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What do pregnant women think about influenza disease and vaccination practices in selected countries

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ABSTRACT

Introduction: We evaluated knowledge, attitudes, and practices (KAP) related to influenza and influenza vaccination among pregnant women in three selected countries.

Methods: During 2017, pregnant women seeking antenatal care at hospitals at participating sites were enrolled. We described characteristics and responses to KAP questions. We also evaluated predictors associated with influenza vaccination during pregnancy at sites with substantial influenza vaccine uptake by multivariable logistic regression.

Results: Overall, 4,648 pregnant women completed the survey. There were substantial differences among the three survey populations; only 8% of the women in Nagpur had heard of influenza, compared to 90% in Lima and 96% in Bangkok (p-value<0.01). Despite significant differences in sociodemographic characteristics in the three populations, most participants across sites who were aware of influenza prior to study enrollment believe they and their infants are at risk of influenza and related complications and believe influenza vaccination is safe and effective. Half of women in Lima had verified receipt of influenza vaccine compared to <5% in Bangkok and Nagpur ($p < .05$). For further analysis conducted among women in Lima only, household income above the poverty line (aOR: 1.38; 95%CI: 1.01, 1.88), having 8+ antenatal visits, compared to 0–4 (aOR: 2.41; 95%CI: 1.39, 2.87, respectively), having 0 children, compared to 2+ (aOR: 1.96; 95%CIs: 1.23, 3.12), and vaccination recommended by a health-care provider (aOR: 8.25; 95%CI: 6.11, 11.14) were strongly associated with receipt of influenza vaccine during pregnancy.

Conclusions: Our findings identify opportunities for targeted interventions to improve influenza vaccine uptake among pregnant women in these settings.

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Introduction

Pregnant women and their infants are at increased risk for severe influenza illness.[1–4] Influenza vaccination is the best way to prevent influenza disease. Since 2012, the World Health Organization has recommended that countries prioritize pregnant women when considering target groups for influenza vaccination programs.[5] An increasing number of middle-income countries are adopting policies for vaccinating pregnant women against influenza. However, influenza vaccination policy and implementation vary by country and region with few countries in Southeast Asia, the Western Pacific and Africa having influenza vaccination policies that target pregnant women.[6] In countries where influenza vaccines are recommended for pregnant women, studies have identified health-care provider recommendation, referral, women's knowledge, attitudes and beliefs about influenza and influenza vaccine as important predictors of influenza vaccine acceptance among pregnant women, but available data are limited.[7–14] Understanding predictors of vaccination against influenza among pregnant women in low- and upper-middle-income countries is important and may inform strategies for improving vaccine uptake in this population. Using data from a multi-country prospective cohort study conducted in a low middle-income country (India) and two upper middle-countries (Peru and Thailand, Table 1),[15] we assessed what factors were associated with influenza vaccination among

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pregnant women by evaluating knowledge, attitudes, and practices related to influenza and influenza vaccination.

Methods

Setting

During 2017, pregnant women were enrolled from antenatal clinics at two tertiary/referral level hospitals in Bangkok, Thailand; four tertiary/referral level hospitals in Lima, Peru; and one secondary/referral level hospital in Nagpur, India. Detailed study methods and site descriptions have been previously published.[15]

Influenza vaccination policies for pregnant woman differed by study site (Table 1). In Thailand, a policy offering influenza vaccination free of charge to pregnant women in their second and third trimesters of gestation was implemented in 2009; however, vaccination coverage in this group was reported to be low (range 0.9% to 1.1%) during the first 3 y of policy implementation.[16] In 2017, the Thailand Ministry of Health provided influenza vaccines to pregnant women using vaccination campaigns held approximately from June to August. In Peru, a policy offering influenza vaccination to pregnant women starting at 20 weeks of gestation was implemented in 2010 after the 2009 influenza pandemic,[17,18] and coverage in this group was reported to be ~19% in 2016.[19] The Government of Peru provides influenza vaccine free of charge during vaccination campaigns and recommends influenza vaccination for pregnant woman.[20] In 2017, influenza vaccine campaigns were held in Peru during May through December. In India, influenza vaccination policies vary by state. In Maharashtra state, which includes the city of Nagpur, influenza vaccination has been recommended for pregnant women since 2015. During 2015–2016, vaccination was recommended only during the third trimester, and in 2017, the recommendation was expanded to include the second and third trimesters. Influenza vaccination is provided by the Government free of charge and given in ANC clinics on optional basis irrespective of the influenza season. Reports from 2015 show that only about 8% of the eligible pregnant population in Maharashtra were vaccinated against influenza.[21]

Participants

Pregnant women were eligible for study participation if they were ≥18 y old and with at least 8 weeks of pregnancy remaining before the end of the influenza season in their countries.[15] Following the same protocol, participants completed an interview at enrollment that collected data on sociodemographic characteristics and asked whether the participant had heard of influenza and influenza vaccine prior to study enrollment.[22] If the participant indicated they had heard of influenza prior to study enrollment, they were asked additional questions regarding knowledge, attitudes, and practices of influenza disease and vaccination (Supplementary material).[22–24] At the end of pregnancy, participants completed a second survey that collected information on whether they had received a recommendation for influenza vaccination from a health-care provider and were vaccinated during the current pregnancy. Participants were eligible for inclusion in this analysis if they completed both an enrollment interview and end of pregnancy interview. For those with available medical records, chart abstraction was performed at the end of pregnancy to obtain information on the number of antenatal visits and pregnancy course. The number of antenatal visits was obtained primarily from chart abstraction, or the end of pregnancy survey was used if missing. For participants who reported receiving influenza vaccine during the current pregnancy, vaccination status was verified using medical records such as vaccination cards or hospital vaccination records.[15]

Variables

After initial exploration of interview data, we collapsed levels of responses for the final analysis. For example, 'strongly agree' and 'agree' were collapsed to 'agree'; and 'strongly disagree' and 'disagree' were collapsed to 'disagree'. We present responses by original categories as supplemental material. Age was categorized in two groups (18–34 and ≥35 y). For *per capita income*, a dichotomous variable (above/below poverty line) was created based on local poverty cutoffs for monthly *per capita* income (Thailand: 3165 Thai Baht[25]; Peru: 338 Peruvian Nuevos Soles[26]). To assess self-perceived health status, we used a visual analogue scale similar to a previously validated "thermometer scale";[27] participants were asked to rate from 0 to 100 where 100 meant the best health they could imagine at the time of enrollment interview. The variable 'any chronic conditions' included any underlying medical condition reported at enrollment, end of pregnancy questionnaire or identified by medical chart review.

Table 1. Influenza vaccination policies for pregnant women at study sites during the study period.

	Recommendation	Year recommendation began	Vaccine financing	Strategy for vaccine distribution
Nagpur	Recommended for pregnant women starting at 13 weeks gestation[a]	2015	Provided by government free of charge	Vaccine was introduced by government in 2015. It is given in ANC clinics on optional basis irrespective of Influenza season
Lima	Recommended for pregnant women starting at 20 weeks gestation	2010	Provided by government free of charge	Vaccine campaigns (May-December)
Bangkok	Recommended for pregnant women starting at 13 weeks gestation	2009	Provided by government free of charge	Vaccine campaigns (June-August)

[a]Third trimester (≥28 weeks gestation) only during 2015 and 2016. Recommendation expanded to include the second trimester (13–27 weeks gestation) in 2017.

Statistical methods

We calculated frequencies of socio-demographic characteristics, underlying conditions, gestational diabetes, gestational hypertension, self-perceived health score, influenza vaccination status, receipt of influenza vaccination recommendations and knowledge of influenza for the full cohort and by site. Among participants who had heard about influenza and influenza vaccine, we also calculated frequencies of responses to questions related to knowledge, attitudes and practices of influenza, overall and by site. We performed Chi-square or Kruskal–Wallis test to evaluate differences between sites. A two-tailed p-value of <0.05 was considered significant.

To identify predictors of influenza vaccination, we developed a multivariable logistic regression model for each site among participants who had heard of influenza disease and vaccination. The models were built with self-reported or verified influenza vaccination as the outcome variable and the following variables selected *a priori*: age (18–34 and ≥35 y), education-level (none, primary, secondary, post-secondary /university), marital status (married/living together, single/widowed/divorced/separated), occupation (working outside home or not), having health insurance, *per capita* income (above/below the poverty line), number of people living in the household, number of antenatal care (ANC) visits during pregnancy (0–4,5-7,8+ visits),[28,29] number of children, gestational diabetes, gestational hypertension, having any chronic medical condition, being previously vaccinated against influenza, self-perceived health score, receipt of influenza vaccination recommendation, and perceptions about influenza disease and influenza vaccination. We present crude and adjusted odds ratios (aOR) as well as the 95% confidence intervals (CI). All analyses were performed in R (version 3.4.4) and RStudio (version 1.1.463).

Ethics

The study protocol was approved by local Institutional Review Boards (IRB) at each site. The study was approved by the Naval Medical Research Unit 6 IRB (Protocol NAMRU6.2016.0015) in compliance with all applicable Federal regulations governing the protection of human subjects and by the Abt Associates IRB. The IRB of the US Centers for Disease Control and Prevention relied on the review of the Abt Associates IRB. All participants provided written informed consent.

Results

There were 8,034 women approached and screened and 4,777 participants enrolled in the study. Of those, we excluded 129 (3%) with incomplete end-of-pregnancy interviews. The final sample for this study was of 4,648 participants: 1,967 (42%) from Nagpur, 1,548 (33%) from Lima, and 1,133 (24%) from Bangkok.

Table 2 summarizes participants' characteristics by site. Overall, participants from Nagpur were younger with 98% between 18 and 34 y old as compared to 84% in Lima and 80% in Bangkok (p-value<0.01). Ninety-seven percent of the Nagpur participants reported not working outside home vs 70% in Lima and 29% in Bangkok (p-value<0.01). Moreover, participants from Nagpur had the lowest rates of being insured (9%) compared to 74% in Lima and 94% in Bangkok (p-value<0.01). Fifty-nine percent of the participants in Lima reported living below the poverty line and 28% in Bangkok (p-value<0.01); data were not available for Nagpur. Bangkok participants had the highest rates of 8+ antenatal visits during this pregnancy (82%) versus 39% in Lima and 10% in Nagpur (p-value<0.01). Fifty percent of the participants in Lima had verified influenza vaccination during the current season whereas less than 2% of the participants each from Bangkok and Nagpur had verified vaccination. Receipt of influenza vaccination recommendation by a health-care provider varied drastically by site (1%, 60% and 17% in Nagpur, Lima and Bangkok, respectively; p-value<0.01). Finally, only 8% of the Nagpur participants had heard of influenza, compared to 90% in Lima and 96% in Bangkok (p-value<0.01).

Table 3 shows responses to questions about perceptions of influenza among those who had heard of it (n = 2,651; 167 in Nagpur, 1,399 in Lima, and 1,085 in Bangkok). To the question "How worried are you about getting sick with the flu", most of Nagpur participants (88%) responded "Very or somewhat worried", compared to 49% in Lima and Bangkok. To the questions, "If a pregnant woman gets the flu, how likely is it that the flu will harm her" and "If a pregnant woman gets the flu, how likely is it that the flu will harm her baby", the majority of participants at all three sites responded "Very or somewhat likely (92% and 96% in Nagpur, 79% and 79% in Lima and 92% and 95% in Bangkok, respectively). Table 4 shows responses to questions about perceptions of influenza vaccine among those who had heard of it (n = 2,198; 43/167, 26% in Nagpur, 1,240/1,399, 89% in Lima, and 915/1,085, 84% in Thailand). To the questions "How well do you think the flu vaccine works in protecting pregnant women from getting the flu", and "When a pregnant woman receives the flu vaccine, how well do you think the flu vaccine works in protecting her baby from the flu after her baby is born", the large majority of Nagpur participants (>97%) responded "*very or somewhat well*" to both questions, compared to 69% and 60% in Lima and 92% and 87% in Bangkok. Likewise, to the questions, "How safe do you think flu vaccines are for pregnant women" and "When a pregnant woman receives the flu vaccine, how safe do you think that vaccine is for her baby", the large majority of Nagpur participants (>97%) responded "*Completely, very or somewhat safe*" to both questions, compared to 71% and 67% in Lima and 87% and 83% in Bangkok. Finally, to the question "Please indicate how much you agree or disagree with the following statement: pregnant women should get the flu vaccine", all Nagpur participants agreed (100%), versus 80% in Lima and 90% in Bangkok. Likewise, to the question "Do you think that a breastfeeding mother should get the flu vaccine if she did not already receive it while pregnant", all Nagpur participants agreed, versus 52% in Lima and 45% in Bangkok.

Television or radio news were the most common sources of information about influenza vaccine for participants at all sites (range: 32–46%), followed by primary care provider (18%) and newspaper or magazine (17%) in Nagpur, community health-care providers (13%) and workplace (8%) in Lima, and social network sites (15%) and signs or billboards (11%) in Bangkok.

Table 2. Characteristics of participants by site (n = 4,648).

	Overall	Nagpur	Lima	Bangkok	
	Total *n* (%)	All *n* (%)	All *n* (%)	All *n* (%)	p-Value
All	4,648	1,967 (42)	1,548 (33)	1,133 (24)	
Age-group (years)					
18–34	4,127 (89)	1,925 (98)	1,297 (84)	905 (80)	<0.01
≥35	521 (11)	42 (2)	251 (16)	228 (20)	
Education					
None	79 (2)	37 (2)	4 (0.3)	38 (3)	<0.01
Primary	927 (20)	343 (18)	121 (8)	463 (41)	
Secondary	2,349 (51)	1,174 (60)	899 (58)	276 (24)	
Post-secondary/University	1,278 (27)	406 (21)	522 (34)	350 (31)	
Marital status					
Married/living together	4,355 (94)	1,962 (100)	1,283 (83)	1,110 (98)	<0.01
Single/Widowed/Divorced/Separated	287 (6)	3 (0)	262 (17)	22 (2)	
Occupation					
Does not work outside home	3,297 (71)	1,888 (97)	1,085 (70)	324 (29)	<0.01
Works outside home	1,338 (29)	68 (3)	462 (30)	808 (71)	
Has health insurance	2,360 (51)	167 (9)	1,136 (74)	1,057 (94)	<0.01
Monthly *per capita* income[a]					
Below poverty line	1,222 (46)	-	909 (59)	313 (28)	<0.01
Above poverty line	1,459 (54)	-	639 (41)	820 (72)	
Number of people living in the household, excluding the mother					
0–2	2,254 (48)	718 (37)	759 (49)	777 (69)	<0.01
3–4	1,349 (29)	625 (32)	505 (33)	219 (19)	
5+	1,033 (22)	621 (32)	278 (18)	134 (12)	
Number of ANC visits during pregnancy					
0–4	1,144 (25)	679 (36)	429 (29)	36 (3)	<0.01
5–7	1,655 (36)	1,019 (54)	475 (32)	161 (15)	
8+	1,671 (36)	196 (10)	578 (39)	897 (82)	
Number of children					
0	2,220 (48)	969 (49)	765 (50)	486 (43)	<0.01
1	1,711 (37)	807 (41)	477 (31)	427 (38)	
2+	704 (15)	183 (9)	301 (20)	220 (19)	
Gestational diabetes	162 (3)	3 (0)	40 (3)	119 (11)	<0.01
Gestational hypertension	318 (7)	162 (8)	86 (6)	70 (6)	<0.01
Any chronic condition[b]	175 (4)	88 (4)	33 (2)	54 (5)	<0.01
Received influenza vaccination in current season (verified)	785 (17)	10 (1)	770 (50)	5 (0)	<0.01
Received influenza vaccination in current season (self-report/verified)	945 (20)	14 (1)	900 (58)	31 (3)	<0.01
Ever previously vaccinated against influenza	636/2330 (27)	0/70 (0)	439/1,305 (34)	197/955 (21)	<0.01
Received influenza vaccination in a previous pregnancy[c]	229/1433 (16)	0/40 (0)	203/785 (23)	26/608 (4)	<0.01
Receipt of influenza vaccination recommendation by healthcare provider	1,096 (24)	13 (1)	894 (60)	189 (17)	<0.01
Self-perceived health score					
Median (interquartile range: 0.25, 0.75)	90 (80,99)	99 (90,100)	70 (50,80)	90 (80,100)	<0.01*
Heard of influenza prior to enrollment	2651 (57)	167 (8)	1,399 (90)	1,085 (96)	<0.01

[a]Income: (India: data not available; Thailand: Monthly income per capita ≥3,165 TBH; Peru: Monthly income per capita ≥338 soles). [b]Derived variable. [c]Among those with a previous pregnancy and with self-response for vaccination (yes/no) (n = 1,433). * Kruskal–Wallis test (All other tested by Chi-square test).

Missing data: Education (n = 15), Marital status (n = 2), Occupation (n = 13), Have health insurance (n = 21), Monthly family income (n = 6), Number of people living in the household (n = 12), Number of ANC visits during pregnancy (n = 178), Number of children (n = 13), Proxy for vaccination (n = 9), Previously vaccinated (n = 2,318), Received vaccination in previous pregnancy (n = 1,442 of those who had a previous pregnancy: 2,874), Receipt of vaccination recommendation by a healthcare provider (n = 92), Self-perceived health score (n = 24), Heard of influenza prior to enrollment (n = 1).

The multivariable analysis for predictors of influenza vaccination was performed with the data from Lima only (n = 1,240) because the other sites did not have significant numbers of vaccinated participants (<5%). We found significant associations between influenza vaccination and receipt of vaccination recommendation by a health-care provider (aOR: 8.25; 95%CI: 6.11, 11.14); being above the poverty line (aOR: 1.38; 95%CI: 1.01, 1.88); having 8+ antenatal visits, compared to 0–4 (aOR: 2.41; 95%CI: 1.39, 2.87, respectively); and, having 0 children, compared to 2+ (aORs: 1.96; 95%CIs: 1.23, 3.12), after adjustment for other covariates (Table 5). Among participants in Lima, over 80% (727/900) received vaccination at the study hospitals and 10% (90/900) received vaccination from a community health provider. Vaccination rates among participants per study hospital ranged from 35% to 65%. When we stratified vaccination according to health-care provider recommended vaccination, vaccination rates were 77% (690/894) among those who received a recommendation from a health-care provider compared to 32% (188/584) among those who did not (p-value<0.001).

Among participants in Bangkok and Nagpur, we evaluated variables associated with receipt of an influenza vaccination recommendation from a health-care provider by site. In Bangkok, 40% (76/189) of participants who received influenza vaccination recommendations had a post-secondary education, versus 29% (273/938) among those who did not receive a recommendation (p-value = 0.01). Those who received a recommendation were more likely to work outside home (78% (147/189) vs 70% (656/938), p-value = 0.04), have received influenza vaccination in the past (32% (55/169) vs 18% (142/768); p-value<0.001) and know about influenza (100% (188/189) vs 95% (891/938); p-value = 0.01). In Nagpur, 69% (9/13) of

Table 3. Attitudes about influenza illness among those who have heard of influenza prior to enrollment (n = 2,651).

		Sites			
	Overall n = 2,651 n (%)	India n = 167 n (%)	Peru n = 1,399 n (%)	Thailand n = 1,085 n (%)	p-Value
How worried are you about getting sick with the flu?					<0.01
Very or somewhat worried	1,354 (51)	147 (88)	678 (48.5)	529 (49)	
Not too worried or not worried at all	1,276 (48)	15 (9)	712 (51)	549 (51)	
Unknown	18 (1)	5 (3)	7 (0.5)	6 (<1)	
If a pregnant woman gets the flu, how likely is that the flu will harm her?					<0.01
Very or somewhat likely	2,258 (85)	153 (92)	1,104 (79)	1,001 (92)	
Very or somewhat unlikely	211 (8)	8 (5)	162 (12)	41 (4)	
Unknown	178 (7)	6 (3)	129 (9)	43 (4)	
If a pregnant woman gets the flu, how likely is that the flu will harm her baby?					<0.01
Very or somewhat likely	2,282 (86)	157 (96)	1,097 (79)	1,028 (95)	
Very or somewhat unlikely	160 (6)	3 (2)	129 (9)	28 (2)	
Unknown	204 (8)	4 (2)	171 (12)	29 (3)	

Note: Positive ("Very worried" and "Somewhat worried"; "Very likely" and "Somewhat likely") and negative ("Not too worried" and "Not worried at all"; "Very unlikely" and "Somewhat unlikely") answers have been collapsed.

Table 4. Attitudes about influenza vaccine among those who have heard of influenza and influenza vaccine prior to enrollment (n = 2,198).

		Sites			
	Overall n = 2,198 n (%)	India n = 43 n (%)	Peru n = 1,240 n (%)	Thailand n = 915 n (%)	p-Value
How well do you think the flu vaccine works in protecting pregnant women from getting the flu?					<0.01
Very or somewhat well	1,735 (79)	43 (100)	853 (69)	839 (92)	
Not too well or not at all	89 (4)	0 (0)	66 (5)	23 (2)	
Unknown	370 (17)	0 (0)	317 (26)	53 (6)	
How safe do you think flu vaccines are for pregnant women?					<0.01
Completely, very or somewhat safe	1,721 (78)	42 (98)	882 (71)	797 (87)	
Completely, very or somewhat unsafe	118 (5)	1 (2)	53 (4)	64 (7)	
Unknown	357 (16)	0 (0)	303 (24)	54 (6)	
When a pregnant woman receives the flu vaccine, how well do you think the flu vaccine works in protecting her baby from the flu after her baby is born?					<0.01
Very or somewhat well	1,579 (72)	42 (98)	745 (60)	792 (87)	
Not too well or not at all	180 (8)	1 (2)	120 (10)	59 (6)	
Unknown	436 (20)	0 (0)	372 (30)	64 (7)	
When a pregnant woman receives the flu vaccine, how safe do you think that the vaccine is for her baby?					<0.01
Completely, very or somewhat safe	1,638 (75)	43 (100)	835 (67)	760 (83)	
Completely, very or somewhat unsafe	135 (6)	0 (0)	50 (4)	85 (9)	
Unknown	423 (19)	0 (0)	353 (29)	70 (8)	
Please indicate how much you agree or disagree with the following statement: Pregnant women should get the flu vaccine					<0.01
Agree	1,858 (85)	43 (100)	994 (80)	821 (90)	
Disagree	136 (6)	0 (0)	81 (7)	55 (6)	
Unknown	203 (9)	0 (0)	164 (13)	39 (4)	
Do you think that a breastfeeding mother should get the flu vaccine if she did not receive it already while pregnant?					<0.01
Yes, she SHOULD	1,096 (50)	43 (100)	642 (52)	411 (45)	
No, she should NOT	604 (28)	0 (0)	223 (18)	381 (42)	
Unknown	496 (22)	0 (0)	373 (30)	123 (13)	

Note: Positive ("Very well" and "Somewhat well"; "Completely safe", "Very safe" and "Somewhat safe"; "Strongly agree" and "Agree") and negative ("Not too well" and "Not at all"; "Completely unsafe", "Very unsafe" and "Somewhat unsafe"; "Disagree" and "Strongly disagree") answers have been collapsed.

participants who received vaccination recommendations had 8 + antenatal visits, versus 10% (184/1938) among those who did not receive recommendations (p-value<0.001); those who received a recommendation also reported a lower health score (mean(sd) = 89.7(8.8) vs 94(7.5); p-value = 0.03). Since very few participants in Nagpur received a provider recommendation, we further investigated factors associated with having heard of influenza. Participants from Nagpur who knew about influenza (n = 167, 8%) had more education (46% (77/167) had post-secondary education vs 18% (328/1799) among those who did

Table 5. Predictors for influenza vaccination among pregnant women, crude OR, adjusted OR (using Peru data only (n = 1,240), with self-reported or verified vaccination variable as dependent variable).

	Vaccinated *n* (%)	Unvaccinated *n* (%)	Crude OR (95% CI)	Adjusted OR (95% CI)
All	733 (59)	507 (41)		
Age-group				
18–34	605 (83)	419 (83)	*Ref*	*Ref*
≥35	128 (17)	88 (17)	1.04 (0.75,1.45)	1.34 (0.89,2.01)
Education				
None/Primary	45 (6)	30 (6)	*Ref*	*Ref*
Secondary	412 (56)	296 (58)	0.81 (0.46,1.44)	0.74 (0.37,1.46)
Post-secondary/University	276 (38)	180 (36)	0.85 (0.48,1.52)	0.75 (0.36,1.54)
Marital status				
Married/living together	622 (85)	426 (84)	*Ref*	*Ref*
Single/Divorced/Separated/Widow	109 (15)	81 (16)	0.93 (0.65,1.32)	0.85 (0.55,1.31)
Occupation				
Does not work outside home	510 (70)	360 (71)	*Ref*	*Ref*
Works outside home	222 (30)	147 (29)	0.97 (0.73,1.27)	0.79 (0.57,1.09)
Has health insurance	556 (76)	358 (71)	1.24 (0.93,1.64)	1.23 (0.88,1.73)
Monthly *per capita* income				
Below poverty line	409 (56)	305 (60)	*Ref*	*Ref*
Above poverty line	324 (44)	202 (40)	1.25 (0.97,1.62)	1.38 (1.01,1.88)
Number of people living in the household				
0–2	355 (48)	252 (50)	*Ref*	*Ref*
3–4	223 (30)	170 (34)	0.97 (0.74,1.29)	1.19 (0.82,1.73)
5+	153 (21)	81 (16)	1.25 (0.88,1.77)	1.27 (0.84,1.92)
Number of ANC visits during pregnancy				
0–4	183 (25)	167 (33)	*Ref*	*Ref*
5–7	237 (32)	140 (28)	1.69 (1.23,2.32)	1.43 (0.99,2.07)
8+	301 (41)	157 (31)	1.75 (1.29,2.38)	2.41 (1.39,2.87)
Number of children				
0	346 (47)	214 (42)	1.47 (1.06,2.04)	1.96 (1.23,3.12)
1	250 (34)	170 (34)	1.28 (0.91,1.8)	1.61 (1,2.58)
2+	134 (18)	122 (24)	*Ref*	*Ref*
Gestational diabetes	16 (2)	15 (3)	0.64 (0.31,1.32)	0.56 (0.23,1.34)
Gestational hypertension	41 (6)	30 (6)	0.95 (0.58, 1.58)	1.22 (0.68, 2.22)
Any chronic condition	20 (3)	9 (2)	1.96 (0.77,4.99)	2.16 (0.71,6.64)
Previously vaccinated against influenza	261 (36)	170 (34)	1.07 (0.82,1.38)	1.02 (0.75,1.38)
Receipt of influenza vaccination recommendation	568 (77)	161 (32)	7.55 (5.69,10.0)	8.25 (6.11,11.14)
Self-perceived health score, *Median (interquartile range: 0.25, 0.75)*	70 (50,80)	70 (60,85)	0.99 (0.99,1.00)	0.99 (0.99,1.00)
Worried about getting sick with influenza				
Very or somewhat worried	360 (49)	246 (49)	0.98 (0.77,1.26)	0.8 (0.59,1.09)
Not worried	369 (50)	258 (51)	*Ref*	*Ref*
Unknown	4 (0.55)	2 (0.4)	2.57 (0.29,23.1)	5.5 (0.46,65.9)
Perception that influenza could harm a pregnant woman				
Very or somewhat likely	582 (79)	397 (78)	1.09 (0.74,1.6)	1.04 (0.62,1.74)
Very or somewhat unlikely	85 (12)	61 (12)	*Ref*	*Ref*
Unknown	63 (9)	48 (9)	0.99 (0.57,1.71)	0.89 (0.42,1.89)
Perception that influenza could harm her baby				
Very or somewhat likely	581 (79)	398 (79)	0.96 (0.62,1.47)	1.17 (0.65,2.09)
Very or somewhat unlikely	65 (9)	48 (9)	*Ref*	*Ref*
Unknown	86 (12)	61 (12)	0.98 (0.57,1.69)	1.2 (0.57,2.53)
Perception of protection provided by influenza vaccine for pregnant women				
Very or somewhat well	508 (69)	345 (68)	1.32 (0.74,2.34)	1.13 (0.53,2.41)
Not too well or not at all	31 (4)	35 (7)	*Ref*	*Ref*
Unknown	193 (26)	124 (24)	1.41 (0.76,2.59)	1.52 (0.66,3.5)
Perception of protection provided by maternal receipt of influenza vaccine for baby				
Very or somewhat well	444 (61)	301 (59)	1.46 (0.95,2.24)	1.18 (0.67,2.08)
Not too well or not at all	58 (8)	62 (12)	*Ref*	*Ref*
Unknown	229 (31)	143 (28)	1.53 (0.96,2.42)	1.33 (0.69,2.58)
Perception of influenza vaccination safety for pregnant women				
Completely, very or somewhat safe	526 (72)	356 (70)	0.93 (0.48,1.79)	0.72 (0.3,1.71)
Completely, very or somewhat unsafe	28 (4)	25 (5)	*Ref*	*Ref*
Unknown	178 (24)	125 (25)	0.93 (0.46,1.84)	0.53 (0.21,1.36)
Perception of maternal influenza vaccination safety for baby				
Completely, very or somewhat safe	497 (68)	338 (67)	1.46 (0.75,2.83)	2.23 (0.95,5.25)
Completely, very or somewhat unsafe	25 (3)	25 (5)	*Ref*	*Ref*
Unknown	210 (29)	143 (28)	1.56 (0.79,3.11)	2.29 (0.91,5.74)

not receive a recommendation (p-value<0.001)), were more likely to be insured (14% (23/167) vs 8% (144/1799); p-value = 0.01), were more likely to have a chronic condition (9% (15/167) vs 4% (73/1799); p-value = 0.006) and reported a lower health score (mean(sd) = 92.8(9.7) vs 94.2(7.3); p-value = 0.02; Supplementary Tables A1–A3).

Discussion

We assessed knowledge, attitudes and practices related to influenza and influenza vaccination among >4,000 pregnant women in one low middle-income country and two upper-income countries with varying influenza vaccination policies for pregnant women. We observed substantial differences regarding influenza and influenza vaccination knowledge, attitudes and practices across sites. In Lima and Bangkok, where influenza vaccination recommendations for pregnant women began 7 y prior to the study, the majority of women had heard of influenza but vaccination rates differed with half of women in Lima vaccinated compared to only 3% in Bangkok. In contrast, in Nagpur where vaccination recommendations began 2 y prior to this study, less than 1 in 10 women had heard of influenza and only 1% received vaccine. Despite significant differences in demographic and socioeconomic characteristics in the three country populations, most participants across sites who were aware of influenza prior to study enrollment believe they and their infants are at risk of influenza and related complications and believe influenza vaccination is safe and effective.

Consistent with prior studies,[7–9,30–34] healthcare provider recommendation was a strong predictor of influenza vaccine receipt among women in Lima, further supported by data from 2016 where 50 of 54 pregnant women interviewed in three different regions of Peru, agreed that doctor's recommendation for influenza vaccination was very important to them.[19] Although we did not ask whether women in our study received an offer of influenza vaccination, 80% of those vaccinated received the vaccine at study hospitals, which is consistent with other studies that suggest provider offer and availability of vaccine are important in a pregnant woman's decision to receive vaccine.[7,35–37] Our findings highlight potential opportunities to increase influenza vaccine uptake among pregnant women by providing education and training to health-care providers regarding the benefits and safety of vaccinating pregnant women and by making influenza vaccine accessible in the antenatal care setting. In prior studies among health-care personnel in Thailand and India, providers infrequently offered influenza vaccine to pregnant women, leading to a demand for education and training among providers about influenza and influenza vaccination.[8,9,38] Increased knowledge and awareness for health-care personnel regarding the risk of influenza infection for both pregnant women and their infants have been associated with increased recommendations for vaccination and higher coverage among pregnant women.[31]

Higher numbers of antenatal visits have also been associated with influenza vaccination;[30] however, more contact with a provider may act as a confounder for provider offer of vaccination given the increased opportunity to be offered vaccination.[7] Furthermore, in this study, self-reported worry about getting influenza disease during pregnancy and perceived safety and effectiveness of influenza vaccine were not associated with receipt of influenza vaccination among participants in Lima, which differs from studies of intention to be vaccinated and receipt of influenza vaccination reported in KAP studies done in the US[39–41] and a recent study of post-partum women in four middle-income countries;[42] however, a previous KAP study in Thailand also did not find the expected associations between influenza-related concerns and vaccination.[8] Unfortunately, given the limited amount of information on KAP and vaccination among pregnant women in low- and middle-income countries, we lack comparable studies to aid us in interpreting our null findings. Our difference in results may also be partially explained by the fact that regardless of what the study participants think or perceive of influenza and influenza vaccination, the action of receiving the vaccine is largely influenced by a health-care provider's recommendation and probably the ability to offer it at that time.

Women in Nagpur and Bangkok had positive perceptions about vaccine safety and effectiveness – among those who knew about influenza and influenza vaccine prior to study enrollment. Moreover, a 2012–2013 survey of 1000 pregnant women in northern India found that despite not being vaccinated and no familiarity with influenza vaccine recommendations, all of the women agreed to vaccination if it were recommended or offered by a trusted healthcare provider and if they were informed of the vaccine safety during pregnancy.[38] In our study, only 8% of the Indian participants were aware of influenza and only 2% of influenza vaccine.

Several limitations should be considered when interpreting our findings. First, we were only able to perform an analysis of factors associated with vaccination with data from Lima because less than 5% of the participants from Nagpur and Bangkok received vaccine during pregnancy. Nonetheless, the findings from the analysis of the Lima site were consistent with the literature,[7–9,30–34] where vaccination recommendation by health-care providers remains a key predictor for vaccination among pregnant women. Second, while our surveys were based on the standardized surveys assessing KAPs, we may have missed other variables that could be associated with vaccination like offer and availability of influenza vaccine.[7,30] For example, pregnant women receiving care from clinicians who are well informed about influenza and promote influenza vaccination among pregnant women may be more likely to be vaccinated compared to pregnant women receiving care from clinicians who do not promote vaccination. Third, sites are located in countries with different timing and vaccination recommendation policies, and participants at sites presented different socio-demographic characteristics which made it harder to pool data for analyses, as we originally planned. Therefore, we present the data overall and by site.

In conclusion, a substantial percentage of pregnant women had not heard about the risks of influenza and the benefits of influenza vaccination. However, pregnant women who have heard of influenza are aware of the risk that influenza poses to them and their infants. Health-care provider recommendation for vaccination is strongly associated with receipt of vaccination. Antenatal visits are opportunities for pregnant women to receive a recommendation to vaccinate from a health-care provider, to be offered influenza vaccination and to make an informed decision to protect their health and the health of their offspring.

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Disclosure of potential conflicts of interest

The authors have no conflicts of interest to declare.

Disclaimers

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention. The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, nor the United States Government.

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