



Rates of Influenza and Tdap Vaccination in Teaching and Private Obstetrical Practices, and the Influence of Vaccine Hesitancy

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Abstract

Objectives We evaluated differences in vaccination rates of patients of teaching and private practices, and explored the rate of vaccine hesitancy in pregnant women.

Methods This was a cross-sectional study of a convenience sample of recently delivered women. Women completed a survey, which included a question about whether they received the influenza and/or Tdap vaccine, and a vaccine hesitancy scale for both influenza and Tdap vaccines. We also reviewed prenatal records to confirm vaccine administration and collected demographic data. Patients who received care on the teaching service (care by residents supervised by faculty) were compared with those who received care from 26 private practitioners in nine groups. The primary outcome was rate of vaccination. Fisher's exact test was performed to compare groups.

Results Of the 231 women approached, 208 (90.0%) agreed to participate. Of the 208 participants, 70 (33.7%) had prenatal care with a teaching practice, and 138 (66.3%) with a private practice. Patients of teaching practices had a higher influenza and Tdap vaccination rate compared with patients of private practices (Influenza: 70% versus 54.3%, $p=0.036$; Tdap: 77.1% versus 58.4%, $p=0.009$). Among the entire cohort, 55.3% had some degree of vaccine hesitancy. This did not differ between teaching and private practices (54.3% versus 55.8%, $p=0.883$).

Conclusions In spite of similar prevalence of vaccine hesitancy, pregnant women cared for in teaching practices had higher vaccination rates than those cared for in private practices.

Significance

What is Already Known on this Subject? Prior studies have assessed individual patient characteristics as predictors of influenza and tetanus, diphtheria, and pertussis (Tdap) vaccination in pregnancy, but little is published on the role of provider type.

What this Study Adds? Teaching practices had higher vaccination rates in pregnancy than private practices despite similar prevalence of vaccine hesitancy between groups. Areas of future research should focus on incorporating evidence-based strategies in practices, particularly private practices, to improve vaccination rates in pregnancy.

Keywords Flu vaccine · Tetanus-diphtheria and pertussis vaccine · Pregnancy · Vaccine hesitancy · Provider type

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Introduction

Pregnant women and/or their infants have an increased risk of developing pertussis and severe influenza infection compared to the general population. (Doraivelu et al., 2019) The highest rates of hospitalization and death due to pertussis are among newborns under two months of age, before they are able to get vaccinated. (Greenberg et al., 2005) Pregnant women with influenza have higher rates of hospital admissions and are more likely to be admitted to intensive care units compared to non-pregnant women. (Dodds et al., 2007; Meijer et al., 2015; Jamieson et al., 2009) Influenza, and tetanus, diphtheria, and pertussis (Tdap) vaccinations during pregnancy have been shown to lower these risks. Thus, the American College of Obstetricians and Gynecologists (ACOG) and the Advisory Committee on Immunization Practices (ACIP) recommends that pregnant women receive both influenza and Tdap vaccines during pregnancy. (Regan et al., 2016; ACOG, 2018, 2019; ACIP, 2013) However, in a recent Center for Disease Control and Prevention (CDC) report, 65% of pregnant women in the United States did not received both vaccines. (CDC, 2017)

Previous studies have assessed individual patient characteristics, such as age, race, socioeconomic status, insurance type and geographic locations as predictors of Tdap and influenza immunization. (Doraivelu et al., 2019; Merritt et al., 2020; Henninger et al., 2013; Strassberg et al., 2018; Goldfarb et al., 2014) However, little is published on provider type as a predictor of vaccination. (O’Leary et al., 2018; Cohen et al., 2019) Provider’s recommendations for administration of these vaccines are important and may be a strong predictor of patient vaccine acceptance. Thus, the objective of our study was to assess the rate of influenza and Tdap vaccination of pregnant women between teaching faculty and private providers. In addition, we sought to evaluate the prevalence of vaccine hesitancy in pregnancy.

Methods

This was a prospective, cross-sectional study of a convenience sample of recently postpartum women who delivered between February 29 and August 12, 2020 at Maimonides Medical Center, Brooklyn, New York, USA. Postpartum patients who delivered after 34 weeks of gestation were approached and consented to participate by filling out the survey. Patients were approached on the postpartum floor and recruited in groups of three (two from private practices and one from teaching practices). As the majority of the recruitment occurred during the COVID-19 pandemic, patients were approached with appropriate personal

protective equipment at all times. Maimonides Medical Center Institutional Review Board approved this study.

One group consisted of patients who had prenatal care in a teaching practice and the other group consisted of patients who had prenatal care in a private practice. There were 26 providers in the nine private practices. The teaching practice was defined as practices that included resident and fellow physicians in training under the supervision of faculty.

The survey consisted of 16 questions, eight questions for influenza vaccine and eight for Tdap vaccine. The first two questions examined the patient’s recollection of receiving the vaccine and whether her provider offered the vaccine. The last six questions examined components of vaccine hesitancy and were derived from a vaccine hesitancy work group. (Larson et al., 2015)

The prenatal chart was reviewed to confirm administration of influenza and Tdap vaccination. Demographic characteristics were also extracted and included the patient’s age, race, parity, and gestational age at delivery.

The primary outcomes were confirmed influenza and Tdap vaccination. Secondary outcomes included vaccine hesitancy among pregnant patients. Vaccine hesitancy was defined as answering strongly agree or agree on any of the six survey questions.

For our sample size calculation, assuming a prevalence of 80% rate of Tdap vaccination in the teaching practice, in order to detect 25% difference in the private group, and a ratio of 2:1, patients from private practice: patients from teaching practice, a minimum of 206 total women was needed for an alpha error of 5% and a beta error of 20%.

Demographic continuous variables included the patient’s age, parity, and the completed gestational age at delivery. These variables were tested for normality with Shapiro-Wilk test. Wilcoxon Rank sum test was used to compare demographic variables if they were not normally distributed or Student’s t test if they were normally distributed. Categorical variables included the patient’s race and vaccine hesitancy. Fisher’s exact test was used to compare categorical variables. The primary outcome was compared between both groups. Only demographic variables that were statistically significantly different (defined as p value < 0.05) between the groups were adjusted for using logistic regression. Vaccine hesitancy were compared between both groups using Fisher’s exact test. We also compared vaccine hesitancy between the influenza vaccine and the Tdap vaccine using McNemar’s test. All statistical analyses were performed on Stata 15.1, StataCorp, College Station, Texas.

Table 1 Patient characteristics between teaching and private practices

Characteristics	Teaching N = 70	Private N = 138	P
Age (years)	28 [25–32]	29 [25–35]	0.213
Race			0.002
White	25 (35.7)	78 (56.5)	
Black	13 (18.6)	18 (13)	
Asian	15 (21.4)	32 (23.2)	
Hispanic	17 (24.3)	10 (7.2)	
Parity	2 [1–3]	2 [1–3]	0.243
Gestational age (completed weeks)	39 [38–40]	39 [38–40]	0.259

Data presented as median [interquartile range] or N (%)

Table 2 Vaccination rate and vaccine hesitancy for influenza vaccine

	Faculty N = 70	Private N = 138	P
Vaccinated	48 (68.6%)	66 (47.8%)	.011 ¹
Hesitancy survey ^a			
Influenza vaccine is important	57 (81.4%)	107 (77.5%)	0.592
Influenza vaccine is effective	57 (81.4%)	104 (75.3%)	0.382
Influenza vaccine is important for health of my community	65 (92.8%)	122 (88.4%)	0.465
Information of influenza vaccine is reliable	64 (91.4%)	126 (91.3%)	1
Influenza vaccine is a good way to protect myself	58 (82.8%)	111 (80.4%)	0.712
I am concerned about the side effects of the influenza vaccine	38 (54.2%)	77 (55.7%)	0.883

¹Adjusted for race by logistic regression

^aDerived from Larson et al. 2015

Results

Of the 231 women approached, 208 (90.5%) agreed to participate. Of those 208 women, 70 (33.7%) had prenatal care with the teaching practice, and 138 (66.3%) with a private practice. Patient demographic characteristics are presented in Table 1. The racial distribution differed between patients who had prenatal care with the teaching practice and those with a private practice ($p = 0.002$). Of the nine private practices included in this study, 4 (44.4%) referred their patients to another site (e.g., their primary care physicians) for vaccination due to lack of vaccine availability on site. The teaching practice had the vaccines available on site.

Among the entire cohort, 123 (59.1%) women were vaccinated with influenza or Tdap vaccine during pregnancy. Of the 208 women, 114 (54.8%) received influenza vaccine, 113 (54.3%) received Tdap vaccine, and 104 (50.0%) received both vaccines. After adjusting for race, patients of the teaching practice had a higher rate of influenza and Tdap vaccination compared with patients of private practices (influenza: 48 [68.6%] versus 66 [47.8%]; adjusted odds

Table 3 Vaccination rate and vaccine hesitancy on Tdap vaccine

	Faculty N = 70	Private N = 138	P
Vaccinated	48 (68.6%)	65 (47.1%)	.003 ¹
Hesitancy survey ^a			
Tdap vaccine is important	62 (88.5%)	108 (78.2%)	0.087
Tdap vaccine is effective	60 (85.7%)	115 (83.3%)	0.841
Tdap vaccine is important for health of my community	66 (94.2%)	122 (88.4%)	0.218
Information of Tdap vaccine is reliable	64 (91.4%)	118 (85.5%)	0.272
Tdap vaccine is a good way to protect myself	65 (92.8%)	115 (83.3%)	0.084
I am concerned about the side effects of the Tdap vaccine	38 (54.2%)	77 (55.7%)	0.883

¹Adjusted for race by logistic regression

^aDerived from Larson et al. 2015

ratio [aOR], 2.00, 95% confidence interval [CI], 1.06–3.76; Tdap: 48 [68.6%] versus 65 [47.1%]; aOR, 2.49, 95% CI, 1.25–4.93). Vaccine hesitancy did not differ between teaching and private practices (Tables 2 and 3), nor between one vaccine and the other. Fear of side effects of both vaccines was the most common reason for vaccine hesitancy (teaching: 38 [54.2%]; private: 77 [55.7%]).

We evaluated whether patients had differences in vaccine hesitancy between the influenza and the Tdap vaccine by comparing their answers on the six vaccine hesitancy survey questions. Of the 44 patients that reported that the influenza vaccine was not important, 25 reported that the Tdap vaccine was important, which was not statistically different to those who reported influenza vaccine is important ($N = 164$), but Tdap vaccine was not ($N = 19$) ($p = 0.451$). Regarding whether the vaccine is effective, of the 161 patients who thought the influenza vaccine was effective, 14 reported that this is not true for the Tdap vaccine. This was significantly different to those who thought the Tdap vaccine was effective ($N = 175$), but influenza was not ($N = 28$) ($p = 0.044$). Of the 187 patients that thought the influenza vaccine was important for the health of their community, 7 did not think this is true for Tdap. This was not significantly different from the 8 who did not think influenza vaccine was important for their community from the 188 patients who thought Tdap was important. ($p > 0.99$). Whether information was reliable on the vaccines did not differ between the influenza and Tdap vaccine (15 patients who thought Tdap information was not reliable of the 190 who thought influenza information was reliable vs. 7 who thought influenza information was not reliable of the 182 who thought Tdap information was reliable, $p = 0.134$). Similarly, patients did not differ in reporting whether the two vaccines were a good way to protect

themselves (12 patients reporting Tdap was not a good way from the 169 patients who thought the influenza vaccine was a good way versus 23 patients reporting influenza was not a good way from 180 patients who thought the Tdap vaccine was a good way, $p=0.090$). Among the question that demonstrated the most vaccine hesitancy in this group, there was no difference in the patient's concerns about the side effects between the influenza and Tdap vaccine (19 who did not have concerns about Tdap vaccine from the 115 who did have concerns with the influenza versus 19 who did not have concerns about the influenza vaccine from the 115 who did have concerns about the Tdap vaccine, $p>0.99$).

Discussion

We found that patients of a teaching practice received the influenza and Tdap vaccine at a higher rate than patients of private practices. In addition, the prevalence of vaccine hesitancy in pregnancy was over 50%, with fear of side effects reported as the most common reason.

Despite the benefits of vaccination, the overall rate of influenza and Tdap vaccination in pregnancy in the United States is dismal. (CDC, 2017) Many OB/GYNs have not yet adopted evidence-based strategies for increasing vaccination rates. (Cohen, 2019) Evidence-based strategies for practices include creating an immunization culture in the office by educating the staff on the importance of vaccination and developing a standardized process of assessing and ordering a vaccine for patients. (ACOG, 2019) Among the multiple private practices included in our study, there was variability in resources and vaccination processes in offices. The teaching practice had vaccines in stock, allowing vaccination during a prenatal visit. One recent study found that on-site availability was a factor that was associated with Tdap vaccination in pregnancy. (O'Leary, 2018) Many private practices, including the ones in this study, cite reimbursement and cost as major barriers to offering on site vaccination. (Leddy, 2009) But, reimbursement for immunization can be maximized with proper documentation to cover these costs. (ACOG, 2019)

Patients' hesitancy, in our study, appeared to be most closely tied to the safety profile of vaccines, which is consistent with other reports in the literature. (Strassberg, 2018) Obstetric providers should include a discussion of the safety of vaccination during pregnancy in their counseling to pregnant patients. That reassurance could include the findings of a recent prospective study including over 1,200 pregnant women that found no association between adverse maternal and neonatal outcomes and maternal pertussis vaccination. (Mohammed, 2021)

The finding that patients were more likely to think that influenza vaccine was not effective compared to Tdap was not surprising, given that influenza vaccine is less effective compared to other adult vaccines. However, obstetric providers should counsel patients of the reduced hospitalizations in those who were vaccinated as well as the numerous newborn benefits. (ACOG, 2019)

We must acknowledge limitations of this study. Patients were recruited postpartum, and thus may not have remembered whether they had received either vaccine during the pregnancy. However, we reviewed their prenatal chart to confirm vaccination. Another limitation included not observing all of the immunization processes in each of the practices, e.g. reminders on the electronic medical record or on-site vaccine availability. Vaccine availability on-site may have played a role since the teaching practice had vaccines on-site, and many private practices did not. However, we found that vaccine hesitancy was similar between patients from both types of practices. Finally, patients were recruited during the peak of the novel coronavirus pandemic during which prenatal visits were spaced out. Thus, some patients may have not had the opportunity to receive vaccines. However, it is unlikely that rate of vaccination would be more affected for one type of practice versus the other as the pandemic affected everyone.

In conclusion, we found that a teaching practice had a higher rate of influenza and Tdap vaccination in pregnancy compared to private practices. We also found that fear of side effects from vaccination was a main factor driving vaccine hesitancy in pregnant women. Despite the strong recommendations from medical societies (Regan et al., 2016; ACOG, 2018, 2019; ACIP, 2013), our study has shown that work still needs to be done in order to improve vaccination rates during pregnancy. Areas of future research should focus on improving on-site factors and incorporating evidence-based strategies in practices (ACOG, 2019) as well as communication strategies for providers regarding vaccination safety during pregnancy.

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Data Availability Available by reasonable request.

Code Availability Not applicable.

Declarations

Conflict of interest Authors report no conflicts of interests.

Ethics Approval Maimonides Medical Center institutional review board approved this study.

Consent to Participate All participants in this study consented to participate.

Consent for Publication Not applicable.

References

- ACOG Committee Opinion No (2018). 732: Influenza Vaccination During Pregnancy. *Obstetrics and gynecology*, 131(4), e109–e114. <https://doi.org/10.1097/AOG.0000000000002588>
- ACOG Committee Opinion No (2019). 772: Immunization Implementation Strategies for Obstetrician- Gynecologists. *Obstetrics and gynecology*, 133(3), e254–e259. <https://doi.org/10.1097/AOG.0000000000003130>
- Centers for Disease Control and Prevention. Low Rates of Vaccination During Pregnancy Leave Moms, Babies Unprotected. Accessed December 10 (2020). <https://www.cdc.gov/media/releases/2019/p1008-vaccination-moms-babies-unprotected.html:text=CDC%20surveyed%20nearly%20%2C100%20women,reported%20receiving%20Tdap%20during%20pregnancy>
- Centers for Disease Control and Prevention (CDC). (2013). Updated recommendations for use of tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine (tdap) in pregnant women—Advisory Committee on Immunization Practices (ACIP), 2012. *MMWR Morbidity and mortality weekly report*, 62(7), 131–135.
- Cohen, C. C., Badger, G. J., & McLean, K. C. (2019). Provider group type and tdap coverage in pregnancy. *Vaccine*, 37(9), 1188–1193. <https://doi.org/10.1016/j.vaccine.2019.01.001>.
- Committee Opinion No. (2017). 718 Summary: Update on immunization and pregnancy: Tetanus, Diphtheria, and Pertussis Vaccination. *Obstetrics and gynecology*, 130(3), 668–669. <https://doi.org/10.1097/AOG.0000000000002293>.
- Dodds, L., McNeil, S. A., Fell, D. B., Allen, V. M., Coombs, A., Scott, J., & MacDonald, N. (2007). Impact of influenza exposure on rates of hospital admissions and physician visits because of respiratory illness among pregnant women. *CMAJ: Canadian Medical Association journal = journal de l'Association medicale canadienne*, 176(4), 463–468. <https://doi.org/10.1503/cmaj.061435>.
- Doraivelu, K., Boulet, S. L., Biswas, H. H., Adams, J. C., Haddad, L. B., & Jamieson, D. J. (2019). Predictors of tetanus, diphtheria, acellular pertussis and influenza vaccination during pregnancy among full-term deliveries in a medically underserved population. *Vaccine*, 37(41), 6054–6059. <https://doi.org/10.1016/j.vaccine.2019.08.044>.
- Goldfarb, I. T., Little, S., Brown, J., & Riley, L. E. (2014). Use of the combined tetanus- diphtheria and pertussis vaccine during pregnancy. *American journal of obstetrics and gynecology*, 211(3), 299e1–299e2995. <https://doi.org/10.1016/j.ajog.2014.05.029>.
- Greenberg, D. P., von König, C. H., & Heining, U. (2005). Health burden of pertussis in infants and children. *The Pediatric infectious disease journal*, 24(5 Suppl), S39–S43. <https://doi.org/10.1097/01.inf.0000160911.65632.e1>.
- Henninger, M., Naleway, A., Crane, B., Donahue, J., & Irving, S. (2013). Predictors of seasonal influenza vaccination during pregnancy. *Obstetrics and gynecology*, 121(4), 741–749. <https://doi.org/10.1097/AOG.0b013e3182878a5a>.
- Jamieson, D. J., Honein, M. A., Rasmussen, S. A., Williams, J. L., Swerdlow, D. L., Biggerstaff, M. S., Lindstrom, S., Louie, J. K., Christ, C. M., Bohm, S. R., Fonseca, V. P., Ritger, K. A., Kuhles, D. J., Eggers, P., Bruce, H., Davidson, H. A., Lutterloh, E., Harris, M. L., Burke, C., Cocoros, N., & H1N1 Pregnancy Working Group. (2009). ... Novel Influenza A (H1N1 2009 influenza virus infection during pregnancy in the USA. *Lancet (London, England)*, 374(9688), 451–458. [https://doi.org/10.1016/S0140-6736\(09\)61304-0](https://doi.org/10.1016/S0140-6736(09)61304-0)
- Larson, H. J., Jarrett, C., Schulz, W. S., Chaudhuri, M., Zhou, Y., Dube, E., Schuster, M., MacDonald, N. E., Wilson, R., & SAGE Working Group on Vaccine Hesitancy. (2015). Measuring vaccine hesitancy: The development of a survey tool. *Vaccine*, 33(34), 4165–4175. <https://doi.org/10.1016/j.vaccine.2015.04.037>.
- Leddy, M. A., Anderson, B. L., Power, M. L., Gall, S., Gonik, B., & Schulkin, J. (2009). Changes in and current status of obstetrician-gynecologists' knowledge, attitudes, and practice regarding immunization. *Obstetrical & gynecological survey*, 64(12), 823–829. <https://doi.org/10.1097/OGX.0b013e3181c4bbb7>.
- Meijer, W. J., van Noortwijk, A. G., Bruinse, H. W., & Wensing, A. M. (2015). Influenza virus infection in pregnancy: A review. *Acta obstetrica et gynecologica Scandinavica*, 94(8), 797–819. <https://doi.org/10.1111/aogs.12680>.
- Merritt, T. A., Rasmussen, S. A., Bright, M. A., Roussos-Ross, D., Sims, S. M., Gurka, M. J., & Thompson, L. A. (2020). Variation in Tdap and Influenza Vaccination Coverage among pregnant women by insurance type - Florida, 2016–2018. *MMWR Morbidity and mortality weekly report*, 69(3), 72–76. <https://doi.org/10.15585/mmwr.mm6903a4>.
- Mohammed, H., Roberts, C. T., Grzeskowiak, L. E., Giles, L. C., Verburg, P. E., Dekker, G., & Marshall, H. S. (2021). Safety of maternal pertussis vaccination on pregnancy and birth outcomes: A prospective cohort study. *Vaccine*, 39(2), 324–331. <https://doi.org/10.1016/j.vaccine.2020.11.052>.
- O'Leary, S. T., Riley, L. E., Lindley, M. C., Allison, M. A., Crane, L. A., Hurley, L. P., Beaty, B. L., Brtnikova, M., Collins, M., Albert, A. P., Fisher, A. K., Jiles, A. J., & Kempe, A. (2018). Immunization Practices of U.S. Obstetrician/Gynecologists for pregnant patients. *American journal of preventive medicine*, 54(2), 205–213. <https://doi.org/10.1016/j.amepre.2017.10.016>.
- Regan, A. K., Klerk, N., Moore, H. C., Omer, S. B., Shellam, G., & Effler, P. V. (2016). Effectiveness of seasonal trivalent influenza vaccination against hospital-attended acute respiratory infections in pregnant women: A retrospective cohort study. *Vaccine*, 34(32), 3649–3656. <https://doi.org/10.1016/j.vaccine.2016.05.032>.
- Strassberg, E. R., Power, M., Schulkin, J., Stark, L. M., Mackeen, A. D., Murtough, K. L., & Paglia, M. J. (2018). Patient attitudes toward influenza and tetanus, diphtheria and acellular pertussis vaccination in pregnancy. *Vaccine*, 36(30), 4548–4554. <https://doi.org/10.1016/j.vaccine.2018.05.121>.

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