



Maternal behavioral health symptom profiles in early family life: complexity and context

Nomi S. Weiss-Laxer¹ · Sara B. Johnson^{1,2} · Sharon R. Ghazarian³ · Lauren M. Osborne⁴ · Anne W. Riley¹

Received: 15 February 2019 / Accepted: 2 July 2019 / Published online: 11 July 2019
© Springer-Verlag GmbH Austria, part of Springer Nature 2019

Abstract

Behavioral health problems affect at least 15% of mothers, but few studies have examined how different problems cluster together. Characterizing symptom profiles and their correlates early in the family life cycle can extend existing understanding beyond that provided by studies based on single problems. Mothers in the Fragile Families and Child Wellbeing study, a national birth cohort of racially diverse and mostly unmarried mothers ($N = 4205$), reported depression, anxiety, and substance dependence symptoms. Latent class analysis (LCA) identified mothers' symptom profiles in their children's third year. We explored associations between symptom profiles and demographics, reproductive health outcomes, functional limitations, and postpartum behavioral health. LCA identified five profiles: (1) Depression only (14.5% of sample), (2) Severe depression and anxiety (5.3%), (3) Anxiety only (2.2%), (4) Depression and substance use (1.4%), and (5) Currently symptom free (76.6%). Depressive symptoms were more moderate when co-occurring with substance dependence and more severe when co-occurring with anxiety. Postpartum depression, postpartum anxiety, and smoking during pregnancy were the most robust correlates of being symptomatic in year 3. Mothers in the "Severe depression and anxiety" group were more likely to be in that profile if they reported functional impairment and/or relationship dissolution. Mothers in the "Depression only" profile were more likely to have higher parity and/or functional impairment. A quarter of mothers of young children had significant behavioral health symptoms, with most reporting depression symptoms. Psychosocial and physical health factors in the pregnancy and postpartum periods were associated with future symptoms, warranting obstetrician and pediatrician attention.

Keywords Maternal behavioral health · Latent class analysis · Fragile families · Early childhood

Introduction

Behavioral health symptoms in mothers of young children, including depression, anxiety, and drug and alcohol dependence

problems, have been well studied as predictors of negative maternal and child outcomes (Grote et al. 2010; Ettinger et al. 2018). For women, these symptoms elevate risk for suicide (World Health Organization 2009), relationship problems (Doss et al.

Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s00737-019-00987-z>) contains supplementary material, which is available to authorized users.

✉ Nomi S. Weiss-Laxer
Nweiss11@jhu.edu

Sara B. Johnson
sjohnson@jhu.edu

Sharon R. Ghazarian
sghazarian@jhmi.edu

Lauren M. Osborne
lmosborne@jhmi.edu

Anne W. Riley
ariley1@jhu.edu

¹ Department of Population Family and Reproductive Health, Johns Hopkins Bloomberg School of Public Health, 615 North Wolfe Street, Baltimore, MD 21205, USA

² Department of Pediatrics, Johns Hopkins School of Medicine, 200 North Wolfe St Room 2017, Baltimore, MD 2017, USA

³ Health Informatics, Johns Hopkins All Children's Hospital, 601 5th Street South, Suite 711, St. Petersburg, FL 33701, USA

⁴ Departments of Psychiatry & Behavioral Sciences and Gynecology & Obstetrics, Johns Hopkins School of Medicine, 550 N. Broadway, Suite 305C, Baltimore 21205, MD, USA

2009), future chronic illnesses (Brown et al. 2018), difficult transitions to parenthood (Lanier and Jonson-Reid 2014), and increased risk for pregnancy and obstetrical complications (Putnam et al. 2015, 2017) and preterm birth (Grote et al. 2010). Although pregnancy (unlike the postpartum period) is “risk neutral” for new-onset psychiatric symptoms (Vesga-Lopez et al. 2008; Putnam et al. 2017), women’s increased healthcare system engagement during this period presents an excellent opportunity to screen for mental health and substance abuse problems and ensure timely treatment. Providing anticipatory guidance to women and their families about how to manage current or emerging behavioral health symptoms during the perinatal and early childhood periods is critical and well within the purview of obstetric care.

Infancy and toddlerhood (i.e., birth to age 3) are characterized by rapidly changing developmental needs and mothers’ competing demands of work, household management, and child rearing (Naerde et al. 2000; Umberson et al. 2010). When family stability and positive parenting trajectories that include responsive caregiving and routine setting are established early (Ettinger et al. 2018), healthy child development is supported (Mistry et al. 2012). While untreated maternal depression and substance abuse can negatively affect parenting practices, family stability, and child development (Richmond and Health 2009), timely interventions with mothers and families can reduce children’s risk of internalizing and externalizing mental health problems, poor school outcomes (Goodman et al. 2011; Smith et al. 2016) and healthcare access (Minkovitz et al. 2005), and family system disruptions (Lander et al. 2013). Compared to married mothers, unmarried mothers are particularly at risk for high psychological distress and behavioral health problems (DeKlyen et al. 2006; Turney 2012; Williams and Cheadle 2015). Rates of unmet mental healthcare need are highest among racial and ethnic minority women (Witt et al. 2011), emphasizing the importance of including a racially diverse group of mothers in prevention research.

Despite the high likelihood that women with depression will also experience symptoms characteristic of other psychiatric disorders, most maternal behavioral health studies focus on single disorders (Turney 2011a, 2011b, 2011c) or a single behavior (i.e., alcohol use (e.g., Liu et al. 2015)). Commendably, some recent research has studied clusters of depression and anxiety symptoms (Farr et al. 2014; Putnam et al. 2015, 2017). Nonetheless, to our knowledge, no study has included both mothers’ mood and anxiety disorder and substance use dependence symptoms to identify broad behavioral health phenotypes in a racially diverse, national sample of mothers. Studies of clinical anxiety problems among perinatal women are less common than studies of depression (Ross and McLean 2006; Goodman et al. 2014).

Acknowledging that perinatal mood and anxiety disorders are the most common complication of childbirth (Sontag-Padilla et al. 2012; Ananth et al. 2013; DeSisto et al. 2014),

the American College of Obstetricians and Gynecologists (ACOG) recommends that depression and anxiety screening occur at least once in the perinatal period (ACOG 2015) and that timely treatment resources be available for women who screen positive. Yet screening is far from routine, and, even when carried out, rates of referral, follow-up, and treatment are disturbingly low (Rowan et al. 2012; Cox et al. 2016). Explanations include obstetric providers’ inadequate knowledge and lack of protocols for behavioral health management (Fuller et al. 2013).

To advance the scientific basis for understanding maternal behavioral health, this study aimed to (1) characterize subgroups of mothers, based on unique symptom patterns derived from self-reports of diagnostically relevant depression, anxiety, alcohol dependence, and drug dependence symptoms during their child’s 3rd year and (2) identify maternal characteristics associated with each symptom profile, including demographic, reproductive, functional impairment related to health, and postpartum behavioral health status.

Materials and methods

From 1998 to 2000, 4898 families (biological mother, father, and child) were enrolled based on randomly selected births sampled from 75 hospitals in 20 U.S. cities with populations over 200,000 (Reichman et al. 2001). Unmarried mothers were oversampled, such that three-quarters of the sample was unmarried, because the parent study’s investigators were particularly interested in the long-term child and family impacts of births to unmarried parents, about whom little longitudinal information was known at the time (Child Trends DataBank 2016). Information about anxiety and depression symptoms was collected in children’s 1st and 3rd years of life. Alcohol and drug dependence symptom information was only collected in year 3; thus, the current study examined responses from all mothers who participated in the year 3 wave ($N = 4205$). The Data Archive at the Office of Population Research of Princeton University approved use of these publicly available and de-identified data and Johns Hopkins School of Public Health IRB determined this study to be exempt.

Measures

Thirty-three mental health and substance dependence symptoms were the basis for identifying behavioral health symptom profiles. Trained interviewers assessed mothers’ symptoms over the phone using items from four subscales of the Composite International Diagnostic Interview-Short Form (CIDI-SF 1.0) (Kessler et al. 1998), shown to have good validity (Kessler et al. 2005) and reliability (Wittchen 1994) in a range of populations (Andrews and Peters 1998). Major

depressive episode (MDE) and generalized anxiety disorder (GAD) symptom questions were administered in year 1 and year 3. Alcohol and drug dependence symptom questions (AD and DD) were administered in year 3. Only if the screener question(s) were endorsed were additional symptom questions asked ([supplemental materials](#)).

We assessed the associations between symptom profiles and a host of maternal characteristics that were selected based on existing literature. Prior history of mental health problems has consistently been demonstrated as one of the strongest predisposing characteristics of maternal behavioral health needs (Manuel et al. 2012). Additional associations have been demonstrated with age of symptom onset (Putnam et al. 2017), parity (Lanier and Jonson-Reid 2014), physical health problems (Brown et al. 2018), and pregnancy and obstetrical complications (Putnam et al. 2015, 2017).

For the current study, demographic characteristics included maternal age, race/ethnicity (collected in this study as a single construct using U.S. Census categories: non-Hispanic white; non-Hispanic black; Hispanic; other), maternal education, year 3 relationship with child's biological father, and year 1 household income as a percentage of the federal poverty line. Reproductive health characteristics included parity and if the woman was currently pregnant. Functional impairment ("Do you have a physical or mental health condition that limits the work you can do?") was assessed in years 1 and 3. Maternal report of overall health was excluded due to collinearity with functional impairment. Binary indicators of postpartum behavioral health included past 12-month probable MDE and/or probable GAD, past month binge drinking (5+ drinks per occasion), hard drug use or marijuana use, and cigarette smoking during pregnancy.

Statistical analyses

Latent class analysis (LCA) was employed to characterize behavioral health profiles identifying subgroups of mothers based on unique symptom patterns (Fig. 1a). LCA is a "person-based" analytic method that describes unobserved latent constructs based on observed variables (Collins and Lanza 2010). LCA estimates both the estimated sample size of each class (or profile) as well as item-response probabilities (range 0–1), which indicate how likely it is for a participant, assigned to a given symptom profile, to endorse a given item (Collins and Lanza 2010). Analyses began with a one-class solution model and were then repeated iteratively increasing the number of classes by one each time. The latent classes are mutually exclusive and exhaustive, assigning all sample members to a unique class. The best fitting model was selected based on relative fit statistics (Bayesian information criteria, Lo-Mendel-Rubin likelihood ratio test, and the Akaike information criterion), an absolute fit statistic

(entropy, with values >0.8 indicating strong subgroup classification) (Jung and Wickrama 2008; Little 2013), as well as theoretical and clinical relevance. In the class enumeration step, each profile was labeled with a meaningful and descriptive name, based on subgroup-specific item-response probabilities (Collins and Lanza 2010). Profiles were further validated by inspecting the overlap between the LCA profiles and probable disorder classification based on the CIDI-SF.

To avoid the loss of 8% of the sample due to listwise deletion, data were multiply imputed with chained equations (MICE) (White et al. 2011), using 15 imputed datasets, the year 3 symptom profile dependent variable, as well as all of the aforementioned maternal characteristics. Data were deemed missing at random (MAR) given significant associations of missingness with race, household poverty status, relationship status, health limitations, and smoking in pregnancy (all $p < 0.05$) (Schafer and Graham 2002; Little 2013).

Symptom profile-specific differences in the maternal characteristics were explored with chi-square tests for categorical variables and t tests for continuous variables. To identify maternal characteristics associated with membership in each profile, predicted profile assignments were treated as manifest dependent variables (categorical; dummy-coded), and their manifest correlates were identified using multinomial logistic regression (MLR; see Fig. 1b). MLR identified the strongest correlates for each symptom profile, adjusting maternal characteristics of the sample (Long and Freese 2006). LCA was conducted in Mplus 8 (Muthén and Muthén 1998–2017) and imputation and regression modeling in Stata 14 (StataCorp L. Stata/SE 14.2 2015).

Results

At the birth of the focal child, 25% of mothers were married and 87% were romantically involved with the biological father (i.e., either married, cohabitating, or not cohabitating but in a romantic relationship). By year 3, only 52.2% of the biological parents were still together. At enrollment, 38.5% were first-time mothers. Mothers identified as non-Hispanic black (48%), Hispanic (26%), or non-Hispanic white (26%); 42% reported household incomes below the federal poverty line. In year 3, mothers had an average of 2.1 children (SD 1.3; range 1–13) and 6.7% were currently pregnant. In addition, 5.7% reported a recent miscarriage, 5.4% an abortion, and <1% experienced both. Eight and a half percent of mothers reported functional impairment due to health.

Table 1 presents frequencies of mothers' year 3 symptoms. Having trouble falling asleep was the most common (20.8%), followed by having low energy (19.7%) and dysphoria on most days for at least a 2-week period

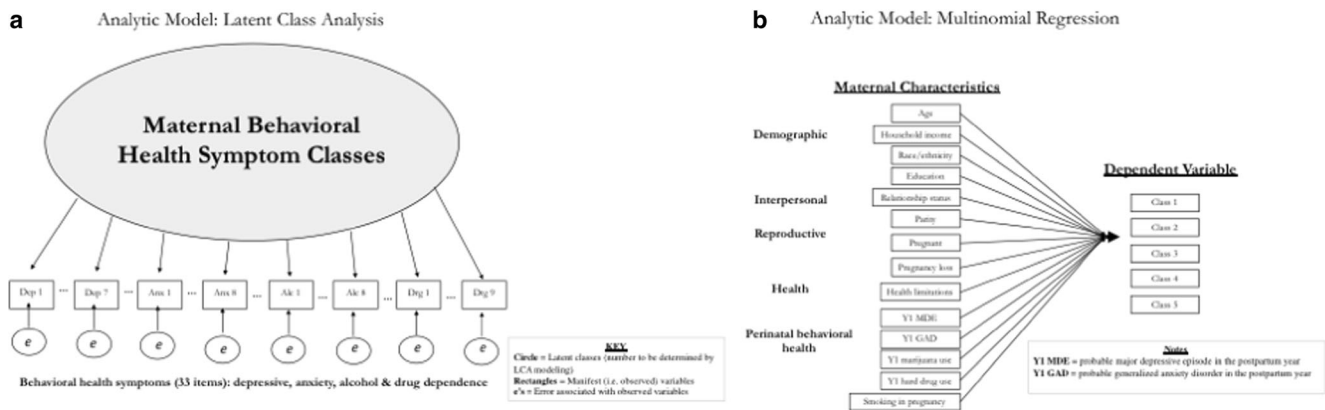


Fig. 1 Analytic model including step #1 (latent class analysis; **a**) and step #2 (regression model; **b**)

(16.7%). Anxiety, alcohol, and drug use items were less frequently endorsed, although 9% endorsed binge drinking.

Profile descriptions

LCA item-level conditional probabilities are presented pictorially in Fig. 2 (see [supplemental materials](#) comparisons of fit statistics). A 5-class model was selected based on relative and absolute fit indices, as well as theoretical and clinical meaningfulness (AIC = 23414.9; BIC = 24487.0; entropy = 0.998). Based on the LMR, the 5-class model fit the data better than the 4-class ($-2LL$ difference = 1096.86, degrees of freedom 34, p value < 0.001), indicating good class homogeneity and class separation (Collins and Lanza 2010). Mapping the LCA symptom profiles onto the CIDI-SF probable disorders demonstrated substantial overlap between the classification methods (Table 2).

Currently symptom free This profile subgroup comprised 76.6% ($N = 3221$) of the sample, having a near-zero probability of endorsing any of the 33 symptoms (prob = 0–0.07).

Depression only This was the largest subgroup of symptomatic mothers (14.5%, $N = 608$), with high probabilities (0.72–1.0) of endorsing 5 of the 7 depression symptoms, and low probabilities of reporting anxiety (prob all < 0.01) and substance dependence symptoms (prob = 0–0.09).

Severe depression and anxiety Mothers in this profile (5.3%, $N = 233$) had high probabilities (prob = 0.89–1.0) of reporting low energy, trouble with sleep, concentration problems, feeling down on themselves, and dysphoria. They had a moderate probability (prob = 0.51) of endorsing thoughts of death, whereas mothers in the “Depression only” subgroup had lower probability (0.35) of endorsing that symptom. These

mothers also had high probabilities (prob = 0.74–0.91) of endorsing anxiety symptoms.

Anxiety only Women in this profile (2.2%, $N = 94$) had moderate to high probabilities (prob = 0.50–0.76) of endorsing anxiety symptoms. Their probabilities of depressive, alcohol, and drug dependence symptoms were negligible (prob = 0–0.12).

Depression and substance use Mothers in this profile (1.4%, $N = 59$) had moderate probabilities (prob = 0.41–0.64) of reporting dysphoria, low energy, trouble falling asleep, and concentration problems and moderate probabilities (prob = 0.41–0.65) of binge drinking, marijuana use, hard drug use, and drugs and/or alcohol “longer than intended.” They had low probabilities (< 0.01) of endorsing anxiety symptoms.

Maternal characteristics varied by symptom profile (Table 3). Compared to the “Currently symptom free” profile, disproportionately more women with “Severe depression and anxiety” were single and poor or near poor. Women assigned to the “Anxiety only” profile were disproportionately married and had higher household incomes compared to the sample as a whole, whereas mothers assigned to the other symptomatic profiles were disproportionately unmarried compared to the sample as a whole.

Mothers in the Severe depression and anxiety profile had the highest proportion of reporting functional impairment due to health (24.2%) (Table 3). Mothers in all year 3 symptomatic profiles reported higher rates of postpartum behavioral health problems compared to women in the Currently symptom free profile. Analysis of problem persistence from the postpartum period showed that among the 15.5% ($N = 618$) of mothers with probable postpartum MDE, 57.1% remained symptomatic in year 3; among the 3.2% of the sample with probable postpartum GAD, 78.8% remained symptomatic in year 3 (results not shown). Comparing mothers in the five profiles, no

Table 1 Year 3 behavioral health symptom frequencies among mothers, $N = 4205$

Symptom	%	N
Depression symptoms		
1. Feeling depressed at least 2 weeks, most days of week, most of each day*	16.7	699
2. Lower energy	19.7	829
3. Weight loss or gain of ≥ 10 pounds	6.4	269
4. Trouble falling asleep	20.8	873
5. Concentration problems	17.9	754
6. Feeling down on yourself	15.8	664
7. Thoughts about death	8.1	343
Anxiety symptoms		
8. Worried 6+ months, worry was excessive, about 1+ things, majority of days*	5.1	213
9. Lacked control over worries*	6.4	270
10. Restless	6.3	265
11. Keyed up/on edge	4.9	206
12. Easily tired	6.0	250
13. Trouble keeping mind on task	5.2	219
14. More irritable than usual	6.1	256
15. Tense, sore, or aching muscles	5.0	212
16. Trouble falling asleep	6.0	253
Alcohol dependence symptoms		
17. Any 4+ drink days in the past year*	9.0	277
18. Alcohol interferes with work/home	0.7	31
19. Alcohol use in dangerous situations	0.7	28
20. Emotional problems from alcohol use	0.7	30
21. Strong desire to drink	0.6	23
22. Spends a lot of time drinking	0.3	11
23. Longer than intended drinking	3.3	139
24. More time to get the same effect drinking	0.5	20
Drug dependence symptoms		
25. Smoked marijuana/pot on own in the past year*	3.4	143
26. Any hard drug use on own in past year*	4.7	197
27. Drugs interfere with work/home	0.6	27
28. Drug use in dangerous situations	0.3	12
29. Emotional problems from drug use	0.7	29
30. Strong desire to use drugs	0.7	28
31. Spends a lot of time use drugs	0.7	29
32. Longer than intended use of drugs	1.0	42
33. More to get the same effect using drugs	0.8	33

*Note: For each disorder, additional symptoms questions asked *only* of women who endorsed the screener question(s)

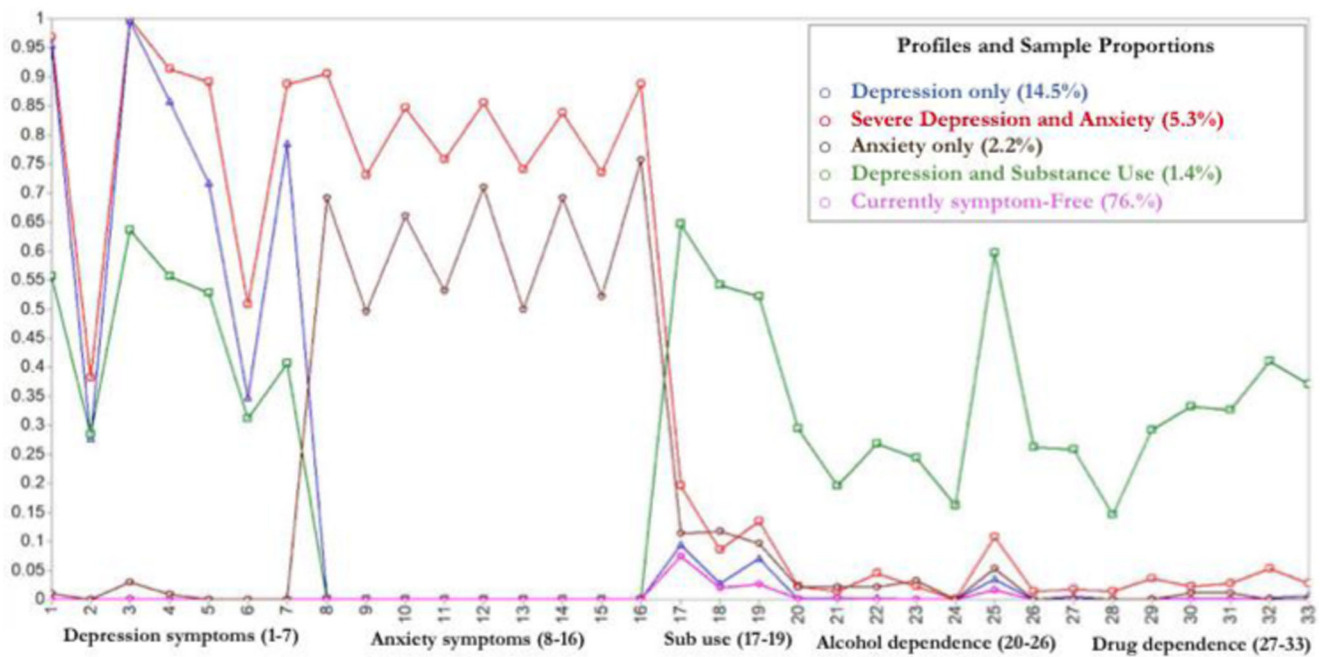
statistically significant differences were observed by race/ethnicity, education, or whether or not the mother was pregnant at the time of data collection.

Maternal characteristics

Table 4 shows the relationship of each maternal characteristic to mothers' odds of endorsing symptoms consistent with each of the four symptomatic profiles, adjusted

for the aforementioned maternal characteristics. Women who reported functional impairment and/or had experienced relationship dissolution had increased odds of endorsing the Severe depression and anxiety profile. Women with higher parity and/or current functional impairment had higher odds of endorsing the Depression only profile.

Postpartum behavioral health problems were the strongest correlates of belonging to a symptomatic year 3 profile. After adjustment for all other maternal characteristics,



Mother's mental health and substance use symptoms based on class membership. The Y-axis represents the probabilities of mothers within a given class endorsing a particular item (Mplus restricts this to 0-1). The X-axis represents each of the 33 items.

Fig. 2 Item-level predicted probabilities associated with maternal behavioral health symptom profiles based on 33-item year 3 latent class analysis, *N*=4205

postpartum MDE and smoking in pregnancy were independently associated with each symptomatic profile.

Postpartum GAD was associated with all except the year 3 Depression only profile. Postpartum marijuana use and

Table 2 Comparison of symptom profiles based on LCA and probable disorders based on CIDI-SF

	Year 3 maternal behavioral health symptom profiles					Total
	Depression and substance use	Severe depression and anxiety	Depression only	Anxiety only	Currently symptom free	
Estimated proportion and class size, % (<i>n</i>)	1.4 (59)	5.3 (223)	14.5 (608)	2.2 (94)	76.6 (3221)	4205
Year 3 probable disorder (CIDI-SF criteria)						
Depression						
Major depressive episode (MDE)	62.7	100.0	96.9	3.2	0.0	20.3
Anxiety						
Generalized anxiety disorder (GAD)	0.0	67.7	0.0	39.4	0.0	4.5
Alcohol dependence						
Probable alcohol dependence (AD)	18.6	0.0	0.0	0.0	0.0	0.3
Any probable disorder						
MDE and/or GAD and/or AD and/or DD	83.1	100.0	96.9	42.6	0.03	21.5
Drug use						
Marijuana use	55.9	8.5	2.8	11.7	2.0	3.4
Hard drug use	52.5	13.5	7.2	9.6	2.6	4.7
Alcohol use						
Binge drinking (5+ drinks in one occasion)	54.2	18.8	9.4	10.6	7.3	9.0

Notes: Item-level missingness ranged from 0 to 4.7%; LCA, latent class analysis; CIDI-SF, World Health Organization Composite International Diagnostic Interview, short form

Table 3 Frequency and between-group differences for correlates of year 3 maternal behavioral health symptom profiles

Class label	Depression only	Severe depression and anxiety	Anxiety only	Depression and substance use	Currently symptom free	Total	Test statistic ¹
Sample % (<i>N</i>)	14.5 (608)	5.3 (223)	2.2 (94)	1.4 (59)	76.6 (3221)	4205	
Maternal age (<i>M</i> , <i>SD</i>), [range 16–50]	27.4 (5.6)	28.2 (5.8)	28.4 (5.8)	27.4 (5.7)	28.4 (6.2)	28.2 (6.1)	0.038 ²
15–24 years	41.0	30.5	30.9	40.7	34.0	34.8	0.009
25–34 years	45.9	53.4	50.0	47.5	47.8	47.9	
35 years and older	13.2	16.1	19.2	11.9	18.2	17.3	
Race/ethnicity (%)							
Non-Hispanic white	21.1	22.9	28.7	20.3	21.7	21.8	0.066
Non-Hispanic black	54.3	46.2	41.5	61.0	47.0	48.1	
Hispanic	20.9	26.5	24.5	13.6	27.3	26.0	
Other	3.5	4.5	5.3	5.1	3.8	3.8	
Relationship status (%)							
Married	26.5	21.1	34.0	23.7	34.2	32.3	< 0.001
Cohabiting	18.3	14.8	16.0	10.2	20.4	19.5	
Not cohabiting (but together)	5.4	3.6	8.5	5.1	5.6	5.5	
Another relationship (not focal father)	19.8	25.1	14.9	33.9	17.5	18.4	
Single	30.0	35.4	26.6	27.1	22.4	24.3	
Maternal education (%)							
Less than high school	35.2	41.0	35.1	35.6	32.3	33.2	0.058
Completed high school	31.0	24.8	31.9	40.7	30.7	30.6	
Any post-secondary education	33.8	34.2	33.0	23.7	37.1	36.2	
Household federal poverty line (FPL), %							
Poor/near poor, < 100% FPL	48.9	50.7	41.5	52.5	39.8	41.9	< 0.001
Low income, 100–199% FPL	26.5	22.9	29.8	23.7	24.7	25.0	
Middle or high income, 200% + FPL	24.7	26.5	28.7	23.7	35.5	33.1	
Currently pregnant (%)	5.16	6.3	7.6	1.7	7.14	6.74	0.218
1 child	23.6	25	28.4	27.3	27.5	26.8	0.139
2 children	32.2	34.3	36.4	29.1	35.4	34.8	
3 or more children	44.1	40.7	35.2	43.6	37.1	38.4	
Year 1 functional limitations (%)	9.9	16.3	12.4	8.9	5.6	7.0	< 0.001
Year 3 functional limitations (%)	15.8	24.2	10.6	15.3	5.9	8.5	< 0.001
Perinatal behavioral health (year 1) (%)							
Major depressive episode	33.4	47.1	30.9	27.1	8.2	14.7	< 0.001
Generalized anxiety disorder	4.8	18.4	13.8	13.6	1.1	3.0	< 0.001
Heavy drinking	7.2	10.3	10.6	25.4	5.3	6.3	< 0.001
Marijuana use	2.5	3.1	4.3	17.0	1.2	1.8	< 0.001
Hard drug use	0.2	0.5	1.1	3.4	0.2	0.2	< 0.001
Smoked during pregnancy	25.7	30.5	30.9	52.5	16.3	19.3	< 0.001

¹ Overall between-group differences in categorical correlates were analyzed using chi-square tests; continuous correlates with a *t* test.² Italics refer to statistically significant between-group differences, *p* value < 0.05

binge drinking were only associated with the “Depression and substance use” profile. We note that the 95% CI

around the marijuana estimates was quite wide, likely due to low levels of endorsement.

Table 4 Adjusted odds ratios (and 95% CIs)^{1,2} of correlates of behavioral health symptom profiles, *N* = 4205

Sample size, % (<i>N</i>)	Depression only		Severe depression and anxiety		Anxiety only		Depression and substance use	
	14.5 (608)		5.3 (223)		2.2 (94)		1.4 (59)	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Maternal age (<i>ref</i> : <25 years)								
25–34 years old	<i>0.72</i>	<i>0.58, 0.90</i>	1.30	0.91, 1.87	1.24	0.73, 2.11	0.86	0.45, 1.64
35 years and older	<i>0.49</i>	<i>0.36, 0.68</i>	0.97	0.58, 1.61	1.19	0.59, 2.40	0.54	0.20, 1.45
Race/ethnicity (<i>ref</i> : non-Hispanic white)								
Non-Hispanic black	0.97	0.73, 1.25	0.78	0.52, 1.18	0.68	0.39, 1.20	1.48	0.70, 3.13
Hispanic	0.79	0.59, 1.06	1.02	0.65, 1.61	0.77	0.41, 1.44	0.88	0.33, 2.33
Other	1.01	0.60, 1.72	1.28	0.59, 2.79	1.26	0.46, 3.46	2.74	0.71, 10.53
Biological father relationship (<i>ref</i> : married)								
Cohabiting	0.88	0.66, 1.18	0.98	0.59, 1.64	0.67	0.34, 1.31	0.40	0.14, 1.13
Together but not cohabiting	0.80	0.51, 1.26	0.81	0.35, 1.88	1.26	0.52, 3.01	0.52	0.13, 2.08
Single (i.e., not in a relationship)	1.19	0.90, 1.57	<i>2.06</i>	<i>1.31, 3.24</i>	0.98	0.53, 1.80	0.87	0.37, 2.01
Another relationship (not biological father)	0.88	0.65, 1.19	<i>1.75</i>	<i>1.08, 2.83</i>	0.62	0.30, 1.28	1.16	0.51, 2.63
Maternal education (<i>ref</i> : <HS)								
Completed high school	1.07	0.85, 1.35	0.71	0.49, 1.05	0.99	0.58, 1.68	1.67	0.87, 3.23
Any post-secondary education	1.27	0.97, 1.65	0.93	0.62, 1.41	0.81	0.44, 1.51	1.15	0.51, 2.61
Household poverty (<i>ref</i> : < 100% poverty line)								
Low income, 100–199% FPL	0.97	0.77, 1.23	0.92	0.63, 1.36	1.21	0.72, 2.06	0.77	0.38, 1.55
Middle or high income, 200% or more FPL	<i>0.73</i>	<i>0.56, 0.97</i>	0.99	0.63, 1.53	0.80	0.42, 1.53	0.78	0.35, 1.76
Year 3 parity (<i>ref</i> : 1 child)								
2 children	1.16	0.89, 1.51	1.28	0.81, 2.02	0.95	0.55, 1.66	0.97	0.45, 2.09
3 or more children	<i>1.37</i>	<i>1.05, 1.78</i>	1.04	0.65, 1.68	0.72	0.38, 1.38	1.01	0.44, 2.29
Currently pregnant	0.67	0.45, 1.01	0.89	0.49, 1.64	1.07	0.48, 2.38	0.15	0.02, 1.15
Functional health limitation (<i>ref</i> : no)								
Year 1	0.89	0.61, 1.29	1.01	0.56, 1.84	1.33	0.62, 2.87	0.85	0.30, 2.42
Year 3	<i>2.75</i>	<i>2.02, 3.75</i>	<i>3.96</i>	<i>2.52, 6.24</i>	1.33	0.61, 2.94	2.15	0.89, 5.21
Prior behavioral health risk								
Year 1 major depressive episode (<i>ref</i> : no)	<i>4.78</i>	<i>3.84, 5.97</i>	<i>6.48</i>	<i>4.68, 8.95</i>	<i>3.31</i>	<i>1.98, 5.53</i>	<i>2.31</i>	<i>1.19, 4.50</i>
Year 1 generalized anxiety disorder (<i>ref</i> : no)	1.42	0.84, 2.41	<i>5.03</i>	<i>2.94, 8.59</i>	<i>5.72</i>	<i>2.73, 11.96</i>	<i>5.75</i>	<i>2.25, 14.70</i>
Year 1 binge drinking (<i>ref</i> : no)	1.08	0.75, 1.57	1.32	0.80, 2.20	1.48	0.74, 2.98	<i>3.54</i>	<i>1.77, 7.06</i>
Year 1 marijuana use (<i>ref</i> : no)	1.62	0.86, 3.06	2.14	0.88, 5.19	2.59	0.84, 8.00	8.30	3.52, 19.54
Year 1 hard drug use (<i>ref</i> : no)	0.44	0.06, 3.33	1.08	0.14, 8.52	2.20	0.22, 22.18	4.44	0.65, 30.26
Smoked during pregnancy (<i>ref</i> : no)	<i>1.52</i>	<i>1.20, 1.91</i>	<i>1.68</i>	<i>1.18, 2.39</i>	<i>1.88</i>	<i>1.14, 3.11</i>	<i>4.32</i>	<i>2.40, 7.80</i>

OR, odds ratio; CI, confidence interval

¹ Italicized ORs and 95% CI indicate < 0.05 *p* value, i.e., that after adjustment for all correlates in the model, the odds of endorsing a given item was statistically significant among mothers assigned to a certain behavioral health symptom profile, compared to the reference “Symptom free” profile

² Multinomial logistic regression model was adjusted for the following maternal characteristics: maternal age, race/ethnicity, relationship status, maternal education, household poverty status, parity, currently pregnant, functional health limitations in year 1 and year 3, postpartum probable major depressive episode (MDE), postpartum generalized anxiety disorder (GAD), year 1 marijuana use, year 1 use of hard drugs, and smoking in pregnancy

Discussion and conclusions

The goal of this study was to describe the complex patterns among mothers of toddlers of 33 common behavioral health symptoms, and to identify maternal characteristics associated with those patterns (profiles). Because unmarried mothers were oversampled, making this a more vulnerable population

than the average, we expected higher than average symptom burden. However, three-quarters of the mothers were symptom free. Four of the five profiles identified symptom clusters that were clinically severe, as reflected in the high overlap with probable psychiatric diagnoses (Table 2). Among mothers with significant symptoms, almost all reported experiencing depressive symptoms; only mothers assigned

to the Anxiety only profile (2.2% of the sample) did not. This study indicates that the routine use of a depressive symptom screener such as the Edinburgh Postnatal Depression Scale (EPDS), a 10-item scale that includes both depression and anxiety symptoms (Cox et al. 1987) and has a break-out subscale (EPDS-A) for those experiencing anxiety alone, can adequately characterize the psychiatric symptoms of a large majority of mothers whose psychosocial circumstances match those of our population.

By taking into account symptoms characteristic of multiple types of disorders, we demonstrated how these symptoms cluster within an individual's experience. Importantly, we observed that when depressive symptoms co-occurred with substance use symptoms, they were more moderate than when mothers had Depression only (i.e., fewer depressive symptoms and "thoughts of death" less likely to be endorsed) and when depressive symptoms co-occurred with anxiety symptoms, mothers experienced more severe depressive symptoms than when they were in the Depression only profile. This finding merits future study, particularly in longitudinal studies where we can observe the developmental trajectories of substance use among mothers. In this study, we only had alcohol and drug dependence information at year 3; future studies could include more follow-up to assess the interaction between substance use, depression, and anxiety. Our finding related to functional impairment was consistent with prior research describing the strong associations between mental health problems, functional impairment, and physical health (Frank and Glied 2006; Brown et al. 2018).

Consistent with prior research, postpartum behavioral health problems elevated mothers' risk for being in symptomatic profiles in their children's 3rd year. Both postpartum anxiety and depression strongly predicted persistence of symptoms in year 3. This is one of the ways in which this study adds to the literature on maternal anxiety, which is not as robust as the maternal depression literature (Ross and McLean 2006; Goodman et al. 2014). Comparing probable CIDI- and LCA-generated classification, we observed that the majority of symptomatic women also had probable disorders, with the exception of women in the Anxiety only profile. For this profile, 43% did not have a probable disorder as per CIDI-SF classification, consistent with evidence of the relatively low rates of anxiety diagnoses compared to self-reported symptoms (Schofield et al. 2014). The persistence of postpartum anxiety highlights the importance of assessing subthreshold anxiety symptoms among this population.

These findings should be interpreted in light of several limitations. Although a strength of this study is its focus on a highly vulnerable population at a critical life period, it is a sample of low-income, mostly unmarried women and is predominantly women of color. Indeed, the Anxiety only profile may be the most under-representative given that these symptoms may be more common among white women with higher

socioeconomic status. That said, the purpose of this study was to describe symptom profiles among a vulnerable population and not to generalize them to the larger U.S. population. Data were collected in the early 2000s, so rates of symptoms and maternal correlates may not represent present day rates. This is especially true of the data on substance use, which predate the current opioid crisis and likely do not represent current practices. Future studies are needed to replicate the findings of this study in other more generalizable and more recently collected data sources. Finally, mothers may have under-reported certain symptoms due to social desirability or fear of being reported to child protective services (in particular for drug and alcohol use behaviors), potentially leading to an underestimate of prevalence (Huang et al. 2007; Breslau et al. 2017) and perhaps reducing the complexity of the profiles.

The complex patterns and persistence of behavioral health symptoms among this racially diverse national sample of mostly low-income, unmarried mothers highlight the critical needs of mothers of young children routinely seen in obstetric and pediatric services. It is instructive that three of the four symptomatic profiles involved depressive symptoms, emphasizing that systematic screening for depression will identify the majority of women from similar psychosocial circumstances with significant behavioral health problems. Such screening, combined with effective referral to treatment, has the potential to improve the lives of women and their families. This might involve integrating behavioral health services into obstetric and pediatric care. For example, Grote and colleagues demonstrated the feasibility and efficacy of a stepped- and collaborative care model among a racially/ethnically diverse Medicaid population to address maternal depression from pregnancy through 18 months postpartum in a public hospital system (Grote et al. 2013, 2015). Such an interdisciplinary approach to maternal mental health and overall well-being has the potential to reduce the incidence, prevalence, and cross-generational transmission of mental health and substance use problems. The dual facts that postpartum mood disorders and smoking in pregnancy were associated with all symptomatic profiles among mothers of 3-year-olds and that timely treatment of these behavioral problems is effective, warrants serious self-scrutiny by obstetricians and pediatricians, especially those in leadership positions. These behavioral health risks are the most common threats to healthy pregnancy and delivery (Grote et al. 2010). Mothers have many obstetric visits for one pregnancy, and within three years of the focal child's birth, a quarter of these mothers gave birth to an additional child and 11% experienced a miscarriage or abortion.

It is incumbent on these medical practices to follow current screening recommendations (Selix and Goyal 2018) by developing provider education and screening and treatment protocols to detect and address behavioral health problems, most notably depression during the pregnancy and postpartum

periods, and especially in health systems serving low-income mothers who are at high risk for inadequate detection and treatment (Witt et al. 2011). Not only are these problems likely to persist, recur, and even become more severe, but without systematic, evidence-based changes to the health system, symptomatic mothers will rarely be screened, referred, and actually see a mental health provider (Cox et al. 2016). Given that this is a critical period in women's lives for maintaining their own health, sustaining stable, healthy romantic and parent-child relationships, and supporting their children's development (Mistry et al. 2012), this is a medical system issue much in need of action.

Funding Dr. Weiss-Laxer was supported by the C. Sylvia and Eddie C. Brown Community Health Scholarship. Dr. Osborne's research was supported by the NIH 1K23 MH110607-01A1 and Doris Duke Early Clinician Investigator Award.

Data availability The Data Archive at the Office of Population Research of Princeton University approved use of these publicly available and de-identified data and Johns Hopkins School of Public Health IRB determined this study to be exempt.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants performed by any of the authors.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

- American College of Obstetricians and Gynecologists (2015) Committee opinion: screening for perinatal depression. *Obstet Gynecol* 125:1268–1271. <https://doi.org/10.1097/01.AOG.0000465192.34779.dc>
- Ananth CV, Keyes KM, Wapner RJ (2013) Pre-eclampsia rates in the United States, 1980–2010: age-period-cohort analysis. *BMJ*. <https://doi.org/10.1136/bmj.f6564>
- Andrews G, Peters L (1998) The psychometric properties of the composite international diagnostic interview. *Soc Psychiatry Psychiatr Epidemiol* 33:80–88. <https://doi.org/10.1007/s001270050026>
- Breslau J, Cefalu M, Wong EC, Burnam MA, Hunter GP, Florez KR, Collins RL (2017) Racial/ethnic differences in perception of need for mental health treatment in a US national sample. *Soc Psychiatry Psychiatr Epidemiol* 52:929–937. <https://doi.org/10.1007/s00127-017-1400-2>
- Brown HK, Qazilbash A, Rahim N, Dennis CL, Vigod SN (2018) Chronic medical conditions and perinatal mental illness: a systematic review and meta-analysis. *Am J Epidemiol* 87:2060–2068. <https://doi.org/10.1093/aje/kwy080>
- Child Trends DataBank (2016) Births to unmarried women. <https://www.childtrends.org/indicators/births-to-unmarried-women> Accessed 7 June 2019
- Collins LM, Lanza ST (2010) Latent class and latent transition analysis: with applications in the social, behavioral, and health sciences. John Wiley & Sons, Inc., Hoboken, NJ
- Cox EQ, Sowa NA, Meltzer-Brody SE, Gaynes BN (2016) The perinatal depression treatment cascade. *J Clin Psychiatry* 77:1189–1200. <https://doi.org/10.4088/JCP.15r10174>
- Cox JL, Holden M, Sagovsky R (1987) Detection of postnatal depression: development of the 10-item Edinburgh Postnatal Depression Scale. *Br J Psychiatry* 150:782–786. <https://doi.org/10.1192/bjp.150.6.782>
- DeKlyen M, Brooks-Gunn J, McLanahan S, Knab J (2006) The mental health of married, cohabiting, and non-coresident parents with infants. *Am J Public Health* 96:1836–1841. <https://doi.org/10.2105/AJPH.2004.049296>
- DeSisto CL, Kim SY, Sharma AJ (2014) Prevalence estimates of gestational diabetes mellitus in the United States, pregnancy risk assessment monitoring system (PRAMS), 2007–2010. *Prev Chronic Dis*. <https://doi.org/10.5888/pcd11.130415>
- Doss BD, Rhoades GK, Stanley SM, Markman HJ (2009) The effect of the transition to parenthood on relationship quality: an eight-year prospective study. *J Pers Soc Psychol* 96:601–619. <https://doi.org/10.1037/a0013969>
- Ettinger AK, Riley AW, Colantuoni E, Mendelson T (2018) Trajectories of early parenting practices among low-income ethnically diverse women. *J Child Fam Stud* 27:615–628. <https://doi.org/10.1007/s10826-017-0895-1>
- Farr SL, Dietz PM, O'Hara MW et al (2014) Postpartum anxiety and comorbid depression in a population-based sample of women. *J Women's Health* 23:120–128. <https://doi.org/10.1089/jwh.2013.4438>
- Frank RG, Glied SA (2006) Better but not well: mental health policy in the United States since 1950. The Johns Hopkins University Press, Baltimore, MD
- Fuller E, Anderson B, Leddy M, Schulkin J (2013) Obstetrician-gynecologists' knowledge, attitudes and practices regarding major depressive disorder. *J Psychosom Obstet Gynaecol* 34:34–38. <https://doi.org/10.3109/0167482X.2012.752811>
- Goodman JH, Chenausky KL, Freeman MP (2014) Anxiety disorders during pregnancy. *J Clin Psychiatry* 75:e1153–e1184. <https://doi.org/10.4088/JCP.14r09035>
- Goodman SH, Rouse MH, Connell AM, Broth MR, Hall CM, Heyward D (2011) Maternal depression and child psychopathology: a meta-analytic review. *Clin Child Fam Psychol Rev* 14:1–27. <https://doi.org/10.1007/s10567-010-0080-1>
- Grote N, Katon W, Lohr MJ (2013) Momcare: culturally relevant treatment services for perinatal depression. *Arch Womens Ment Health* 16:S4
- Grote N, Katon W, Russo J et al (2015) Collaborative care for perinatal depression in socioeconomically disadvantaged women: a randomized trial. *Depress Anxiety* 32:821–834. <https://doi.org/10.1002/da.22405>
- Grote NK, Bridge JA, Gavin AR et al (2010) A meta-analysis of depression during pregnancy and the risk of preterm birth, low birth weight, and intrauterine growth restriction. *Arch Gen Psychiatry* 67:1012–1024. <https://doi.org/10.1001/archgenpsychiatry.2010.111>
- Huang ZJ, Wong FY, Ronzio CR, Yu SM (2007) Depressive symptomatology and mental health help-seeking patterns of U.S.- and foreign-born mothers. *Matern Child Health J* 11:257–267. <https://doi.org/10.1007/s10995-006-0168-x>
- Jung T, Wickrama KA (2008) An introduction to latent class growth analysis and growth mixture modeling. *Soc Personal Psychol Compass* 2:302–317. <https://doi.org/10.1111/j.1751-9004.2007.00054.x>
- Kessler R, Berglund P, Demier O et al (2005) Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Arch Gen Psychiatry* 62:593–602. <https://doi.org/10.1001/archpsyc.62.6.593>

- Kessler RC, Andrews G, Mroczek D, Ustun B, Wittchen HU (1998) The World Health Organization composite international diagnostic interview short-form (CIDI-SF). *Int J Methods Psychiatr Res* 7:171–185
- Lander L, Howsare J, Byrne M (2013) The impact of substance use disorders on families and children: from theory to practice. *Soc Work Public Health* 28:194–205. <https://doi.org/10.1080/19371918.2013.759005>
- Lanier P, Jonson-Reid M (2014) Comparing primiparous and multiparous mothers in a nurse home visiting prevention program. *Birth* 41:344–352. <https://doi.org/10.1111/birt.12120>
- Little TD (2013) *Longitudinal structural equation modeling*. Guilford Press, New York
- Liu W, Mumford EA, Petras H (2015) Maternal patterns of postpartum alcohol consumption by age: a longitudinal analysis of adult urban mothers. *Prev Sci* 16:353–363. <https://doi.org/10.1007/s1121-014-0522-y>
- Long JS, Freese J (2006) *Regression models for categorical and limited dependent variables using Stata*, 2nd edn. Stata Press, College Station, Texas
- Manuel JI, Martinson ML, Bledsoe-Mansori SE, Bellamy JL (2012) The influence of stress and social support on depressive symptoms in mothers with young children. *Soc Sci Med* 75:2013–2020. <https://doi.org/10.1016/j.socscimed.2012.07.034>
- Minkovitz C, Strobino D, Scharfstein D, Hou W, Miller T, Mistry KB, Swartz K (2005) Maternal depressive symptoms and children's receipt of health care in the first 3 years of life. *Pediatrics* 115:306–314. <https://doi.org/10.1542/peds.2004-0341>
- Mistry KB, Minkovitz CS, Riley AW, Johnson SB, Grason HA, Dubay LC, Guyer B (2012) A new framework for childhood health promotion: the role of policies and programs in building capacity and foundations of early childhood health. *Am J Public Health* 102:1688–1696. <https://doi.org/10.2105/AJPH.2012.300687>
- Muthén LK, Muthén BO (1998-2017) *Mplus user's guide*, 8th edn. Muthén & Muthén, Los Angeles, CA
- Naerde A, Tambs K, Mathiesen KS et al (2000) Symptoms of anxiety and depression among mothers of pre-school children: effect of chronic strain related to children and child care-taking. *J Affect Disord* 58:181–199. [https://doi.org/10.1016/S0165-0327\(99\)00119-6](https://doi.org/10.1016/S0165-0327(99)00119-6)
- Putnam K, Robertson-Blackmore E, Sharkey K et al (2015) Heterogeneity of postpartum depression: a latent class analysis. *Lancet Psychiatry* 2:59–67. [https://doi.org/10.1016/S2215-0366\(14\)00055-8](https://doi.org/10.1016/S2215-0366(14)00055-8)
- Putnam KT, Wilcox M, Robertson-Blackmore E et al (2017) Clinical phenotypes of perinatal depression and time of symptom onset: analysis of data from an international consortium. *Lancet Psychiatry* 4(6):477–485
- Reichman N, Teitler J, Garfinkel I, McLanahan S (2001) Fragile families: sample and design. *Child Youth Serv Rev* 23:303–326
- Richmond JB, Health C (2009) Maternal depression can undermine the development of young children: Working Paper No. 8. Cent Dev Child Harvard Univ
- Ross LE, McLean LM (2006) Anxiety disorders during pregnancy and the postpartum period. *J Clin Psychiatry* 67:1285–1298. <https://doi.org/10.4088/JCP.v67n0818>
- Rowan P, Greisinger A, Brehm B, Smith F, McReynolds E (2012) Outcomes from implementing systematic antepartum depression screening in obstetrics. *Arch Womens Ment Health* 15:115–120. <https://doi.org/10.1007/s00737-012-0262-6>
- Schafer JL, Graham JW (2002) Missing data: our view of the state of the art. *Psychol Methods* 7:147–177. <https://doi.org/10.1037/1082-989X.7.2.147>
- Schofield CA, Battle CL, Howard M, Ortiz-Hernandez S (2014) Symptoms of the anxiety disorders in a perinatal psychiatric sample: a chart review. *J Nerv Ment Dis* 202:154–160. <https://doi.org/10.1097/NMD.0000000000000086>
- Selix NW, Goyal D (2018) Recent policy changes in perinatal depression screening and treatment. *J Nurse Pract* 14:117–123. <https://doi.org/10.1016/j.nurpra.2017.11.016>
- Smith VC, Wilson CR, Goodman SH et al (2016) Families affected by parental substance use. *Clin Child Fam Psychol Rev* 138:1–27. <https://doi.org/10.1007/s10567-010-0080-1>
- Sontag-Padilla L, Schultz D, Reynolds KA, et al (2012) Maternal depression: implications for systems serving mother and child
- StataCorp L. *Stata/SE 14.2* (2015), College Station, TX
- Turney K (2011a) Maternal depression and childhood health inequalities. *J Health Soc Behav* 52:314–332. <https://doi.org/10.1177/002214651>
- Turney K (2012) Pathways of disadvantage: explaining the relationship between maternal depression and children's problem behaviors. *Soc Sci Res* 41:1546–1564. <https://doi.org/10.1016/j.ssresearch.2012.06.003>
- Turney K (2011b) Chronic and proximate depression among mothers: implications for child well-being. *J Marriage Fam* 73:149–163. <https://doi.org/10.1111/j.1741-3737.2010.00795.x>
- Turney K (2011c) Labored love: examining the link between maternal depression and parenting behaviors. *Soc Sci Res* 40:399–415. <https://doi.org/10.1016/j.ssresearch.2010.09.009>
- Umberson D, Pudrovska T, Reczek C (2010) Parenthood, childlessness, and well-being: a life course perspective. *J Marriage Fam* 72:612–629
- Vesga-Lopez O, Blanco C, Keyes K et al (2008) Psychiatric disorders in pregnant and postpartum women in the United States. *Arch Gen Psychiatry* 65:805–815. <https://doi.org/10.1001/archpsyc.65.7.805>
- White IR, Royston P, Wood AM (2011) Multiple imputation using chained equations: issues and guidance for practice. *Stat Med* 30:377–399. <https://doi.org/10.1002/sim.4067>
- Williams D, Cheadle J (2015) Economic hardship, parents' depression, and relationship distress among couples with young children. *Soc Ment Health* 6:73–89. <https://doi.org/10.1177/2156869315616258>
- Witt WP, Keller A, Gottlieb C, Litzelman K, Hampton J, Maguire J, Hagen EW (2011) Access to adequate outpatient depression care for mothers in the USA: a nationally representative population-based study. *J Behav Health Serv Res* 38:191–204. <https://doi.org/10.1007/s11414-009-9194-y>
- Wittchen HU (1994) Reliability and validity studies of the WHO—composite international diagnostic interview (CIDI): a critical review. *J Psychiatr Res* 28:57–84. [https://doi.org/10.1016/0022-3956\(94\)90036-1](https://doi.org/10.1016/0022-3956(94)90036-1)
- World Health Organization (2009) *Mental health aspects of women's reproductive health: a global review of the literature*. WHO Press 61:178. <https://doi.org/10.1176/appi.ps.61.4.42>

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.