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Depression and Rural Environment Are Associated With Poor Oral Health Among Pregnant Women in Northern Appalachia

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Abstract

Both oral health problems and depression among pregnant women contribute to maternal–infant health outcomes. Little is known, however, about the potential effects of clinically significant depression on the oral health status of pregnant women. The purpose of the present study was to determine the influence of clinically significant depression and rural- or urban-dwelling status on oral health outcomes among pregnant women. Pregnant women (*N* = 685) in rural (i.e., West Virginia) and urban

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(i.e., Pittsburgh, PA) areas of northern Appalachia were assessed by calibrated examiners regarding gingivitis, oral hygiene, and DMFT (decayed, missing, and filled teeth), completed the Center for Epidemiologic Studies–Depression Scale (CES-D) and provided demographics. Participants were categorized based on clinically significant depressive symptoms (CES-D $\geq$ 16) and rural/urban domicile. Women with depression and those living in rural areas had worse oral health on all three indices than their non-depressed and urban counterparts. Depression, particularly among women in rural areas, affects certain oral health indices and represents a modifiable target for intervention. Moreover, treatments designed specifically for rural populations may be of particular utility. Women who are pregnant or planning to become pregnant may benefit from regular depression screenings from their dental and medical health care providers.

Keywords
oral health, pregnancy, depression, Appalachia, rural, health disparities

Oral health among pregnant women is a crucial issue in terms of its impact on both maternal and fetal overall health and its specific implications for gestation (Silk, Douglass, Douglass, & Silk, 2008; Xiong, Buekens, Fraser, Beck, & Offenbacher, 2006). Described as a "mirror of overall health" (McNeil, Crout, & Marazita, 2012), oral health status often reflects systemic health problems, such as cardiovascular and respiratory diseases (Needleman & Hirsch, 2007; Seymour, Preshaw, & Steele, 2002).

During pregnancy, oral health reflects not only the mother's overall and gestational health but also the future health of the child. Women experience a variety of physiological and behavioral changes during pregnancy that affect oral health, such as higher oral cavity acidity due to increased vomiting and acid reflux, decreased attention to oral hygiene, hormonal changes, and cravings for foods with high-sugar content (Scheutz, Baelum, Matee, & Mwangosi, 2002; Silk et al., 2008). Combined, these factors increase pregnant women's experience of problems such as periodontitis, gingivitis, caries, oral lesions, and teeth movement (Silk et al., 2008). In the long term, children of women with tooth decay during pregnancy experience increased rates of caries (Boggess & Edelstein, 2006). Children of women with caries during pregnancy also are susceptible to other poor health outcomes, such as respiratory infection (Boggess & Society for Maternal-Fetal Publications Committee, 2008).

Pregnant women with periodontitis at the time of delivery are more likely to experience preeclampsia (Boggess et al., 2003). In addition, there is evidence to suggest an association between maternal periodontitis and poor infant outcomes, such as preterm labor and low-birth weight infants (Lopez, Smith, & Gutierrez, 2002; Moliterno, Monteiro, Da Silva Figueredo, & Fischer, 2005). It should be noted, however, that the mechanism by which this association occurs is controversial in the literature (Clothier, Stringer, & Jeffcoat, 2007; Silk et al., 2008), and it is possible that periodontitis represents a "surrogate" for another maternal variable (Boggess & Edelstein, 2006). Regardless, maternal oral health during pregnancy appears to predict a range of child health outcomes, and so the oral health of pregnant women—and those factors that affect their oral health—warrants study.

Both pre- and post-natal depression is associated with negative maternal and fetal outcomes (Dayan et al., 2006). West Virginia has one of the highest rates of depression of any state in the United States (Centers for Disease Control and Prevention, 2010), and depression is prevalent elsewhere in Appalachia, including Appalachian counties of Pennsylvania (Davis, Bangs, Wallace, & Crawley, 2007). It is estimated that 20% of women experience significant depression during pregnancy, but that the majority of these cases are left untreated (Marcus, Flynn, Blow, & Barry, 2003).

Clinically significant depression during pregnancy has been associated with obstetrical complications (e.g., spontaneous abortion, early labor, increased bleeding; Bonari et al., 2004) both nationwide and in Appalachia specifically (Jesse, Seaver, & Wallace, 2003). Depression during pregnancy also is related to negative infant outcomes such as increased likelihood of lower Apgar scores, admission to neonatal intensive care units, and elevated cortisol levels at birth (Bonari et al., 2004; Zax, Sameroff, & Babigian, 1977).

In the general adult population in the United States, the prevalence rate of depression is significantly higher among rural-dwelling adults as compared with those living in urban settings (Probst et al., 2006). More specific to the present study is that in both Canada and Australia, women living in rural areas are more likely to experience postpartum depression in comparison with their urban-dwelling peers (Griepsma et al., 1993; Vigod et al., 2013). It is unknown, however, how rural–urban status may differentially affect depression during pregnancy or how dwelling status may interact with depression to affect oral health outcomes.

Rural–Urban Differences in Oral Health

Greater prevalence of oral disease and edentulism (i.e., toothlessness) has been documented in rural populations relative to urban ones (Eberhardt et al.,

2001; Meit et al., 2014). Differences in oral health status between rural and urban populations have been observed across the life span. Although rural and urban children/adolescents do not have significantly different caries experience, rural children/adolescents, compared with their urban counterparts, report more unmet dental need (Vargas, Ronzio, & Hayes, 2003). For adults, prevalence of unmet dental need, caries experience, and edentulism is significantly greater for those living in rural versus urban areas (Vargas, Dye, & Hayes, 2002). Likewise, rural older adults are more likely than their urban counterparts to be edentulous and to report poor oral health status (Vargas, Yellowitz, & Hayes, 2003). Indeed, similar trends are observed internationally (e.g., rural Australians have poorer oral health than those living in major cities, antenatal women living in rural Sri Lanka have greater prevalence of decayed and filled teeth than their urban counterparts; Crocombe, Stewart, Brennan, Slade, & Spencer, 2013; Karunachandra, Perera, & Fernando, 2012). Rural–urban differences in oral health status likely are the product, in part, of differences in dental treatment utilization patterns (e.g., frequency, symptomatic vs. preventive; Vargas, Dye, & Hayes, 2003) and other oral health behaviors. In addition, differences in socioeconomic status, culturally based oral health values, dental insurance coverage, and availability of dental services likely also play important roles (Skillman, Doescher, Mouradian, & Brunson, 2010).

Oral Health in Appalachia

There is an array of health issues, including oral health concerns, in Appalachia (Ludke & Obermiller, 2012). Many parts of Appalachia are rural, so a substantial proportion of residents of the region are affected by factors that contribute to poor oral health in rural areas (McNeil et al., 2012). Specifically, caries experience and prevalence of decayed, missing, and filled teeth (DMFT) is higher in Appalachia relative to other regions of the United States (Krause, May, Lane, Cossman, & Konrad, 2012; McNeil et al., 2012; Polk et al., 2008). In addition, utilization of dental treatment, including preventive and restorative care, and the desire for orthodontic care is poor in Appalachia (Martin et al., 2008). Rates of tooth loss are higher in Appalachia than in the United States as a whole and are persistent across time (Gorsuch, Sanders, & Wu, 2014; Hendryx, Ducatman, Zullig, Ahern, & Crout, 2012). Prevalence of edentulism in Appalachia is disproportionate when compared with other regions of the United States (Slade, Akinkugbe, & Sanders, 2014), and rates of edentulism are particularly high in West Virginia (National Oral Health Surveillance System, 2010), the only state in the United States entirely encompassed within Appalachia.

Objectives and Hypotheses

This study was designed to assess the impact of clinically significant levels of depression on oral health in pregnant women in Appalachia, exploring the influence of rural–urban status and other psychosocial factors. It was predicted that high levels of depression and having a rural domicile would be associated with poorer oral health status. In addition, rural-dwelling women were expected to have higher levels of depression than their urban counterparts and to be more likely to meet a cutoff for a clinically significant level of depression. Differences in education and income were expected across rural–urban and depression status factors. Rural–urban and depression status were expected to interact, with depressed rural women being most at risk for poor oral health and negative demographic indices.

Method

Design

The women in this study were participants in the Center for Oral Health Research in Appalachia (COHRA) study of pregnant women recruited in northern Appalachia (COHRA2 cohort), specifically from across the state of West Virginia and from the urban Pittsburgh, Pennsylvania area. Enrollment for the COHRA2 cohort began in 2011, following an earlier COHRA cohort of households/families (i.e., COHRA1). Pregnant women were recruited and initially assessed during their second trimester. This study is part of a larger, longitudinal project on pregnant women and their offspring, including genetic, microbiological, community-level, environmental, and psychosocial variables; additional details about the protocol are available from Neiswanger et al. (2015). This research was approved by the Institutional Review Boards of West Virginia University and the University of Pittsburgh.

Participants

The total sample consisted of 685 women, ranging in age from 18 through 42 years (M age = 28.4, SD = 5.4), who were recruited from November 2011 through February of 2015. Given the design requirements of the study related to genetic factors, all women were Caucasian and not of Hispanic descent. Eligibility criteria included being at least 18 years old, being fluent in English, having a singleton pregnancy, and not having a serious medical condition (e.g., tuberculosis, being immunocompromised).

Instruments

Oral health indices. The presence or absence of generalized gingivitis was assessed by the oral examiner. In addition, an Oral Rating Index (ORI) was assigned by the oral examiner as a visual measure of oral hygiene and overall gingival health (ORI; Camgoz, Gurgan, Kajiwara, & Kawamura, 2008; Kawamura, Fukuda, Inoue, Sasahara, & Iwamoto, 2000). For ease of exposition, ORI scores, originally ranging from −2 to +2, were converted to a 1 to 5 scale, with more positive scores indicating better gingival health. A caries assessment was conducted to yield an index of DMFT, including white spots. Examiners were trained and calibrated on all indices; reliability data can be found in Neiswanger et al. (2015).

Center for Epidemiologic Studies–Depression Scale (CES-D). The CES-D (Radloff, 1977) was completed at the time of enrollment. With a 0 to 3 response format, and a range of 0 to 60, higher scores are indicative of more depression. A standardized cutoff score (i.e., ≥16; Radloff, 1977) was used, such that women scoring at or above that level were considered as clinically depressed, whereas the remainder of the women were regarded as not depressed.

Demographic information. Age, ethnicity and race, location of domicile, educational level, and annual household income were recorded.

Procedure

After telephone screening, women were assessed in-person by calibrated oral examiners (i.e., licensed dentists or dental hygienists) to evaluate oral health status via methods described above and to collect biological samples (e.g., unstimulated saliva for bacterial and human DNA, gingival samples for bacterial DNA and RNA, supra-gingival plaque samples for biochemical analysis of bacteria) to address study questions beyond the scope of those described here. Information about training of examiners and inter-reliability can be found in Neiswanger et al. (2015). Thereafter, participants were contacted by telephone for a structured interview by trained staff

Women were provided information about any possible clinically significant oral health findings at their in-person appointment. In addition, participants whose CES-D scores met or exceeded the criterion for a clinically significant level of depression were contacted, provided information about the level of depression that was suggested by the CES-D as well as about mental health care options in their community, and encouraged to make an

appointment for further evaluation and possible treatment. Help in securing follow-up mental health care related to their possible depression also was offered.

Design and Statistical Analyses

Participants were sorted into depressed (i.e., CES-D ≥ 16) and non-depressed (i.e., CES-D < 16) groups and were classified based on their domicile (i.e., in West Virginia, or in the Pittsburgh, PA, area).[1] Participants from West Virginia were considered rural and those from the Pittsburgh, Pennsylvania area were regarded as urban. A 2 (depressed–non-depressed) × 2 (rural or urban) factorial design was the basis for the univariate ANOVAs that were conducted on educational level, household income, and the three oral health indices. Missing data were excluded pairwise and are reflected in the degrees of freedom for the various statistical tests.

Results

Across the entire sample, CES-D scores ranged from 0 through 52 ($M = 9.9$, $SD = 9.0$). There were 336 (49.1%) women who were rural dwelling and 349 (50.9%) who were urban dwelling. In terms of depression, the rural women had significantly higher CES-D scores ($M = 11.5$, $SD = 9.6$), and the urban women had lower scores ($M = 8.3$, $SD = 8.1$), $t(683) = 4{,}81$, $p < .0005$. Furthermore, 133 (19.4%) women met the criterion for a clinically significant level of depression (i.e., CES-D ≥ 16) and 552 (80.6%) did not. Of the 336 rural-dwelling women, 80 (23.8%) met criterion for a clinically significant level of depression, whereas 53 (15.2%) of the 349 urban-dwelling women met that criterion. There were 17 women (12.8%) in the depressed group and 27 women (4.9%) in the non-depressed group who reported taking antidepressant medication, which was a significant difference between groups, $\chi^2(1, N = 685) = 11.10$, $p < .001$.

Table 1 presents means and results from statistical tests. The ANOVAs revealed main effects for both education and income, such that both income and education were higher among women living in urban areas. The interaction effects for both education and income were significant, indicating that income and education among non-depressed women were greater among women in urban areas than in rural areas, but education and income did not differ by dwelling status among women with clinically significant levels of depression.

ANOVAs further revealed a main effect for depression status for all three oral health indices and a main effect for rural–urban status for all of them as

Table 1. Demographics, Generalized Gingivitis, ORI, and DMFT Means (Standard Deviations) and ANOVA Results by Main Effects (Depression Status and Urban–Rural Distinction) and their Interaction.

	Depressed		Non-depressed					
Variable	Rural	Urban	Rural	Urban	ANOVA	Depression status	Urban–Rural	Interaction
Demographics								
Education	4.1 (1.5)	4.5 (1.6)	4.5 (1.6)	5.6 (1.6)	$F(3, 685)$	20.63	24.72	5.36
					p	.0005	.0005	.021
					η_p^2	.03	.04	.01
Annual household income	31,869 (32,962)	32,037 (29,747)	50,144 (48,331)	88,630 (87,477)	$F(3, 548)$	23.29	6.21	6.10
					p	.0005	.013	.014
					η_p^2	.04	.01	.01
Oral health indices								
Generalized gingivitis	0.41 (0.50)	0.23 (0.42)	0.30 (0.46)	0.13 (0.34)	$F(3, 680)$	6.67	18.54	.075
					p	.01	.0005	.78
					η_p^2	.01	.03	.00
ORI	3.1 (1.2)	2.8 (1.2)	2.7 (1.3)	2.3 (1.2)	$F(3, 680)$	14.49	9.19	.21
					p	.0005	.003	.65
					η_p^2	.02	.01	.00
DMFT	15.85 (7.2)	11.0 (8.0)	12.9 (7.2)	8.4 (6.9)	$F(3, 680)$	15.45	45.21	0.21
					p	.0005	.0005	.82
					η_p^2	.02	.06	.00

Note. Education: 1 = eighth grade or less, 2 = ninth to 12th grade, but no diploma, 3 = high school graduate or GED (General Educational Development), 4 = some college, but no degree, 5 = associate degree, 6 = bachelor's degree, 7 = master's degree, 8 = doctoral degree; ORI = Oral Rating Index; DMFT = decayed, missing, and filled teeth.

well, but no interaction effects. Findings were that depressed women, and those living in rural areas, had significantly poorer oral health. On average, depressed women had significantly more decayed, missing, or restored teeth (DMFT = 13.9) than their non-depressed counterparts (DMFT = 10.5), $t(653) = -4.55$, $p < .001$. Also on average, rural women (DMFT = 13.6) also had significantly more negatively affected teeth compared with their urban peers (DMFT = 8.8), $t(653) = 8.63$, $p < .001$.

Discussion

Depression was found to be an important factor relating to oral health in pregnant women in northern Appalachia. Consistent with prior literature including general population and other groups, these findings are unique in emphasizing the importance of depression to oral health during the perinatal period. This factor provides a target for possible intervention that may affect oral health, psychological health, and overall health. Detection of clinically significant depression is of critical importance during pregnancy and postpartum due to its potential impact on self-care, readiness to care for an infant, potential for relation to self-harm, and life functioning. Various evidence-based psychotherapeutic and pharmacotherapeutic approaches are available for depression that could improve mood and overall quality of life in pregnant women.

These results additionally point out that women residing in rural areas of northern Appalachia, specifically in West Virginia, have a greater burden of oral health problems than their urban counterparts. Prior literature has found similar oral health vulnerabilities in other rural samples, possibly related to socioeconomic factors and access to dental care, as well as oral health and other cultural values.

There was no evidence in this study that depression and rural–urban status interacted in affecting oral health in this group of Appalachian women. Nevertheless, depressed, rural women did have lower levels of education and household income than other groups in this sample. Although the sample size overall was large, the relatively smaller numbers of depressed women in both the rural and urban subsamples (i.e., 19.4% of the total sample) may have made it difficult to detect interactions of depression and rural–urban status relating to oral health.

In this sample, urban-dwelling status was associated with higher income and higher education levels among women who did not meet criterion for clinically significant depression. Among women who had clinically significant depression, income and education did not vary by dwelling status. There is evidence in the literature to suggest income- and education-based inequalities in the prevalence of depression in the general population (Dohrenwend

et al., 1992; Kessler, Foster, Saunders, & Stang, 1995; Lorant et al., 2003). These results are not surprising, given that rural populations tend to have lower incomes and lower levels of education than their urban counterparts (Housing Assistance Council, 2010).

Limitations

Overall, the effect sizes are low, so depression and rural–urban status explain only some of the variance observed in oral health status in this northern Appalachian sample of pregnant women. The West Virginia sample was not exclusively rural, depending on one's definition of rurality, in that participants came from across the state, which includes cities and urbanized areas. Nevertheless, the relation of residency in West Virginia to poorer oral health indicators is significant and may relate to social and economic conditions. For design reasons, this sample included only Caucasian women, so the results may not be generalizable to other ethnic and racial groups. This demonstration of the importance of depression to oral health during pregnancy, however, provides a basis for study and possible intervention in other ethnic and racial groups. In addition, there are numerous factors that affect oral health that were not included in the present study, such as access to dental care services, dental insurance, and oral health values (Allison, Locker, Jokovic, & Slade, 1999; Bloom, Simile, Adams, & Cohen, 2012).

Future Research

Opportunities for future research in the domain of maternal depression and oral health are plentiful. In general, future research in this area would benefit from including a wide variety of behavioral, socioeconomic, and environmental variables, to more accurately model the factors contributing to both depression and oral health among prenatal and peripartum women. Policy-level interventions, particularly in rural areas, (e.g., incentivize health care providers for screening for depression among pregnant women) are another direction for future investigations. Future research may also benefit from incorporating experimental methods to test the effects of treatment for depression during pregnancy on postpartum oral health outcomes. Both cognitive-behavior therapy and interpersonal therapy have been shown to be effective treatments for depression among pregnant women (Yonkers et al., 2009). Using a more longitudinal approach, such as including infant child oral health outcomes in the study, may help to uncover the potentially complex associations between maternal oral health, depression, and child oral, mental, and systemic health.

Clinical Implications

The association between depression and poor oral health implies a need for screening and attention to depression among pregnant and perinatal women in both dental and primary care settings. Mental health care providers, too, should be aware of the oral health consequences of depression during pregnancy to encourage appropriate self-care and professional dental assessment and treatment. To provide better access to oral health care to rural populations, practitioners may consider incorporating Internet-based, mobile, or community-based services (Skillman et al., 2010).

Conclusion

Pregnant women who are clinically depressed or those from rural areas of northern Appalachia, have a greater burden of oral disease, specifically caries. Both clinically significant levels of depression and dwelling in a rural environment (i.e., West Virginia) are associated with more generalized gingivitis and poorer overall gingival health, as well as with lower education and household income. Depression provides a modifiable target for interventions with pregnant women in northern Appalachia who are vulnerable to disparities that burden them with greater oral disease and socioeconomic disadvantage.

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Note

1. Additional analyses were conducted including non-depressed women taking antidepressants in the depressed group, in comparison with the other non-depressed women. There were 14 rural women and 13 urban women, for a total of 27 participants, who reported taking antidepressants but were not classified by the Center for Epidemiologic Studies–Depression Scale (CES-D) as significantly depressed. Analyses were conducted with and without these women in the depressed group. The pattern of results was the same for both analyses, therefore, only the analyses based on classification of women based on the CES-D were used.

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