Trends in Influenza Vaccine Coverage in Pregnant Women, 2008 to 2012

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Abstract

Context: Pregnant women are at increased risk of severe influenza-related complications and hospitalizations and are a priority group for influenza vaccination.

Objective: To examine coverage of seasonal and pandemic influenza A (H1N1) vaccines in pregnant women in a managed care setting, from 2008 to 2012.

Design: Retrospective cohort study of 10,145 pregnant women.

Main Outcome Measures: H1N1 and seasonal influenza vaccination rates.

Results: Seasonal influenza vaccine coverage increased from 38% to 63% between the 2008-2009 and 2010-2011 seasons, and then dropped to 61% in 2011-2012. Vaccine coverage was higher in women considered at high risk of influenza complications, increasing from 43% in 2008-2009 to 71% in 2010-2011, before decreasing to 69% in 2011-2012. H1N1 vaccine coverage was greater than seasonal influenza coverage in 2009-2010 in the overall pregnant population (61% vs 53%) and in the high-risk group (64% vs 59%). We observed statistically significant differences in vaccination rates by trimester, gravidity, maternal age, and race/ethnicity.

Conclusions: Vaccination rates increased significantly from 2008 to 2011, then dropped slightly in 2011-2012. Continued efforts are needed to ensure adequate vaccination coverage in this high-risk population.

Introduction

Pregnant women are at increased risk of severe influenza-related complications and hospitalizations.[1-7] Physiologic changes in the respiratory, cardiovascular, and immune systems during pregnancy may contribute to this increased risk.[8-10] In addition, women who are infected with influenza during pregnancy may have an increased risk of adverse outcomes such as preterm delivery, small-for-gestational-age infants, lower-birth-weight babies, and stillbirths.[11-14] The inactivated influenza vaccine is considered both safe and effective to use during pregnancy.[15-20] The American College of Obstetricians and Gynecologists and the Advisory Committee on Immunization Practices have recommended that pregnant women receive seasonal and pandemic influenza vaccinations, regardless of trimester.[21,22] There is also evidence that infants of vaccinated mothers have increased passive immunity, as well as significantly fewer influenza infections and hospitalizations than infants of unvaccinated mothers.[6,20,23-25]

Despite the recommendations of professional medical societies and good evidence for its benefits, influenza vaccination rates in pregnant women have historically been low.[6] Before 2009, vaccination coverage in pregnant women ranged from less than 10% to 33%.[17,26,27] Seasonal vaccination rates have risen dramatically since the 2009 H1N1 pandemic, with recent vaccination coverage rates during pregnancy reported at approximately 50%,[27-29] but still fall well below the Healthy People 2020-recommended target of 80% vaccination coverage for pregnant women.[30]

The goal of this retrospective cohort study was to compare seasonal trivalent influenza vaccine (TIV) coverage rates in pregnant women during four consecutive influenza seasons (2008-2009, 2009-2010, 2010-2011, 2011-2012), as well as the novel monovalent pandemic H1N1 vaccine (MIV) during the 2009-2010 influenza season. We also describe vaccination patterns observed by maternal factors such as high-risk medical conditions, trimester of pregnancy, gravidity, age at vaccination, and race/ethnicity.

Methods

We identified 13,975 pregnancies (of 12,036 women) that occurred during 4 consecutive influenza seasons, defined as October 1 through March 31 of each year (2008 to 2012) at Kaiser Permanente Northwest (KPNW), a managed care organization serving 470,000 members in Oregon and Washington. Of these, 11,086 pregnancies (10,145 women) met the following inclusion criteria: estimated date of delivery recorded in Health Plan databases, at least 12 months of membership in the year before October 1 of each influenza season, pregnant (1 to 41 weeks' gestational age) at either of 2 vaccine index dates (MIV index date or TIV index date), and had a prenatal visit scheduled between the pregnancy start date and 40 weeks' gestation. Pregnancy start date was calculated as 40 weeks before the estimated date of delivery.

Multiple pregnancy episodes (including pregnancies ending in live births, spontaneous abortions, and therapeutic abortions) during the study period were allowed, but the sample was unduplicated so that we did not select more than one pregnancy episode per woman per influenza season. In instances when a woman had more than one pregnancy episode per influenza season (n = 145), we selected the first episode for inclusion in analyses.

We obtained vaccination data from Health Plan databases and the Oregon state immunization registry.[31] Most pregnant women in our Health Plan are vaccinated at influenza vaccination clinics, typically offered during October of each year, well before the usual peak of influenza in our community (typically January to February). However, a small number of women may be vaccinated at a prenatal visit, in a nurse treatment room, or outside the Health Plan.

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We defined vaccine coverage as the total number of vaccinated pregnant women divided by the total eligible population of pregnant women. Eligible TIV and MIV populations were defined independently. For each population, we used the date of TIV or MIV vaccination recorded in the Health Plan database as index dates. We randomly assigned index dates to unvaccinated women, which matched the vaccination date distribution of vaccinated women in the relevant population. Women who were not pregnant on their TIV index date were excluded from TIV analysis, and those not pregnant on their MIV index date were excluded from the MIV analysis.

We defined trimester by weeks of gestation at the TIV or MIV index date (first trimester, 1 to 13 weeks' gestation; second trimester, 14 to 27 weeks' gestation; third trimester, 28 to 41 weeks' gestation). Gravidity was defined as the cumulative number of pregnancies as assessed and recorded in the electronic medical record (EMR) by clinicians. This count includes the current pregnancy as well as prior pregnancies of any outcome. To ensure that the current pregnancy was counted, we selected the latest gravidity assessment between 8 weeks of gestation and the estimated date of delivery.

We defined high-risk status using medical record data from the year before each influenza season. We categorized women with ICD-9 codes for the following disease categories as high risk: chronic cardiac disease, chronic pulmonary disease, chronic renal disease, diabetes mellitus, hemoglobinopathies, immunosuppressive disorders, malignancies, metabolic diseases, liver diseases, and selected neurological/musculoskeletal conditions (Table 1).

Table 1. High-risk conditions for influenza complications

High-risk category and subcategory	ICD-9 codes[a]
Chronic cardiac disease	
Acute rheumatic fever	391-392
Chronic rheumatic heart disease	393-398
Hypertensive heart disease	402, 404
Ischemic heart disease	410-414
Diseases of pulmonary circulation	416-417
Other forms of heart disease	421, 423- 425, 427.1-427.5, 427.8, 428-429
Atherosclerosis, polyarteritis nodosa	440, 446
Congenital anomalies	745-747
Surgical/device conditions	V42.1, V45.0, V45.81, V45.82
Cardiovascular syphilis	093
Candidal endocarditis	112.81
Myocarditis caused by toxoplasmosis	130.3
Chronic pulmonary	
Other metabolic and immunity disorders	277.0, 277.6
COPD and allied conditions	491-496
Pneumoconioses/other lung diseases caused by external agents	500-506, 507.0-507.1, 508
Other diseases of respiratory system	510, 513-517, 518.0-518.3, 519.0, 519.9
Congenital anomalies	748.4-748.6, 759.3
Lung transplant	V42.6
Tuberculosis	011, 012
Diseases due to other mycobacteria	031.0
Sarcoidosis	135
Chronic renal disease	
Hypertensive renal disease	403
Nephritis, nephrotic syndrome, and nephrosis	581-583, 585-587, 588.0, 588.1
Chronic pyelonephritis	590.0
Other specified disorders of kidney and ureter	593.8
Dialysis and transplant	V42.0, V45.1, V56
Diabetes mellitus	
Diabetes mellitus	250-251, 648.0
Complications of diabetes	357.2, 362.0, 362.11, 366.41
Hemoglobinopathies	
Anemias	282-284
Immunosuppressive disorders	
HIV/Retroviral disease	042-044, 079.5, V08
Disorders involving immune mechanism	279
Diseases of blood and blood-forming organs	288.0, 288.1, 288.2
Polyarteritis nodosa	446
Diseases of musculoskeletal system and connective tissue	710.0, 710.2, 710.4, 714
Organ/tissue transplants	V42.0-V42.2, V42.6-V42.9
Radiation/chemotherapy	V58.0, V58.1
Malignancies	
No subcategory	140-208
Other metabolic and immunity disorders	
Disorders of adrenal glands	255
Other disorders	270, 271, 277.2, 277.3, 277.5, 277.8
Liver diseases	
Chronic liver disease and cirrhosis	571
Liver abscess and sequelae of chronic liver disease	572.1-572.8
Neurological/musculoskeletal	
Psychotic conditions	290, 294.1
Mental retardation	318.1, 318.2
Hereditary and degenerative diseases of CNS	330-331, 333.0, 333.4-333.9, 334, 335
Other disorders of CNS	340, 341, 343, 344.0
Disorders of peripheral nervous system	358.0, 358.1, 359.1, 359.2
Late effects of CVD	438
Chondrodystrophy	756.4

[a] ICD-9 codes are listed using the least number of digits possible. Trailing digits are dropped when all codes using these digits are included. For example, the code 255 represents all codes 255.XX. Likewise the code 507.0 represents all codes 507.0X.

CNS = central nervous system; COPD = chronic obstructive pulmonary disease; CVD = cardiovascular disease; HIV = human immunodeficiency virus; ICD-9 = International Classification of Diseases, Ninth Revision.

The KPNW institutional review board reviewed and approved this study protocol. Because this was a retrospective, data-only study, informed consent was waived.

Results

The study population was 73% white. Mean maternal age at index date was 29.5 years, and mean gestational age was 20.3 weeks (Table 2). Most (60%) of the women had a history of 2 or fewer prior pregnancy episodes, and 86% of the participants were classified as having a normal influenza risk.

In the total population of women, TIV coverage increased by 25 percentage points between the 2008-2009 and 2010-2011 influenza seasons, and then dropped slightly during the 2011-2012 influenza season (Figure 1). Coverage rates during the 2008-2009, 2009-2010, 2010-2011, and 2011-2012 seasons were 38%, 53%, 63%, and 61%, respectively. Rates of MIV coverage during the 2009-2010 influenza season were higher than rates of TIV coverage that year (61% vs 53%).

Influenza vaccine coverage was even higher in women (N = 1563 pregnancies) classified as having high risk of influenza complications at the time of pregnancy (Table 3). The TIV coverage in the high-risk influenza group increased from 43% in 2008-2009 to 71% in 2010-2011, before declining slightly to 69% in the 2011-2012 influenza season. Likewise, MIV coverage (2009-2010) in the high-risk influenza group was 64%.

Table 2. Demographic and maternal characteristics of study population

Age at index date (N = 11,086 pregnancies)[a]	Mean ± SD
Maternal age, years	29.5 ± 5.8
Gestational age, weeks	20.3 ± 11.6
Ethnic category (N = 10,145 women)	Number (%)
Hispanic	1113 (11.0)
Not Hispanic	3559 (35.1)
Unknown	5473 (53.9)
Racial categories (N = 10,145 women)	Number (%)
White	7406 (73.0)
Asian/Pacific Islander	917 (9.1)
Black or African American	387 (3.8)
American Indian, Aleutian, or Eskimo	75 (0.7)
Unknown	1360 (13.4)
Gravidity (N = 11,086 pregnancies)[a]	Number (%)
1	3208 (28.9)
2	3021 (27.2)
3	1965 (17.7)
4	1071 (9.7)
≥5	1069 (9.6)
Unknown	752 (6.8)
Influenza risk status (N = 11,086 pregnancies)[a]	Number (%)
High risk	1563 (14.1)
Normal risk	9523 (85.9)

[a] Maternal age, gravidity, and influenza risk status were assessed for each pregnancy episode. Individual women were counted more than once if pregnant in multiple seasons.
SD = standard deviation.

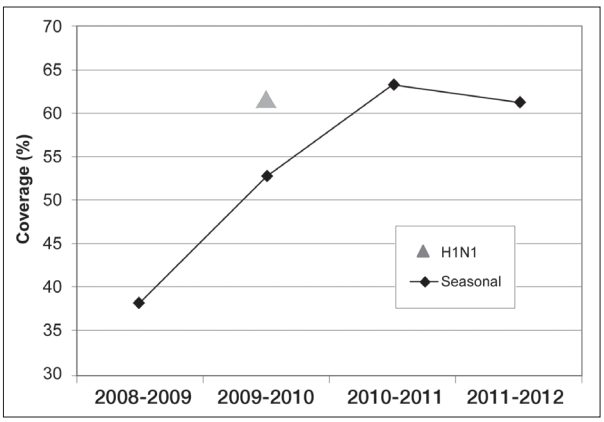

Figure 1. Seasonal and H1N1 influenza vaccination coverage rates, by influenza season.

Triangle = H1N1 influenza vaccination (2009-2010 season only); diamonds = seasonal influenza vaccination.

Nearly all (94%) of the women in our study began their prenatal care during their first trimester. Our data show that women in later pregnancy were generally more likely to get the seasonal vaccination (see Table 3). Although seasonal vaccination rates during the first trimester increased from 35% to more than 50% during the study period, they were still consistently lower than vaccination rates during later pregnancy. There were no significant differences in MIV vaccination rates by trimester during the 2009-2010 influenza season.

Vaccination rates also differed significantly by maternal age and gravidity. During the 2008-2009 and 2009-2010 influenza seasons, the lowest vaccination rates were observed in the 18- to 25-year age group (see Table 3). There were no significant differences by age group during the 2 most recent influenza seasons. In general, higher gravidity (an individual's total number of pregnancies) was associated with lower vaccination rates.

Vaccination coverage increased over the study period for all racial and ethnic groups. The largest increase in TIV coverage occurred in Hispanic women: from 33% in 2008-2009 to 69% in 2011-2012 (see Table 3). In women of known race, the largest increase was seen in black women, from 32% in 2008-2009 to 60% in 2011-2012. During the most recent influenza season studied, the highest vaccination rates were observed among Hispanic (69%) and Asian/Pacific Islander (66%) pregnant women.

Discussion

Vaccination rates in our population of pregnant women increased steadily over the first three influenza seasons during our study period, before declining slightly during the most recent influenza season. The coverage rates we observed are significantly higher than historic rates but are consistent with more recent reports of vaccine coverage.[26-29] We found that rates of MIV coverage during the 2009-2010 influenza season were higher than for TIV coverage, suggesting that improved vaccination rates may have been spurred by increased awareness or concern about H1N1 infection, as well as by increased efforts on the part of clinicians and of our managed care organization to increase vaccination rates in this population.[27] Table 4 summarizes a number of strategies

our Health Plan has implemented over the past several years to improve influenza vaccination coverage during pregnancy, including patient reminders on after-visit summaries, clinician reminders on prenatal visit checklists, and clinician tools and reminders in the EMR.

More than 94% of the women in our study started prenatal care during their first trimester of pregnancy, allowing adequate opportunity for vaccination during early pregnancy. We observed improved coverage rates during the first trimester of pregnancy over the past 4 influenza seasons, which suggests increased awareness of the current guidelines emphasizing that all pregnant women should be vaccinated, regardless of trimester.[21,22] Despite these improvements, during the most recent influenza season we still observed the highest coverage rates in the third trimester. Women often cite concerns about getting vaccinated in early pregnancy as a reason for not receiving influenza vaccines,[26] a fact that supports the need for continued education for both clinicians and patients emphasizing vaccine safety in all trimesters.

Overall, we observed the lowest vaccination rates in the 18- to 25-year age group and in women with a history of more pregnancies. During the 2008-2009 and 2009-2010 influenza seasons, pregnant women age 26 years or older were significantly more likely to get vaccinated than younger women, a finding that is consistent with other published data on this subject.[28,32,33] However, we found no significant differences by age during the 2 most recent influenza seasons studied.

Earlier studies have reported that white women are more likely to be vaccinated than women of other racial and ethnic groups.[29,32,33] Interestingly, in our study population we consistently observed the highest coverage rates in Asian/Pacific Islanders during the entire study period, as well as Hispanics during the last 2 influenza seasons. We saw increases in vaccination coverage in all racial and ethnic groups, but we saw the largest increases in blacks (from 32% in 2008-2009 to 60% in 2011-2012) and Hispanics (from 33% to 69%), to the extent that coverage in these ethnic and racial groups is now on par

Table 3. Maternal characteristics of vaccinated women, 2008-2012

	2008-2009		2009-2010 trivalent influenza vaccine		2009-2010 monovalent influenza vaccine		2010-2011		2011-2012	
Characteristic	Number/total (%)	p value	Number/total (%)	p value	Number/total (%)	p value	Number/total (%)	p value	Number/total (%)	p value
Trimester[a]		0.06		**< 0.0001**		0.15		**< 0.0001**		**< 0.0001**
First (1-13 weeks)	317/918 (35)		379/899 (42)		556/939 (59)		525/900 (58)		554/989 (56)	
Second (14-27 weeks)	396/961 (41)		469/876 (54)		591/950 (62)		553/887 (62)		527/907 (58)	
Third (28-41 weeks)	320/827 (39)		498/780 (64)		535/856 (63)		596/858 (69)		620/881 (70)	
Maternal age[a,b]		**< 0.0001**		**< 0.0001**		**< 0.0001**		0.18		0.06
< 18 years	26/67 (39)		28/58 (48)		35/70 (50)		33/49 (67)		45/60 (75)	
18-25 years	170/631 (27)		244/575 (42)		278/615 (45)		300/507 (59)		319/568 (56)	
26-35 years	676/1629 (42)		872/1558 (56)		1092/1676 (65)		1067/1663 (64)		1060/1721 (62)	
≥36 years	161/379 (42)		202/364 (55)		277/384 (72)		274/426 (64)		277/428 (65)	
Race[c]		**0.0002**		**0.0026**		**0.0004**		0.41		0.27
White	756/1917 (39)		1008/1863 (54)		1241/1995 (62)		1246/1992 (63)		1271/2106 (60)	
Black	35/110 (32)		52/97 (54)		54/100 (54)		58/95 (61)		59/98 (60)	
Asian/Pacific Islander	114/254 (45)		116/208 (56)		155/223 (70)		155/233 (67)		169/257 (66)	
Other/unknown	128/425 (30)		170/387 (44)		232/427 (54)		215/325 (66)		202/316 (64)	
Ethnicity[c]		**0.0019**		**< 0.0001**		**< 0.0001**		**0.0084**		**0.0016**
Non-Hispanic	578/1399 (41)		569/979 (58)		682/1027 (66)		521/801 (65)		437/689 (63)	
Hispanic	93/280 (33)		133/274 (49)		185/304 (61)		204/292 (70)		214/310 (69)	
Unknown	362/1027 (35)		644/1302 (49)		815/1414 (58)		949/1552 (61)		1050/1778 (59)	
Gravidity[a,b,d]		**0.01**		0.16		**0.0008**		**0.0025**		**0.0060**
1	266/665 (40)		401/737 (54)		510/809 (63)		546/831 (66)		549/847 (65)	
2	264/662 (40)		381/724 (53)		476/769 (62)		463/732 (63)		478/786 (61)	
3	154/410 (38)		247/480 (52)		323/508 (64)		295/469 (63)		339/536 (63)	
4	78/239 (33)		136/252 (54)		160/273 (59)		176/276 (64)		145/265 (55)	
≥5	84/251 (33)		124/257 (48)		134/270 (50)		136/257 (53)		156/272 (57)	
Risk for influenza complications[c]		0.06		**0.01**		0.21		**0.0009**		**0.0007**
Normal risk	886/2362 (38)		1129/2185 (52)		1435/2360 (61)		1410/2273 (62)		1408/2350 (60)	
High risk	147/344 (43)		217/370 (59)		247/385 (64)		264/372 (71)		293/427 (69)	

[a] Mantel-Haenszel χ^2. Boldface numbers indicate statistically significant.

[b] Maternal age and gravidity are assessed for each pregnancy episode. Individual women may have been counted more than once if pregnant in multiple influenza seasons.

[c] Chi squared. Boldface numbers indicate statistically significant.

[d] Eighteen percent of gravidity records were missing in the electronic medical record for influenza season 2008-2009.

Table 4. Kaiser Permanente Northwest regional strategies for improving influenza vaccination coverage during pregnancy

Date implemented	Description of strategy
1997-1998	Influenza immunization information was added as a standard "trailer" on after-visit summaries. Summaries are printed directly from the EMR at the end of ambulatory care visits.
June 2008	Department of Obstetrics and Gynecology implemented a clinician checklist with reminder to recommend vaccination to pregnant women during influenza season (defined as November 1 to March 31).
March 2009	Influenza vaccination became a "hard stop" in all inpatient admission order sets. A hard stop means the clinician must order influenza vaccination, note that the patient already received the vaccine, or provide a reason for not ordering the vaccine.
March 2010	Implementation of a set of orders in the EMR for clinicians to use at the "New OB" (first prenatal) visit, including an order for seasonal influenza vaccination.
May 2011	Implementation of a provider tool in the EMR flagging pregnant women who have not yet received influenza vaccination.

EMR = electronic medical record.

with, or exceeding, coverage in other groups. Taken together, these findings suggest that outreach efforts in our Health Plan to improve vaccination coverage in pregnant women (including all age, racial, and ethnic groups) are having a positive impact, such that differences that once existed between groups of pregnant women are no longer as critical.

A major limitation of our study is that our population may not be representative of the general population of pregnant women. Specifically, our study population was predominately white. Furthermore, as members of a managed care organization, our population is more likely to receive earlier and more regular prenatal care than is the general population, thus increasing the opportunity for vaccination during pregnancy.

Conclusion

In summary, we observed significant improvements in influenza vaccine coverage in pregnant women over the past several influenza seasons. We saw higher rates of vaccination in women considered at higher risk of complications from influenza. Consistent with earlier studies, we also saw the highest coverage rates in later stages of pregnancy and in older pregnant women. However, age-related differences in vaccination rates appear to be decreasing over time, such that there were no significant differences by age during the two most recent influenza seasons. Our race/ethnicity findings were somewhat surprising in that coverage rates were fairly consistent across all groups during the most recent influenza season. The lowest coverage rates were observed during the first trimester and in women with a history of more pregnancies, suggesting that these groups of pregnant women may require additional encouragement from their clinicians and public health campaigns to receive influenza vaccination.

Finally, it appears that vaccination coverage in pregnant women may have plateaued, or may even be starting to decline, possibly because of decreasing concern or awareness about influenza as we get farther out from the 2009-2010 H1N1 pandemic. Continued efforts are needed not only to maintain recent improvements in vaccination coverage but also to continue progress toward the Healthy People 2020 target of 80% vaccination coverage in this high-priority group. ❖

Disclosure Statement

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To Go Unvaccinated

If he [my next-door neighbor] is to be allowed to let his children go unvaccinated, he might as well be allowed to leave strychnine lozenges about in the way of mine.

— *Methods and Results*, Thomas Huxley, 1825-1895, English biologist