



## Influenza vaccination of pregnant women: Engaging clinicians to reduce missed opportunities for vaccination



Joseph G. Giduthuri<sup>a,b,\*</sup>, Vidula Purohit<sup>c,d</sup>, Nicolas Maire<sup>a,b</sup>, Abhay Kudale<sup>c,d</sup>, Jürg Utzinger<sup>a,b</sup>, Christian Schindler<sup>a,b</sup>, Mitchell G. Weiss<sup>a,b</sup>

<sup>a</sup>Swiss Tropical and Public Health Institute, Basel, Switzerland

<sup>b</sup>University of Basel, Basel, Switzerland

<sup>c</sup>The Maharashtra Association of Anthropological Sciences, Centre for Health Research and Development, Pune, India

<sup>d</sup>Savitribai Phule Pune University, Pune, India

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### ABSTRACT

**Background:** Antenatal influenza vaccination (AIV) is an effective intervention for protecting pregnant women and their newborns against influenza. Although the World Health Organization recommends AIV at any stage of pregnancy, in low- and middle-income countries, including India, it is rarely provided. Research suggests that antenatal care (ANC) provider practices explain much of this limited coverage. Our study in urban Pune, India, assessed the feasibility of a two-stage clinician-engagement strategy to reduce missed opportunities for AIV in urban private-practice ANC clinics.

**Methods:** Clinicians were randomized to intervention and control groups in slum and middle-class study sites. Intervention-group clinicians (active clinicians) were assessed on vaccination-related views and practices, and were presented with authoritative AIV recommendations from global, academic and professional medical organizations. In a second meeting after a community survey, findings concerning vaccination-related views and experiences were explained to active clinicians. Assessments of community vaccination views were not provided to control-group clinicians. Both groups maintained logs of ANC clinic visit vaccination status throughout the 11-month study period to enable identification of missed and taken opportunities for vaccination. Analyses were restricted to visits of women in their third trimester without previous AIV in the current pregnancy.

**Results:** Overall, 30 clinicians participated. After first and second interactions, active clinicians in middle-class communities vaccinated at 12.2% and 37.8%, respectively. Middle-class control clinicians vaccinated at <0.2% throughout the study. This difference in AIV taken opportunities between middle-class active and control clinics was statistically significant ( $p < 0.05$ ) after first and second interactions. In slum-community sites, active clinicians' AIV activity was minimal throughout.

**Conclusions:** Our approach for engaging clinicians effectively reduced missed opportunities for AIV in urban middle-class settings of Pune. It may also improve maternal vaccination for other conditions. The absence of any similar effect in slum-based clinics likely reflects critical limitations of vaccine access.

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### 1. Introduction

Influenza is an acute respiratory infectious disease that accounts for considerable morbidity and mortality worldwide, commonly as seasonal epidemics affecting high-risk groups and occasionally as pandemics [1–4]. Globally, seasonal epidemics are estimated to result in 3–5 million cases, and about 250,000–500,000 deaths per year [1]. During outbreaks of influenza, pregnant women are

at high risk [2,3,5], and the rates of hospitalization and morbidity are higher among pregnant women compared to their non-pregnant counterparts [3,6,7]. Studies have shown that maternal influenza vaccination can prevent laboratory-confirmed influenza in pregnant women and their newborns (<6 months) [8–11]. Importantly, vaccines are widely considered safe [12–15] and effective for preventing influenza at any stage of the pregnancy [16,17].

Though seasonal influenza vaccination for pregnant women has been recommended by the World Health Organization (WHO) since 2012 [16,18], many low- and middle-income countries (LMICs) [19], including India, have yet to implement effective policies. Indeed, reports indicate very poor influenza vaccination

\* Corresponding author at: Swiss Tropical and Public Health Institute, P.O. Box, CH-4002 Basel, Switzerland.

E-mail address: [joseph.giduthuri@swisstph.ch](mailto:joseph.giduthuri@swisstph.ch) (J.G. Giduthuri).

uptake among pregnant women throughout India [20,21]. Various community determinants have been suggested to explain this low coverage, including vaccine hesitancy; cost, access and availability of vaccines; and cultural and religious beliefs that discourage vaccine uptake in pregnant women [22,23]. Although WHO's SAGE report on vaccine hesitancy emphasized the role of community views as barriers to vaccination [24], studies of influenza vaccination for pregnant women indicated that clinicians who do not prescribe influenza vaccine in the course of antenatal care (ANC) are the most important factors explaining low coverage in diverse high-income country settings, including Australia, Germany and the United States of America [25–28]. Wilson and colleagues [29] emphasized the complex mix of health worker and community factors in LMICs.

Our previous experience in urban and rural areas of Pune district, in western India, indicated that limited uptake was less well-explained by community hesitancy or lack of vaccine confidence than by failure of clinicians to recommend and provide influenza vaccination [30]. Other studies in India [20,21] and elsewhere [25,31,32] are consistent with our experience in Pune. Inasmuch as clinicians who are expected to recommend and administer the vaccine play a critical role in explaining low vaccination coverage, strategies to improve antenatal influenza vaccination (AIV) prescribing among clinicians are needed. The studies on maternal influenza vaccination, cited above, show that under-prescribing is not primarily a matter of clinicians' limited awareness of the safety and efficacy of AIV, which appears to be less of an issue, but more a matter of clinicians' concerns about community hesitancy that explained their reluctance to recommend AIV in the course of ANC. Consequently, we formulated a strategy to engage ANC providers with authoritative information about the importance of vaccination and findings from a study of vaccine acceptance in their communities of practice to improve vaccination coverage.

To examine the feasibility of this strategy, we made use of the concept of missed opportunities for vaccination (MOV) developed by WHO [33,34]. Our objective was to determine whether engaging clinicians with professional evidence, and findings from community study of receptiveness to vaccination could reduce missed opportunities for recommended AIV in pregnant women in ANC. This study aimed to determine whether engaging clinicians in this way might reduce MOV with influenza vaccine for pregnant women receiving ANC, and to examine the feasibility of this approach for potential benefits in immunization programmes.

## 2. Methods

### 2.1. Setting

The study was carried out in Pune city in Maharashtra, India, from July 2015 to May 2016. Pune was the major focus in India of the 2009 influenza pandemic and subsequent outbreaks. Urban Pune has a population of 3.1 million, according to the 2011 census. The study was conducted in seven of the city's 76 administrative wards; namely, Aundh, Baner, Gokhale Nagar, Karve Road, Kothrud, Pashan and Paud Road. In these selected wards, ANC is provided in both public and private health sectors. We only included private-sector clinicians in the study because policy and clinical practice in the government sector does not include AIV in ANC. The study was conducted at private clinics, each run by only one doctor.

### 2.2. Study design

All registered medical practitioners providing ANC in the study areas were identified and contacted, and all doctors who agreed to participate were included. Randomization of participating

clinicians to an intervention and control arm was done separately for middle-class and slum sites. We refer to clinicians in the intervention arm with whom we actively engaged as active clinicians. The study commenced in July 2015, lasted for 11 months and included two clinician interactions with active clinicians (September 2015 and December 2015). Hence, there were three study periods – before, between and after the two interactions. In the first clinician interaction (Clin-1), active clinicians were interviewed and provided with AIV implementation recommendations (global, academic and local) intended to motivate clinicians' influenza vaccination practices for pregnant women coming for ANC.

Between the two clinician interactions, a qualitative community survey of women and some of their spouses was conducted in neighbouring communities of active clinics to assess community views about vaccination, and particularly for AIV during pregnancy. A first analysis of those data was completed and summarized to brief active clinicians in the second clinician interaction (Clin-2).

At all participating study clinics, both active and control clinics, influenza and tetanus vaccination status was noted in all daily ANC-visit records during the entire study period. The status of tetanus toxoid (TT) vaccination was monitored as an indication of the clinic capacity to vaccinate women receiving ANC. In India, TT is the only mandatory vaccine given to all pregnant women in the course of ANC. It was used as a proxy indicator to assess capacity of clinicians to vaccinate pregnant women. An interim analysis of vaccination logs for influenza and tetanus was completed, and all active and control-group clinicians were given feedback at the Clin-2 interaction (mid-December 2015) on record-keeping and monitoring of their vaccination practices. In Clin-2, active clinicians were also informed about community views on AIV awareness and acceptance based on the qualitative survey of community stakeholders.

### 2.3. Recruitment

*Clinician sample:* We used a free web-based search engine called [Practo.com](#) [35] to identify private-sector clinicians routinely providing ANC regardless of their designated specialty (e.g. primary care, obstetrics and gynaecology). Researchers contacted all clinicians in designated middle-class and slum communities to explain the rationale for studying vaccination practices in the course of ANC. We inquired about whether they were vaccinating for tetanus, and if they were, and if they agreed to participate and to provide daily vaccination status records for all patients for all vaccinations, including influenza vaccination, and if they also agreed to be available for one or two required meetings, they were recruited in the study. This recruitment process preceded randomization of the sample.

*Community sample:* Purposive sampling was used to recruit 60 women, aged 20–35 years, comprising three subgroups: 20 previously pregnant, 20 currently pregnant and 20 who had never been pregnant. Another group of 30 spouses of these women was selected, 10 for each of the three groups.

### 2.4. Instruments

Instruments for assessment and intervention with active clinicians were prepared for the two scheduled interactions. A qualitative community assessment was prepared for the community study, and vaccination logs and reporting forms were prepared to monitor vaccination status in all clinic visits of ANC patients of active and control clinicians. These instruments were developed in English and translated into Marathi. Electronic versions were created for administering all three interviews on an Android tablet device running Open Data Kit (ODK) software. Paper versions of

these instruments are available on a WHO website in a document with further information about the rationale and development of the study [36,37].

Daily vaccination logs were prepared to document the influenza and tetanus vaccination status of patients in each ANC visit, including whether they were vaccinated that day, previously or never for influenza and tetanus thus far in the course of their pregnancy. It also included the estimated due date (EDD) and age of the pregnant woman.

The Clin-1 interaction comprised a baseline interview that included a section with authoritative information about recommendations of AIV during pregnancy. The following documents were also presented and discussed with clinicians: (i) the WHO recommendations on seasonal influenza vaccination for pregnant women in any trimester [18]; (ii) a review article by Ortiz and colleagues, highlighting the need and the value of influenza vaccination of pregnant women [38]; and (iii) an Indian policy report of an expert panel of the Federation of Obstetrics and Gynaecological Societies of India (FOGSI), explaining increased risk of complications from influenza during pregnancy and recommending vaccination in the second or third trimester [39].

The community survey was a semi-structured qualitative interview instrument with versions for women and male spouses. It included questions about socio-demographic characteristics, the quality of health system experiences, experience and views of antenatal vaccination and childhood vaccination generally, and consideration of the role of vaccines for influenza-like illness affecting a pregnant woman.

The Clin-2 interview for active clinicians assessed changes in their views about influenza vaccination. In addition to feedback from that clinic's vaccination activities based on interim analysis of vaccination monitoring, the interview included a section with community views of vaccination, based on our community survey. The key community survey findings, provided only to active clinicians, elaborated on the following points: community awareness and willingness to take most vaccines prescribed by their doctor, likelihood of discussing any questions with their husband, consideration of price (especially among slum community respondents), vaccination status of respondents, awareness of minor adverse events, and respondents' prevailing view that vaccination during pregnancy will mainly benefit the newborn child.

### 2.5. Statistical analysis

Daily vaccination log sheets were kept by all study clinics and collected by the study team on fortnightly visits. These data from a form logging vaccination status for all clinic visits each day were entered for analysis in pre-structured MS Excel worksheets. After initial data entry, a subsample of 20% of forms was randomly selected for second entry and compared with data from the first entry to identify entry errors. A research associate supervised data collection and data entry, and assessed the quality of the logs. Additional support was provided, as needed, to all study clinicians to maintain their daily logs.

Our analysis was guided by consideration of MOV, a strategy for evaluating vaccination performance developed by WHO [40]. An MOV refers to any clinic visit for health services by a patient who is eligible for vaccination (i.e. not yet vaccinated), which does not result in that person receiving vaccine [33,34]. We adapted the analysis to consider "taken opportunities" and calculated rates of taken opportunities. We considered an ANC visit of a pregnant woman as eligible for AIV if she had not previously been vaccinated against influenza in her current pregnancy.

Our analysis was restricted further to consider eligible ANC-visits only in the third trimester of pregnancy because it is a better proxy for vaccination during the entire pregnancy, inasmuch as

there are likely to be fewer subsequent vaccination opportunities than after an earlier MOV. Furthermore, this approach reduced potential bias from a preference for later vaccination to extend protection for the newborn and to account for the recommendation of FOGSI that AIV be given in the second or third trimester, notwithstanding WHO's recommendation for any trimester [39,41].

We defined the binary outcome variable "taken opportunity" as 1 if the opportunity of providing AIV was taken at the respective visit and as 0 otherwise. Three different study periods (SPs) were compared: SP1, the period before the first interaction was considered as baseline (from July to mid-September 2015); SP2, the period between the first and the second interaction as mid-line (mid-September to December 2015); and SP3, the period after the second interaction as the end-line (January to May 2016). These periods varied from one active clinician to another based on Clin-1 and Clin-2 interview dates for that clinic. The SPs for control clinicians were determined by active clinicians' median dates of Clin-1 and Clin-2, respectively.

Descriptive statistics of the proportion of "taken opportunities" among eligible ANC visits are presented for each of the three SPs, both for individual clinics and for the four groups of clinics according to study arm and setting (i.e. middle-class vs. slum sites). Mixed logistic regression analyses with random clinician intercepts were conducted to assess intervention and SP effects on the binary outcome of AIV taken opportunity. As there was almost no AIV administered in slum clinics, our analysis was restricted to middle-class clinics. The respective models included categorical variables for the SP (SP1, SP2 and SP3) and for the study arm (active vs. control) as well as interactions between the two variables. For comparisons between active and control clinics, analyses were also stratified by SP. For the comparison of active and control clinicians, the resulting odds ratios (ORs) relate to the median odds of taken opportunities within the groups, inasmuch as random effects are defined at the logit-level. An additional analysis was conducted among middle-class study clinics to assess whether the rate of taken opportunities changed during the period between the first and the second interaction, or during the period after the second interaction. The respective models included time from start of period as a continuous variable along with its square and interactions of these variables with study arm. All statistical analyses were performed using statistical software Stata/IC version 14.0 (Stata Corp.; College Station, Texas, United States of America). Stata's margins function was used to derive estimates of median rates of taken opportunities for AIV in different groups of clinicians and different SPs.

### 2.6. Ethics statement

The Institutional Ethics Committee of the Maharashtra Association of Anthropological Sciences, the Ethics Committee of North-west and Central Switzerland (EKNZ) and the WHO Ethics Review Committee (WHO reference no. 2015/571608-0) provided ethical approval for this study. Written informed consent was obtained from all participating clinicians and community participants in the qualitative survey.

## 3. Results

Initially, 72 ANC clinicians were identified in the selected municipal wards, of which the 56 clinicians with adequate practice profile information were contacted. Among them, 37 clinicians (slum = 18, middle-class = 19) agreed to participate. In the first two weeks of the study, seven clinicians dropped-out because of difficulty in maintaining vaccination logs. Among the 30 remaining clinicians studied, 11 were active and five were controls in the

slum communities; five were active and nine were controls in the middle-class communities. The sample comprised 22 female and eight male doctors, and 70% (21/30) had at least 15 years of professional experience. Overall, 73% (22/30) of study clinicians reported the data for analysis (at least one ANC visit log per day for ≥75% of their clinic working days). However, more than a quarter (8/30) of clinicians indicated difficulties in maintaining vaccination logs over longer periods. The characteristics of clinicians were comparable between study arms and further details are provided in Table 1. All 16 active clinicians participated in the first and second interaction. At the end of the study we only identified 1.7% of incomplete records without EDD or vaccination status and we excluded such records from the analyses.

**Table 1**  
Clinician characteristics and monitoring performance.

	Middle-class/ Active	Middle-class/ Control	Slum/Active	Slum/Control
<b>Study clinics recruitment</b>				
Recruited	7	12	12	6
Dropout	2	3	1	1
Participated	5	9	11	5
<b>Gender</b>				
Male	–	1	3	4
Female	5	8	8	1
<b>Professional experience</b>				
<15 years	2	3	3	1
≥15 years	3	6	8	4
<b>Reporting performance<sup>§</sup></b>				
<75%	1	1	5	1
≥75%	4	8	6	4
<b>Maintaining daily logs<sup>*</sup></b>				
Easy	2	7	6	4
Moderate	–	1	2	–
Difficult	3	1	3	1

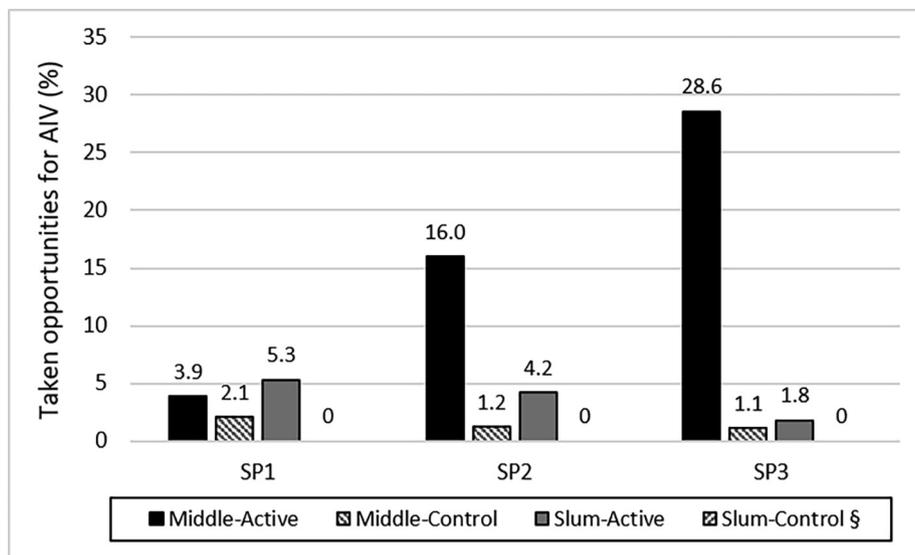
<sup>§</sup> Reporting performance is the proportion of clinician working days with reported vaccination data.

<sup>\*</sup> After the study, all study clinicians were asked about the difficulty in maintaining daily vaccination logs.

### 3.1. Influenza vaccination status

Overall, the rate of taken opportunities for influenza vaccination was 14.1% in active clinics and 1.3% in control clinics irrespective of the gestational age of the pregnant women. Fig. 1 shows the proportions of taken opportunities for vaccinating against influenza for pregnant women in the third trimester in active and control clinics of middle-class and slum sites across the three SPs. Before the first interaction (SP1), only minor differences were observed between active and control clinics from middle-class sites, with rates of 3.9% and 2.1%, respectively. While the rate across slum active clinicians was 5.3% owing to one clinician (out of 11) having vaccinated 18.5% of 27 eligible ANC visits in that clinic, slum control clinicians had no influenza vaccinations in ANC visits. After the first (Clin-1) interview (SP2), middle-class active and control clinicians were vaccinating against influenza at rates of 16.0% and 1.2%, respectively. A further increase to 28.6% was observed in middle-class active clinicians after the second (Clin-2) interview (SP3), but in slum-based active clinicians, AIV decreased from SP2 (4.2%) to SP3 (1.8%) (Fig. 1). None of the control clinicians from slum sites had any taken opportunities to vaccinate against influenza throughout the study.

The estimates of median AIV taken-opportunity rates in Table 2 reflect the same patterns indicated in Fig. 1 for middle-class active clinicians. Estimated median rates increased from 2.6% in SP1 to 12.2% in SP2 (OR = 5.2, 95% confidence interval (CI): 2.4–11.0) among middle-class active clinicians, but rates remained stable among middle-class controls (0.2% in SP1 and 0.1% in SP2). Among middle-class active clinicians, the median rate of taken opportunities for AIV strongly increased further from SP2 to SP3 (OR = 4.4, 95% CI: 2.4–7.9). After the second interaction (SP3), middle-class active clinicians were vaccinating at a substantially higher rate of 37.8%, while the rate in middle-class control clinicians remained unchanged (0.2%). Differences observed in AIV activity between middle-class active and control clinicians before any interventions (in SP1) were not statistically significant ( $p = 0.23$ ). However, after the first and second interventions, the differences in rates of taken opportunities between middle-class active and control clinicians were statistically significant ( $p < 0.05$ ).



**Fig. 1.** Influenza vaccination status of study clinics by study periods for ANC visits of third-trimester pregnant women. The Y-axis shows the proportion of taken opportunities for AIV among antenatal care visits of eligible pregnant women in the third trimester who were not previously vaccinated. The proportions were calculated from the pooled data of the respective periods within the respective clinician groups. SP1: Study period before any interaction occurred; SP2: Study period between the first and second intervention; and SP3: Study period after second intervention. The taken-opportunity rates for slum-community active clinicians in any study period represented AIV by only one clinician.

§ Slum-community control clinicians reported no influenza vaccinations of pregnant women throughout the entire study period.

**Table 2**  
Changes in AIV rates of taken opportunities of middle-class active and control study clinicians over study periods.

	SP1	SP2	SP3	SP1 - SP2	SP2 - SP3
	Rate (%) [95% CI]	Rate (%) [95% CI]	Rate (%) [95% CI]	(OR [95% CI])	
Active clinicians	2.6 [0.2–25.3]	12.2 [1.1–62.6]	37.8 [4.8–87.9]	5.2 [2.4–11.0] <sup>*</sup>	4.4 [2.4–7.9] <sup>*</sup>
Control clinicians	0.2 [0.02–3.9]	0.1 [0.01–2.6]	0.2 [0.02–3.4]	0.7 [0.2–2.0]	1.5 [0.5–4.1]
Active vs. Control (p-value)	0.23	0.02	0.003	NA	NA

OR: odds ratio; CI: confidence interval;

SP: study period (SP1 = before first interaction, SP2 = between 1st and 2nd interaction, SP3 = after 2nd interaction). A mixed logistic regression model with random clinician intercepts and categorical variables for study arm and period, and including their interaction-term, was used to estimate the effects of clinician interactions; all estimates and p-values of the table were derived from this model. Median rates of taken opportunities for AIV were derived using Stata's margins function with random effects assumed to be 0. The odds ratios are adjusted estimates and refer to comparisons between consecutive periods among active or control clinicians, and p-values refer to the differences in rates between active and control clinicians across the different study periods.

<sup>\*</sup>  $p < 0.001$ .

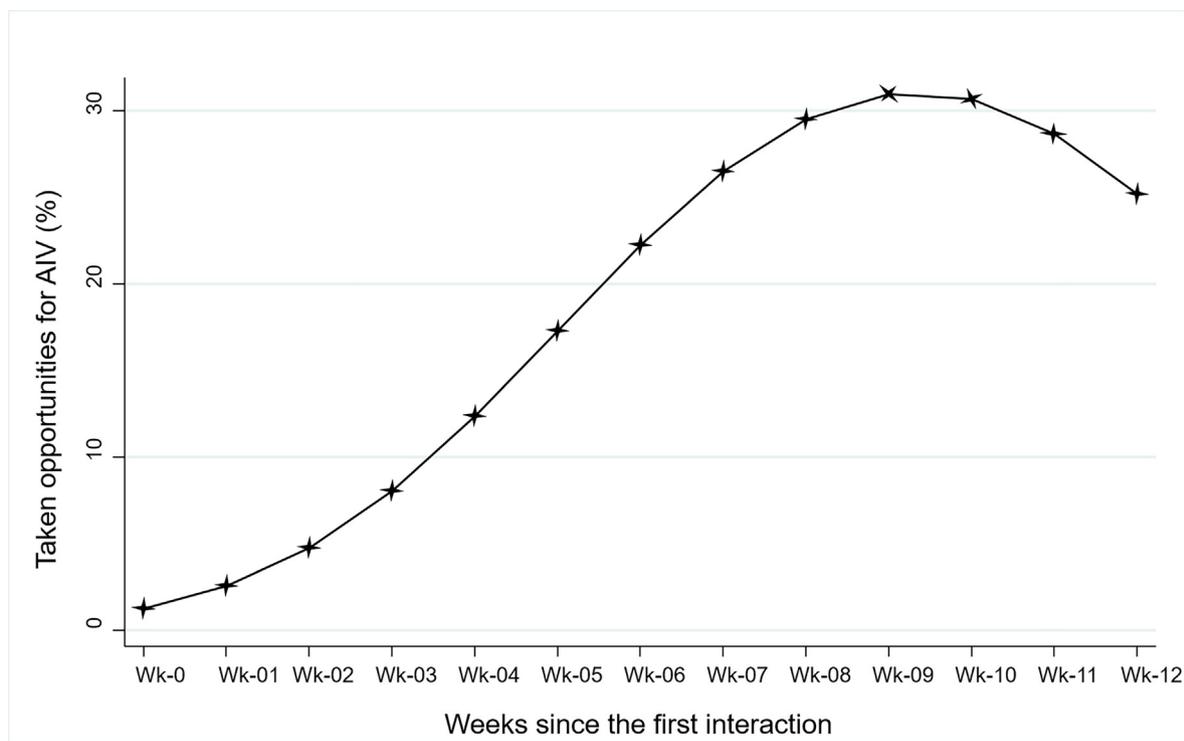
Fig. 2a shows the estimated time course of the median rate of AIV taken opportunities with pregnant women in the third trimester between the first and the second interactions among middle-class active clinicians. The AIV-rate increased up to approximately 10 weeks and then began to decline. Fig. 2b shows the corresponding median rates over 12 weeks from the second interaction for middle-class active clinicians. A statistically significant upward trend was observed in both study periods after the two interactions.

#### 4. Discussion

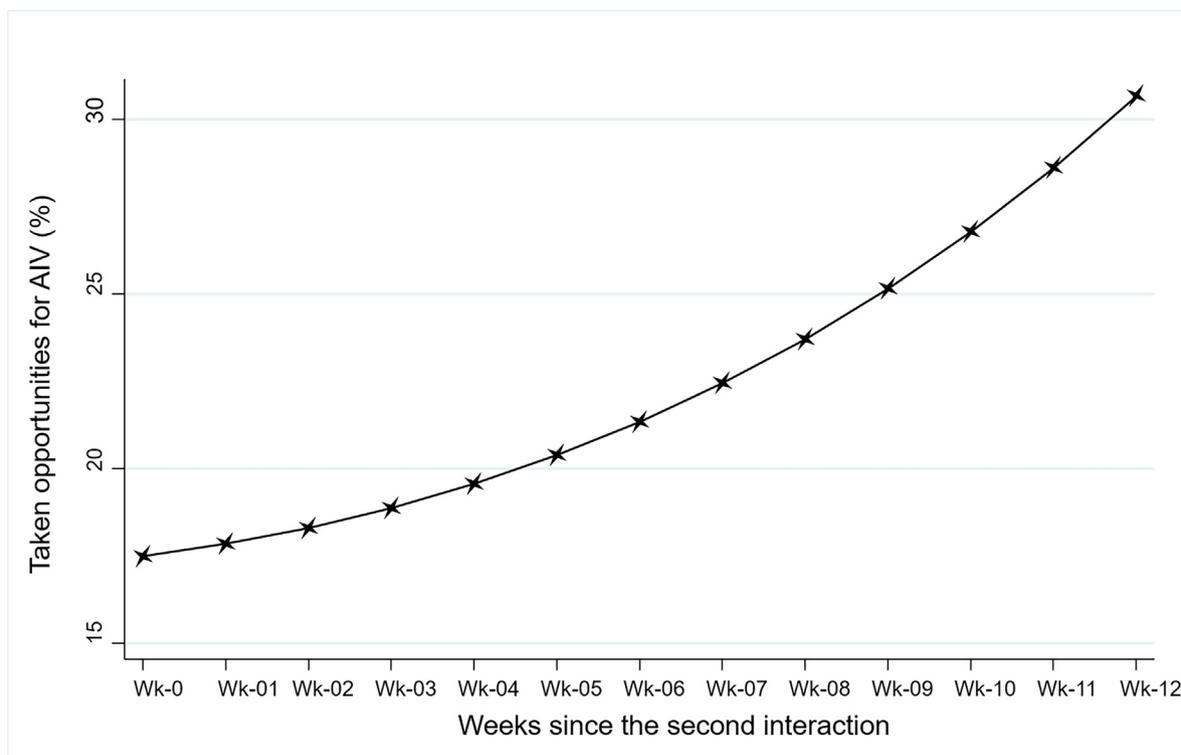
This study examined the feasibility of engaging private clinicians with an approach that includes two strategic interactions to reduce missed opportunities for AIV in urban Pune, India. Active clinicians from middle-class areas responded to both interventions, but active clinicians from slum areas did not respond to either of these interventions. In the active middle-class community clinics, both intervention effects were statistically significant.

In the first interaction, all active clinicians from middle-class and slum sites were presented with information documenting the value and need for influenza vaccination during pregnancy, based on WHO recommendations, academic literature and recommendations of FOGSI. This initial engagement activity increased rates of taken opportunities for AIV from 2.6% to 12.2% in middle-class active clinicians. As the impact of the first interaction providing authoritative professional information may have begun to wane, a second interaction provided complementary information about views of vaccine acceptance in communities where the clinicians practice. Although this strategy was effective in urban middle-class private-practice settings, it failed in slum communities. Structural factors of health systems, probably including affordability of vaccines and other community factors not assessed in this study, are critical.

Other approaches for improving maternal influenza vaccination coverage at ANC facilities in high-income countries have also targeted potential vaccine recipients. In the United States of America, development of an educational pamphlet in Connecticut advising



**Fig. 2a.** Impact of first interaction on middle-class active clinicians. The figure illustrates the time course of median rates of taken opportunities for AIV with eligible pregnant women in the third trimester over the second study period (SP2, i.e. after the first interaction) among middle-class active clinicians. Estimates were derived from a mixed logistic regression model with random clinician intercepts, an indicator variable for study arm, a variable for time since intervention and its square, and an interaction term for these variables and study arm, using Stata's margins function with random effects assumed to be 0, predicted from mixed logistic regression. There was statistically significant positive time trend in the middle-class active group of clinicians up to about week 10 ( $p < 0.001$ , likelihood ratio test).



**Fig. 2b.** Impact of the second interaction on middle-class active clinicians. The figure illustrates the time course of median rates of taken opportunities for AIV with eligible pregnant women in the third trimester over the third study period (SP3, i.e. after the second interaction) among middle-class active clinicians. Estimates were derived from a mixed logistic regression model with random clinician intercepts, an indicator variable for study arm, a variable for time since intervention and its square, and an interaction term between these variables and study arm, using Stata's margins function with random effects assumed to be 0, predicted from mixed logistic regression. The time trend in the middle-class active group of clinicians was weaker in SP3 than in SP2 but still statistically significant ( $p < 0.05$ , likelihood ratio test).

pregnant women of the safety and value of the influenza vaccine reduced concerns about safety and improved vaccination uptake [42]. Use of text messaging reminders have also proved to be effective in targeting low-income pregnant women in the United States and improving vaccination rates [43,44]. It is not clear, however, that such strategies targeting women rather than clinicians would be effective in settings like Pune, where influenza vaccination is less well-known.

Other studies have targeted ANC providers, offering information about the importance of influenza vaccination during pregnancy [31,45,46]. At a suburban medical centre in Santa Monica, California, brief educational sessions to increase awareness among family physicians about recommendations of the Advisory Committee on Immunization Practices (ACIP) resulted in a 15-fold increase in the rate of vaccination in 2003 [45]. Another study in Houston demonstrated the positive impact on AIV of educating ANC providers [47]. Strategies based on reminders to providers to vaccinate have also been employed [31,45,48]. Our study, however, may be the first to employ a strategy based on reporting findings from a qualitative survey of community vaccine acceptance to engage clinicians and thereby promote influenza vaccination at ANC facilities. The approach recognizes the relevance and exploits synergies of acknowledging both clinician and community stakeholders.

Clinicians' appreciation of both the value and the difficulty of monitoring pregnant women's vaccination status was a notable finding of our study. Nearly 73% of all study clinicians maintained and reported vaccination status in  $\geq 75\%$  of ANC-visit records, but limited capacity for consistent vaccination monitoring was a probable limitation of ours and other strategies for improving vaccination coverage. Maintaining the logs was challenging, and clinicians who dropped out of the study did so mainly because of that. One-third of the clinicians reported that it had been difficult to maintain

records in their busy clinical practice settings. The relatively good reporting performance that was achieved reflected the influence of the research team, reminding and motivating clinic staff during their fortnightly visits to log vaccination data. Improved strategies are needed to make such vaccination logs easier to maintain, not only in urban settings like our study sites but also in rural areas where clinical record-keeping may be an even greater challenge. Demonstrating the value of such data for clinicians themselves and improved monitoring technology are required to inform practice and test strategies for improving coverage.

Several limitations of the study should be noted, and a need to further refine the approach is recognized. Although the observed increase in rates of AIV among middle-class active clinicians improved vaccination performance, the overall vaccination rates that were achieved remained relatively low (<40%). Efforts to further enhance the impact of the approach, building on current experience, are therefore needed. Undertaken as a pilot to examine the feasibility of the strategy, rigorous features of a randomized control trial were lacking, and the geographical sample had limited statistical-power. Information bias from clinicians who may have under reported unvaccinated ANC visits could have compromised estimates of taken opportunity rates, although we do not have any indication of that. More detailed information and the ability to track pregnant women patients and potential interventional effects over repeated visits would also have been desirable.

Notwithstanding such limitations, findings are nevertheless relevant for consideration in comparable urban private-practice settings in India and possibly other middle- and perhaps low-income countries. Strategic consideration of community views for influencing provider practices may be useful in diverse settings where strident anti-vaccination rhetoric may obscure a broader, but quieter, base of community acceptance, which clinicians need

to know about. Limits to generalizability, however, should also be noted. Health services in rural areas and government-sector clinics in India are structurally different from urban private-practice with regard to administrative constraints, facilities, resources and motivating incentives of private practice. Strategies for implementation should also consider implications of nurse practitioners who vaccinate, rather than doctors, among various distinctive setting-specific factors. New research is needed to address such questions for improving AIV by adapting this approach in the government health sector and in rural areas of India and other LMICs.

## 5. Conclusions

Clinicians providing antenatal care play a critical role in efforts to improve coverage with AIV. A two-stage strategy for engaging clinicians with authoritative professional evidence recommending use of AIV and complementary information about community views in clinicians' areas of practice was found to be effective in urban private-practice settings of middle-class communities in Pune, India. This was not the case, however, in slum communities where access to the vaccine appears to have been constrained by cost and structural features of the health system. Both the appreciation of the value of vaccination logs and difficulty maintaining them were notable. Further strengthening of the approach based on this initial experience, and efforts to apply the clinician engagement strategy in government healthcare settings and in rural areas, hold promise for improving vaccination coverage among pregnant women for influenza and potentially for other conditions as well.

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## Conflict of interest

The authors have no conflicts of interest to declare.

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