

# 2009 Pandemic Influenza A Vaccination of Pregnant Women King County, Washington State, 2009–2010

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**Purpose:** The objectives were to estimate 2009 pandemic influenza A (pH1N1) vaccination coverage among pregnant women and identify associated factors.

**Methods:** A multimodal survey was distributed to 5341 women who gave birth between November 1, 2009, and January 31, 2010, identified by hospitals in King County, Washington State, with maternity services ( $n=11$ ).

**Results:** Of 4205 respondents, 3233 (76.9%) reported that they had received pH1N1 vaccine during pregnancy or within 2 weeks after delivery. Women whose prenatal care provider recommended vaccine had a higher vaccination prevalence than women whose provider did not (81.5% vs 29.6%; adjusted prevalence ratio=2.1; 95% CI=1.72, 2.58). Vaccination prevalence was lower among women who had received prenatal care from a midwife only compared with women who had received care from other providers (62.9% vs 78.8%; adjusted prevalence ratio=0.89; 95% CI=0.83, 0.96).

**Conclusions:** Among pregnant women in King County, pH1N1 vaccination coverage was high. To improve coverage during nonpandemic seasons, influenza vaccine should be recommended routinely by prenatal care providers and vaccination provided where prenatal care is received. Barriers to midwives providing vaccination recommendations to patients should be explored.

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Pregnant and early postpartum women, particularly those in the second or third trimester of pregnancy through the second week postpartum, and their infants, are at increased risk for serious complications from influenza virus infection.<sup>1–5</sup> During the 2009 influenza A (H1N1) pandemic, pregnant women had a higher hospitalization rate than the general population and accounted for a higher than expected proportion of deaths; approximately 5% of 2009 pandemic influenza A (pH1N1)-related deaths in the U.S. were among pregnant women, compared with the estimated 1% of the general U.S. population who are pregnant at any given time.<sup>1,6–8</sup> Likewise, infants aged less than 6 months had the highest rates of pH1N1-related hospitalizations among all children during the pandemic.<sup>9</sup> Increased morbidity and

mortality among pregnant women and their infants have been observed during previous influenza pandemics and nonpandemic influenza seasons.<sup>10–12</sup>

Vaccination of pregnant women against influenza is recommended by the Advisory Committee on Immunization Practices (ACIP) and the American Congress of Obstetricians and Gynecologists (ACOG) to protect the mother and her newborn infant.<sup>13,14</sup> During the 2009 pandemic, pregnant women were one of the groups at high risk and prioritized by the CDC to receive initial supplies of pH1N1 vaccine, which started becoming available nationally on October 5.<sup>15</sup> However, annual vaccine uptake among pregnant women typically has been low<sup>13,16–18</sup>; national vaccine coverage among pregnant women during the 2007–2008 and 2008–2009 influenza seasons was 24.2% and 11.3%, respectively.<sup>13</sup> Barriers to maternal influenza vaccination that have been identified include vaccine safety concerns and misperception regarding risk of influenza infection.<sup>18–20</sup>

Beginning in September 2009, Public Health–Seattle and King County (PHSKC) implemented an enhanced vaccination strategy to increase influenza vaccination of

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pregnant women; PHSKC serves a population of more than 1.9 million residents, and nearly 30,000 births occur in the county each year. All 11 hospitals in the county with maternity services were requested to implement processes to ensure that all pregnant women delivering in their hospitals had access to pH1N1 vaccination. In addition, PHSKC requested that prenatal care providers (i.e., obstetricians, family practitioners, and midwives), including obstetricians in King County (KC) who typically do not vaccinate patients, recommend and administer the vaccine to their pregnant patients. All 11 hospitals complied with this request by making vaccine available through their affiliated prenatal care providers (i.e., those who deliver babies at their hospital) as soon as supplies permitted; one hospital established a hospital-based vaccination clinic that provided influenza vaccines to women planning to deliver at that hospital. Women were referred to the hospital-based clinic by prenatal care providers with obstetric privileges at that hospital and completed hospital registration as part of scheduling a vaccination appointment. The local chapter of ACOG also actively encouraged obstetricians, through e-mails and newsletters, to recommend influenza vaccination. In addition, a limited number of PHSKC vaccination clinics, located at community centers throughout the county, provided and prioritized vaccine at no cost for pregnant women of all ages.

To evaluate the effectiveness of the pH1N1 vaccination strategy for pregnant women, PHSKC surveyed women in KC who were pregnant when the pH1N1 vaccine became available. The objectives of this evaluation were to estimate pH1N1 vaccination coverage among women in KC during the third trimester of pregnancy and to identify sociodemographic factors, beliefs, and practices associated with vaccination.

## Methods

Women were included in the study if they were KC residents and had given birth at a KC hospital between November 1, 2009, and January 31, 2010. During this time frame, supplies of pH1N1 vaccine became available to hospitals and providers caring for pregnant women; initial supplies, which started arriving in KC during the third week of October, were limited, and the majority of women who delivered during that time would have been in their third trimester and should have been prioritized for vaccination by providers. To identify study participants, PHSKC requested that all 11 KC hospitals with maternity services provide a list of all deliveries among KC residents during the specified time, including the delivery date and the mother's name, date of birth, address, telephone number, race/ethnicity, primary language, and pH1N1 vaccination status (if available). Pregnant women who were KC residents but did not deliver during the specified time, delivered at a hospital outside KC, or delivered at home or at a birthing facility

operated by a midwife were not included in the current study. Women who experienced a stillbirth were included.

To maintain privacy, each mother was assigned a unique identifier that was used throughout the study. During April 12, 2010, through June 30, 2010, a multimodal (paper, telephone, and Internet) cross-sectional survey was sent to women who met the study's inclusion criteria. The anonymous 23-question survey, available in both English and Spanish, was mailed to study participants along with a \$2 incentive. Four days later, a contracted survey group called the mothers and offered the option of completing the survey by telephone. Two follow-up letters were mailed 2 weeks apart to nonrespondents; the first contained an Internet link to the survey available online, and the second contained another paper copy of the survey. A lottery incentive to win \$100 was included in the final mailing. Attempts were made to contact mothers by telephone until they completed the survey, refused, or were identified as having invalid contact information.

Survey questions asked about prenatal care, receipt of pH1N1 and seasonal influenza vaccine during pregnancy or within 2 weeks of delivery (when risk remains elevated), prenatal care providers' recommendations for pH1N1 vaccination, availability of vaccination through prenatal care providers, location of immunization receipt, perception about risk for serious illness from pH1N1 or seasonal influenza infections, reasons for not getting vaccinated (if applicable), preferred location to receive vaccination, and sociodemographic information (mother's date of birth, race/ethnicity, language, education level, insurance coverage, underlying risk factors in addition to pregnancy, and parity at the time of the survey). To help respondents differentiate between seasonal influenza vaccine and pH1N1 vaccine, a paragraph was included describing the two influenza vaccines available during the 2009–2010 influenza season in the survey.

Survey data were analyzed by using SAS 9.1. Frequencies were calculated for categorical variables. Unadjusted and adjusted log binomial regression models were used to estimate pH1N1 vaccination prevalence ratios. Women were excluded from the regression analyses if they did not indicate whether they had received the pH1N1 vaccine ( $n=32$ ). The following sociodemographic variables were included in the final regression analysis model: maternal age at the time of the survey (<20, 20–24, 25–29, 30–34,  $\geq 35$  years); maternal race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and non-Hispanic other); maternal language (English, Spanish, other); highest level of maternal education (<college degree,  $\geq$ college degree); and insurance coverage (private insurance, other, or none). On the basis of factors associated with influenza vaccine receipt identified in previous studies, the following variables were also included in the final regression analysis model: prenatal care provider (midwife only vs other provider, including obstetrician, family practitioner, community clinic, and hospital-based clinic); vaccine recommendation by the prenatal care provider (yes vs no); vaccine availability through the prenatal care provider (yes vs no); and perception of risk for serious illness from pH1N1 infection (high risk vs not at high risk or does not know). Interaction terms were examined but determined to be nonsignificant, and they were not included in the final model.  $P$ -values of  $\leq 0.05$  were considered to be significant in all analyses. This survey was conducted as a public health program evaluation and classified as nonresearch by the Washington State IRB and a CDC human participants review coordinator.

**Table 1.** Socioeconomic characteristics of pregnant women in King County, Washington State, who participated in a 2009 pandemic influenza A vaccination survey, 2009–2010

Characteristic	n (%)
<b>Age, years (&lt;0.1% missing data)</b>	
<20	126 (3.0)
20–24	525 (12.5)
25–29	1037 (24.7)
30–34	1359 (32.3)
≥35	1156 (27.5)
<b>Race/ethnicity (0.8% missing data)</b>	
Non-Hispanic white	2274 (54.5)
Non-Hispanic Asian/other Pacific Islander	882 (21.2)
Hispanic	563 (13.5)
Non-Hispanic black	319 (7.7)
Non-Hispanic Native Indian/Alaska Native	35 (0.8)
Non-Hispanic other (including biracial)	97 (2.3)
<b>Primary language (0.4% missing data)</b>	
English	2973 (71.0)
Spanish	364 (8.7)
Other	851 (20.3)
<b>Highest education level completed (0.6% missing data)</b>	
<high school diploma	324 (7.8)
High school diploma	994 (23.8)
College degree	1685 (40.3)
Graduate degree	1066 (25.5)
Other or technical degree	110 (2.6)
<b>Parity (1% missing data)</b>	
First pregnancy	1857 (44.6)
Second or subsequent pregnancy	2308 (55.4)
<b>Healthcare coverage<sup>a</sup> (0.5% missing data)</b>	
Private health insurance	2827 (67.6)
Medicaid or Medical Assistance program	1118 (26.7)
Military	31 (0.7)
Indian Health Service or Alaska Native Health Service	9 (0.2)
Other source	100 (2.4)
No insurance	182 (4.4)
<b>Underlying risk factors (0.3% missing data)</b>	
Asthma or chronic lung disease	309 (7.3)

(continued)

**Table 1.** (continued)

Characteristic	n (%)
Immunosuppressive disorder	51 (1.2)
Diabetes	49 (1.2)
None	3805 (90.5)
<b>Prenatal care provider<sup>a</sup> (6.5% missing data)</b>	
Obstetrician	2933 (74.6)
Midwife	379 (9.6)
Family medicine provider	321 (8.2)
Community clinic or public health clinic	307 (7.8)
Hospital-based pH1N1 vaccination clinic for pregnant women	26 (0.7)
Other provider	43 (1.1)
No prenatal care	10 (0.3)

Note: The sample size was  $n=4205$ .<sup>a</sup>Respondents could select more than one answer option. pH1N1, pandemic influenza A

## Results

A total of 5341 pregnant women reported by hospitals met the inclusion criteria; of those, 4205 (78.7%) completed the survey (56% paper, 40% telephone, and 4% Internet). The median age of respondents was 31 years (range=13–49 years); 54.5% were non-Hispanic white; 21.2% were non-Hispanic Asian or other Pacific Islander; 13.5% were Hispanic; 7.7% were non-Hispanic black; and 0.8% were non-Hispanic American Indian/Alaska Native (Table 1). Seventy-one percent of survey respondents spoke English as their primary language. Sixty-eight percent of respondents reported having private medical insurance, and 31.1% received Medicaid or Medical Assistance or had no insurance. Approximately all (99.6%) respondents reported having prenatal care during their most recent pregnancy; 74.6% of respondents received prenatal care from an obstetrician (Table 1).

Of the 4205 respondents, 76.9% (95% CI=75.6, 78.1) reported having received the pH1N1 vaccine, and 70.9% (95% CI=69.6, 72.3) reported having been vaccinated against seasonal influenza; 62.0% (95% CI=60.6, 63.5) had received both vaccines during their most recent pregnancy or within 2 weeks after delivery. Vaccination prevalence was higher among Hispanic women (80.7%) and lower among non-Hispanic black women (69.7%), compared with non-Hispanic white women (77.0%), although these differences did not reach significance in the final model (Table 2). English or Spanish speakers were significantly more likely to have been vaccinated than were women who spoke a language other than English or Spanish (79.0% and 85.9% vs 68.7%, respectively).

**Table 2.** 2009 pandemic influenza A vaccination prevalence among pregnant women in King County, Washington State, by SES, belief about influenza risk, and practice variables, 2009–2010

Predictor variable	% (95% CI)	Unadjusted prevalence ratio (95% CI)	Adjusted prevalence ratio (95% CI)
<b>Race/ethnicity (n=4139)</b>			
Non-Hispanic white	77.0 (75.2, 78.7)	1.00 (ref)	1.00 (ref)
Hispanic	80.7 (77.2, 83.7)	1.05 (1.00, 1.10)	1.02 (0.95, 1.09)
Non-Hispanic black	69.7 (64.4, 74.6)	0.91 (0.84, 0.98)	0.99 (0.93, 1.05)
Other	79.4 (76.8, 81.8)	1.03 (0.99, 1.07)	1.01 (0.98, 1.04)
<b>Maternal age, years (n=4171)</b>			
<20 (ref)	69.6 (61.1, 77.0)	1.00 (ref)	1.00 (ref)
20–24	69.4 (65.3, 73.2)	1.07 (1.00, 1.15)	1.04 (0.98, 1.11)
25–29	74.3 (71.5, 76.9)	1.15 (1.08, 1.22)	1.06 (1.00, 1.12)
30–34	79.7 (77.5, 81.8)	1.00 (0.88, 1.14)	1.01 (0.91, 1.13)
≥35	82.1 (79.8, 84.3)	1.18 (1.11, 1.26)	1.07 (1.01, 1.13)
<b>Highest education level completed (n=4151)</b>			
<college degree (ref)	73.8 (71.4, 76.0)	1.00 (ref)	1.00 (ref)
Undergraduate or graduate degree	79.5 (78.0, 81.0)	1.08 (1.04, 1.12)	1.00 (0.96, 1.03)
<b>Language (n=4160)</b>			
English (ref)	79.0 (77.5, 80.4)	1.00 (ref)	1.00 (ref)
Spanish	85.9 (82.0, 89.1)	1.09 (1.04, 1.14)	1.02 (0.95, 1.10)
Other	68.7 (65.5, 71.8)	0.87 (0.83, 0.91)	0.93 (0.89, 0.97)
<b>Healthcare coverage (n=4152)</b>			
Private insurance	80.4 (78.9, 81.8)	1.12 (1.08, 1.17)	1.02 (0.99, 1.06)
Other or no insurance (ref)	71.7 (69.2, 74.0)	1.00 (ref)	1.00 (ref)
<b>Location of prenatal care (n=3873)</b>			
Midwife only	62.9 (57.6, 68.0)	0.80 (0.73, 0.87)	0.89 (0.83, 0.96)
Other provider (ref)	78.8 (77.5, 80.2)	1.00 (ref)	1.00 (ref)
<b>Had vaccine recommended by provider (n=4032)</b>			
No (ref)	29.6 (24.5, 35.2)	1.00 (ref)	1.00 (ref)
Yes	81.5 (80.2, 82.7)	2.76 (2.30, 3.31)	2.10 (1.72, 2.58)
<b>Provider had vaccine available (n=3926)</b>			
No (ref)	71.7 (68.4, 74.8)	1.00 (ref)	1.00 (ref)
Yes	81.6 (80.2, 82.9)	1.14 (1.09, 1.19)	1.14 (1.09, 1.19)
<b>Belief about pH1N1 risk (n=4161)</b>			
High risk	85.4 (84.0, 86.6)	1.39 (1.33, 1.45)	1.27 (1.21, 1.33)
Not at high risk or does not know (ref)	61.6 (59.0, 64.2)	1.00 (ref)	1.00 (ref)

pH1N1, pandemic influenza A

Women who recalled receiving a recommendation for vaccination by their prenatal care provider (reported by 93.1% of women) had a substantially higher prevalence of pH1N1 vaccination compared with women who did not

recall their provider recommending vaccination (81.5% vs 29.6%; adjusted prevalence ratio [APR]=2.10; 95% CI=1.72, 2.58). Vaccination prevalence was higher among women who had received prenatal care from a

family practitioner (83%) or an obstetrician (78%) than from a midwife only (62.9%). Among women who had received prenatal care from a midwife only, 71.2% of those whose midwife was associated with a hospital system (HM; reported by 69.1%) were vaccinated, compared with 46.9% of those who had received prenatal care from an independent midwife (IM; reported by 30.9%;  $p < 0.001$ ). Women who had received prenatal care from a midwife only (both HM and IM) also were less likely to report that they had received a recommendation for pH1N1 vaccination than were women who had received care from other provider types (83.8% vs 94.1%;  $p < 0.001$ ).

Women whose prenatal care providers made vaccination available in their offices or through another location (reported by 76% of women) were more likely to have been vaccinated compared with women whose providers did not (81.6% vs 71.7%; APR=1.14; 95% CI=1.09, 1.19). Ninety percent of women who had received prenatal care from a family practitioner reported that their provider had made vaccination available, compared with 78.7% of women who received care from an obstetrician or 72.4% of women who had received care from a midwife only (both HM and IM). Among unvaccinated women, 20.6% stated that not being able to find a vaccination provider was a reason for not having been vaccinated (Table 3); 11% of these respondents were non-Hispanic white, 1% were non-Hispanic black, 2.9% were Hispanic, and 5.3% were another race/ethnicity. Sixty-five percent of vaccinated and unvaccinated women who responded to the survey reported that their obstetrician's office would be the most convenient vaccination location, followed by a pharmacy (8.4%). A substantial proportion of women

(45.3%) were vaccinated at their obstetrician's office during the 2009–2010 influenza season. Few women (1.8%) were vaccinated in the hospital postpartum.

Women who believed that they had been at high risk for serious complications if infected with pH1N1 had a higher prevalence of pH1N1 vaccination compared with women who had not believed that they were at high risk or who had not known their risk (85.4% vs 61.6%; APR=1.27; 95% CI=1.21, 1.33; Table 2). Among unvaccinated women, 26.1% reported that a perception that they were not at risk for serious illness was a reason for not being vaccinated (Table 3). Thirty-six percent of women who had received prenatal care from a midwife only (both HM and IM) reported this misperception as a reason for not having been vaccinated compared with 24.5% of women who had received care by another provider type.

The most commonly reported reason for not receiving influenza vaccination was safety concerns, reported by 58% of unvaccinated women (Table 3). Safety concerns included ones regarding the effects of the vaccine on the mother's health or the fetus. Seventy-four percent of women who had received prenatal care from a midwife only (both HM and IM) reported safety concerns as a reason for not being vaccinated (50.8% were non-Hispanic white, 5.8% non-Hispanic black, 8.3% Hispanic, and 9.2% of another race/ethnicity), compared with 56.7% of women who had received prenatal care from another provider type. Some unvaccinated women reported in the comments section that they had become sick as a result of being vaccinated in the past, and others believed that they had become infected with influenza during previous seasons despite being vaccinated. Fifty-three percent of all women who responded to the survey planned to get the influenza vaccination for the next season, 27% were undecided, and 20% did not plan to get vaccinated.

**Table 3.** Reasons for not receiving the 2009 pandemic influenza A vaccine while pregnant or within 2 weeks after delivery<sup>a</sup>

Reason	%
I was concerned about the safety of the vaccine.	58.3
I did not think I was at risk for serious illness with 2009 pH1N1 (swine) influenza.	26.1
I could not find the vaccine.	20.6
My provider did not recommend it.	9.6
I do not normally get a flu vaccination.	5.1
The cost was too high.	0.6
Some other reason.	10.1

Note: Respondents could select more than one answer option. The sample size was  $n=940$ .

<sup>a</sup>Among unvaccinated survey respondents, King County, Washington State  
pH1N1=pandemic influenza A

## Discussion

The current paper describes the findings of a large survey with a high response rate among pregnant women from diverse racial/ethnic and sociodemographic backgrounds. The results indicate that approximately 77% of mothers responding to the survey who delivered between November 1, 2009, and January 31, 2010, were vaccinated while pregnant or within 2 weeks after delivery. This estimate is considerably higher than the CDC estimate that 46.6% of all pregnant women had received pH1N1 vaccine during the 2009–2010 influenza season nationally.<sup>21</sup> National vaccination rates among pregnant women during past influenza seasons have ranged from 10% to 25% consistently.<sup>13</sup> Although the current findings

should be considered in light of the fact that they were obtained during an influenza pandemic, the vaccination rates reported are encouraging and might be attributable in part to using enhanced vaccination strategies that should be considered during nonpandemic influenza seasons.

Multiple correlates of pH1N1 vaccination were identified. After controlling for selected confounders, it was determined that women whose prenatal care provider recommended vaccination, women whose provider made vaccination available, and women who understood that they and their infants were at high risk for serious illness if infected with influenza virus were substantially more likely to have been vaccinated compared with other women. These findings are consistent with previously reported correlates of seasonal influenza vaccination,<sup>17,18,20</sup> and they highlight the essential role of prenatal care providers in maximizing influenza vaccination rates among pregnant women. Studies have reported that obstetricians believe that women should be vaccinated by their primary care provider or through public health efforts, rather than by an obstetrician,<sup>18,22</sup> yet the majority of women in the current study reported that their obstetrician's office would be the most convenient place to receive influenza vaccination.

During the 2009–2010 influenza season, at the request of PHSKC and with support from hospitals providing maternity services, obstetricians and other prenatal care providers recommended and made vaccination readily available to their pregnant patients, which required a change in routine operations for the majority of obstetrics offices and clinics. The current results demonstrate that seasonal influenza vaccination rates might be improved if more pregnant women are informed of their risk for serious influenza-related illness, if more providers recommend influenza vaccination, and if more providers offer to administer influenza vaccine to their patients. Nearly 21% of unvaccinated women reported that they were not vaccinated because vaccination was not available. Until more prenatal care providers routinely offer influenza vaccination in their offices and clinics, hospital-based vaccination clinics or postdelivery hospital-based immunization programs might be an effective alternative for increasing influenza vaccination coverage among pregnant and early postpartum women.

Approximately 60% of unvaccinated women reported that concern regarding pH1N1 vaccine safety was the main reason that they had not been vaccinated. In Washington State, vaccine safety concerns among pregnant women might have been elevated because of a state law (RCW 70.95M.115) effectively prohibiting administration of vaccines containing mercury as a preservative to pregnant women and to children aged <3 years. Al-

though this law was suspended during the pandemic, the law required healthcare providers who offered a preservative-containing vaccine to pregnant or lactating women to inform them that they were receiving a vaccine with more mercury than is usually allowed in Washington State. Influenza vaccines are considered safe for pregnant women, and vaccination is recommended by CDC, ACIP, and ACOG because it is an effective strategy to prevent influenza infections among pregnant women and their infants through age 6 months.<sup>13,14,23–25</sup> This is particularly important because infants are ineligible to receive influenza vaccine until they are aged  $\geq 6$  months. Prenatal care providers should increase efforts to counsel pregnant women about the safety of influenza vaccines and to allay concerns about harmful effects of the vaccine that might be a barrier to vaccine receipt.

The current findings also indicate that women who received prenatal care from a midwife only (both HM and IM) were considerably less likely to be vaccinated against pH1N1 or to have vaccination recommended to them compared with women who received prenatal care from other types of providers. Moreover, among women who received care from a midwife only, the vaccination prevalence was significantly higher among those receiving care from a midwife associated with a hospital system compared with those by independent midwives or midwives working in a clinic not associated with a hospital. Independent midwives might not have been part of a team of prenatal care providers that included obstetricians or other physicians.

This finding might partly be explained by the fact that independent midwives were less likely to have vaccine available because, according to predetermined shipment arrangements with the national vaccine distributor, providers in KC had to order 100 or more doses of vaccine from PHSKC. Women who received prenatal care from a midwife only reported a lower prevalence of vaccine availability through their providers compared with women who received care from a family practitioner or obstetrician. Still, it was determined that women who had received prenatal care from a midwife (both HM and IM) were less likely to report that vaccine was recommended to them and more likely to report safety concerns and misperception about risk of influenza infection as reasons for not having been vaccinated compared with those who received care from other providers.

Outreach by PHSKC and local ACOG to prenatal care providers about the importance of influenza vaccination during pregnancy did not specifically target midwives, and it is unclear how much, if any, of this information midwives received. Additional studies exploring the reasons for lower vaccination coverage among midwifery patients should be done. In the interim, public health

professionals might consider extending influenza vaccine education efforts to midwives and encouraging them to recommend and, where possible, administer vaccine to their pregnant patients.

This study had potential limitations. The survey was conducted with mothers who had delivered when vaccine became available locally; because women in their third trimester of pregnancy were at high risk and received a higher priority for receiving limited supplies of vaccine than women in other trimesters, had the survey included all pregnant women (rather than just those who delivered during a 3-month timeframe), it might have yielded a lower estimate of pH1N1 vaccination prevalence than that reported here. However, in a PHSKC survey, nearly all prenatal care providers in KC reported that they recommended influenza vaccination to their pregnant patients, and they estimated that they had vaccinated more than 75% of their pregnant patient population during the 2009–2010 influenza season (personal communication, Kathryn G. Koelemay, MD, MPH, PHSKC, January 24, 2011), which indicates that the coverage rate might not have decreased substantially if women in all trimesters of pregnancy had been included, given sufficient availability of vaccine. The current survey included only mothers who delivered at a KC hospital and not women who delivered at home, at a birthing center, or outside KC ( $n=319$  mothers). In addition, according to statistics provided by Washington State Department of Health Center for Health Statistics, which were requested to verify sample completeness, 134 eligible hospital births were not reported by the hospitals. For these reasons, the current study might have potential undercoverage and under-reporting, and results might not be generalizable to the entire population of pregnant women in KC.

Approximately all women who responded to the current survey reported that they had had prenatal care during their most recent pregnancy. This finding suggests potential for nonresponse bias in that nonresponders might have had less access to prenatal care and lower rates of pH1N1 vaccination. However, the authors do not believe that these limitations would change the conclusions because even if every woman who had given birth outside a KC hospital during the study period or who did not respond to the survey ( $n=1621$ ) had not been vaccinated, pH1N1 vaccination coverage would be 56% (3233 of 5794), higher than CDC national estimates (46.6%)<sup>21</sup> or vaccination prevalence estimates among pregnant women during a typical influenza season (10%–25%).<sup>13</sup>

There is also potential for misclassification or recall bias because women were not asked directly the name of the facility where they had been vaccinated, but where they had received prenatal care and whether they had been vaccinated in the same facility where they received

prenatal care. Vaccination location was then derived from the answers provided. Also, it was not possible to verify that women who did not recall receiving a vaccination recommendation actually did not receive one. The authors believe the potential for misclassification by provider type was low because the majority of women in the study reported the specific name of their provider, which allowed verification of the information and corrections to be made as indicated. Efforts were also taken to minimize misclassification by vaccine type by clearly describing the difference between the pH1N1 and seasonal influenza vaccines in the survey, and separate questions were asked for each vaccine type.

The high vaccination prevalence estimates that are reported here might have been a result of the enhanced effort between the public health program, prenatal care providers, and hospitals that provide maternity services to ensure vaccination of pregnant women in a pandemic situation. The current findings underscore the prenatal care provider's role in improving vaccination rates among pregnant women. Seasonal influenza vaccination coverage rates might improve if providers recommend influenza vaccine, make it available in their offices, counsel women about the risks for influenza infection among pregnant women and their newborns, and educate women about the vaccine's safety.

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