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Intendedness of Pregnancy and Other Predictive Factors for Symptoms of Prenatal Depression in a Population-Based Study

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Abstract Prenatal depression (PD) as a risk factor for adverse birth outcomes is well documented. Less is known about maternal risks for PD, which could inform preventive strategies for perinatal and interconceptional care. This exploratory study investigates associations between prenatal depression symptoms and unintended and mistimed pregnancies and other maternal risk factors for PD. A subset of birth records from the New York Statewide Perinatal Data System (n = 19,219) was used in this secondary analysis of cross-sectional data. Univariate and multivariate multinomial regression was used to identify factors that are independently associated with four self-reported levels of prenatal depression symptoms. Women with unintended pregnancies were more likely (AOR, 95 % CI) to report severe (3.6, 2.6–5.1) or moderate (2.0, 1.6–2.5) prenatal depression symptoms and less likely to report no symptoms, compared to women with intended pregnancies. Likewise, women with mistimed pregnancies were more likely to report severe (2.7, 2.2–3.5) or moderate (1.7, 1.5–2.1) prenatal depression symptoms than no symptoms, compared to women with intended pregnancies. Low education, drug use, smoking, minority race, being unmarried and having Medicaid insurance were also significant, independent predictors of PD symptoms. Results suggest that routine screening for depression, intendedness of pregnancy and other associated risk factors such as smoking and drug use during prenatal and interconceptional care visits may enable coordinated interventions that can reduce prenatal depression and unintended and mistimed pregnancies and improve pregnancy outcomes.

Keywords Prenatal depression risks · Intendedness of pregnancy · Unintended, unwanted, mistimed pregnancy · Prenatal depression · Maternal depression screening · Prenatal, interconceptional, perinatal care

Introduction

Depression that begins during pregnancy is a prevalent form of obstetric morbidity that elevates risk of poor pregnancy outcomes, including slower fetal growth rates, premature delivery and low birth weight [1–4]. One study reported that women with prenatal depression (PD) had 13 % greater incidence of premature delivery (OR 2.61) and 15 % greater incidence of low birth weight (OR 4.75) than non-depressed women [2]. These adverse outcomes may be mediated by stress and depression-induced increases in cortisol and other changes in maternal and infant body chemistry [2–4] and the adverse effects of frequently co-occurring risks such as use of tobacco, alcohol and other drugs and inadequate medical care that are associated with prenatal depression [5]. Furthermore, prenatal depression has been shown to be a strong predictor of postpartum depression [6–9], which would extend and compound risks for the developing infant and mother [10].

Prenatal depression is estimated to occur in 10–20 % of pregnancies in the US [11, 12]. However, studies show that only 18 % of pregnant women who meet criteria for depressive disorders seek treatment during pregnancy and

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postpartum [13]. Consequently, a majority of cases of prenatal depression do not receive clinical treatment, despite multiple visits to health care providers during pregnancy. Prenatal depression is potentially modifiable, especially when identified early in pregnancy [14–18]. Additional knowledge of risk factors for PD, increased attention to modifiable factors and a preventive approach to early identification of at-risk women by health care providers could reduce risks and morbidity attributable to prenatal depression, and in some cases, to postpartum depression as well.

Researchers have explored risk factors for depression during pregnancy and have found numerous maternal psychological, social, economic, demographic, health and behavioral factors that have univariate associations with prenatal depression [5, 19–21]. Unintended pregnancy has been evaluated as an adjusted risk factor for prenatal depression in a relatively small number of studies, but most have shown a positive relationship between unintended pregnancy and symptoms of PD [5, 6, 22–26]. A large, nationally representative cohort study of more than 11,000 infants in Ireland found that unintended pregnancy was associated with an increased risk of prenatal depression (RR 1.36, 95 % CI 1.19–1.54) [25]. A cohort study of 1,600 US pregnancies revealed an association between mid-pregnancy depression symptoms and unwanted pregnancy (OR 2.05, 95 % CI 1.12–3.75) [6]. Bunevicius et al. [24] studied the prevalence of, and risk factors for prenatal depression by trimester in a sample of Lithuanian women and found a strong association between unintended and unwanted pregnancies and prenatal depressive disorder in all three trimesters, with AORs (95 % CI) ranging from 6.07 (1.64–22.46) to 15.35 (3.18–72.24).

This study investigates risk factors for prenatal depression, focusing on unintended and mistimed pregnancies. Our study aim is to increase understanding of the effect of pregnancy intendedness and other predictive factors on PD symptoms through secondary analysis of a population-based sample. For health care providers, more information about who may be at elevated risk for prenatal depression is crucial to planning and implementing preventive approaches to the identification (via screening for depression, intendedness and other associated risk factors) and treatment of depression during all stages of reproductive health care.

Methods

The cross-sectional sample for our secondary analysis included all women with recorded births of live infants in a 13-county region in central New York State during 2011 (N = 19,219). This region includes the cities of Watertown, Syracuse, and Binghamton NY, has a mix of urban,

Table 1 Symptoms of prenatal depression by selected maternal characteristics (N = 18,394)

Maternal Characteristics	Symptoms of prenatal depression, row percent				Total n (row)
	None	Mild	Moderate	Severe	
Intendedness of pregnancy					
Not then or in future (unintended)	58.3	29.3	8.7	3.7	1,551
Later (mistimed)	58.9	30.2	8.1	2.8	5,288
Then or sooner (intended)	77.4	17.6	4.1	0.9	11,249
Total	70.3	22.3	5.7	1.7	18,088
Education					
< 12th grade	60.2	29.1	7.6	3.0	2,680
HS or GED	65.3	24.9	7.6	2.2	4,629
Some college	68.0	23.4	6.7	1.9	4,105
Associates	73.9	20.3	4.6	1.1	1,942
Bachelors and higher	80.9	16.0	2.5	0.6	5,023
Total	70.3	22.3	5.7	1.7	18,379
Age (Years)					
< 17	56.6	33.4	8.0	2.0	401
18–24	64.5	26.0	7.1	2.3	5,917
25–34	73.6	20.1	4.9	1.4	9,964
35+	73.7	19.8	5.1	1.4	2,112
Total	70.3	22.3	5.7	1.7	18,394
Race/ethnicity					
Hispanic	64.9	26.1	6.1	2.9	897
Black	60.4	28.3	8.0	3.4	1,292
Other	68.3	23.2	6.4	2.1	1,281
White	71.7	21.4	5.4	1.4	14,924
Total	70.3	22.3	5.7	1.7	18,394
Medical insurance					
Medicaid/self-pay	62.0	27.8	7.5	2.7	7,480
Private/other types	76.1	18.5	4.5	1.0	10,912
Total	70.3	22.3	5.7	1.7	18,392
Employed during pregnancy					
Yes	75.1	19.4	4.6	0.9	10,620
Total	70.3	22.3	5.7	1.7	18,394
Imputed marital status					
Unmarried	61.6	27.9	7.9	2.6	8,432
Married	77.7	17.5	3.9	0.9	9,962
Total	70.3	22.3	5.7	1.7	18,394
Number of previous terminations					
2 or more	56.9	32.0	6.6	4.5	606
1	65.6	25.8	6.4	2.2	1,733
0	71.4	21.5	5.6	1.5	16,015
Total	70.3	22.3	5.7	1.7	18,354
Entry to prenatal care					
Third trimester or no care	63.0	26.3	7.3	3.4	617
Second trimester	66.1	25.3	6.3	2.4	3,336

Table 1 continued

Maternal Characteristics	Symptoms of prenatal depression, row percent				Total n (row)
	None	Mild	Moderate	Severe	
First trimester	71.8	21.3	5.5	1.5	14,187
Total	70.4	22.2	5.7	1.7	18,140
Any maternal medical risk					
Yes	70.8	21.9	5.7	1.5	11,356
Total	70.3	22.3	5.7	1.7	18,394
Gestational diabetes					
Yes	70.4	22.6	5.4	1.6	1,093
Total	70.3	22.3	5.7	1.7	18,394
Pre-pregnancy diabetes					
Yes	68.3	24.8	5.0	1.9	161
Total	70.3	22.3	5.7	1.7	18,394
Alcohol use during pregnancy					
Yes	51.6	35.7	8.7	4.0	126
Total	70.4	22.2	5.7	1.7	18,389
Drug use during pregnancy					
Yes	44.2	37.2	11.1	7.4	631
Total	70.4	22.2	5.7	1.7	18,387
Cigarettes per day, 1st trimester					
>20	51.9	28.3	16.0	3.8	106
10–20	54.4	32.3	9.4	3.9	2,102
1–9	57.4	29.4	10.2	3.1	1,424
Non-smoker	74.0	20.1	4.7	1.2	14,757
Total	70.3	22.3	5.7	1.7	18,389

suburban and rural populations, and has demographic and socioeconomic profiles that are similar to much of the US. Self-reported symptoms of depression during pregnancy, pregnancy intendedness and a set of other potential predictor variables (Table 1) based on literature review and availability were obtained from the New York Statewide Perinatal Data System (SPDS) after receiving exempt status from the Institutional Review Board of SUNY Upstate Medical University. The sample was chosen based on convenient access to the data and because we thought it was likely to be representative of many regions of the US.

The outcome of interest is a self-rated measure of severity of depression symptoms during pregnancy with five levels: 'not depressed at all', 'a little depressed', 'moderately depressed', 'very depressed', and 'very depressed and had to get help'. The latter two levels were combined for the statistical analyses, and the four categories of symptom severity are hereafter referred to as 'none' (the referent category), 'mild', 'moderate' and 'severe'. The SPDS measure of depression symptoms was originally developed for use by the Prenatal Risk Assessment Monitoring System (PRAMS) [27], and has been field-tested and validated.

Within 72 h after delivery, women in this study were asked via written survey to reflect back on their pregnancy and self-rate their prenatal depression symptoms and their desire/intention to become pregnant just before their latest pregnancy, given the following choices: wanted to be pregnant… 'sooner', 'then', 'later', and 'not then or in the future' [27]. Responses for the first two categories were combined for statistical analysis and the resulting three categories are hereafter referred to as 'intended' (the referent category), 'mistimed' and 'unintended', respectively.

Of the original 19,219 SPDS records, 1,160 (6.0 %) cases were excluded, including 825 (4.3 %) cases with a missing outcome variable and 335 (1.7 %) with one or more missing predictor variables. Comparisons of characteristics of women with missing and non-missing prenatal depression symptoms were conducted using Chi square and exact probability tests.

Non-collinear potential predictor variables with unadjusted odds ratios $\geq$1.5 (equivalent to $r \geq 0.1$, a "small" effect size [28]) for prenatal depression in the univariate analyses were selected for preliminary multivariate regression modeling (Table 2). Predictor variables with non-significant ($p \geq 0.05$) adjusted odds ratios in the preliminary multivariate models were excluded from the final model (Table 3). All multivariate models used simultaneous entry of predictor variables.

All research was conducted in accordance with prevailing ethical standards. All statistical analyses used two-tailed tests of significance, a priori $\alpha = 0.05$ and 95 % CIs, and were carried out using SPSS, Version 20.

Results

The prevalence of self-reported depression symptoms during pregnancy and the set of potential risk factors included in this study are summarized in Table 1. The prevalence of self-reported levels of no symptoms, mild, moderate and severe prenatal depression symptoms was 70, 22, 6 and 2 %, respectively. About 62 % of women reported that their pregnancy was intended, 30 % reported it as mistimed and approximately 9 % said it was unintended.

The univariate multinomial regression analysis identified a subset of the risk factors we evaluated (Table 1) that met our criteria for preliminary multivariate analysis. These variables are shown in Table 2. Variables in the final model are shown in Table 3.

Pregnancy Intendedness

The adjusted odds ratios and 95 % CIs for predictive variables retained in the final multinomial logistic regression model are presented in Table 3. Compared to women

Table 2 Univariate odds ratios for prenatal depression symptoms by selected maternal characteristics

Maternal characteristic	Symptoms of depression (referent group: no symptoms)								
	Mild			Moderate			Severe		
	Odds ratio	95 % CI	*p*	Odds ratio	95 % CI	*p*	Odds ratio	95 % CI	*p*
Intendedness of pregnancy									
Not then or in the future (unintended)	2.21	1.95–2.49	<0.001	2.79	2.28–3.42	<0.001	5.76	4.13–8.03	<0.001
Later (mistimed)	2.25	2.09–2.44	<0.001	2.55	2.23–2.93	<0.001	4.29	3.31–5.56	<0.001
Then or sooner (intended)	1.00			1.00			1.00		
Education									
12th grade and below	2.45	2.19–2.75	<0.001	4.07	3.24–5.11	<0.001	6.80	4.46–10.38	<0.001
HS diploma or GED	1.93	1.74–2.13	<0.001	3.74	3.03–4.60	<0.001	4.52	3.00–6.82	<0.001
Some college	1.74	1.57–1.94	<0.001	3.14	2.53–3.90	<0.001	3.78	2.48–5.78	<0.001
Associates	1.39	1.22–1.59	<0.001	2.01	1.52–2.64	<0.001	1.98	1.13–3.47	0.017
Bachelors and higher	1.00			1.00			1.00		
Age (Years)									
< 17	2.16	1.73–2.69	<0.001	2.12	1.45–3.11	<0.001	1.92	0.93–3.96	0.079
18–24	1.47	1.36–1.59	<0.001	1.67	1.46–1.91	<0.001	1.98	1.56–2.51	<0.001
35+	0.98	0.87–1.11	0.762	1.05	0.84–1.30	0.690	1.01	0.68–1.52	0.953
25–34	1.00			1.00			1.00		
Race/ethnicity									
Hispanic	1.35	1.15–1.57	<0.001	1.25	0.94–1.66	0.128	2.23	1.47–3.39	<0.001
Black	1.57	1.37–1.78	<0.001	1.75	1.40–2.17	<0.001	2.82	2.02–3.93	<0.001
Other	1.14	0.99–1.30	0.069	1.24	0.98–1.57	0.078	1.54	1.03–2.32	0.036
White	1.00			1.00			1.00		
Medical insurance									
Medicaid/self-pay	1.84	1.72–1.98	<0.001	2.08	1.83–2.36	<0.001	3.37	2.66–4.26	<0.001
Private/other types	1.00			1.00			1.00		
Employed during pregnancy									
No	1.58	1.47–1.70	<0.001	1.88	1.66–2.13	<0.001	3.49	2.74–4.45	<0.001
Yes	1.00			1.00			1.00		
Imputed marital status									
Unmarried	2.01	1.87–2.16	<0.001	2.56	2.25–2.92	<0.001	3.49	2.73–4.46	<0.001
Married	1.00			1.00			1.00		
Number of previous terminations									
2 or More	1.87	1.56–2.23	<0.001	1.48	1.06–2.07	0.022	3.64	2.41–5.49	0.022
1	1.30	1.16–1.46	<0.001	1.25	1.01–1.53	0.037	1.55	1.10–2.20	0.013
0	1.00			1.00			1.00		
Entry to prenatal care									
Third trimester or no care	1.41	1.17–1.70	<0.001 < 0.001	1.51	1.10–2.07	0.011	2.67	1.68–4.23	<0.001
Second trimester	1.29	1.18–1.41		1.24	1.05–1.45	0.010	1.77	1.36–2.31	<0.001
First trimester	1.00			1.00			1.00		
Any maternal medical risk									
Yes	0.94	0.88–1.02	0.119	0.99	0.87–1.12	0.825	0.79	0.63–1.00	0.046
No	1.00			1.00			1.00		
Gestational diabetes									
Yes	1.02	0.88–1.18	0.847	0.94	0.72–1.24	0.661	0.91	0.56–1.50	0.721
No	1.00			1.00			1.00		

Table 2 continued

Maternal characteristic	Symptoms of depression (referent group: no symptoms)								
	Mild			Moderate			Severe		
	Odds ratio	95 % CI	*p*	Odds ratio	95 % CI	*p*	Odds ratio	95 % CI	*p*
Pre-pregnancy diabetes									
Yes	1.15	0.80–1.66	0.449	0.90	0.44–1.84	0.764	1.14	0.36–3.60	0.828
No	1.00			1.00			1.00		
Alcohol use during pregnancy									
Yes	2.20	1.50–3.23	<0.001	2.10	1.10–3.99	0.024	3.24	1.29–8.09	0.012
No	1.00			1.00			1.00		
Drug use during pregnancy									
Yes	2.77	2.32–3.30	<0.001	3.24	2.47–4.25	<0.001	8.08	5.80–11.26	<0.001
No	1.00			1.00			1.00		
Cigarettes per day, 1st trimester									
>20	2.01	1.28–3.32	0.002	4.90	2.83–8.49	<0.001	4.41	1.58–12.31	0.005
10–20	2.18	1.97–2.42	<0.001	2.75	2.32–3.25	<0.001	4.41	3.37–5.75	<0.001
1–9	1.88	1.66–2.13	<0.001	2.81	2.32–3.41	<0.001	3.27	2.33–4.58	<0.001
Non-smoker	1.00			1.00			1.00		

with intended pregnancies, the adjusted odds (95 % CI for AOR, 95 % CI for *r*, an effect size measure, *p* value) of severe depressive symptoms (vs. no symptoms) were 3.6 (2.6–5.1, $r = 0.25$–0.41, $p < 0.001$) times greater for women with unintended pregnancies. Similarly, women with mistimed pregnancies were 2.7 (2.0–3.5, $r = 0.19$–0.33, $p < 0.001$) times more likely to report severe depression symptoms (vs. no symptoms) than were women with intended pregnancies. We also observed similar patterns of smaller, but significant AORs (ranging from 1.7 to 2.0, $r = 0.14$–0.19, all $p < 0.001$) for moderate and mild depression symptoms (vs. no symptoms) associated with unintended and mistimed pregnancies, relative to the odds for intended pregnancies.

Drug Use

Maternal drug use during pregnancy was also found to be strongly associated with prenatal depression (Table 3). Women whose medical records indicated prenatal use of illicit drugs or non-prescribed medications were [AOR (95 % CI)] 3.2 (2.2–4.5) and 1.5 (1.1–2.0) times more likely to report severe and moderate depression symptoms than no symptoms, respectively, when compared to women with no known history of prenatal drug use.

Smoking

Compared to non-smokers, women who smoked during the first trimester were more likely to report prenatal depression symptoms than no symptoms, independent of other risk factors (Table 3). For example, women who reported smoking 20 or more cigarettes per day during the first trimester were [AOR (95 % CI)] 3.1 (1.7–5.4) times more likely to report moderate symptoms rather than no symptoms of PD, compared to the non-smokers. Compared to non-smokers, smoking as few as one to nine cigarettes per day during the first trimester was a significant, independent predictor of an increased likelihood [AOR (95 % CI)] of reporting mild 1.4 (1.2–1.5), moderate 1.9 (1.5–2.3) or severe 1.7 (1.2–2.5) symptoms of PD, rather than no symptoms.

Sociodemographic Factors

Adjusted relative odds for prenatal depression symptoms vs. no symptoms were also generally higher for women with lower levels of educational attainment (compared to college graduates), for younger mothers (compared to older mothers), for Hispanic and Black mothers (compared to White mothers) and for those with Medicaid insurance (compared to private or other insurance, Table 3).

Multiple Risks

Maternal risk factors for self-reported prenatal depression symptoms and for poor pregnancy outcomes frequently co-occur in pregnant women. For example, 11.8 % of women with unintended or mistimed pregnancies used drugs during pregnancy, 10 times the rate observed for intended

Table 3 Predictors of prenatal depression symptoms, multinomial logistic regression model

Maternal characteristic	Severity of depression symptoms (referent group: no symptoms)								
	Mild			Moderate			Severe		
	Adjusted odds ratio	95 % CI	*p*	Adjusted odds ratio	95 % CI	*p*	Adjusted odds ratio	95 % CI	*p*
Intendedness of pregnancy									
Not then or in the future (unintended)	1.75	1.54–1.99	<0.001	1.99	1.62–2.46	<0.001	3.61	2.56–5.10	<0.001
Later (mistimed)	1.75	1.61–1.90	<0.001	1.74	1.50–2.02	<0.001	2.67	2.02–3.51	<0.001
Then or sooner (intended)	1.00			1.00			1.00		
Cigarettes per day, 1st trimester									
>20	1.31	0.83–2.07	0.252	3.06	1.75–5.36	<0.001	2.20	0.77–6.28	0.140
10–20	1.61	1.44–1.81	<0.001	1.82	1.51–2.19	<0.001	2.38	1.76–3.22	<0.001
1–9	1.35	1.18–1.54	<0.001	1.86	1.52–2.29	<0.001	1.74	1.21–2.49	0.003
Non-smoker	1.00			1.00			1.00		
Drug use									
Yes	1.62	1.34–1.95	<0.001	1.50	1.12–2.01	0.007	3.16	2.20–4.55	<0.001
No	1.00			1.00			1.00		
Race/ethnicity									
Hispanic	1.19	1.01–1.41	0.034	1.09	0.81–1.47	0.554	1.81	1.17–2.80	0.008
Black	1.19	1.03–1.37	0.016	1.25	0.99–1.57	0.064	1.76	1.23–2.51	0.002
Other	1.12	0.97–1.30	0.110	1.31	1.02–1.68	0.031	1.44	0.94–2.22	0.096
White	1.00			1.00			1.00		
Education level									
12th grade and below	1.20	1.04–1.38	0.012	1.84	1.40–2.40	<0.001	1.87	1.13–3.11	0.015
HS diploma or GED	1.13	1.00–1.28	0.046	2.02	1.60–2.57	<0.001	1.79	1.11–2.87	0.017
Some college	1.16	1.03–1.30	0.014	2.00	1.58–2.53	<0.001	1.81	1.13–2.90	0.013
Associates	1.12	0.98–1.29	0.102	1.59	1.20–2.11	0.001	1.39	0.78–2.49	0.263
Bachelors and higher	1.00			1.00			1.00		
Medical insurance									
Medicaid/self-pay	1.22	1.11–1.33	<0.001	1.07	0.92–1.25	0.382	1.41	1.07–1.87	0.016
Private/other types	1.00			1.00			1.00		
Imputed marital status									
Unmarried	1.25	1.14–1.37	<0.001	1.36	1.16–1.59	<0.001	1.21	0.90–1.63	0.199
Married	1.00			1.00			1.00		

pregnancies (1.8 %), and 66.4 % of the drug users were carrying an unintended or mistimed child. Nearly one-third (30.7 %) of women with unintended pregnancies and 28.5 % of women with mistimed pregnancies smoked during pregnancy; in contrast 13.9 % with intended pregnancies smoked during their pregnancy. Furthermore, 67.4 % of women known to use drugs during pregnancy also smoked during pregnancy.

Comparisons of characteristics of women with missing (vs. non-missing) prenatal depression symptoms found that women with missing information about PD symptoms were significantly more likely to be Black (11.4 % of missing cases vs. 7.2 % of non-missing cases), be 35 years old or older (16.4 vs. 11.5 %) have Medicaid insurance (51.2 vs. 40.7 %), have no high school diploma (28.2 vs. 14.6 %) and have unintended (12.6 vs. 8.6 %) or mistimed (37.9 vs. 29.2 %) pregnancies.

Discussion

Nearly 30 % of childbearing women in our sample reported some prenatal depression symptoms, which is higher than the range of 10–20 % commonly reported in US studies [11, 12, 29]. One possible explanation is that our sample of US births is, in fact, a census of births in a 13-county region in central New York, and may capture more women with prenatal depression than other (e.g. facility-based) sampling methods. Alternatively, it could be that women in this region have greater prevalence of PD

than the norm. Another possible explanation is misclassification due to different instruments used to measure prenatal depression across studies; some portion of the women who reported mild symptoms in our study might not be classified as having depressive symptoms using other depression screens. About 8 % reported moderate or severe prenatal depression symptoms, which is in line with estimates of PD from other studies, and these women are the focus of our findings. In addition, missing value analysis for prenatal depression symptoms revealed that women with missing information about PD symptoms tend to have characteristics associated with elevated risk of moderate or severe symptoms, which suggests that the prevalence of moderate and severe symptoms may be greater than 8 % in this population.

Our findings suggest an inverse association between intendedness of pregnancy and symptoms of prenatal depression, with 95 % CI estimates of AORs for severe PD symptoms (referent: no PD symptoms) of 2.6–5.1 ($r = 0.25$–0.41) for unintended pregnancies (referent: intended pregnancies) and 2.0–3.5 ($r = 0.19$–0.33) for mistimed pregnancies (Table 3). Based on Cohen's [28] guidelines, the effect sizes we observed for the independent (i.e., adjusted) relationship between pregnancy intendedness and severe depressive symptoms ranged from nearly-moderate to nearly-strong. Although Cohen's guidelines are meant to be interpreted in the context of other similar studies (see below), we find it striking to observe these levels of independent effects for pregnancy intendedness, because prenatal depression is likely to be affected by a complex combination of multiple interacting biological, physiological, psychosocial and environmental factors.

Our findings are consistent with other reports [6, 24, 25], in which AORs for depressive symptoms in unintended pregnancy [AOR, (95 % CI for AOR, 95 % CI for r)] varied between 1.36 (1.19–1.54, $r = 0.05$–0.13) and 15.35 (3.18–74.24, $r = 0.30$–0.76) times the odds for depressive symptoms in intended pregnancies [24, 25]. It is interesting that most of the studies of unintended pregnancy and risk for prenatal depression show convergent results, because they differ markedly in terms of study design, sampling methods and populations, instruments used to measure depressive symptoms and pregnancy intendedness, and in the covariates controlled in the adjusted odds ratios [6, 21, 24, 25]. Replicated results under disparate conditions suggest that the association between unintended and mistimed pregnancies and prenatal depression symptoms may be relatively strong, consistent and insensitive to differences in methods and measures among studies.

There is evidence to suggest that women with unintended pregnancies have greater risk of adverse pregnancy outcomes than women with intended pregnancies [1–4, 30–32]. Orr et al. [30] evaluated the association between intendedness of pregnancy and preterm birth in a large prospective cohort and found that unintended pregnancy was significantly associated with preterm delivery (adjusted RR 1.82, 95 % CI 1.08–3.08, $p = 0.026$). Another study found that women who reported that their pregnancies were unwanted had more than twice the risk of infant mortality during the first 28 days following delivery than women with intended pregnancies [31]. In a case–control study, Sable et al. [32] showed that mothers of very low birth weight infants were significantly more likely to report that they had felt unhappy about the pregnancy (OR 1.53) than those who had a normal-weight baby.

It also appears that on the whole, women with unintended pregnancies and those with prenatal depression share similar risk profiles for poor pregnancy outcomes. A study of women with unintended or mistimed pregnancies using PRAMS data found that compared to women with intended pregnancies, mothers with unintended and mistimed pregnancies were more likely to consume less than the recommended amount of preconception folic acid (AOR 2.4, 95 % CI 1.7–3.2), smoke prenatally (2.0, 1.5–2.9), smoke postpartum (1.9, 1.4–2.6) and report postpartum depression (2.0, 1.5–2.6) [33].

In addition, these women were less likely than women with intended pregnancies to initiate prenatal care during the first trimester (0.3, 0.3–0.5) and breastfeed for 8 or more weeks (0.7, 0.6–1.0) [33]. In this study, we also found a negative relationship between self-reported prenatal depression symptoms and breastfeeding at hospital discharge; 39.4 % (650/1,561) of mothers with unintended pregnancies were breastfeeding, while the comparable rates for mothers with mistimed and intended pregnancies were 51.7 % (2,688/5,199) and 64.0 % (7,201/11,250), respectively ($\chi^2 = 422.4$, $df = 2$, $p < 0.001$, $V = 0.15$). Similar to the Cheng et al. study [33], other research confirms the association between unintended or unwanted pregnancies and continued smoking [34, 35]. Thus it appears that unintendedness, in and of itself, may signal a need for further inquiry regarding history of other risk factors during prenatal care visits. We discuss using this signal in our conclusions.

Consistent with many studies [5], we found that compared to mothers who did not smoke during pregnancy, mothers who smoked during the first trimester of pregnancy were about 2–3 times more likely to report moderate or severe symptoms of prenatal depression rather than no symptoms (Table 3). There was also a strong trend towards greater numbers of cigarettes smoked per day being associated with higher levels of depression symptoms (Table 3).

It is well documented that maternal smoking during pregnancy poses significant threats to the fetus and

developing infant. As cited and summarized in Roy et al. [36], children of women who smoke during pregnancy show "low birth weight [37], increased risk of stillbirth [38], altered cardiorespiratory responses [39], and increased asthma and wheezing [40] as well as behavioral abnormalities, including increased evidence of attentional deficits, impaired learning and memory, lowered IQ, and cognitive dysfunction". Other studies have also revealed that women who smoke during pregnancy may have increased incidence of depression and thus reduced motivation to quit smoking during pregnancy [41]. Although screening for smoking may be routine during the initial prenatal visit, it may be frequently discussed in isolation from other barriers to quitting that also adversely impact pregnancy outcomes, such as unintended pregnancy, stress, anxiety and depression. In our conclusions, we recommend an integrated approach to risk screening and better coordinated interventions.

We also observed strong associations between drug use and reported prenatal depression symptoms, after adjusting for smoking and other predictive factors. Compared to women not known to use drugs, women who did were 3.2 times more likely to report severe symptoms of depression rather than no symptoms. Our findings are similar to other reports regarding drug use and depression [5] and drug use and intendedness [42, 43].

Other studies have demonstrated increased risk for perinatal depression or prenatal depression symptoms associated with low educational attainment [44, 45], Hispanic ethnicity [6] and Black race [46, 47]. We likewise found that women with low education and Hispanic and Black mothers are at increased risk for severe PD symptoms during pregnancy after controlling for intendedness and other socioeconomic and behavioral factors (Table 3).

Limitations of this Study

The outcome variable is a measure of severity of depression symptoms during pregnancy, and is not a clinical diagnosis of depression by a qualified practitioner. In addition, it is based on a single question, unlike most standard screening tools for depression, which have multiple questions and dimensions. Furthermore, prenatal depression symptoms and pregnancy intendedness are self-reported measures that were collected after delivery, and are therefore subject to recall bias [46, 47]. One source of bias is that the birth outcome was known at the time of data collection, which may influence a mother's retrospective assessment of intendedness and depression symptoms. In addition, birth intendedness is a subjective concept that may be influenced by social norms and stigma [48]. The social bias is for women who did not want to get pregnant to report they had wanted the pregnancy.

The use of data sets for secondary analysis—like birth records—that are not designed around specific research questions can result in incomplete information; for example, the SPDS data does not distinguish between chronic depressive symptoms and symptoms originating in the prenatal period. Furthermore, the distribution of unmeasured confounders could be unequally distributed among childbearing women with and without symptoms of prenatal depression. Similarly, the results of our (and any) regression modeling procedures may be sensitive to the particular set of predictor variables that were included.

This study is also subject to the general limitations of any cross-sectional study. The concurrent measurement of predictive factors and prenatal depression symptoms precludes assessment of the temporal sequence between exposures of interest and prenatal depression symptoms. For example, we found strong relationships between intendedness of pregnancy, self-reported depressive symptoms, smoking and substance abuse. Although it was not our aim, our cross-sectional study cannot assess causal pathways and the temporal sequence of relationships within this constellation of risk factors.

Central New York, like many regions and US states, has a relatively small minority population compared to the US as a whole. In our sample, Whites made up 80.7 % of the birth mothers, whereas US birth mothers consisted of 54.4 % Whites and 45.6 % minorities in 2010 [49]. Lower minority representation in our sample must be considered when assessing the generalizability of our study results to regions with larger proportions of minorities.

Strengths of This Study

This is the first study of pregnancy intendedness as a predictor of prenatal depression symptoms that uses a large, population-based sample. Our study also uses validated and field-tested PRAMS questions to measure self-reported prenatal depression symptoms and pregnancy intendedness.

Except for underrepresentation of minorities, most socioeconomic and demographic characteristics of our sample are similar to the US profile of birthing mothers. For example, 33.1 % of US birth mothers were 24 and younger and 14.5 % were 35 and older in 2010 [49]. In our sample, 34.4 % of mothers were 24 or younger and 11.7 % were 35 and older. Our sample was also similar to the US profile for education, smoking and use of WIC.

We also found that our estimate of the overall prevalence of moderate and severe PD symptoms is within range of other published studies that used different methods, instruments and facilities-based samples. Most importantly, our findings on the association between intendedness and prenatal depression symptoms and on other risk factors for PD are entirely consistent with the results of longitudinal

studies that measured depression symptoms using a variety of standard screening tools (e.g. BDI-II, CES-D and EPDS) throughout the course of the pregnancy and into the post-partum period. These replicated findings support the validity of our results, despite the methodological limitations of the study. Both the similarity of our demographics to US norms and consistency of our findings with published results suggest that our population-based study may have generalizable findings for many communities throughout the US.

Future Directions

Although relatively few studies have examined unintended pregnancy as an adjusted risk factor for prenatal depression, most of these studies, which vary substantially in size, design and methods, have found unintended and mistimed pregnancies to be risk factors for prenatal depression. This study, like others, demonstrates substantial effect sizes for the relationship between intendedness and depressive symptoms while controlling for potential confounders. Therefore, a reasonable next step would be to evaluate the impact of a trial program that incorporates *routine, repeated* screening for depression and associated risks during prenatal *and interconceptional* care, plus coordinated interventions and support on the prevalence of PD, smoking and other risk behaviors, and unintended and mistimed pregnancies. Future research should include prospective studies of potential moderators of intendedness for prenatal depression, such as race, cultural background, age and socioeconomic status, in order to tailor interventions to specific groups of women.

Conclusion

Our result suggest that unintended pregnancies may be a signal that concealed co-morbidities and other risks for adverse pregnancy outcomes may be present or emergent during the course of the pregnancy. In order to effectively intervene and increase the likelihood of positive outcomes for current and future pregnancies, providers need to fully understand the complex network of risks and mediators affecting the mother and fetus, and seek to address them using coordinated and integrated evidence-based approaches.

The first step in effective intervention requires a fully-informed provider; the results of this and other studies indicate an urgent need to incorporate routine screening for depression, intendedness and associated risk factors such as smoking and substance abuse into standard protocols for *all* prenatal care visits. Abbreviated versions of screening tools are available and make screenings a feasible practice in routine care; for example, a validated two-question screening tool for depression was found to be feasible and effective in clinical practice in several studies [50–54].

We also recommend a preventive approach to optimize women's health and readiness for a successful pregnancy *prior to conception*. Preventive screening for risk factors that might impact future pregnancies should be a routine part of medical care for all women of reproductive age. Interventions for smoking and drug use may be more successful during preconceptional and interconceptional life stages, when stress and anxiety may be lower than during pregnancy. Depression too, is treatable and more treatment options are available during preconceptional and interconceptional stages than during pregnancy. Unintended and mistimed pregnancies may be addressed through family planning consultation and contraception services during the post-partum and interconceptional periods to prevent recurrence. In summary, a preventive, routine approach to risk evaluation and coordinated, evidence-based interventions for co-occurring risk factors *throughout a woman's reproductive lifespan* may help reduce the burden that unintended pregnancies, maternal depression and frequently co-occurring risks place on newborn children in our communities.

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