed to assess motives for smoking with the assumption that smoking motives underlie tobacco dependence and provide information about mechanisms that drive the development and maintenance of tobacco dependence (Piper et al., 2004). Recent studies examining the latent structure of the WISDM-68 suggest that it can be organized into two overarching factors. One factor is that of primary dependence motives (PDM), which reflect core features of tobacco dependence that emerge later in the development of nicotine dependence. PDM have been found to be the strongest predictors of relapse, smoking rate and other measures of dependence including the FTND (Piasecki et al., 2010; Piper et al., 2008). Secondary dependence motives (SDM) do not contribute beyond the PDM to predicting relapse and smoking heaviness, but are more highly related than PDM to withdrawal symptoms that involve a desire for relief from distressing

symptoms (Piasecki et al., 2010), and are believed to play a significant role in the early stages of tobacco use (Piper et al., 2004; Piper et al., 2008). In the current study, emotional abuse was predictive of one PDM subscale (Tolerance), and physical and emotional abuse and neglect were associated with a second “core” feature of primary dependence—that of smoking within 5 minutes. Emotional and physical abuse were related to two SDM subscales (Negative Reinforcement and Behavioral Choice-Melioration). Thus, in this relatively young group of smokers (M age = 25), high levels of childhood abuse were related to both early and late emergent dependence motives. Of the early emergent dependence motives, abuse was most consistently and strongly related to Negative Reinforcement. This finding lends support to the hypothesis that use of smoking to regulate negative affect may be the mechanism that underlies the development of the childhood abuse-nicotine dependence relationship. (Acierno et al., 2000; Anda et al., 1999; Jun et al., 2008; Mamun et al., 2007; Nichols & Harlow, 2004; Roberts et al., 2008).

Similar to findings in other studies (Anda et al., 1999; Jun et al., 2008; Nichols & Harlow, 2004), we found an increased risk of nicotine dependence in pregnant smokers who had experienced multiple categories of trauma. Anda and colleagues have argued that adverse childhood experiences are interrelated and cumulative (Edwards, Holden, Felitti, & Anda, 2003), noting a strong dose-response relationship with a number of negative mental and physical health outcomes including depressive disorders (Chapman et al., 2004), suicide attempts in adolescence and adulthood (Dube et al., 2001), alcohol abuse and dependence (Anda et al., 2002; Dube, Felitti, Dong, Giles, & Anda, 2003), illicit drug use (Felitti et al., 1998), and a number of health risk factors for the leading causes of death (Felitti et al., 1998). Interestingly, number of adverse childhood experiences has been found to be related to risky sexual behavior (Hillis, Anda, Felitti, Nordenberg, & Marchbanks, 2000); unintended pregnancy in adults (Dietz et al., 1999); and adolescent pregnancy (Hillis et al., 2004)—outcomes that are highly relevant to the population of pregnant smokers.

The percentage of women who had experienced high levels of trauma in the current study (59%) is higher than percentages reported in a large, population-based survey of individuals aged 15 years or older, (Macmillan et al., 1997); and higher than those found in a large, representative sample of pregnant Norwegian women (Lukasse, Schei, Vangen, & Oian, 2009). However, rates in the current study are similar to those found in a large sample ($N = 1,476$) of predominantly African American, low income pregnant women receiving prenatal care in urban, community-based health centers in which 70% of women reported having experienced at least one adverse childhood experience (Chung, Mathew, Elo, Coyne, & Culhane, 2008). Thus, although rates of moderate to extreme childhood trauma found in this study sample would not be considered to be representative of rates in the general population, similar rates might be found in clinical samples of low income women.

In this sample of treatment-seeking pregnant smokers, we also found high lifetime rates of MDD (77%) and high rates of current MDD at the threshold (26.4%) or partially remitted (12.9%) level. These rates are higher than rates of current MDD in a representative sample of Medicaid eligible women who continued to smoke following confirmation of their pregnancies (9%; Flick et al., 2006); and higher than rates in an epidemiologic sample of pregnant women who had smoked within the past year, but did not meet DSM-IV criteria for

nicotine dependence (10.2%; Goodwin, Keyes, & Simuro, 2007). However, in this same study, rates of MDD in women who met criteria for nicotine dependence (31.5%) were similar to rates found in the current study (26.4%).

We evaluated the hypothesis that use of nicotine to regulate affective problems might serve as a mechanism underlying the association between childhood trauma and nicotine dependence (Anda et al., 1999; Jun et al., 2008; Mamun et al., 2007; Roberts et al., 2008) by testing whether MDD diagnosis and current depressive symptoms mediated the childhood trauma-nicotine dependence relationships. We found evidence that current depressive symptoms, as measured by the CES-D, accounted for 17% and 14% of the relationship between emotional abuse and WISDM-68 Total and WISDM-68 Negative Reinforcement, respectively. Contrary to our hypotheses, there was no evidence that depressive symptoms mediated relationships between childhood trauma and smoking within the first five minutes, nor did we find evidence that a diagnosis of lifetime or current MDD played a mediating role in any of the childhood trauma-nicotine dependence relationships.

Our finding that MDD was not significantly related to childhood trauma in mediation analyses is contrary to findings in previous studies (Molnar, Buka, & Kessler, 2001; Chapman et al., 2004). Indeed, the distribution of lifetime and current MDD across the low versus high trauma level groups was quite similar (data not shown), suggesting that in this sample, women with low levels of trauma were equally as likely to have a depressive disorder as those with high trauma levels. In addition, although mediation analyses revealed a significant relationship between current depressive symptoms and all of the trauma variables excluding sexual abuse, in models unadjusted for race we found only marginally significant differences in CES-D scores between high and low trauma groups (results not shown). These findings are contrary to those of Chung and colleagues (Chung et al., 2008), who found significantly higher levels of depressive symptoms in low income, pregnant women who had a history of physical or sexual abuse, relative to those who did not. It is possible that other factors, including smoking (Chaiton, Cohen, O'Loughlin, & Rehm, 2009), may have been more influential than childhood trauma in increasing risk for MDD in this group of low income women.

Depressive symptoms accounted for a relatively small proportion of the relationship between childhood abuse and WISDM Negative Affect in the mediation analyses. Depression may be only one of several potentially important affect-related mediating variables. In the case of smokers with a history of childhood abuse, it may be useful to examine measures of affect regulation. There is evidence that childhood trauma results in sensitization of the hypothalamic-pituitary-adrenal axis leading to hyper-reactive pituitary-adrenal and autonomic responses to stress in adulthood (Anda et al., 2006; Heim & Nemeroff, 2001; Heim et al., 2002; Heim et al., 2000). Behaviorally, there is evidence that children and adult victims of childhood abuse have difficulty regulating affective responses to psychosocial stressors (Cloitre, Stovall-McClough, Zorbas, & Charuvastra, 2008; Muehlenkamp, Kerr, Bradley, & Adams, 2010; Shields & Cicchetti, 1998; Glaser, Van, Portegijs, & Myin-Germeys, 2006). These data suggest that individuals with a history of childhood trauma will have more frequent and intense experiences of negative emotions in response to daily stress and greater difficulty modulating expression of negative affect

within interpersonal relationships, than individuals without such histories (Glaser et al., 2006; Cloitre, Koenen, Cohen, & Han, 2002). Examination of the relationship of emotional reactivity and daily stressors to craving and tobacco use in smokers with childhood trauma histories may provide additional information about the relationship of such processes to smoking in this population. Should affective factors be found to be related to smoking, this information could be used to develop treatments tailored to address these factors in this population of smokers.

Although the sample on which these study results are based cannot be considered to be representative of pregnant smokers, several lines of data suggest that the findings may be highly relevant to smoking cessation treatment in this population. Women who are most likely to continue smoking during pregnancy are more likely to receive care in public maternity clinics, have fewer years of education, lower incomes, and to be single, than women who spontaneously quit (Solomon & Quinn, 2004). Individuals with a history of childhood abuse can be characterized by similar demographic variables as indicated by data from the National Comorbidity Study (NCS) showing that childhood abuse is predictive of unemployment, reliance on Medicaid and other public funding for health care, and income below the poverty level in adulthood (Zielinski, 2009). Thus, the prevalence of childhood abuse may be high among low income pregnant smokers and these individuals may be the least likely to benefit from existing treatments due to high levels of nicotine dependence (Gilman et al., 2008; Solomon & Quinn, 2004).

There are a number of important limitations to note. This study focused on a very low SES group of treatment-seeking pregnant smokers, who had knowledge they would be compensated \$40 for attending study visits. These factors associated with the clinical trial from which the sample was drawn may limit the generalizability of our findings to the general population of pregnant smokers. In addition, findings are based on a cross sectional design that does not allow for the evaluation of causal relationships between childhood abuse and nicotine dependence. Subscales on the CTQ assessing the different types of trauma were highly correlated. In the case where multiple types of trauma were found to be related to measures of nicotine dependence, our sample size did not provide the power needed to conduct multivariate logistic regression analyses, which would have allowed us to disentangle unique relationships between particular types of trauma and nicotine dependence, versus common relationships (Briere & Runtz, 1988). However, the assessment of multiple types of childhood trauma did provide more accurate information about the incidence of multiple types of trauma in this population of smokers and allowed us to assess the cumulative impact of multiple types of trauma on nicotine dependence outcomes. The trial from which the data were drawn assessed a limited number of affective variables, and did not include assessment of posttraumatic stress disorder (PTSD) with a structured clinical interview. Future studies should include assessment of PTSD and PTSD symptom severity and affective factors, such as emotion regulation processes, that could shed additional light on how smoking functions in individuals with a history of childhood abuse.

Despite these limitations, we believe this study makes an important contribution to understanding the potential role that childhood trauma and depression may play in the severity of nicotine dependence among pregnant smokers. The results add to an emerging

literature indicating a strong association between childhood trauma, smoking and nicotine dependence, and provide additional information on the role that depression plays in those relationships. In addition, these findings highlight the possibility that childhood trauma may be a common risk factor underlying both nicotine dependence and the demographic, behavioral and psychosocial characteristics that have been identified as potential risk factors for persistent smoking during pregnancy (e.g., low socioeconomic status, low educational attainment, stress, problems with adaptive functioning and interpersonal relationships, mental health disorders; Goodwin et al., 2007; Wakschlag et al., 2003). Future studies should focus on identifying affective processes that are related to smoking in this population in order to identify potential targets for more effective smoking cessation interventions.

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Table 1
Childhood Trauma Questionnaire Subscale Inter-Correlations

	<i>Emotional Abuse</i>	<i>Physical Abuse</i>	<i>Sexual Abuse</i>	<i>Emotional Neglect</i>	<i>Physical Neglect</i>
Emotional Abuse	-----				
Physical Abuse	*0.68	-----			
Sexual Abuse	*0.35	*0.39	-----		
Emotional Neglect	*0.67	*0.49	*0.28	-----	
Physical Neglect	*0.61	*0.52	*0.33	*0.70	-----

*
 $p < .0001$

Table 2

<i>Demographic and Smoking Characteristics</i>	<i>N = 201</i>
<i>Variable</i>	<i>Mean (SD)/ % (freq)</i>
Age (years)	25.13 (4.77)
Weeks Pregnant	19.79 (7.05)
Race/Ethnicity (%)	
African-American, Non-Hispanic	54.2 (109)
White, Non-Hispanic	33.3 (67)
Hispanic	8.5 (17)
Other	4.0 (8)
Education Level (%)	
Less than high school	34.0 (68)
High school/GED	34.0 (68)
Some college or greater	32.0 (65)
Marital Status (%)	
Married & living with partner	19.4 (39)
Not married & living with partner	22.4 (45)
Never married, not living w/ partner	47.8 (96)
Widowed, divorced, or separated	10.5 (21)
Employment Status (%)	
Employed/Student	28.9 (58)
Homemaker	21.4 (43)
Unemployed	49.8 (100)
Receiving Medicaid or County Health Care (%)	65.0 (130)
Annual Family Income (%)	
Less than \$10,000	16.4 (33)
\$10,000 - \$19,999	37.3 (75)
\$20,000 - \$29,999	14.9 (30)
More than \$30,000	13.9 (28)
Don't know	12.9 (26)
Prefer not to say	4.5 (9)
CES-D Score	20.4 (12.60)
Age started smoking (years)	15.51 (3.61)
Smoking rate before finding out pregnant (cigs/day)	16.48 (9.01)
Current smoking rate (cigs/day)	10.62 (10.48)
Smoke within 5 minutes of waking (%)	21.0 (42)

Note. CES-D = Center for Epidemiologic Studies Depression Scale

Table 3
Correlation Matrix for Demographic and Nicotine Dependence Variables

<i>Demographic Variables</i>	<i>Nicotine Dependence Variables</i>				
	<i>Smoke 5 min wake</i>	<i>Age started smoke</i>	<i>Pre-preg cigs/day</i>	<i>Preg cigs/day</i>	<i>WISDM Total</i>
Income > \$20,000 yr.	-0.02	0.04	0.04	0.16*	0.07
High School Ed	0.13	0.08	-0.01	-0.08	0.08
White Race	0.16*	-0.28***	0.21**	0.19**	0.24***
Employed/Student	-0.08	0.01	-0.01	0.04	-0.00
Living with Partner	-0.00	0.01	0.03	0.09	0.01
Age	0.11	0.21**	0.10	0.13	0.04
Weeks Pregnant	0.03	-0.13	0.08	0.07	0.00

*
 $p < .05$,

**
 $p < .01$,

 $p < .001$

Table 4
Frequency and Percentage of Mood Disorder Diagnoses in Sample

Diagnosis and Mood Disorder Specifiers	Frequency <i>N</i> = 198	Percent of sample
Major Depressive Disorder, Lifetime	152	76.8
Major Depressive Disorder, Current	52	26.3
Major Depressive Disorder , in Partial Remission	25	12.6
Major Depressive Disorder, in Full Remission	75	37.9
Dysthymic Disorder, Lifetime	1	0.5
Bipolar Disorder, Lifetime	9	4.5
Bipolar Disorder, Current	7	3.5
Bipolar Disorder, in Full Remission	2	1.0
Negative History of Mood Disorder	36	18.2

Table 5
Logistic Regression Analyses for High Childhood Trauma Predicting Smoking Within 5
Minutes of Waking, Controlling for Race

<i>Trauma Variable</i>	<i>^a AOR</i>	<i>95% CI</i>
Emotional Abuse		
Emotional Abuse	2.69**	1.32, 5.47
White Race	2.12*	1.04, 4.33
Physical Abuse		
Physical Abuse	2.25*	1.04, 4.87
White Race	2.30*	1.13, 4.65
Sexual Abuse		
Sexual Abuse	0.63	0.29, 1.36
White Race	2.32*	1.15, 4.69
Emotional Neglect		
Emotional Neglect	2.08*	1.03, 4.22
White Race	2.15*	1.06, 4.36
Physical Neglect		
Physical Neglect	2.68**	1.29, 5.57
White Race	2.13*	1.05, 4.35
Number of categories of trauma		
Number of categories of trauma	1.25*	1.03, 1.53
White Race	2.11*	1.04, 4.30

Note.

^a Adjusted ORs were calculated in models with the predictor variable while controlling for race.

* $p < .05$,

** $p < .01$

Table 6
Summary of Mediated Effects for CES-D that Statistically Significantly Reduced the Relationship between Emotional Abuse and WISDM-68 Total

Variable	Parameter	SE	<i>t</i> value	<i>p</i> value
Step 1. Model: Emotional Abuse predicting WISDM-68 Total				
Intercept	48.85	1.42	34.28	<.0001
White Race	7.26	2.23	3.26	.0013
Emotional Abuse	7.62	2.25	3.38	.0009
Step 2. Model: Emotional Abuse predicting CES-D				
Intercept	21.71	1.16	18.73	<.0001
White Race	-8.28	1.81	-4.57	<.0001
Emotional Abuse	4.43	1.83	2.42	.0165
Step 3. Model: CES-D predicting WISDM-68 Total controlling for Emotional Abuse				
Intercept	42.42	2.32	18.29	<.0001
White Race	9.72	2.28	4.26	<.0001
Emotional Abuse	6.30	2.23	2.83	.0051
CES-D	0.30	0.09	3.46	.0007

Note. CES-D = Center for Epidemiologic Studies Depression Scale; WISDM-68 = Wisconsin Inventory of Smoking Dependence Motives.

Table 7
Summary of Mediated Effects for CES-D that Statistically Significantly Reduced the Relationship between Emotional Abuse and WISDM-68 Negative Reinforcement

Variable	Parameter	SE	t value	p value
Step 1. Model: Emotional Abuse predicting WISDM-68 Negative Reinforcement				
Intercept	4.28	0.13	33.53	<.0001
White Race	0.69	0.20	3.48	.0006
Emotional Abuse	0.80	0.20	3.97	.0001
Step 2. Model: Emotional Abuse predicting CES-D				
Intercept	21.71	1.16	18.73	<.0001
White Race	-8.28	1.81	-4.57	<.0001
Emotional Abuse	4.43	1.83	2.42	.0165
Step 3. Model: CES-D predicting WISDM-68 Negative Reinforcement controlling for Emotional Abuse				
Intercept	3.73	0.21	17.89	<.0001
White Race	0.90	0.20	4.42	<.0001
Emotional Abuse	0.69	0.20	3.44	.0007
CES-D	0.03	0.01	3.31	.0011

Note. CES-D = Center for Epidemiologic Studies Depression Scale; WISDM-68 = Wisconsin Inventory of Smoking Dependence Motives.