**Supplement to ‘Knowledge, attitudes, and practices regarding seasonal influenza vaccination during pregnancy in Costa Rica: a mixed-methods study’**

**Supplemental methods**

**Survey**

*Questionnaire*

A questionnaire was adapted from the US CDC influenza survey and modified following evaluation of technical and cultural appropriateness by personnel from the Center for Strategic Development and Information on Health and Social Security of CCSS and the Institutional Review Board of Universidad del Valle de Guatemala (UVG). Prior to study implementation, informed consents and data collection instruments were evaluated with 12 women in their immediate postpartum period at the Mexico Hospital in San José, Costa Rica. Minor changes in the wording of some questions were required. We did not pilot test the physicians’ questionnaires. The finalized survey instrument for postpartum women had 35 items including demographics (age, province of residence, education, occupation, gestational age, number of children, vaccination status of other children), number of prenatal visits, recommended vaccination by clinician, knowledge of influenza vaccination safety and benefits, influenza vaccination status, reasons for and for not receiving vaccination. The final survey for prenatal care physicians had 28 items including demographics (age, sex, province, years of employment as obstetrician or general practitioner, works in multiple healthcare facilities), treated patients with influenza, influenza vaccination status, knowledge of influenza transmission and risk of disease, and behavior regarding influenza vaccination. There were no open-ended questions to minimize interviewer bias.

Surveys were administered verbally in Spanish by trained healthcare professionals from June 26-July 31, 2017. Surveys were done one to three days postpartum in the maternity hospitals from which participants were recruited. Data was collected with ViewSonic ViewPad 7 tablets using the Open Data Kit (ODK JAVA) platform. We also reviewed vaccination cards and medical records from the Latin American Center of Perinatology form to obtain information on influenza vaccination and chronic diseases.

*Sampling*

To calculate sample size, the lowest influenza vaccination coverage among pregnant women in Central America (32%) [1] and lowest proportion of physicians recommending the seasonal influenza vaccine found in a similar survey in Guatemala (82%) [2] were used as key indicators. For the reference populations, we used birth projections in CCSS hospitals for the study period (12,247 births) and the number of prenatal care physicians listed for CCSS hospitals (403 doctors) [3]. We used a design effect of two for the two sampling stages, 95% confidence interval (95%CI), and 10% replacement rate. Applying 5% accuracy for postpartum women and 7% for prenatal care physicians, we calculated sample sizes of 814 postpartum women and 200 prenatal care physicians.

Equation used to obtain sample sizes for surveys of postpartum women and prenatal care physicians [4].

Where:

* *N* = population size
* = Quantile with standard normal distribution
* = Confidence level
* *P* = Expected proportion in the population.
* *d* = Absolute accuracy required
* Design effect

We used probabilistic, two-stage, stratified and conglomerate sampling to select samples of postpartum women and prenatal care physicians (family and community doctors, and obstetricians) in CCSS maternity hospitals. Stratification was based on hospital location (East, Northeast, South). In stage one, conglomerates (hospitals) were identified by probability proportional to the number of deliveries in each hospital or number of doctors who provided prenatal care in each hospital. In stage two, we invited all postpartum women regardless of age who gave birth in each hospital and all physicians who had provided prenatal care during 2017 to participate. We excluded postpartum women who could not respond to interview questions because of their clinical conditions, non-residents of Costa Rica, and individuals who remained outside of Costa Rica during their pregnancy, up to seven days before delivery.

**Focus groups**

We held two focus groups of six healthcare workers each to identify factors that influence healthcare workers’ ability to make informed decisions regarding seasonal influenza vaccination. Session topics included perceptions of influenza vaccination, sources of information, and factors that could stimulate or hinder vaccination among healthcare workers. Groups included individuals in leadership positions who were subject matter experts on influenza vaccination, identified by staff from the CCSS Department of Epidemiology and Health Surveillance Unit of the Costa Rican Ministry of Health. Our convenience sample included teaching staff in healthcare facilities and universities, staff in medical and nursing headquarters, vaccination program coordinators, infectious disease specialists, and pulmonologists.

Focus groups were held in San José, Costa Rica, in August 2017. An anthropologist guided two-hour sessions using a script with questions and evaluated verbal and nonverbal phenomena. To facilitate discussion, we attempted to prevent hierarchical relationships from coinciding in the same focus group. Individuals who could not remain throughout the session were excluded. Sessions were recorded with two digital recorders, transcribed within five days, and translated into English.

We analyzed information obtained from focus groups by coding and classifying the discussions, using the guiding questions as initial categories, which were then transformed by regrouping and indexing using the N’Vivo 11 (QSR International, Melbourne, Australia) software. The data is interpreted from the original information, as well as with the transformed conceptual information.

**Statistical analysis**

*Principal components analysis*

Principal components factor analyses (PCA) were used to examine potential factors to represent five knowledge variables for postpartum women and eight variables for prenatal care physicians. First, we assigned scores of 1 (agree) and 0 (disagree) for each variable. Variables representing ‘the vaccine causes harm,’ ‘everyone has the same risk of hospitalization from influenza,’ ‘everyone has the same risk of infection from influenza,’ and ‘influenza vaccine causes flu-like symptoms’ were reverse-coded for ease of interpretation. Participants who did not know or did not respond to a knowledge question were assigned 0 for that question. PCA for postpartum women showed that the first factor explained 36.7% of the variability in the data and only included with ‘vaccination protects against severe disease.’ The resultant compound factor for prenatal care physicians explained 23.3% of the variability and also only included one variable, ‘influenza may be transmitted from birds or pigs to people.’ Subsequent factors explained little variability, therefore compound factors were not used to represent knowledge variables for either subgroup—only ‘vaccination protects against severe disease’ and ‘influenza may be transmitted from birds or pigs to people.’

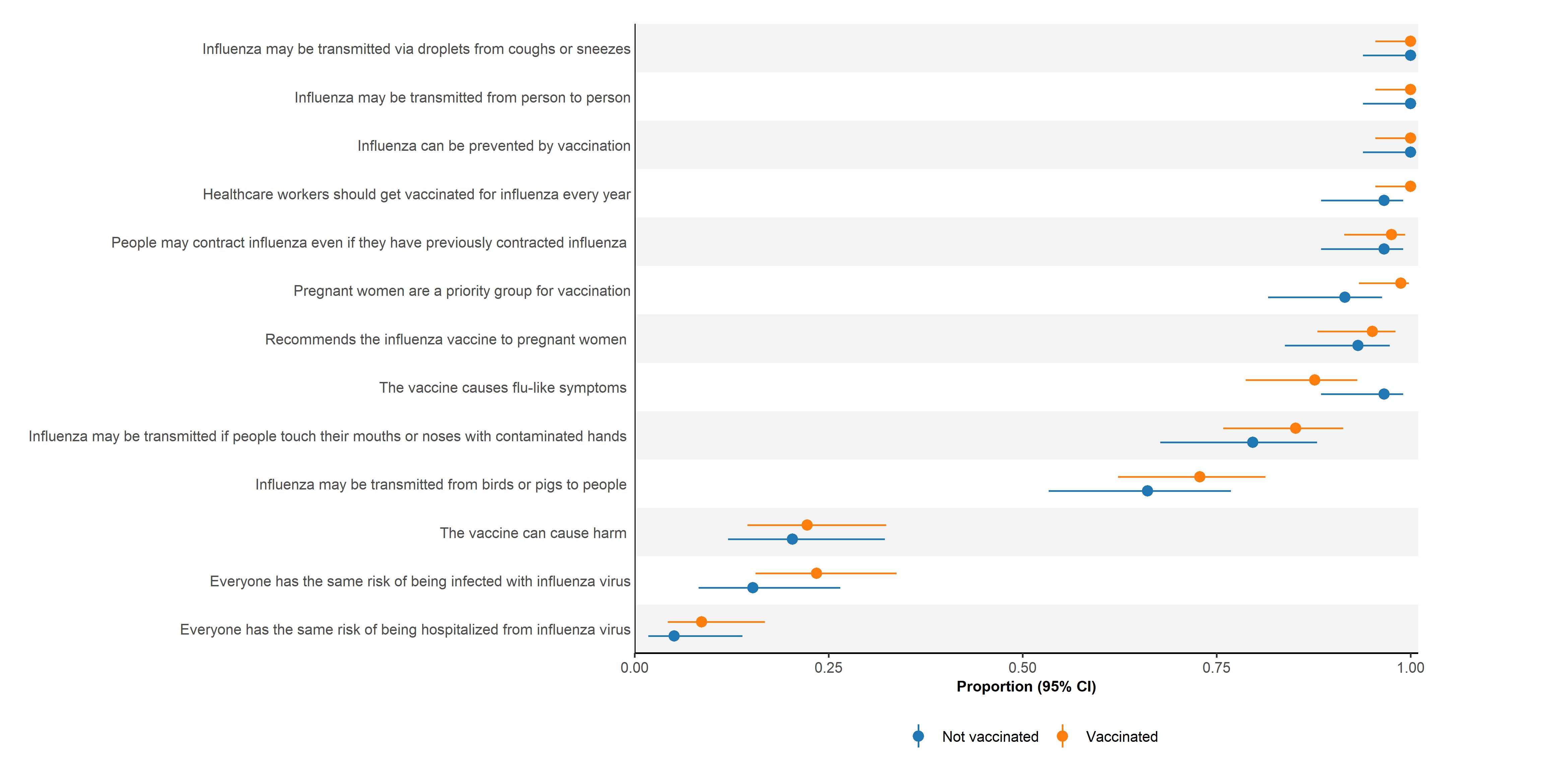
*Logistic regression*

Logistic regression was used to analyze associations between exposures of interest (demographics, prenatal care variables, sources of information regarding vaccination), and self-reported influenza vaccination, which was done separately for postpartum women and prenatal care physicians. For postpartum women, we also conducted a sensitivity analysis restricted to verified vaccinations only. Participants self-reported their vaccination status, which we subsequently verified with vaccination cards and medical records. This sensitivity analysis excluded participants with unverified influenza vaccinations and those who did not provide complete demographics. Statistical significance was evaluated through the Wald Chi-square test. Variables found to be significant at *P*<0.20 from unadjusted analyses were included in manual forward step-wise multivariable logistic regression models to evaluate associations with influenza vaccination. Variables with the smallest *P-*value from unadjusted analyses were added one at a time to the forward step-wise regression models and removed at a *P*<0.20 significance level. Values of *P*<0.05 were considered statistically significant. Variance inflation factors were used to assess collinearity among independent variables. We report unadjusted and adjusted odds ratios, and 95%CIs.

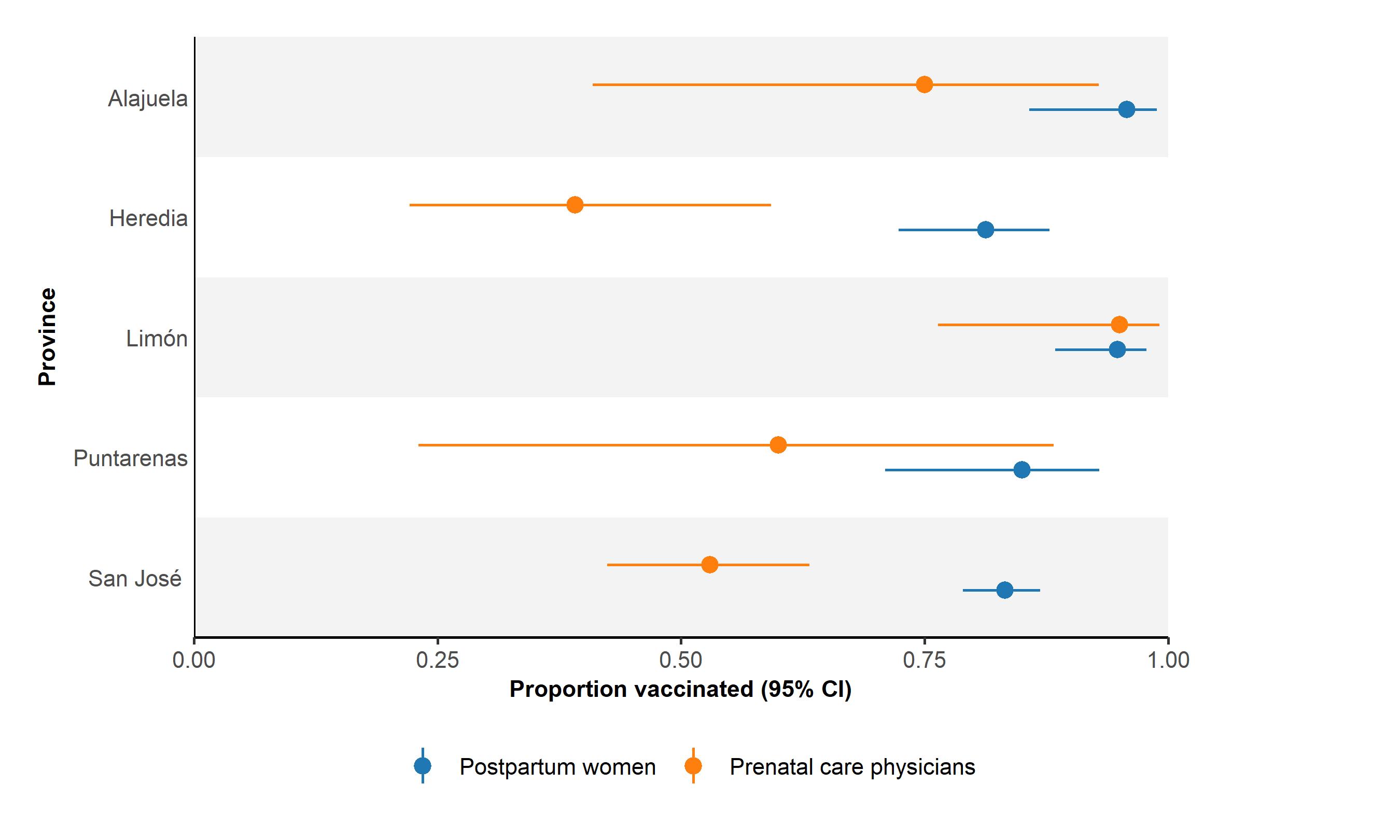
*Multiple imputation*

We used multiple imputation with predictive mean matching for these missing data to increase statistical power and minimize selection bias, which was done separately for postpartum women and prenatal care physicians. In the postpartum women imputation model, we included demographics (age group, province of residence, race, education, occupation, comorbidity, number of children in household, average age and vaccination status of other children in household, number of prenatal visits, received vitamin supplements during pregnancy, tetanus vaccination status, clinician recommended vaccine, self-reported vaccination status), as well as all knowledge of influenza vaccination variables listed in Table S2. In the prenatal care physician model, we included all demographics (age group, sex, profession, years in profession, province, service network, treated influenza patients, self-reported vaccination status) and knowledge/attitude variables described in Table 3. We created 20 imputed datasets, each using 20 cycles of regression switching, and used Rubin’s rules to combine the estimated regression coefficients and variances from the completed datasets [5].

**Figure S1. Knowledge and attitudes of seasonal influenza vaccination by vaccination status of prenatal care physicians (N=146), Costa Rica, July-August, 2017.**



**Figure S2. Seasonal influenza vaccination coverage (self-reported), postpartum women (N=642) and prenatal care physicians (N=140) by province, Costa Rica, July-August, 2017.**



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| Table S1. Principal components factor analysis of knowledge variables, Costa Rica, July-August, 2017. | | |
| Characteristic | Factor Pattern |
| *Postpartum women (N=642)* |  |
| Influenza causes serious illness | 0.14 |
| Aware of an influenza vaccine | 0.04 |
| Perceived vaccine as safe | 0.12 |
| Vaccination protects against severe disease | **0.96** |
| Influenza may be transmitted from person to person | 0.20 |
| *Eigenvalue* | 1.34 |
| Explained variance | 36.7% |
| Prenatal care physicians (N=146) |  |
| Influenza may be transmitted from birds or pigs to people | **0.98** |
| People may contract influenza even if they have previously contracted influenza | 0.10 |
| Influenza may be transmitted if people touch their mouths or noses with contaminated hands | 0.08 |
| Influenza can be prevented with vaccination | 0.02 |
| The vaccine does not cause flu-like symptoms | 0.01 |
| Not everyone has the same risk of being infected with influenza virus | 0.05 |
| Not everyone has the same risk of being hospitalized from influenza virus | 0.07 |
| The vaccine does not cause harm | 0.10 |
| *Eigenvalue* | 1.74 |
| Explained variance | 23.3% |

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| Table S2. Knowledge of influenza vaccination, postpartum women (N=642), Costa Rica, July-August, 2017. | | |
|  | Agree | |
| Knowledge | N | % (95% CI) |
| Influenza causes serious illness | 550 | 85.7 (82.7-88.2) |
| Influenza may be transmitted from person to person | 490 | 76.3 (72.9-79.4) |
| Aware of an influenza vaccine | 623 | 97.0 (95.4-98.1) |
| Perceived vaccine as safe | 589 | 91.7 (89.4-93.6) |
| Vaccination protects against severe disease | 421 | 65.6 (61.8-69.1) |
| CI: confidence interval | | |

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| Table S3. Sources of information about influenza vaccination, prenatal care physicians (N=146), Costa Rica, July-August, 2017. | | |
| Source of information | N | % (95% CI) |
| Conversations with family, friends, or coworkers | 17 | 11.6 (7.4-17.9) |
| Mass media | 71 | 48.6 (40.7-56.7) |
| Informal information from the healthcare facility | 70 | 47.9 (40.0-56.0) |
| Training in the healthcare facility | 31 | 21.2 (15.4-28.6) |
| Doctor or nurse at healthcare facility | 44 | 30.1 (23.3-38.0) |
| Medical consultation | 6 | 4.1 (1.9-8.7) |
| CI: confidence interval | | |

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| Table S4. Associations between demographics and prenatal care, and verifieda influenza vaccination, postpartum women (n = 580b), Costa Rica, July-August, 2017. | | | | |
| Variable | OR (95% CI) | P-value | aORc (95% CI) | P-value |
| Age group (Ref: 18-34 years) |  | 0.378 |  | – |
| <18 years | 0.69 (0.30-1.76) |  | – |  |
| ≥35 years | 0.65 (0.34-1.34) |  | – |  |
| Province (Ref: San José) |  | 0.002 |  | 0.042 |
| Heredia | 0.91 (0.50-1.71) |  | 0.76 (0.38-1.55) |  |
| Limón | 4.46 (1.78-15.07) |  | 4.48 (1.60-16.18) |  |
| Alajuela | 4.68 (1.38-29.25) |  | 2.62 (0.73-16.87) |  |
| Puntarenas | 1.20 (0.51-3.30) |  | 0.64 (0.25-1.88) |  |
| Other | 0.65 (0.24-2.08) |  | 0.82 (0.27-2.89) |  |
| Race (Ref: Mestiza) |  | 0.382 |  | – |
| White | 0.86 (0.51-1.52) |  | – |  |
| Mulata | 1.98 (0.83-5.87) |  | – |  |
| Other | 0.73 (0.18-4.94) |  | – |  |
| Education (Ref: no formal education/primary school) |  | <0.001 |  | <0.001 |
| Secondary school | 0.32 (0.11-0.77) |  | 0.31 (0.10-0.80) |  |
| Bachillerato | 0.15 (0.05-0.42) |  | 0.23 (0.07-0.68) |  |
| University | 0.10 (0.03-0.25) |  | 0.12 (0.04-0.31) |  |
| Concurrent chronic disease (Ref: no) | 1.17 (0.63-2.35) | 0.638 | – | – |
| ≥37 weeks gestational age (Ref: <37 weeks) | 0.91 (0.36-1.98) | 0.826 | – | – |
| Number of other children in household (Ref: 0) |  | 0.242 |  | – |
| 1 | 1.45 (0.81-2.70) |  | – |  |
| 2 | 1.62 (0.88-3.10) |  | – |  |
| ≥3 | 1.81 (0.86-4.31) |  | – |  |
| Average age of other children in household (Ref: no other children) |  | 0.166 |  | – |
| <5 | 1.60 (0.87-3.08) |  | – |  |
| 5-10 | 1.36 (0.77-2.47) |  | – |  |
| >10 | 2.26 (0.99-6.13) |  | – |  |
| Vaccination status of other children in household (Ref: not vaccinated) |  | 0.013 |  | 0.048 |
| Vaccinated | 3.35 (1.19-4.58) |  | 2.36 (1.10-5.02) |  |
| No other children in household | 1.21 (0.65-2.20) |  | 1.50 (0.73-3.02) |  |
| Number of prenatal visits (Ref: <6) |  | 0.057 |  | – |
| >8 | 1.01 (0.47-2.03) |  | – |  |
| 6-8 | 2.04 (0.91-4.33) |  | – |  |
| Received iron, folic acid, multivitamin, or calcium supplements during pregnancy (Ref: no) | 1.61 (0.24-6.80) | 0.573 |  | – |
| Vaccinated for tetanus during pregnancy (Ref: no) | 2.94 (1.65-5.12) | <0.001 | 4.58 (2.25-9.33) | <0.001 |
| Received vaccination recommendation by clinician during prenatal check-up (Ref: no) | 4.03 (2.50-6.50) | <0.001 | 3.44 (2.03-5.88) | <0.001 |
| Vaccination protects against severe disease (Ref: disagree) | 1.22 (0.77-1.91) | 0.404 | – | – |
| Ref: reference; OR: odds ratio; aOR: adjusted odds ratio; CI: confidence interval | | | | |
| a Verified with vaccination cards or medical records | | | | |
| b Analyses excluded participants with unverified influenza vaccinations and those who did not provide complete demographics | | | | |
| c Adjusted for the other variables listed in the model | | | | |

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| Table S5. Associations between demographics and sources of information, and self-reported influenza vaccination, prenatal care physicians (n = 140a), Costa Rica, July-August, 2017. | | | | | |
| Variable | OR (95% CI) | P-value | aORb (95% CI) | P-value |
| ≥35 Years of age (Ref: 24-34 years) | 1.34 (0.69-2.64) | 0.392 | – | – |
| Male sex (Ref: Female) | 1.02 (0.52-2.00) | 0.965 | – | – |
| General physician (Ref: Obstetric physician) | 1.65 (0.82-3.32) | 0.161 | – | – |
| ≤10 Years in profession (Ref: >10 years) | 1.27 (0.64-2.55) | 0.495 | – | – |
| Works in multiple healthcare facilities (Ref: No) | 0.42 (0.19-0.93) | 0.032 | – | – |
| Health facility province (Ref: San José) |  | 0.033 |  | 0.027 |
| Heredia | 0.56 (0.22-1.44) |  | 0.58 (0.23-1.49) |  |
| Limón | 12.16 (1.68-88.09) |  | 15.73 (1.97-125.86) |  |
| Alajuela | 1.91 (0.43-8.50) |  | 2.64 (0.49-14.16) |  |
| Puntarenas | 1.39 (0.22-8.91) |  | 1.34 (0.21-8.55) |  |
| Service network (Ref: Northeast) |  | 0.013 |  | – |
| East | 3.30 (1.43-8.10) |  | – |  |
| South | 1.10 (0.47-2.55) |  | – |  |
| Treated patients with influenza (Ref: No) | 1.33 (0.63-2.80) | 0.453 | – | – |
| Source of information (Ref: no) |  |  |  |  |
| Conversations with family, friends, or coworkers | 0.61 (0.21-1.70) | 0.339 | – | – |
| Mass media | 0.99 (0.51-1.94) | 0.979 | – | – |
| Informal information from the healthcare facility | 1.70 (0.87-3.37) | 0.123 | – | – |
| Training in the healthcare facility | 3.13 (1.30-8.41) | 0.010 | 3.44 (1.36-9.62) | 0.012 |
| Doctor or nurse at healthcare facility | 1.64 (0.79-3.50) | 0.189 | – | – |
| Medical consultation | 0.72 (0.13-4.00) | 0.692 | – | – |
| Influenza may be transmitted from birds or pigs to people (Ref: disagree) | 1.38 (0.66-2.86) | 0.392 | – | – |
| Ref: reference; OR: odds ratio; aOR: adjusted odds ratio; CI: confidence interval | | | | | |
| a Excluded 6 who did not know vaccination status. | | | | | |
| b Adjusted for the other variables listed in the model | | | | | |

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| Table S6. Where prenatal care physicians refer pregnant women for influenza vaccination (N=129), Costa Rica, July-August, 2017. | | | |
| Location | N | % (95% CI) |
| Same healthcare facility during prenatal care appointment | 104 | 80.6 (73.0-86.5) |
| Same healthcare facility during appointment different from prenatal care | 16 | 12.4 (7.8-19.2) |
| Other CCSS healthcare facility | 42 | 32.6 (25.1-41.0) |
| Private provider | 17 | 13.2 (8.4-20.1) |
| Does not refer them to a specific facility | 11 | 8.5 (4.8-14.6) |
| CI: confidence interval | | | |

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| Table S7. Reasons for non-vaccination, prenatal care physicians (N=59), Costa Rica, July-August, 2017. | | | |
| Reason | N | % (95% CI) |
| Too busy to get vaccinated | 19 | 32.2 (21.7-44.9) |
| Was not offered the vaccine | 12 | 20.3 (12.0-32.2) |
| Fear of side effects | 11 | 18.6 (10.7-30.4) |
| Fear of contracting influenza | 8 | 13.6 (7.0-24.5) |
| Influenza does not cause serious illness | 7 | 11.9 (5.9-22.5) |
| Does not consider the vaccine to be effective | 2 | 3.4 (0.9-11.5) |
| CI: confidence interval | | | |

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