Factors Associated with Seasonal Influenza Vaccination in Pregnant Women

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Abstract

Background: This observational study followed a cohort of pregnant women during the 2010–2011 influenza season to determine factors associated with vaccination.

Methods: Participants were 1105 pregnant women who completed a survey assessing health beliefs related to vaccination upon enrollment and were then followed to determine vaccination status by the end of the 2010–2011 influenza season. We conducted univariate and multivariate analyses to explore factors associated with vaccination status and a factor analysis of survey items to identify health beliefs associated with vaccination.

Results: Sixty-three percent ($n=701$) of the participants were vaccinated. In the univariate analyses, multiple factors were associated with vaccination status, including maternal age, race, marital status, educational level, and gravidity. Factor analysis identified two health belief factors associated with vaccination: participant's positive views (factor 1) and negative views (factor 2) of influenza vaccination. In a multivariate logistic regression model, factor 1 was associated with increased likelihood of vaccination (adjusted odds ratio [aOR]=2.18; 95% confidence interval [CI]=1.72–2.78), whereas factor 2 was associated with decreased likelihood of vaccination (aOR=0.36; 95% CI=0.28–0.46). After controlling for the two health belief factors in multivariate analyses, demographic factors significant in univariate analyses were no longer significant. Women who received a provider recommendation were about three times more likely to be vaccinated (aOR=3.14; 95% CI=1.99–4.96).

Conclusion: Pregnant women's health beliefs about vaccination appear to be more important than demographic and maternal factors previously associated with vaccination status. Provider recommendation remains one of the most critical factors influencing vaccination during pregnancy.

Introduction

PREGNANT WOMEN are at increased risk for severe influenza-related complications and hospitalizations^{1–7} and are a priority group for influenza vaccination.^{8–9} Prior to the 2009 outbreak of novel influenza A (H1N1) virus, vaccination coverage in pregnant women in the United States ranged from <10% to 33%.^{10–13} Since 2009, coverage rates in this population have increased to about 50% nationally,^{12,14–17} with some healthcare systems reporting up to 70%,¹⁶ but still fall below the recommended Healthy People 2020 target of 80%.¹⁸

The Health Belief Model identifies five critical factors (severity, susceptibility, benefits, barriers, and cues to action) predictive of health behavior changes and has been successfully applied to a diverse range of preventative health and patient compliance issues, including receipt of influenza vaccination in children, the elderly, and adults with asthma.^{19–21} Previous literature has demonstrated that health belief factors associated with higher vaccination rates during pregnancy include trust in vaccine recommendations by health care providers or organizations, perceived effectiveness of influenza vaccination, perceived susceptibility to influenza, perceived seriousness of influenza illness during

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pregnancy, and perceived regret about not getting vaccinated.^{7,12,15,22–27} Other factors commonly associated with increased vaccination rates include higher maternal age, higher education and socioprofessional levels, later stage of pregnancy at the time of vaccination, history of prior influenza vaccination, and provider recommendations to get vaccinated.^{15,23–25,27–30}

Factors often associated with lower vaccination rates during pregnancy include black or Hispanic race/ethnicity, perception that the vaccine had not been adequately tested, concerns about vaccine effects on maternal or fetal health, and lack of knowledge about influenza risk during pregnancy, benefits of vaccination, or where to get vaccinated.^{7,23,25,26,28,29,31,32}

The objective of this study was to examine a variety of factors previously associated with influenza vaccination during pregnancy in a large cohort of pregnant women. Factors of interest included sociodemographic characteristics, provider recommendation to vaccinate, and pregnant women's health beliefs about vaccination. In addition to assessing each of these factors independently, we used multivariate analyses to explore the relative impact of these factors on vaccination status in pregnant women.

Materials and Methods

Study population and recruitment

The Pregnancy and Influenza Project (PIP) is a prospective cohort study of pregnant women enrolled in Kaiser Permanente Northwest (KPNW) and Kaiser Permanente Northern California (KPNC). Details of the study were published previously.³³ In brief, the study took place during the 2010–2011 influenza season at two study sites. Participants in the study included English-speaking (both study sites) and Spanish-speaking (KPNC only) pregnant women who had at least one prenatal visit at a Kaiser Permanente obstetrics and gynecology clinic, an expected delivery date after November 15, 2010, and were at least 16 years of age in the KPNW region or 18 years of age in the KPNC region. Potential participants were identified through electronic medical records, and were recruited between December 2010 and May 2011. The women were contacted by telephone, screened for eligibility, and asked to provide written consent for study participation. Inclusion criteria included health plan enrollment for the entire 2010–2011 season and completion of the enrollment interview. Women vaccinated postpartum were excluded from analysis.

The Kaiser Permanente Northwest and Northern California Institutional Review Boards reviewed and approved the study protocol and materials.

Data collection

Enrolled participants completed a 20- to 30-minute baseline enrollment interview that included questions about demographics; obstetric history; provider recommendation to vaccinate; and knowledge, attitudes, and beliefs about vaccination. Interviews were administered by telephone (as opposed to in prenatal clinics) to avoid any potential interference with provision of medical services. All interviews were administered by professional research staff using computer-assisted telephone interview methods. Participants

in KPNC had the option of completing interviews in Spanish or English.

We defined gravidity as the cumulative number of pregnancies, as reported by the participant during the enrollment interview. This count included the pregnancy during the study period and prior pregnancies of any outcome. Women were followed for 6 months post delivery. Medical diagnoses and vaccination data were obtained through electronic data extraction of health plan databases and state immunization registries by an experienced data analyst. We identified women at “high risk for influenza complications” (e.g., heart disease, pulmonary disease, diabetes mellitus) using electronic medical record data from the year prior to the influenza season. A detailed code list, previously developed for use in a study of influenza vaccination in health care workers,³⁴ is available from the authors by request.

It is important to note that influenza vaccination is strongly recommended at prenatal visits. Kaiser Permanente has implemented a number of strategies to increase influenza vaccination during pregnancy (e.g., clinician checklists, standard order sets for prenatal visits that include influenza vaccination, and “flags” in the electronic medical record for pregnant women who have not yet been vaccinated). Walk-in vaccination clinics are typically offered in the fall of each year.

The Health Belief Model

The Health Belief Model identifies five factors predictive of health-behavior change: perceived susceptibility (personal assessment of the risk of getting ill), perceived severity (assessment of the seriousness or consequences of getting ill), perceived barriers (assessment of negative influences related to implementation of the health behavior), perceived benefits (assessment of positive consequences of implementing the health behavior, including reduction in worry or regret), and cues to action (external influences promoting health behavior). Survey items were adapted from previous literature^{19,23,24,28} and assessed the major domains of the Health Belief Model. Survey items and response options are displayed in Table 1.

Statistical analysis

We performed univariate analyses to examine the association between select sociodemographic and obstetric characteristics, survey items, and vaccination status. Comparisons were made using chi-squared and Fisher's exact tests.

We conducted an exploratory principal factor analysis to identify and group variables that were correlated with each other, which allowed us to enter a smaller number of key factors into our multivariable analyses. We excluded the provider recommendation from the factor analysis due to the different format of the item (yes/no) and also because it did not assess vaccination knowledge, attitudes, and beliefs as did the other survey items. Due to the ordinal nature of the data, we first obtained polychoric correlations among the observed variables and then performed exploratory factor analysis using the principal factor method to extract the factors. The Kaiser-Guttman rule, proportion of common variance criteria, and scree test were used as guidelines when selecting the number of factors retained. When selecting the rotation matrix, we followed the technique from Tabachnick and Fidell³⁵ and chose the VARIMAX rotation method due to the very low correlation between the factors.

TABLE 1. PREGNANCY AND INFLUENZA PROJECT SURVEY ITEMS BY HEALTH BELIEF MODEL DOMAINS AND FACTOR ANALYSIS RESULTS

Survey items ^{a,b} (source references)	Health belief model domain ^c	Factor ^d
1. How effective do you think the flu vaccination is in preventing you from getting the flu? (19,23,24)	3	1
2. How effective do you think a mother's flu vaccination is in preventing her baby from getting the flu after she delivers? (19)	3	1
3. With no flu shot, I would feel very vulnerable to the flu. (28)	1	1
4. I don't like getting shots or injections. (28)	4	n.s.
5. I feel I have received all the information I need to decide if I should get a flu shot. (28)	5	1
6. If I don't get a flu shot and end up getting the flu, I'd be mad at myself for not getting the shot. (28)	3	1
7. I get sick with the flu more easily than other people my age. (24,28)	1	n.s.
8. I am concerned about side effects from the influenza vaccine. (19,23,24,28)	4	2
9. The flu shot could give me the flu. (19,28)	4	2
10. Friends or family members have discouraged me from getting a flu shot. (28)	5	2
11. I am not at risk of getting seriously ill from the flu. (28)	2	n.s.
12. I believe the influenza vaccine is safe and does not pose a risk to my baby. (23,24)	3	1
13. I am concerned there may be something that I don't know about the flu shot. (23,28)	4	2

^aResponse options for items 1–2: 1, very effective; 2, somewhat effective; 3, not too effective; 4, not at all effective.

^bResponse options for items 3–13: 1, strongly agree; 2, somewhat agree; 3, somewhat disagree; 4 strongly disagree.

^cHealth belief model domains: Domain 1, Perceived Susceptibility to Influenza; Domain 2, Perceived Severity of Getting Ill with Influenza; Domain 3, Potential Benefits of Influenza Vaccination; Domain 4, Perceived Barriers to Vaccination; Domain 5, Cues to Action.

^dFactors identified by exploratory factor analysis: Factor 1, Positive Views of Influenza Vaccination; Factor 2, Negative Views of Influenza Vaccination.

n.s., not significant.

For each of the underlying factors, we calculated factor scores using the standardized scoring coefficients obtained from the previous analysis; we entered these scores as continuous variables in a multivariate logistic regression model to assess the association between these factors and vaccination status. Model 1 adjusted for all baseline characteristics displayed in Table 2 as well as the provider recommendation variable in Table 3, without including health belief factors as covariates. Model 2 adjusted for all variables in model 1 and included health belief factors as covariates. We made an *a priori* decision to control for month of enrollment to offset any potential seasonality effects or potential bias on responses to survey items. Five participants with missing demographic data were excluded from the multivariate analyses. As these participants represent less than 1% of our study population, we did not conduct sensitivity analysis to determine potential impact on analyses. All analyses were conducted using SAS 9.2 (SAS Institute, Cary, North Carolina).

Results

We examined 7180 pregnant women for study eligibility, and 1616 women were confirmed as eligible and enrolled in the main PIP study. Recruitment and enrollment procedures for the PIP study have been described in detail previously.³³ Reasons for ineligibility included: no longer pregnant, no longer a health plan member, or planning to relocate. For this substudy, we also excluded from analysis women who were not health plan members for the entire 2010–2011 influenza

season ($n=139$), women who completed the enrollment interview after delivery ($n=138$), women who did not complete the enrollment interview or failed to complete it within a 10-day window ($n=125$), women who received the vaccine prior to pregnancy onset ($n=99$), and those who received influenza vaccination postpartum ($n=10$), resulting in a final study population of 1105 (see Fig. 1).

Table 2 shows baseline sociodemographic and maternal characteristics. The majority of women (67%) fell in the 26–35 year age range, 84% were married, 76% were white, and 13% were Hispanic. The majority of women (74%) had at least a bachelor's degree. Only 12% of women had one or more prepregnancy medical condition associated with high risk for influenza complications. Roughly equal proportions of women reported gravidity of one, two, or three or more pregnancies (36%, 32%, and 32%, respectively), including the current pregnancy.

Nearly two-thirds of pregnant women (701/1105; 63%) received a seasonal inactivated influenza vaccine during the 2010–2011 influenza season. Most vaccinated women received their vaccine in either the first (0–13 weeks gestation) (48%) or second (14–26 weeks gestation) (47%) trimesters of pregnancy; only 6% of women in our sample received their vaccine during the third trimester (27 weeks to delivery) of pregnancy. The majority (97%) of vaccinated women received their vaccine prior to completing the enrollment interview. Vaccinated women were more likely to have higher maternal age, be married, have higher education, and have lower gravidity (Table 2). Vaccinated women were less likely to be black or Hispanic. There were no

TABLE 2. SOCIODEMOGRAPHIC AND MATERNAL CHARACTERISTICS OF WOMEN ENROLLED IN THE PREGNANCY AND INFLUENZA PROJECT

	Total n = 1105	Vaccinated n = 701	Vaccinated (%)	p
Study site				0.3882
Site 1 (KPNC) ^a	664	428	64	
Site 2 (KPNW) ^b	441	273	62	
Month of study enrollment				<0.0001
Oct–Nov	106	77	73	
Dec–Jan	558	403	72	
Feb–Mar	333	183	55	
Apr–May	108	38	35	
Maternal age at delivery				0.041
25 years or younger	112	65	58	
26–30 years	291	169	58	
31–35 years	450	303	67	
36 years or older	252	164	65	
Marital status				0.0119
Married	926	605	65	
Lives with partner	108	58	54	
Other ^c	71	38	54	
Race				0.0073
White	835	531	64	
Black/African American	41	16	39	
Asian/Pacific Islander	157	110	70	
Multi/other	54	34	63	
Unknown	18	10	56	
Ethnicity ^d				0.0525
Non-Hispanic	952	615	65	
Hispanic	149	84	56	
Education ^e				0.0001
HS Grad, GED, or less	102	54	53	
Some college	182	103	57	
Bachelor's degree	415	254	61	
Master's degree or more	405	290	72	
High risk influenza status ^f				0.8906
Normal risk	969	614	63	
High risk	136	87	64	
Gravidity ^g				0.0323
1	393	256	65	
2	357	239	67	
3 or more	355	206	58	

^aKPNC, Kaiser Permanente, Northern California.^bKPNW, Kaiser Permanente, Northwest.^cOther includes separated, divorced, and never married.^dMissing ethnicity data for four participants, two unvaccinated and two vaccinated during pregnancy.^eMissing education data for one participant, unvaccinated.^fIncludes chronic medical conditions such as cardiac disease, renal disease, diabetes, etc. diagnosed in the year prior to current influenza season. Detailed code list available from the authors.^gTotal number of pregnancies, including the current pregnancy, as reported by the participant during the enrollment interview.

significant differences between vaccination status by study site, high-risk influenza status, or high-risk pregnancy status.

Univariate analyses of survey items by vaccination status are presented in Table 3. The majority (76%) of women reported that their health care provider had recommended influenza vaccination. Of women who were vaccinated, 86% reported that their provider had recommended vaccination. All but three of the health belief survey items were associated with vaccination status and items were highly correlated with each other (range of Pearson's *r* values, -0.61 to 0.63 ; data not shown). We extracted two factors out of the 13 survey

items analyzed using factor analysis. The correlation between these two factors was -0.15 . Factor 1 (eigenvalue = 3.59) accounted for 77% of the total variance; this factor corresponds with participants' positive views of influenza vaccination. The six survey items loading into this factor included items 1–3, 5, 6, and 12 (Table 1). Factor 2 (eigenvalue = 1.03) accounted for 22% of the total variance; this factor corresponds to participants' negative views of influenza vaccination. The four items loading into this factor included items 8–10 and 13. The remaining three items (items 4, 7, and 11) did not contribute significantly to the factor loadings.

TABLE 3. UNIVARIATE AND FACTOR ANALYSES OF SURVEY ITEMS BY VACCINATION STATUS

	Total n = 1105	Vaccinated n = 701	Vaccinated (%)	p
Provider recommendation ^a				
Since you became pregnant, did your doctor or other health care professional recommend that you get a flu vaccine?				<0.0001
Yes	839	603	72	
No	242	83	34	
Don't know	24	15	62	
Factor 1: Positive views of influenza vaccination				
How effective do you think the flu vaccination is in preventing you from getting the flu?				<0.0001
Very/somewhat effective	800	582	73	
Not too/at all effective	171	44	26	
Don't know/refused	134	75	56	
How effective do you think a mother's flu vaccination is in preventing her baby from getting the flu after she delivers?				<0.0001
Very/somewhat effective	582	411	71	
Not too/at all effective	211	88	42	
Don't know/refused	312	202	65	
With no flu shot, I would feel very vulnerable to the flu.				<0.0001
Strongly/somewhat agree	538	420	78	
Somewhat/strongly disagree	546	272	50	
Don't know/refused	21	9	43	
I feel like I have received all the info I need to decide if I should get a flu shot.				<0.0001
Strongly/somewhat agree	1016	672	66	
Somewhat/strongly disagree	87	27	31	
Don't know/refused	2	2	100	
If I don't get a flu shot and end up getting the flu, I'd be mad at myself for not getting the shot.				<0.0001
Strongly/somewhat agree	579	444	77	
Somewhat/strongly disagree	503	242	48	
Don't know/refused	23	15	65	
I believe the influenza vaccine is safe and does not pose a risk to my baby.				<0.0001
Strongly/somewhat agree	860	634	74	
Somewhat/strongly disagree	187	43	23	
Don't know/refused	58	24	41	
Factor 2: Negative views of influenza vaccination				
I am concerned about side effects from the influenza vaccine.				<0.0001
Strongly/somewhat agree	436	196	45	
Somewhat/strongly disagree	660	501	76	
Don't know/refused	9	4	44	
The flu shot could give me the flu.				<0.0001
Strongly/somewhat agree	376	189	50	
Somewhat/strongly disagree	706	498	71	
Don't know/refused	23	14	61	
Friends or family members have discouraged me from getting a flu shot.				0.1370
Strongly/somewhat agree	183	109	60	
Somewhat/strongly disagree	912	588	64	
Don't know/refused	10	4	40	
I am concerned that there may be something that I don't know about the flu shot.				<0.0001
Strongly/somewhat agree	488	272	56	
Somewhat/strongly disagree	604	418	69	
Don't know/refused	13	11	85	

(continued)

TABLE 3. (CONTINUED)

	Total n = 1105	Vaccinated n = 701	Vaccinated (%)	p
Noncontributory items				
I don't like getting shots or injections.				0.8918
Strongly/somewhat agree	610	385	63	
Somewhat/strongly disagree	482	307	64	
Don't know/refused	13	9	69	
I get sick with the flu more easily than other people my age.				0.0251
Strongly/somewhat agree	125	93	74	
Somewhat/strongly disagree	968	601	62	
Don't know /refused	12	7	58	
I am not at risk of getting seriously ill from the flu.				0.7287
Strongly/somewhat agree	507	317	63	
Somewhat/strongly disagree	575	368	64	
Don't know/refused	23	16	70	

^aProvider recommendation question not included in factor analysis.

Table 4 shows multivariate analysis of significant factors associated with vaccination status. Without including the Health Belief Model factors as covariates (Model 1), we found that enrollment earlier in the influenza season was positively associated with vaccination (vaccination clinics

are typically offered in October of each year). Higher education (master's degree and above) and provider recommendation to vaccinate were positively associated with vaccination, and black race was negatively associated with vaccination. After including the two factors from the Health Belief Model, earlier enrollment and provider recommendation were still positively associated with vaccination, but the effects of race and education were no longer significant and were dropped from the final model (Model 2). In the adjusted model, the odds of getting flu vaccination was 2.18 times higher for every one-unit increase in the score of the first factor (positive views of influenza vaccine); and the odds of getting flu vaccination decreased by a factor of 0.36 for every one-unit increase in the score of the second factor (negative views of influenza vaccine).

Discussion

The current study evaluated factors associated with influenza vaccination during pregnancy, including sociodemographic factors, obstetric characteristics, maternal health beliefs, and provider recommendation to vaccinate. The proportion of women vaccinated in our study population was 63%, which is consistent with other recently published vaccination rates but still significantly below the Healthy People 2020 target of 80%. This percentage also represents a slight decline from higher vaccination rates noted during the 2009–2010 H1N1 pandemic.^{12,14–16}

The factor analysis identified 10 survey items that loaded significantly onto two discrete factors. The first factor was a “positive view of the benefits of vaccination” which corresponds mostly closely to domain 3 of the Health Belief Model (Potential Benefits of Vaccination). The second factor was a “negative view of the risks of vaccination” which corresponds with domain 4 (Perceived Barriers to Vaccination). These findings are consistent with prior research linking multiple health beliefs with vaccination,^{7,12,15,22–26,28,29,31,32} but our findings suggest that domains 3 and 4 of the Health Belief Model may be particularly salient to pregnant women.

Previous studies have found maternal characteristics such as maternal age, race, ethnicity, and educational level to be

FIG. 1. Study CONSORT (consolidated standards of reporting trials) flow diagram. PIP, Pregnancy and Influenza Project.

TABLE 4. MULTIVARIATE LOGISTIC REGRESSION MODELS OF VARIABLES ASSOCIATED WITH VACCINATION DURING PREGNANCY

Variable	Model 1 ^a		Model 2 ^b	
	OR	95% CI	aOR	95% CI
Enrollment (i.e., timing of survey)				
October–November	1.0 (ref)		1.0 (ref)	
December–January	0.97	0.59–1.58	0.76	0.39–1.50
February–March	0.50	0.30–0.84	0.48	0.24–0.97
April–May	0.25	0.14–0.47	0.24	0.10–0.57
Race				
White	1.0 (ref)			
Black/African American	0.37	0.19–0.74		
Asian/Pacific Islander	1.36	0.91–2.03		
Multi/Other	0.96	0.51–1.79		
Unknown	1.13	0.36–3.48		
Education				
HS Grad, GED, or less	1.0 (ref)			
Some college	1.01	0.59–1.72		
Bachelor's degree	1.10	0.68–1.78		
Master's degree or more	1.70	1.04–2.77		
Provider recommendation				
No	1.0 (ref)		1.0 (ref)	
Yes	4.06	2.96–5.59	3.14	1.99–4.96
Unknown	3.40	1.33–8.69	3.30	0.94–11.60
Factor 1: Positive views of influenza vaccination			2.18	1.72–2.78
Factor 2: Negative views of influenza vaccination			0.36	0.28–0.46

^aModel 1: All baseline characteristics (Table 2) and the provider recommendation for vaccination variable (Table 3) were entered into the multivariate analysis. After dropping nonsignificant variables ($p > 0.05$), enrollment period, race, education, and provider recommendation were retained as significant variables. Only significant variables in the model are displayed in the table above.

^bModel 2: All variables included in Model 1 and Factors 1 and 2 (Table 3) were entered into the multivariate analysis. After dropping nonsignificant variables ($p > .05$), enrollment period, provider recommendation, Factor 1, and Factor 2 were retained as significant variables in the final model. Only significant variables in the model are displayed in the table above.

aOR, adjusted odds ratio; CI, confidence interval; OR, odds ratio; ref, reference group.

significantly associated with vaccination rates.^{15,23–25,27,30} While certain baseline factors (e.g., race and education) were significantly associated with vaccination status in our initial multivariate model, only provider recommendation remained significant after adding the health belief factors to the model. We found that women who had received a recommendation from a health care provider to get vaccinated and had positive views of influenza vaccination were more likely to be vaccinated. In contrast, women with a negative view of influenza vaccination were less likely to be vaccinated.

Limitations of prior studies include that women in these studies were often interviewed retrospectively during the postpartum period, and in most cases vaccination status was defined by participant self-report. Our prospective cohort design allowed us to interview women during pregnancy, and vaccination status was confirmed via electronic medical record versus only self-report.

Our study also had several limitations. First, the majority of our participants had already been vaccinated prior to the interview and thus their responses to survey items may have been subject to social-desirability and recall bias (e.g., women who were already vaccinated may have endorsed more positive views of vaccination).^{36–38} However, it is important to note that we attempted to ameliorate the effects of confounding by controlling for enrollment month (and therefore timing of survey) in the multivariate analyses. Second, the current study focused on women who are

members of integrated health care delivery systems and thus may not be representative of the general population of pregnant women for reasons including their access to regular prenatal visits and low-cost or free influenza vaccination. Furthermore, our population included predominately non-Hispanic, Caucasian, well-educated, married pregnant women, suggesting that findings related to race and ethnicity in particular should be interpreted with caution. Finally, a limitation of the health beliefs survey used for this study is that each Health Belief Model domain was not equally represented in terms of the number of items included. Specifically, domains 1, 3, and 4 contained three or four items each, whereas domains 2 and 5 were represented by only one or two questions. This survey design may have influenced the results of the factor analysis.

Conclusions

Our findings highlight that provider recommendation to vaccinate remains one of the most important factors in determining influenza vaccination during pregnancy. Certain domains of the Health Belief Model (i.e., benefits of vaccination and barriers to vaccination) may also offer a useful framework for better understanding of critical health beliefs that are associated with vaccination. Public health initiatives should focus on increasing trust in vaccine safety and effectiveness. Likewise, pregnant women's misperceptions about vaccination still need to be overcome in this priority group.

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Author Disclosure Statement

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