JOURNAL OF WOMEN'S HEALTH
Volume 23, Number 9, 2014

DOI: 10.1089/jwh.2014.4824

Predictors of Postpartum Depression

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Abstract

Objective: To examine sociodemographic factors, pregnancy-associated psychosocial stress and depression, health risk behaviors, prepregnancy medical and psychiatric illness, pregnancy-related illnesses, and birth outcomes as risk factors for post-partum depression (PPD).
Methods: A prospective cohort study screened women at 4 and 8 months of pregnancy and used hierarchical logistic regression analyses to examine predictors of PPD. The study sample include 1,423 pregnant women at a university-based high risk obstetrics clinic. A score of ≥ 10 on the Patient Health Questionnaire-9 (PHQ-9) indicated clinically significant depressive symptoms.
Results: Compared with women without significant postpartum depressive symptoms, women with PPD were significantly younger ($p < 0.0001$), more likely to be unemployed ($p = 0.04$), had more pregnancy associated depressive symptoms ($p < 0.0001$) and psychosocial stress ($p < 0.0001$), were more likely to be smokers ($p < 0.0001$), were more likely to be taking antidepressants (ADs) during pregnancy ($p = 0.002$), were less likely to drink any alcohol during pregnancy ($p = 0.02$), and were more likely to have prepregnancy medical illnesses, including diabetes ($p = 0.02$) and neurologic conditions ($p = 0.02$).
Conclusion: Specific sociodemographic and clinical risk factors for PPD were identified that could help physicians target depression case finding for pregnant women.

Introduction

The post-partum period is a high-risk time for development of major depressive episodes. Two systematic reviews have found that 7%–13% of women will experience a serious episode of postpartum depression (PPD).[1,2] Women who experience PPD have an increased risk of future depressive episodes and resulting functional impairment.[3,4] PPD has been shown to adversely affect maternal functioning and is a risk factor for poor mother–infant bonding, subsequent delayed child developmental milestones,[5–7] and child and adolescent mental health disorders.[8,9]

Several systematic reviews have examined risk factors for development of PPD.[1,2] Risk factors found to be associated with moderate to high risk of PPD include depression or anxiety during pregnancy, stressful life events, low levels of social support, previous history of depression, and the personality factor of neuroticism.[1,2] Pregnancy-related complications such as preeclampsia, premature labor, and other labor-related complications were associated with significant but lower level of risk in most studies.[1] Markers of lower socioeconomic status such as unemployment and lower educational attainment have also been associated with significant but lower risk of PPD.[1,2]

The systematic reviews found that a limitation of the literature was that few studies included the full wide range of potential risk factors for PPD, such as sociodemographic factors; prepregnancy medical illness; health risk behaviors such as smoking, drug and alcohol use; depression history prior to and during pregnancy; psychosocial stress; intimate partner violence during pregnancy; pregnancy-related complications such as gestational diabetes and pregnancy-related hypertension; and adverse birth outcomes such as preterm birth, low birth weight, and fetal death.[1,2]

The purpose of this study was to examine a wide range of socio-demographic factors, health risk behaviors, depression history, prepregnancy medical illness, pregnancy-related illnesses, and birth outcomes as risk factors for PPD.

Materials and Methods

Participants in this study were women receiving prenatal care at the University Obstetrics Clinic between January 2004 and June 2011, who delivered at the University of Washington Hospital. The university's Obstetrics and Gynecology Clinic and Obstetrics Inpatient Service have linked electronic records. Questionnaires assessing mood and other important sociodemographic, medical, and behavioral information were

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introduced as a quality improvement initiative in January 2004.[10] All women receiving obstetrical care and completing at least one survey during their second or third trimester as well as at 6-week postpartum follow-up were eligible for the study. Women presented to this tertiary care clinic at different pregnancy trimesters, and therefore, some had only one questionnaire completed during pregnancy and others had two (i.e., 4- and 8-month questionnaires). Clinic staff were responsible for screening patients with the survey questionnaire and once completed, obtaining written informed consent to link medical records with survey results. Given the nature of a busy, urban obstetrics clinic, staff were unable to get a small percentage of questionnaires completed.

Exclusion criteria included being < 15 years of age at the time of delivery or inability to complete the questionnaire due to language difficulty or mental incapacity. All procedures were approved by the University of Washington Human Subjects Institutional Review Board.

Study variables and measures

The Patient Health Questionnaire-9 (PHQ-9) was used to assess depressive symptoms during the second or third trimester and postpartum.[11] A continuous PHQ-9 severity measure was used as an independent variable. When questionnaires were filled out at both 4 and 8months, the mean PHQ-9 score was used. A PHQ-9 of ≥ 10 was utilized as the main outcome variable to define significant depressive symptoms at the post-partum visit. A PHQ-9 of ≥ 10 has been found in obstetrics and gynecology (Ob-Gyn) patients to have the highest sensitivity (73%) and specificity (98%), compared to a structured psychiatric interview diagnosis of major depression. Information about antidepressant (AD) use in pregnancy was obtained from the self-report questionnaire.[11] Self-report of AD use in pregnancy has been found to have high concordance with pharmacy records.[12]

Sociodemographic information on age, marital status, race/ethnicity, education, and employment, as well as general health history, health risk behaviors, social history, and psychosocial stressors were collected during either the second or third trimester. Chronic medical problems prior to pregnancy were screened for with a standard list that included hypertension, diabetes, asthma, thyroid disorders, migraines, arthritis, seizure disorders, heart failure, cancer, and other heart disease. Tobacco status was assessed using the Smoke-Free Families prenatal screen that was developed to screen for smoking during pregnancy.[13] Women with any current smoking were classified as smokers.

Diagnosis of pregnancy-induced/gestational hypertension was based on outpatient and inpatient physician *International Classification of Diseases, Ninth Revision* (ICD-9) diagnoses of 642.3, 642.4, 642.5, 642.6, and 642.7, respectively.[14] Diagnosis of gestational diabetes mellitus (GDM) was determined by a physician ICD-9 diagnosis of 648.8 in the outpatient or inpatient medical record.[15] GDM is clinically defined as glucose intolerance with the first recognition or onset in pregnancy;[16] therefore, this diabetes category could potentially include women with previously unrecognized type 2 diabetes.

The Prenatal Psychosocial Profile Stress Scale is an 11-item self-report scale that measures perceived current hassles and stressors.[17] Women indicate the extent to which each item is a current hassle or stressor on a 4-point Likert scale [1 (no stress) to 4 (severe stressor)] with a range of 11 to 44. It has been shown to have high reliability and validity in pregnant populations. The three-question Abuse Assessment Screen has been validated in pregnant patients as a sensitive and specific screen for intimate partner violence.[18] Each item is rated as ''yes'' or ''no,'' and the percentage of women with at least one measure of intimate partner violence was described. The revised four item alcohol screening questionnaire, the T-ACE (Take [number of drinks], Annoyed, Cut-down, Eye-opener), was employed to assess use of alcohol during pregnancy. The T-ACE modification of the alcohol screening questionnaire, the CAGE (Cut-down, Annoyed, Guilt, Eye-opener), substitutes the guilt question with an alcohol tolerance question.[19] The T-ACE has been found to outperform obstetric staff assessment of alcohol use by pregnant women.[19] Women with any use of alcohol during pregnancy were identified with the T-ACE.

Offspring birth weight, gestational age at birth, and fetal death were obtained from study participants' computerized medical records. Low birth weight was based on a gestational weight threshold of 2,500 g. Pre-term birth was determined as less than 37 weeks of completed gestation.

Statistical analyses

We selected the study sample from the entire screening sample ($N = 3,039$). The 1,423 women whose data were included in the study were compared with the 1,616 women who were excluded based on missing key data on baseline demographic and clinical variables using Fischer exact tests and *t*-tests. Due to significant inclusion group differences, non-response propensity scores were created using baseline variables (demographics, medical conditions, health risk behaviors, pregnancy variables, and depression). The inverse of the probability of not responding was used to weight our regression analyses.

We compared baseline variables for the women with and without PPD (having a postpartum PHQ-9 score ≥ 10) using Fischer Exact tests and *t*-tests. Hierarchical logistic regression analyses were used to predict the odds of PPD. We first examined the unadjusted association between prepregnancy PHQ-9 scores and PPD. In the next model, we added demographic variables and reevaluated the odds for prepregnancy depression. The third model contained the demographics and medical conditions. The fourth model added health-related behaviors to the model, and the fifth model added pregnancy-related variables. Lastly, we calculated a final model predicting PPD, including all odds ratios and their 95% confidence intervals for all the predictor variables.

Because an increase of five points on the PHQ-9 is associated with significant clinical change,[20] we recalculated the odds of PPD based on pregnancy PHQ-9 total scores formed by creating groups with five-point intervals, adjusting for all other study variables. Lastly, we conducted a sensitivity analysis by examining the final model without the use of the propensity weights.

Results

A total of 3,039 women were screened either at four months or eight months (or at both time periods) of pregnancy. Of these, 1,515 women were excluded due to lack of a

postpartum assessment (the vast majority of these women attended post-partum visits at clinics closer to their homes rather than the university high-risk obstetrics clinic); 84 were excluded due to only filling out the 8-month questionnaire which had no questions on medical history and 17 were excluded due to lack of data on birth outcomes (preterm labor or low birth weight), leaving a study sample of 1,423.

Univariate analyses comparing the pregnancy data for those women who were and were not included in this study revealed significant group differences. Those women not eligible for this study were slightly younger ($p < 0.001$, although the difference in means was only 1.3 years), less likely to be college educated ($p < 0.001$), and more likely to be single ($p < 0.001$), non-white ($p < 0.001$), and unemployed ($p < 0.001$) than the women included in the study sample. In addition, ineligible women reported being slightly more depressed ($p < 0.003$), 0.5 difference on PHQ-9), were more likely to have a baby die ($p < 0.01$), and less likely to have GDM ($p < 0.006$) or preeclampsia ($p < 0.02$) than those women retained for analysis. Due to these differences, we created nonresponse propensity weights utilizing the variables in Table 1, and have applied these weights to our regression analyses.

Table 1 displays the descriptive data for the groups with and without PPD. A total of 6.7% of women had a PHQ-9 score of ≥ 10 during pregnancy, and 5.8% had a score of ≥ 10 at the postpartum check. Women with PPD reported significantly more depressive symptoms during pregnancy than women without PPD. In addition, women with PPD were significantly younger, less likely to be married, less educated, and more likely to report being unemployed than women without PPD. In terms of medical conditions, women with PPD in comparison with women without PPD reported higher rates of diabetes, migraines, and a trend ($p = 0.06$) for hypertension and neurological conditions (0.07). Women with PPD were more likely to report current smoking, taking an

Table 1. Descriptive Data for Women With and Without Post-Partum Depression (PPD)

Variables[a] *mean (SD) or percent (*n*)*	*Total sample* N = *1,423*	*PHQ-9 (0–9) no PPD* n = *1,340*	*PHQ-9 (≥ 10) PPD* n = *83*	p *Value from* t-*test or Fisher's Exact test*
	Depression			
Pregnancy PHQ-9 Total Score[b]	3.4 (3.4)	3.1 (3.1)	7.8 (5.3)	0.0001
Pregnancy PHQ-9 (≥ 10)[c]	6.7 (95)	4.9 (66)	34.9 (29)	0.0001
Pregnancy minor depression PHQ-9 (5–9)[c]	4.4 (62)	4.1 (55)	8.4 (7)	0.09
	Demographic variables			
Age[b]	31.5 (5.9)	31.7 (5.9)	28.5 (6.3)	0.0001
Race[c]				
White	73.8 (1006)	74.1 (953)	68.8 (53)	0.17
African American	5.6 (76)	5.4 (70)	7.8 (6)	
Hispanic	4.6 (63)	44 (56)	9.1 (7)	
Other	16.0 (218)	16.1 (207)	14.2 (11)	
Married[c]	89.4 (1257)	90.5 (1197)	72.3 (60)	0.0001
At least some college[c]	85.5 (1200)	86.6 (1143)	68.7 (57)	0.0001
Unemployed[c]	40.1 (564)	38.7 (511)	63.9 (53)	0.0001
	Prepregnancy medical conditions			
Asthma[c]	10.7 (152)	10.4 (139)	15.7 (13)	0.14
Diabetes[c]	7.3 (104)	6.9 (92)	14.5 (12)	0.02
GI disorders[c]	7.2 (103)	7.0 (93)	12.0 (10)	0.12
Heart conditions[c]	4.7 (67)	4.5 (60)	8.4 (7)	0.11
Hypertension[c]	6.6 (94)	6.3 (84)	12.0 (10)	0.06
Migraine[c]	14.1 (200)	13.2 (176)	29.6 (24)	0.0001
Neurological conditions[c]	2.0 (28)	1.8 (24)	4.9 (4)	0.07
Thyroid problems[c]	7.0 (99)	6.8 (91)	9.6 (8)	0.37
	Health-related behaviors			
Current cigarette smoking[c]	5.5 (78)	4.0 (53)	30.5 (25)	0.0001
Taking an antidepressant[c]	7.0 (100)	6.2 (83)	20.5 (17)	0.0001
Drinking alcohol during pregnancy[c]	14.1 (201)	14.3 (190)	11.6 (11)	0.54
Intimate partner violence during the past year[c]	2.5 (36)	2.3 (30)	7.2 (6)	0.02
Stress total score[b]	14.3 (3.4)	14.0 (3.1)	18.3 (4.9)	0.0001
	Pregnancy-related variables			
GDM[c]	20.7 (294)	20.7 (278)	19.3 (16)	0.89
Preeclampsia[c]	21.2 (301)	20.6 (277)	28.9 (24)	0.10
Low birth weight[c]	11.5 (164)	10.8 (145)	22.9 (19)	0.002
Preterm birth[c]	15.0 (214)	14.2 (190)	28.9 (24)	0.001
Fetal deaths	0.35 (5)	0.37 (5)	0 (0)	1.0

[a]Only a mean of 2.7% of the model variables were missing.
[b]Mean (standard deviation [SD]).
[c]Percent (*n*).
GI, gastrointestinal; GDM, gestational diabetes mellitus; PHQ-9, Patient Health Questionnaire-9; PPD, post-partum depression.

AD [women taking an AD had higher PHQ-9 scores than women not treated with ADs: PHQ-9 = 6.1 (4.5) versus 3.1 (3.2), $p < 0.001$], being a victim of intimate partner violence in the past year, and had higher stress scores than women without PPD. The percentage of women with GDM and preeclampsia during the pregnancy did not differ between the depression groups. However, having an infant with low birth weight or having a preterm birth were both significantly more prevalent in the women with PPD. There were five fetal deaths, all in women without PPD.

Table 2 presents the logistic regression results. The unadjusted odds ratio (OR) for PHQ-9 scores assessed during pregnancy was 1.25 (95% confidence interval [95% CI] = 1.21–1.29). The addition of the demographic variables and medical conditions did little to change this result. The addition of the health-related behaviors minimally reduced the odds to 1.10 (1.05–1.15). The addition of the pregnancy-related variables did not change the odds ratio. Therefore, there is a 10% increase in the odds of reporting PPD for every one-point increase in PHQ-9 score assessed during pregnancy. A clinically significant five-point increase in PHQ-9 scores assessed during pregnancy resulted in a 70% increase in the odds of PPD [OR = 1.70, 95% CI = 1.34–2.16, $p = .0001$], after adjusting for all the demographic, medical conditions, health-related behaviors, and pregnancy-related variables. The final model in Table 2 shows the odds ratios and their 95% confidence intervals for all included variables. In addition to depression, women with PPD were significantly more likely to be younger, to be unemployed and to have prepregnancy diabetes and neurological conditions, to be smokers; to report using Ads, and

Table 2. Risk Factors Associated with Post-Partum Depression

Model	*Odds ratio (95% CI) for total PHQ-9 Score (1 point)*	p *Value*
Unadjusted total PHQ-9 score assessed during pregnancy	1.25 (1.21–1.29)	0.0001
Total PHQ-9 Score assessed during pregnancy adjusted for demographic variables[a]	1.22 (1.18–1.26)	0.0001
Total PHQ-9 Score assessed during pregnancy adjusted for demographic variables[a] and medical conditions[b]	1.21 (1.17–1.25)	0.0001
Total PHQ-9 Score assessed during pregnancy adjusted for demographic variables,[a] medical conditions,[b] and health-related behaviors[c]	1.10 (1.05–1.16)	0.0001
Final multi-variable model		
Total PHQ-9 Score assessed during pregnancy	1.10 (1.05–1.15)	0.0001
Demographic variables[a]		
Age	0.94 (0.91–0.97)	0.0001
White race	1.01 (0.69–1.48)	0.95
Married	1.14 (0.73–1.77)	0.58
Some college	1.18 (0.77–1.82)	0.44
Unemployment	1.50 (1.02–2.21)	0.04
Prepregnancy medical conditions[b]		
Asthma	0.61 (0.37–1.00)	0.05
Diabetes	1.98 (1.12–3.52)	0.02
GI disorders	0.74 (0.42–1.32)	0.31
Heart conditions	1.92 (0.98–3.79)	0.06
Hypertension	0.70 (0.39–1.25)	0.23
Migraines	1.40 (0.93–2.11)	0.10
Neurological conditions	2.37 (1.12–5.02)	0.02
Thyroid problems	0.70 (0.34–1.46)	0.34
Health-related behaviors[c]		
Current cigarette smoking	2.84 (1.80–4.48)	0.0001
Taking an antidepressant	2.23 (1.35–3.68)	0.002
Drinking alcohol during pregnancy	0.46 (0.24–0.90)	0.02
Intimate partner violence within the past year	0.53 (0.24–1.13)	0.10
Stress total score	1.14 (1.09–1.19)	0.0001
Pregnancy-related variables[d]		
GDM	0.68 (0.40–1.13)	0.13
Preeclampsia	1.43 (0.95–2.17)	0.09
Low birth weight	1.38 (0.79–2.43)	0.26
Preterm birth	1.07 (0.64–1.81)	0.79

The above analyses are propensity weighted.

[a]Demographic variables: age, race, marital status, education, unemployment.

[b]Prepregnancy medical conditions: asthma, hypertension, diabetes, neurological condition, heart condition, GI condition, thyroid problems, migraines.

[c]Health-related behaviors: current cigarette smoking, taking an antidepressant, any domestic violence in the past year, drinking alcohol during pregnancy, and stress total score.

[d]Pregnancy-related variables: GDM, preeclampsia, low birth weight, and preterm birth.

95% CI, 95% confidence interval.

to endorse more stress and less alcohol use during pregnancy in comparison with the women without PPD.

For our sensitivity analysis, we ran the same complete model without the propensity weights. The significance and odds ratios for all the variables were similar for the propensity weighted and unweighted models, except for four variables which became nonsignificant: unemployment ($p=0.37$), asthma ($p=0.41$), neurological problems ($p=0.31$), and alcohol consumption during pregnancy ($p=0.18$). These variables were less robustly associated with PPD in the weighted model, and all four of these variables also occurred in higher rates in women who were excluded from the study, which probably accounts for differences in the weighted versus unweighted samples.

Discussion

PPD is a very common disorder that causes significant functional impairment and increases risk of poor mother–infant bonding and delays in infant development. Therefore, enhancing the understanding of vulnerability factors could raise awareness for obstetricians and primary care physicians about high-risk populations. Our data show that depressive symptoms in pregnancy, AD use at the time of pregnancy screening, younger age, unemployment, prepregnancy diabetes and neurologic disorders, smoking, less alcohol use during pregnancy, and a high degree of psychosocial stressors were independent predictors of risk of PPD. Of these, neither smoking nor prepregnancy diabetes (or other medical disorders) were found to be associated with risk in the previous meta-analyses[1,2] but were likely not included as predictors in many previous studies.

Our findings emphasize that one of the highest risk factors for PPD, which is potentially modifiable, is depressive symptoms in pregnancy. We found that for every one-point change in depressive symptoms there was an associated 10% increased risk of PPD. A significant clinical increase of five-points on the PHQ-9 was associated with an approximately 70% increased risk of PPD. These data emphasize the importance of improving case-finding of patients with depression using well-validated tools such as the PHQ-9 coupled with development of effective primary care or Ob-Gyn evidence-based depression interventions. Screening for depression and referral out-of-clinic to mental health specialists is not likely to be effective due to data showing that approximately half of primary care patients with depression do not follow through with primary care referrals to mental health specialists.[21] Collaborative depression care interventions integrated into medical clinics which include a physician-supervised care manager, longitudinal measurement of depressive symptoms, and increasing intensity of care based on persistent symptoms have been shown to be an effective way to improve quality of treatment of depression, and depressive and functional outcomes, in both primary care[22] and Ob-Gyn settings.[23]

The finding that younger, unemployed, psychosocially stressed women with adverse health habits such as smoking, and development of depressive disorders and medical disorders in early adulthood, are vulnerable to PPD is supported by epidemiologic data showing that women growing up in socially disadvantaged environments tend to have greater risk for both medical and psychiatric disorders, which often develop at younger ages than women growing up in less vulnerable situations.[24,25] Recent research has focused on the effect of stressors over a woman's life-course in adding to risk of pregnancy-related complications, low birth weight, preterm labor, and PPD.[26] Prospective studies suggest that maternal exposure to low socioeconomic status in childhood and exposure to violence/mental health issues in childhood was associated with low birth weight in offspring.[27–30] An emerging literature suggests that causal mechanisms link maternal early-life risk and offspring birth weight. Specifically, through a causal pathway that includes adolescent substance use and prenatal substance use,[31,32] researchers have shown that maternal exposure to maltreatment and economic disadvantage during early childhood is associated with offspring low birth weight.

Physicians strongly advise women to quit smoking during pregnancy due to its association with risk of low birth weight.[33] Depression during pregnancy has been found to increase risk of not being able to quit smoking.[34] Many pregnant women do quit smoking, and it is possible that those in our sample who had not quit by the 4- or 8-month screening had both stronger nicotine dependence and more psychological vulnerabilities that they cope with by smoking.[34,35]

We also found that prepregnancy diabetes was associated with a higher risk of PPD. Lower socioeconomic status,[36] childhood adversity,[37] and depression[38] have been found to be associated with a higher risk of prepregnancy metabolic abnormalities and diabetes, suggesting that development of this disorder early in a woman's life may reflect psychological and social vulnerabilities. Obesity and prepregnancy diabetes are also linked to the risk for pregnancy-induced hypertension and GMD, which may increase patient's perception of stress during pregnancy and risk of PPD.[39]

AD use is likely a marker of depressive episodes that occurred prior to pregnancy. However, AD use in observational studies of medical populations is usually an example of confounding by severity, since only approximately half of patients in primary care are accurately recognized by physicians as having depression, and only half of those diagnosed are effectively treated.[40] Thus, AD prescriptions may be correlated with more severe and persistent episodes of depression, which are more likely to be recognized but are still often inadequately treated. We examined whether there was evidence of less than adequate treatment in patients in our sample who were treated with ADs and found significantly more depressive symptoms based on the PHQ-9 in these patients compared to those not treated with ADs.

The strengths of this study include the large sample size, using propensity weights to allow use of the full screening sample, and inclusion of a full range of predictor variables. Limitations include study of a population from one large university clinic in one geographical region of the United States, lack of use of structured psychiatric interviews for diagnosis of depression and history of prior depressive episodes, and not assessing body mass index (BMI) or social support. However, the PHQ-9 has been validated in a large Ob-Gyn study of 3,000 patients and found to have high sensitivity and specificity for the diagnosis of major depression based on structured psychiatric interview,[11] and we did assess prepregnancy diabetes, hypertension, and gestational diabetes—all of which are associated with prepregnancy BMI. Moreover, the PHQ-9 is being widely used in quality improvement efforts in many primary care settings. We also found a lower rate of probable major depression based on a PHQ-9 score of ≥ 10 during pregnancy

(6.7%) and postpartum periods (5.8%) than has been found in many previous studies. The relatively high educational level and the high percentage of married women in our sample may have served as protective factors for development of affective illness. The finding that less alcohol use during pregnancy was associated with a high risk of PPD was surprising and may reflect the limitations of the questionnaire used, which identified a minority of women with ''any use'' of alcohol but very few with abuse or dependence problems. It also may reflect underreporting of alcohol use. The single 6-week postpartum screen for depression may have missed some women who develop PPD within a three-month period. However, a recent large study found that most post-partum episodes began within the first postpartum month.[41]

Conclusion

In summary, we found that younger age, unemployment, antenatal depressive symptoms, taking ADs, psychosocial stressors, prepregnancy chronic physical illnesses (diabetes and neurologic conditions), and smoking were independent predictors of development of PPD. Attention to these risk factors may help primary care and Ob-Gyn physicians focus depression case-finding efforts.

Disclosure Statement

No competing financial interests exist.

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