Understanding Maternal Smoking During Pregnancy: How Does Social Capital Get Under the Skin?

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Abstract

Smoking during pregnancy is associated with poor health outcomes for both mother and child. However, over half of women who smoke continue to smoke while they are pregnant. Previous studies on maternal smoking during pregnancy that have considered measures of residential context have been limited by their homogenous samples of women and their omission of important contextual factors. In this paper we focus on the association between county-level social capital and the odds of women smoking during pregnancy using a 100 percent sample in the US. Mothers living in nonmetropolitan counties were 5 percent more likely to smoke during pregnancy than their metropolitan counterparts. Nonetheless, social capital may moderate the negative impact of residence on smoking. Specifically, a one unit increase in social capital index was found to reduce 8 percent of the odds of smoking during pregnancy among those mothers living in nonmetropolitan counties.

Introduction

There is growing evidence that smoking during pregnancy is associated with a number of poor health outcomes for both the mother and her child (in utero, childhood, and through adolescence). In addition to the multiple health risks associated with smoking at any time (e.g., stroke and heart disease), smoking during pregnancy is related to an increased risk of the mother developing breast cancer (Innes & Byers, 2001). Maternal smoking during pregnancy (MSDP) has been found to impose an adverse impact on birth outcomes, including placental abruption (Ananth et al., 1999), stillbirth (Hogberg & Cnattingius, 2007), greater irritability and hypertonicity (Stroud et al., 2009), physical abnormalities and birth defects (Lammer et al., 2005), slowed intrauterine growth, increased odds of pre-term delivery, reduced and low birth weight (Agrawal et al., 2010; US Department of Health Human Services, 2001), frequent admission to neonatal intensive care units, increased risk for sudden infant death syndrome (DiFranza & Lew, 1995; Martin et al., 2003; Mathews, 2001; Shah et al., 2006), and infant mortality (Cnattingius, 2004). The negative effects of MSDP could extend further into children's later life, such as conduct disorder, attention and cognitive deficits, low scholastic achievement, early age of smoking initiation, early age of regular smoking, and substance abuse (Agrawal et al., 2010; Buka et al., 2003; Fried et al., 1992; Leech et al., 1999; Wakschlag et al., 1997).

Despite these risks, at least half of women who smoke prior to their pregnancy continue to do so while they are pregnant (Ebrahim et al., 2000). In 2007, 10.4 percent of pregnant women in the US smoked while they were pregnant (U.S. Department of Health and Human Services, 2011). *Healthy People 2020* aims to reduce the percentage of women who smoke while they are pregnant to 1.4 percent (U.S. Department of Health and Human Services, 2011).

To effectively address this concern, finding determinants of MSDP becomes crucial. The goal of this study is to investigate whether or not the factors beyond individual characteristics matter and if so, to understand how they get under the skin.

Individual Factors of MSDP

The majority of studies on MSDP concentrate on individual-level predictors that cover a range of dimensions (e.g., socioeconomic, demographic, and health status). For example, women who continue to smoke during their pregnancy are featured by low household incomes (Martin et al., 2008; Wakschlag et al., 2003), few years of education (Cnattingius et al., 1992; Colman & Joyce, 2003; Kahn et al., 2002; O'Campo et al., 1992; Orr et al., 2005; Wakschlag et al., 2003; Zimmer & Zimmer, 1998), unemployed (Zimmer & Zimmer, 1998), not married (Flick et al., 2006; Orr et al., 2005; Wakschlag et al., 2003), already having a child (Cnattingius et al., 1992; Colman & Joyce, 2003; Martin et al., 2008; O'Campo et al., 1992; Schramm, 1997), having elevated maternal depressive symptoms (Orr et al., 2005), receiving delayed prenatal care (Zimmer & Zimmer, 1998), consuming more than one drink per week during pregnancy (Martin et al., 2008), and smoking heavily prior to pregnancy (Cnattingius et al., 1992; Colman & Joyce, 2003; Wakschlag et al., 2003).

Race, ethnicity, and age of the mother also play a role in whether she continues to smoke during her pregnancy. Camilli and colleagues (1994) found that Mexican-American women were nearly three times more likely to quit smoking during their pregnancy than non-Hispanic white women. In addition, Zimmer & Zimmer (1998) found that black women were less likely to quit smoking than white women. Similarly, a study showed that although teenagers were more likely to quit smoking during pregnancy when compared to older mothers, they were substantially more likely to resume smoking after pregnancy (Colman & Joyce, 2003).

Residential Factors of MSDP

According to *Healthy People 2020* (U.S. Department of Health and Human Services, 2012), disparities in health outcomes and behaviors are not only relevant to biological differences and personal features, but also a function of both residential environment and policies. The importance of residence and social interactions beyond individuals has drawn more and more health researchers' attention in the past few decades. The literature has confirmed that residential environment affects human health and currently the key question has become how the residential factors affect individual behaviors and/or health (Boardman, 2004; Matthews & Yang, 2010; Taylor et al., 1997; Yang et al., 2011b).

Despite this research trend, we found that studies on MSDP in the US have a lag in this regard and have mainly focused on racial segregation and socioeconomic status. For example, Pickett and colleagues (2002) examined a sample of white women living in California and found that living in a predominantly working-class environment doubles the odds of smoking during pregnancy. In another study on pregnant women living in California, the results showed that women living in a neighborhood (defined by ZIP code) with a higher percentage of the population receiving public assistance were more likely to smoke while they were pregnant (Finch et al., 2001). The analytic results of a sample of women from South Carolina suggested that mothers living in medium poverty neighborhoods had greater odds of smoking during pregnancy compared to women living in low poverty neighborhoods (Nkansah-Amankra, 2010). This study also found that when women live in predominantly black neighborhoods this reduces the odds of smoking during pregnancy by 64 percent (Nkansah-Amankra, 2010). Shaw et al. (2010) found that a more racially and ethnically homogeneous county is associated with reduced odds of smoking for US-born Hispanic and Black mothers; however, this study was limited to

mothers of Hispanic and Black race/ethnicity.

The studies above indicated that residential context really matters in MSDP studies; however, their conclusions may not be easily generalized. More specifically, these studies were limited by only including women from one state or metropolitan area or restricting the samples to women of a particular race or ethnicity (e.g., Bell et al., 2007). Smoking prevalence in the US varies both regionally and by race/ethnicity (Datta et al., 2006; King et al., 2006; King et al., 1999; Mathews, 1998; Osypuk et al., 2006; Pastor et al., 2002; Perreira & Cortes, 2006); therefore, focusing attention on women from only one place or of one racial/ethnic background may limit our understanding of MSDP in the US. To the best of our knowledge, a study on MSDP using the nationwide data is not yet available.

Moreover, several residential factors have not been fully considered in the MSDP literature. This study will fill this gap by investigating the relationships of rurality and social capital with MSDP. A recent study showed that smoking prevalence among pregnant women is higher among women living in rural areas than it is for women living in urban areas (Stevens et al., 2010), but whether this residential differential can be completely attributed to the difference in individual features (e.g., educational attainment) is unclear. Similarly, social capital has been found to promote human health and minimize residential health disparities (Song et al., 2010; Yang et al., 2011a); however, its association with MSDP remains underexplored. This study is among the first to explicitly take both factors into account and to depict a clear picture of whether and how these factors play a role in determining maternal smoking behavior.

Rurality, Social Capital, and MSDP

The relationships between rurality, social capital, and MSDP have not been widely discussed, but some recent articles lead us to believe that they are interrelated. First, rural

sociologists have suggested that social capital is stronger in rural than urban areas and rural dwellers are more likely to help and trust each other despite the sparse distribution of population (Beaudoin & Thorson, 2004; Beggs et al., 1996; Hofferth & Iceland, 1998). Putman (2000) divided social capital into various dimensions (e.g., altruism and community engagement) and examined whether social capital differs by the size of community. He concluded that rural areas have stronger social capital than do urban, and concluded that the reason why metropolitan residents share low social capital is because of where they live, not who they are (Putnam, 2000). It is clear that social capital varies across residence (i.e., rural/urban or metropolitan/nonmetropolitan).

Second, the rurality of a place where a person lives is associated with variations in smoking prevalence, with rates of cigarette smoking higher in rural area (Stevens et al., 2010). Both female adolescents (19 percent) and female adults (27 percent) living in the most rural counties are more likely to smoke than their urban counterparts (11 percent and 20 percent, respectively) (Eberhardt & National Center for Health Statistics, 2001). As for pregnant women, research has shown that this number is even higher among women living in rural areas (Bailey & Cole, 2009; Bullock et al., 2001; Stevens et al., 2010), with some studies reporting rates of MSDP in rural areas as high as 39 percent (Bailey, 2006).

Third, past research points toward a significant and apparently causal relationship between social capital and health outcomes (Berkman & Glass, 2000; Berkman & Syme, 1979; Wolf & Bruhn, 1998) and some potential links between social capital and health behaviors may be applied to the relationships between MSDP and social capital. Social capital has been found to provide both tangible and intangible assistance (Kawachi et al., 1999; Putnam, 2002) and the diffusion of information has been found to be more rapid in a community where residents know

and trust one another and that are more tightly bounded (Rogers, 1995). Extending this argument, in communities with higher social capital, information about the adverse effects of smoking during pregnancy are more likely to be shared, and this in turn may influence an individual women's decision to not smoke during pregnancy. Similarly, if a new approach to quit smoking is available, pregnant women are more likely to adopt it due to information diffusion.

Another path is drawn from the finding that social capital reinforces healthy behaviors and exerts control over deviant ones (Evans & Kutcher, 2011; Giordano & Lindstrom, 2011; Kawachi et al., 1999). The stronger bonds that social capital represents will discourage the occurrence of unhealthy behaviors such as MSDP. On the other hand, positive behaviors, such as smoking cessation, are encouraged for their possible benefits. It is also likely that people would not smoke around pregnant women, which establishes a healthy environment to help mothers who want to quit smoking quit. The last potential explanation for why social capital matters are that high social capital is a major source of moderators that can buffer stress (Ross & Mirowsky, 2001; Smith & Lincoln, 2011). As found in the individual level analysis, stressed or depressed mothers are more likely to smoke (Orr et al., 2005; Weaver et al., 2008). A mother living in an area with stronger social capital may receive better support to handle stressors and thus she may be less likely to smoke during pregnancy.

Hypotheses

The discussion above demonstrated that the associations among rurality, social capital, and MSDP are intertwined and little research has attempted to untangle them. We extend prior work on MSDP by focusing on how county-level social capital is associated with the odds of a woman smoking during her pregnancy and how social capital and rurality interact to affect

MSDP. As previous research has shown, factors associated with MSDP may not be limited to individual-level behaviors and characteristics; therefore, multilevel models were estimated to identify whether characteristics of counties in which women live affect the likelihood of MSDP. Multilevel modeling techniques are uniquely useful for identifying whether residential context has an impact on an individual's health status, even after individual characteristics are controlled. By utilizing logistic multilevel modeling, we tested the following hypotheses:

> (H1) Defining rurality with metropolitan/nonmetropolitan dichotomy, mothers living in nonmetropolitan counties have higher odds of smoking during pregnancy.

> (H2) Net of other covariates, stronger social capital at the county-level leads to lower odds of maternal smoking at individual level.

> (H3) Social capital and rurality interact with each other to affect MSDP and given the metro/nonmetro status, social capital further reduces the likelihood of smoking during pregnancy.

Data and Measures

This study utilizes multiple secondary data sources. The primary secondary data source is the National Center for Health Statistics (NCHS) non-public use detailed natality files with county identifiers for all counties in the US (National Center for Health Statistics, 2007a). This data file is based on a 100 percent sample of mothers who had a live birth in the US during the 2007 calendar year. To create this dataset, NCHS compiles information from the standard birth certificate, which was prepared from individual records processed by each registration area through the Vital Statistics Cooperative Program (National Center for Health Statistics, 2007b). While these data files include information on all live births that occurred within the US (both US residents and nonresidents), these analyses are restricted to data on mothers who reside within

the continental US. In addition, because MSDP is not reported on the birth certificates in California, mothers residing in California were excluded from the analyses. The dependent variable and the independent individual-level variables (demographic, social, and health information of the mothers) were derived from this data source.

Individual-level measures

The dependent variable, *MSDP*, was measured as a dichotomous variable that indicated whether the mother smoked during her pregnancy (coded as 1 if she did and 0 otherwise). The mother was considered to be a smoker if she smoked any number of cigarettes during any time throughout her pregnancy. As for the independent variables, *maternal age* at the time of birth was measured as a set of three dichotomous variables: 19 years of age and younger, 20-34 years of age (reference category), and over 34 years of age. Dichotomous variables representing various self-reported race and ethnicity data were included in the models. *Race* was measured as a set of five dichotomous variables: white (reference category), black, American Indian/Alaskan Native, and Asian, and *ethnicity* was measured as a dichotomous variable to specify whether the mother was Hispanic or non-Hispanic. A dichotomous variable measuring *marital status* was included in the model that specified whether or not the mother was married at the time of the infant's birth or not.

Measures of the mother's highest level of education completed at the time of the infant's birth were also included in the models as a measure of socioeconomic status. A set of four dichotomous variables were created to measure *maternal education*: less than high school (reference category), high school degree or equivalent, some college or associate degree, and bachelor's degree or higher.

Measures of maternal weight gain during pregnancy were included in the models as a

way to assess the overall health and nutrition of the mother during her pregnancy (Sparks, 2009). *Maternal weight gain* was measured as a set of dichotomous variables: low weight gain (0-15 pounds), average weight gain (16-40 pounds, reference category), and high weight gain (over 40 pounds). The Adequacy of Prenatal Care Utilization Index (APCUI) was used in this study. The APCUI is a measure of prenatal care utilization that takes into account the month the prenatal care began and the number of prenatal care visits and then adjusts for the gestational age of the infant at delivery (Kotelchuck, 1994a, b). The *APCUI* was measured as a set of dichotomous variables: inadequate care (reference category), intermediate care, adequate care, and adequate plus care. The dichotomous variable, *first birth*, was included in the models to identify whether this was the mothers first birth (coded 1) or higher order birth (coded 0).

County-level measures

Three variables were created to capture the *socioeconomic status (SES)*, the *social capital index*, and the *nonmetropolitan status* at county-level. To measure SES, we used principal component analysis (PCA) with the following seven social measures extracted from the 2005-2009 American Community Survey (ACS) estimates (American Community Survey, 2005-2009): log of per capital income (factor loading: 0.943), percentage of population with at least a bachelor degree (0.826), percentage of population employed in professional, administrative, and managerial positions (0.774), percentage of family with annual income greater than $75,000 (0.899), poverty rate (-0.797), percentage of population receiving public assistance (-0.376), and percent of female-headed families with children (-0.524). The PCA results indicated that almost 60 percent of the variance was explained by one factor (eigenvalue=4.030). The regression method was used to calculate the factor score, which was used as the SES variable in the analysis.

The PCA was also applied to generate the social capital index. We obtained the following variables from Rupasingha et al. (2006): the number of civil associations per 10,000 population, the number of non-profit organizations per 10,000 population, mail response rate of 2000 census, and 2004 presidential election voting rate. The PCA indicated that one component (eigenvalue=1.942) would suffice to capture roughly 50 percent of the total variance among these variables, and the factor loadings for the four variables were 0.771, 0.813, 0.398, and 0.727, respectively. The PCA results were comparable with the original paper (Rupasingha et al., 2006). The third county-level measure is nonmetropolitan status, which is used to capture the concept of rurality. We used the definition released by the US Office of Management and Budget and defined nonmetropolitan counties (coded 1) as those counties that do not contain any urbanized areas with more than 50,000 dwellers or those counties that do not have a total urbanized area of 100,000 population and strong economic ties (defined by commuting patterns) with adjacent counties (Economic Research Service, 2003).

Methodology

In order to examine the factors associated with the odds of MSDP, two separate sets of regression analyses were conducted. First, individual-level characteristics of women were included in a model predicting the odds of MSDP. Second, because a two-level hierarchical structure characterizes this data, with pregnant women nested within their county of residence, we tested whether multilevel modeling was necessary for these analyses. These models were implemented in HLM 6 (HLM, 2008; Raudenbush & Bryk, 2002). In order to determine whether multilevel modeling was an appropriate analytic strategy, a null model with no explanatory variables included was estimated (results not shown). The null model had a statistically significant variance of the intercept, which indicated that multilevel modeling was an

appropriate analytic strategy for this study. Next, we investigated the relationship between individual- and county-level predictors of MSDP among women across the continental US using multilevel logistic regression models. These models allowed us to test the hypotheses above.

Results

Descriptive Statistics

Table 1 includes the descriptive statistics for all measures included in the analyses. As for MSDP, 11 percent of mothers reported smoking during their pregnancy. This statistic is similar to what is reported in *Healthy People 2020* (10.4 percent) (U.S. Department of Health and Human Services, 2011). The age of the mothers included in these analyses varied, with 11 percent of the mothers 19 years of age or younger and 14 percent of the mothers 35 years of age or older. The race of the mothers in this study included 17 percent of mothers who were black, 1 percent American Indian/Alaskan Native, and 4 percent Asian. The sample included 20 percent of mothers who were Hispanic. Sixty percent of the mothers were married at the time their infant was born. As for maternal education, 28 percent of mothers had a high school degree or equivalent, 25 percent had some college education or an associate's degree, and 27 percent had a bachelor's degree or higher. Maternal weight gain varied among the mothers included in the sample, with 14 percent of mothers with a low weight gain and 21 percent of mothers with a high weight gain. As for prenatal care utilization, 13 percent of mothers received intermediate care, 39 percent received adequate care, and 32 percent received adequate plus prenatal care. Approximately 40 percent of the mothers were having their first birth.

Table 1 Here

Sixty-six percent of the counties included in the model are nonmetropolitan counties. Both the SES and social capital index measures were created using PCA; therefore, these

measures have a mean of 0 and a standard deviation of 1. The mean of the interaction between nonmetropolitan and social capital index could be interpreted as the average social capital index score among nonmetropolitan counties.

Multilevel Logistic Regression Results

The results of the multilevel logistic regression models of MSDP are displayed in Table 2 and the odds ratios are reported. Model I includes only the individual-level measures. The individual-level results from Model 1 are consistent with the individual-level results in Model II, which includes both the individual-level and county-level measures. For brevity, only the Model II results are discussed here. In Model II, we found that the odds of MSDP were 41 percent lower for those mothers 19 years of age or younger and 8 percent lower for mothers 35 years of age and older when compared to mothers 20 through 34 years of age. Both racial and ethnic differences were found when predicting the odds of MSDP. Compared to white mothers, the odds of MSDP for black, American Indian/Alaskan Native, and Asian mothers were lower by approximately 69, 33, and 79 percent, respectively. Hispanic mothers were 90 percent less likely than non-Hispanic mothers to smoke while they were pregnant. The odds of MSDP were 66 percent lower for married mothers than they were for mothers who were not married.

Table 2 Here

As for maternal education, the higher the level of education a mother completed the less likely she was to smoke while she was pregnant. The magnitude of this relationship increases with education attainment. Explicitly, compared to mothers with less than a high school degree, mothers with a high school degree or equivalent were approximately 40 percent less likely to smoke while they were pregnant, mothers with some college education or an Associate's degree were 67 percent less likely to smoke while they were pregnant, and mothers with a Bachelor's

degree or higher were 94 percent less likely to smoke while they were pregnant.

Both weight gain during pregnancy, prenatal care utilization, and parity were significant predictors of MSDP. Mothers with low weight gain were approximately 17 percent more likely to smoke while they were pregnant and mothers with high weight gain were 13 percent more likely to smoke while they were pregnant compared to mothers with an average weight gain. Compared to mothers who received inadequate prenatal care, mothers who received intermediate, adequate, or adequate plus prenatal care were approximately 21 percent, 31 percent, and 27 percent less likely to smoke while they were pregnant. Women who were having their first birth were 29 percent less likely to smoke during pregnancy compared to women who were having their second, third, or higher order birth.

Accounting for maternal characteristics, those mothers who live in nonmetropolitan counties are 5 percent more likely to smoke while they are pregnant compared to mothers who live in metropolitan counties. This finding echoed the literature that smoking prevalence, especially among pregnant women, differs significantly by rurality (Bailey & Cole, 2009; Bullock et al., 2001; Stevens et al., 2010). In addition, other things equal, a one unit increase in the county SES score was associated with a 13 percent decrease in the likelihood of maternal smoking. Surprisingly, after controlling for both individual- and county-level covariates, the social capital index was found to be positively associated with MSDP. One plausible explanation for this unexpected finding may be related to both rurality and social capital. Specifically, Yang and colleagues (2011a) discussed the complexity of rurality and argued that social capital increases with rurality. Using dichotomous rurality measures, they found that social capital was stronger in nonmetropolitan counties than metropolitan counties. This current study used a similar measure of rurality and social capital as Yang et al. (2011a). The

nonmetropolitan status may only capture the population and economic dimensions of rurality; and hence, the positive relationship between social capital and maternal smoking may result from the argument that high social capital could be considered as a cultural dimension of rurality (Bealer et al., 1965). It should be noted that this explanation is a consequence of the fact that there is no agreement on how to measure rurality in rural sociology. Further investigations are warranted. However, the interaction between rurality and social capital index helps to better understand whether the explanation above stands or not. The analytic finding strengthens our explanation. Explicitly, among the mothers living in nonmetropolitan areas, those who are exposed to strong social capital were 8 percent less likely to smoke than their counterparts who experienced weak social capital. This finding was found after accounting for all other covariates, and followed the theoretical pathways linking social capital to better health outcomes (Kawachi et al., 1997; Song et al., 2010).

Discussion

Using multilevel logistic regression models, we were able to test each of our proposed hypotheses and gain a better understanding of how social capital can "get under the skin" (Taylor et al., 1997). We were able to confirm that mothers who lived in nonmetropolitan counties had higher odds of smoking while they were pregnant compared to mothers who lived in metropolitan counties (H1). In addition, while we hypothesized that strong social capital is negatively related to the odds of maternal smoking (H2), our results did not directly support this argument. Our explanation for this unexpected finding is that social capital could be regarded as the cultural dimension of rurality and our dichotomous rurality indicator did not capture this dimension. By including an interaction between nonmetropolitan status and social capital, we found direct support for our hypothesis (H3), because among those women living in

nonmetropolitan counties, stronger social capital was associated with lower odds of smoking during pregnancy, *ceteris paribus*.

In addition, our individual-level measure results match the findings reported in previous studies. Following Colman and Joyce (2003), we found that teenage mothers were less likely to smoke while they were pregnant. We also found racial and ethnic differences in the odds of MSDP. Consistent with the results reported by Zimmer and Zimmer (1998) and Perreira and Cortes (2006), black mothers were less likely to smoke while they were pregnant compared to white mothers. In this study, we found that Hispanic mothers were 90 percent less likely to smoke while they were pregnant compared to non-Hispanic mothers. This finding was similar to that reported by Camilli and colleagues (1994) who found that Mexican-American women were nearly three times more likely to quit smoking during their pregnancy than non-Hispanic white women. As reported previously, mothers who were married at the time their baby was born were less likely to smoke while they were pregnant (Flick et al., 2006; Orr et al., 2005; Wakschlag et al., 2003).

Maternal education was a significant predictor of MSDP. Consistent with previous findings, the higher the level of education the mother received the lower the odds of mothers smoking while they were pregnant (Cnattingius et al., 1992; Colman & Joyce, 2003; Kahn et al., 2002; O'Campo et al., 1992; Orr et al., 2005; Wakschlag et al., 2003; Zimmer & Zimmer, 1998). Since weight gain during pregnancy is one way to assess the overall health and nutrition of a mother during her pregnancy (Sparks, 2009), we were not surprised to find that mothers with low weight gain and mothers with high weight gain were significantly more likely to smoke while they were pregnant compared to mothers with an average weight gain. Consistent with earlier findings (Zimmer and Zimmer, 1998), more prenatal care utilization is associated with lower

odds of MSDP. Mothers who were having their first birth were approximately 29 percent likely to smoke compared to those mothers who were having a higher order birth.

Conclusions

This study made significant contributions to the MSDP literature by using a nationwide level dataset to investigate whether and how two underexplored factors—rurality and social capital—are associated with MSDP. However, several limitations are notable. First, several individual-level measures that may be associated with MSDP such as employment status, income, and health insurance coverage were not included in the models as these measures were not included in the natality files.

Second, the residential context measures may have been measured using smaller units of geography such as the census-tract; however, the NCHS non-public use detailed natality files only include geographic information on the mother's state and county of residence. While how to measure residential context is still debatable, it has been documented that the associations found with ecological data may be altered with the change of the definitions of ecology (Fotheringham & Wong, 1991). Therefore, using different spatial scales in the analysis may lead to different conclusions (Openshaw, 1984); however, we believe our ecologic unit is most relevant to useful policy implications (Lobao & Hooks, 2003) and our measures, social capital in particular, are the best available in the literature. Our social capital measure closely matches the definition used by Putnam (2000) and has been recently adopted in health studies (Yang et al., Forthcoming; Yang et al., 2011a; Yang et al., 2009). This social capital index is not without flaws, but it offers a way for researchers to explore its applicability and usefulness (Rupasingha et al., 2006).

Third, the causality between MSDP and the explanatory variables could not be established, because the data are cross-sectional. Fourth, the results of this study cannot be generalized to mothers from California, Hawaii, and Alaska, as well as mothers with information missing from their infant's birth certificate. Finally, it should be noted that issues related to the validity and reliability of data derived from information included on birth certificates could potentially bias the results of this study. There are inconsistencies in who fills out the information on the birth certificate (Woolbright & Harshbarger, 1995), which could result in differences in how items are reported. Also, studies have shown that issues with validity may exist when using data that includes information on smoking and prenatal care utilization derived from birth certificates (Northam & Knapp, 2006). In spite of this, these data are the most representative available that include information on the mothers' residence. In addition, these potential biases are not limited to the NCHS data, but are also present in other large secondary data sources.

Several policy implications can be drawn from the results of this study. The results of this study show that higher levels of education and higher levels of prenatal care utilization were found to be associated with a decrease in the odds of MSDP. Both education and prenatal care utilization are areas that can be targeted in order to reduce smoking prevalence during pregnancy. However, as this study showed, it is not only "down stream" approaches that may be helpful reducing the prevalence of smoking during pregnancy. As shown in the Model II results, increases in the socioeconomic status of the counties in which mothers live can reduce the odds of MSDP. This is an "upstream approach" that may not only reduce the likelihood of women smoking while they are pregnant, but also will improve the overall condition of counties. More importantly, the protective association of social capital with MSDP among nonmetropolitan

counties should be fully utilized. For example, disseminating information of the adverse

consequences of maternal smoking in the places where people meet may further reduce MSDP in

nonmetropolitan counties, which may in turn minimize the maternal smoking prevalence

between metropolitan and nonmetropolitan counties.

Acknowledgments

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Table 1. Descriptive statistics of variables at both individual-level and county-level.

Variables	Mean	Standard Deviation
Individual-level measures (N=3,683,492)		
Smokes	0.11	0.31
Maternal age (Age 20-34=reference)		
Age 19 or younger	0.11	0.31
Age 35 and older	0.14	0.34
Race (White=reference)		
Black	0.17	0.38
American Indian/Alaskan Native	0.01	0.11
Asian	0.04	0.21
Ethnicity		
Hispanic	0.20	0.40
Marital status		
Married	0.60	0.49
Maternal education (Less than High School=reference)		
High school/GED	0.28	0.45
Some college/Associate's degree	0.25	0.43
Bachelor's degree or higher	0.27	0.44
Weight gain during pregnancy (Average gain=reference)		
Low weight gain	0.14	0.34
High weight gain	0.21	0.40
Prenatal Care Utilization (Inadequate care=reference)		
Intermediate care	0.13	0.33
Adequate care	0.39	0.49
Adequate plus care	0.32	0.47
Parity		
First birth	0.40	0.49
County-level measures (N=3,036)		
Metropolitan status		
Nonmetropolitan	0.66	0.47
Socioeconomic Status		
SES	0.00	1.00
Social Capital		
Social Capital Index	0.00	1.00
Social Capital Index*Nonmetropolitan	0.09	0.88

Note: The mean values represent the percentage of the groups coded 1.

Table 2. Multilevel logistic regression models predicting the odds of maternal smoking during pregnancy with individual-level and county-levels variables.

Variables	Model I	Model II
Individual-level measures (N=3,683,492)		
Intercept	1.568***	1.592***
Maternal age (Age 20-34=reference)		
Age 19 or younger	0.595***	0.589***
Age 35 and older	0.921***	0.920***
Race (White=reference)		
Black	0.315***	0.308***
American Indian/Alaskan Native	0.684***	0.675***
Asian	0.218***	0.210***
Ethnicity		
Hispanic	0.106***	0.101***
Marital status		
Married	0.347***	0.341***
Maternal education (Less than High School=reference)		
High school/GED	0.611***	0.605***
Some college/Associate's degree	0.341***	0.334***
Bachelor's degree or higher	0.066***	0.063***
Weight gain during pregnancy (Average gain=reference)		
Low weight gain	1.166***	1.169***
High weight gain	1.127***	1.130***
Prenatal Care Utilization (Inadequate care=reference)		
Intermediate care	0.774***	0.788***
Adequate care	0.680***	0.691***
Adequate plus care	0.724***	0.730***
Parity		
First birth	0.697***	0.709***
County-level measures (N=3,036)		
Metropolitan status		
Nonmetropolitan		1.045*
Socioeconomic Status		
SES		0.866***
Social Capital		
Social Capital Index		1.246***
Social Capital Index*Nonmetropolitan		0.922***
Variance Components		
Intercept	0.283***	0.237***

Note: Results are reported in Odds Ratios.
*$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$.