Applying Inverse Probability Weighting to Measure Contraceptive Prevalence Using Data from a Community-Based Reproductive Health Intervention in Pakistan

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CONTEXT: *Many community-based reproductive health programs use their program data to monitor progress toward goals. However, using such data to assess programmatic impact on outcomes such as contraceptive use poses methodological challenges. Inverse probability weighting (IPW) may help overcome these issues.*

METHODS: *Data on 33,162 women collected in 2013–2015 as part of a large-scale community-based reproductive health initiative were used to produce population-level estimates of the contraceptive prevalence rate (CPR) and modern contraceptive prevalence rate (mCPR) among married women aged 15–49 in Pakistan's Korangi District. To account for the nonrandom inclusion of women in the sample, estimates of contraceptive prevalence during the study's four seven-month intervention periods were made using IPW; these estimates were compared with estimates made using complete case analysis (CCA) and the last observation carried forward (LOCF) method—two approaches for which modeling assumptions are less flexible.*

RESULTS: *In accordance with intervention protocols, the likelihood that women were visited by intervention personnel and thus included in the sample differed according to their past and current contraceptive use. Estimates made using IPW suggest that the CPR increased from 51% to 64%, and the mCPR increased from 34% to 53%, during the study. For both outcomes, IPW estimates were higher than CCA estimates, were generally similar to LOCF estimates and yielded the widest confidence intervals.*

CONCLUSION: *IPW offers a powerful methodology for overcoming estimation challenges when using program data that are not representative of the population in settings where cost impedes collection of outcome data for an appropriate control group.*

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Ensuring universal access to sexual and reproductive health care services and protecting reproductive rights are essential components of Sustainable Development Goal 3, ensuring healthy lives, and Goal 5, achieving gender equality and empowering women and girls.[1] Improving individuals' reproductive health requires increasing their access to contraceptives and to information about reproductive health rights. Access to and use of contraceptives are positively associated with economic growth, and negatively associated with poverty and maternal and child mortality.[2–7] Although the prevalence of contraceptive use is rising globally, many women living in resource-constrained settings continue to have insufficient access to reproductive health care services, and large inequities exist in contraceptive use and knowledge, as well as in education about reproductive health care services and rights.[8]

Pakistan has the second highest total fertility rate in South Asia.[9] Following a period of rapid increase throughout the 1990s, the contraceptive prevalence rate (CPR) and modern contraceptive prevalence rate (mCPR) among married women aged 15–49 have risen slowly in the last decade; between 2007 and 2013, for example, the CPR increased from 30% to 35% and the mCPR increased from 22% to 26%.[10,11] Moreover, unmet need for family planning remains high (17%) among married women of reproductive age.[12] Studies from Pakistan have found that knowledge of contraceptive choices is positively associated with use of a method.[13–16] To increase access to education on contraception, the Pakistani government and nongovernmental organizations have launched several large-scale community-based reproductive health programs during the last two decades. These programs, which typically last 6–24 months,[17] often target priority groups in accordance with their programmatic objectives[18,19] and rely on community members who are familiar with the local context to provide contraceptive counseling within their neighborhoods.

Evidence on the effectiveness of community-based reproductive health programs from high-fertility, resource-constrained settings remains limited.[17,19–21] In a recent systematic review, Sarkar and colleagues identified four studies in which community-based family planning interventions that targeted young married women in India, Malawi or Nepal led to increased contraceptive use.[19] Similarly, in their Cochrane systematic review, Belaid and colleagues found that community-based interventions focusing on counseling were positively associated with demand for family planning services.[17] A 2018 study conducted in Karachi, Pakistan, found that a reproductive health program that relied on community health workers for door-to-door counseling led to an 11% increase in contraceptive prevalence.[20] These studies highlight the need for generating robust evidence to assess the effectiveness of community-based interventions in improving uptake of modern contraceptive methods.

Many community-based reproductive health programs use their internal data to monitor progress toward programmatic goals, to assess the extent to which the intervention is delivered as planned and to tailor the intervention to the local context.[17] While these data sets are typically large and are often the only source of data to monitor program activities, using them to assess the program's impact on contraceptive use poses methodological challenges. For instance, in programs that target certain population subgroups, intervention recipients are selected purposefully, in accordance with program goals, and thus are not representative of the whole population. In the absence of randomized intervention allocation and complete follow-up of a population, novel methodological approaches are needed to more accurately estimate program outcomes. To minimize bias in estimates, methodological approaches that consider program implementation and data collection process are needed. However, few studies in the literature on community-based reproductive health programs have addressed these methodological issues.[17,19]

The last observation carried forward (LOCF) and complete case analysis (CCA) approaches are commonly used in analyses of purposefully sampled data with selective follow-up. However, these approaches, while easy to use, have weaknesses,[22–25] including their reliance on assumptions that may not hold when modeling contraceptive method preferences. For instance, in such models, the LOCF approach assumes that an individual's contraceptive method remains stable over time. While this is a reasonable assumption for permanent contraceptive methods, it may not hold if women decide to initiate, switch or discontinue a method.[26] In these cases, the LOCF approach may produce biased estimates for which the direction of bias is unclear.[27] Use of CCA can be problematic as well. This method uses only information available in the program data (i.e., it does not allow imputation) and produces unbiased estimates if data are missing at random. However, in the data from programs in which particular women are prioritized for services, those who are not targeted will be observed less frequently than their counterparts who are given priority, and results will be biased if the two groups differ systematically from each other.

In this study, we advance the literature by proposing inverse probability weighting (IPW) as a suitable approach for deriving unbiased estimates of contraceptive prevalence using nonrepresentative program data collected for monitoring purposes—in this case, from a community-based reproductive health program that gave priority to women who were using a traditional contraceptive method or no method at all at baseline. IPW can help overcome estimation challenges arising from using purposefully sampled data by leveraging available information on the implementation of programs that target certain population groups. The method is particularly beneficial when researchers know the parameters of prioritization and can model the prioritization schedule for visits. Although IPW is increasingly used in reproductive health research,[28–30] to our knowledge this is the first study to apply IPW to guide program monitoring using purposefully sampled data.

We demonstrate the application of this method by calculating trends in the CPR and mCPR among married women aged 15–49 in the Korangi District of Karachi between 2013 and 2015. We use data from a large-scale community-based reproductive health intervention called the Willows project. We compare our results with LOCF and CCA estimates, because the LOCF method was used by the Willows project at the time of intervention to monitor program activities, and because CCA is often used by researchers to address missing data. Finally, we present IPW estimates over the course of project implementation according to women's baseline contraceptive method (e.g., no method, traditional method) and education level, because earlier work identified disparities in contraceptive prevalence according to these factors.[26,31]

Study Setting and Intervention

The Willows project is a large-scale community-based reproductive health program that has expanded to more than 60 project sites across Ghana, Turkey, Tanzania and Pakistan since its launch in 1999. Its main objective is to improve women's awareness and uptake of locally available reproductive health services. The program relies on field educators selected from local communities to deliver contraceptive information, counseling and referrals, and gives priority to women who do not use contraceptives or use traditional methods.[32]

In Pakistan, the Willows project was implemented in Korangi District, Karachi, Sindh Province, between April 2013 and September 2015. The prevalence of modern contraceptive use remains relatively low in urban areas of Sindh Province, though it increased slightly, from 25% to 28%, between 2012–2013 and 2017–2018.[10,12] Karachi is among the most populous cities in the world, with a population of 21 million as of 2017;[20] Korangi, a periurban district in Karachi, had a population of almost 2.5 million.[33] In recent years, the availability of family planning services has improved across Karachi in both the public and private sectors.[34]

The Willows project selected Korangi as the intervention site because it is a community with low socioeconomic indicators, low contraceptive prevalence and low utilization of reproductive health care services (despite the availability of such services). Baseline program data on all married women of reproductive age in Korangi were collected between September 2012 and April 2013 (before the intervention started).

Willows trained a cadre of field educators to disseminate information and provide education about contraceptive methods, reproductive health care and health rights through visits to married women of reproductive age. Field educators were selected among women 18 or older who had at least 12 years of schooling, resided in the community and spoke the local languages. After an initial screening to ascertain their attitudes toward contraception (only candidates who were supportive of family planning were selected), potential field educators attended a two-week training program whose curriculum covered sexual and reproductive health, as well as contraceptive methods (including their effectiveness, benefits and side effects). During the subsequent intervention, field educators were supported by supervisors who regularly monitored the accuracy and completeness of the data recorded in the client information forms that field educators completed during visits to clients.

Visits fell into two categories: counseling visits and drop-in visits. During counseling visits, field educators provided information on available contraceptive methods, including the pill, male condoms, injectables, implants, IUD, spermicides, tubal ligation and vasectomy; they discussed the benefits and side effects of each method and made recommendations regarding the most suitable option for the client's needs. For pregnant women, counseling visits also included information on prenatal and postnatal care, as well as postpartum contraception. At the end of the visit, field educators and clients agreed on the topics to be discussed during the next visit. In addition to providing information on contraceptives, field educators referred women to health care providers at the client's preferred facility and coordinated closely with the providers to ensure women obtained high-quality family planning services (field educators did not provide any health services themselves). Final decisions regarding contraceptive method choice were made by each woman in consultation with the facility-based provider. During each counseling visit, the field educator collected data on the client's pregnancy status and current contraceptive use, and recorded this information on the client information form.

In addition, field educators routinely conducted shorter drop-in visits with women who had recently adopted a modern method. During these visits, field educators inquired about women's satisfaction with the method to ensure sustained use. Clients who required drop-in visits were identified by Willows staff at the end of each week using referral information collected directly from local health facilities, and referral results (i.e., whether referrals had been completed) were recorded on the client information forms. If a woman had discontinued use of a modern contraceptive method, this would be recorded in the client information form and a new counseling visit would be scheduled. Field educators stopped visiting a client if she switched to relying on a permanent contraceptive method (tubal ligation or vasectomy).

As noted above, the Willows project staff visited and worked with health facilities and service providers in the community. Staff provided information on the project and offered counseling and training to physicians and nurses at facilities that had reliable stocks of contraceptive methods. While Willows did not provide family planning supplies directly, it liaised with local government health services and other family planning organizations to ensure that their referral sites had sufficient contraceptive supplies.

The Willows project developed a data monitoring system called the Manual Client Assessment, Services and Evaluation System, which was used to monitor the flow of information on program activities and to develop work plans for the upcoming week. The system involved the use of a series of physical boxes in which client information form data were used to categorize clients into one of 10 priority categories: contraceptive nonusers who were at risk for pregnancy; pregnant women; postpartum women; effective users of traditional methods (defined below); contraceptive nonusers who wanted children immediately; unsatisfied users of modern methods; satisfied users of short-term modern methods; satisfied users of long-term modern methods; women who were considered in need of follow-up; and women who received a referral from the field educator. Each week, field educators delivered to the Willows field office all of the client information forms that they had completed during the previous week's visits, both for completed visits and for visits in which women were not reached. If applicable, these forms were sorted into one of the client priority categories and were digitized in the Willows management information system to generate work plans.

METHODS

Data and Study Population

Our analysis used weekly management information system data collected between 2012 and 2015. During the baseline period, field educators registered all married women aged 15–49 living in Korangi and collected information on their sociodemographic characteristics, contraceptive use and reproductive history. No counseling was carried out during this time.

The baseline period was followed by the intervention period (April 2013–September 2015), which for our analysis we divided into four seven-month intervals. We chose seven-month periods because shorter intervals could have resulted in some women who did not fit any of the 10 priority categories receiving no visits from field educators in some weeks, which would have violated the IPW assumption of having nonzero probability of being in the sample (i.e., receiving the Willows intervention in the study period). Using the weekly management information system data, we built a panel data set to track each participant's use of any contraceptive and use of a modern method. If a woman received more than one visit in a period, we used information from the latest visit to ensure that we used the most recent information on her contraceptive use.

Baseline registration collected information from 45,415 married women aged 15–49. We excluded 10,553 women who died or moved outside of Korangi during the study, and 1,700 women for whom we did not have baseline information on sociodemographic characteristics, current contraceptive use or pregnancy history. The analytic sample thus consisted of 33,162 women.

Ethical approval for the study was granted by the institutional review board of the Harvard T.H. Chan School of Public Health (protocol no. IRB16–2089).

Measures

Our primary outcomes of interest were the CPR and mCPR among married women aged 15–49. We defined CPR as the proportion of women who were using any contraceptive method and mCPR as the proportion who were using a modern method. We categorized the pill, male condoms, injectable (one-, two- or three-month formulations), IUD, implant, tubal ligation and vasectomy as modern methods. In the Willows management information system, and thus in our analyses, the calendar method (also known as the rhythm method and periodic abstinence) and withdrawal were combined and reported as traditional methods. The Willows project further classified use of traditional methods as effective or ineffective. Effective users were defined as women who had not had a pregnancy in the last five years despite regular sexual activity and use of only traditional methods. Ineffective users were defined as those who had been using a traditional method for less than five years, or who had experienced pregnancy while using a traditional method during the last five years, regardless of length of use.

Our analyses included a variety of woman-level covariates that reflected the Willows project prioritization criteria. A review of the project protocols indicated that the contraceptive method a woman was using at the time of a client visit was an important determinant of method use at future visits. To capture this relationship, we coded a categorical variable for the contraceptive method reported in the period that directly preceded the current period. If this information was missing, we carried forward the most recent observation, an approach used in earlier work.[35] We also included continuous variables for a woman's age and duration of marriage (both measured in years), and a dichotomous measure of whether she had had a pregnancy in the last two years.

In addition, we included measures of education level, ethnicity, religion, employment status and number of living children, because earlier studies found that these characteristics were associated with contraceptive use in Pakistan.[36–38] Level of education was classified as none, primary, or secondary or greater. Ethnicity was classified as Urdu speaking, Sindhi, Punjabi, Balochi, Pashtun, Saraiki, Bengali or Memon. Women's religion was categorized as Sunni Muslim, Shia Muslim, Christian or Hindu. A binary variable indicated whether the respondent was employed (i.e., worked outside of the home for wages). Number of living children was a continuous variable. Finally, we included a series of dichotomous contraceptive history variables, measured at baseline, that indicated whether the woman had ever used the pill, male condom, injectable, IUD or implant.

Analysis

First, we investigated the extent to which program implementation adhered to the Willows protocols regarding prioritization of clients for upcoming visits. This was a crucial first step, because IPW methodology produces unbiased estimates under the assumption that the covariates used to model visits accurately reflect the program implementation process.[21] In other words, if program implementation did not follow the stated protocols for client prioritization, then IPW cannot reduce bias in estimates. To assess adherence to protocols, we compared, for each study period, the observed baseline characteristics of women who were in the sample with those of women who were not.

Next, for each period, we used IPW to generate predicted probabilities of women being in the sample. To derive weights, we first fitted logistic regression models to estimate the probability of a woman being in the sample during a particular period using observed covariates. Our logistic regression analyses for each period included all women except those who had adopted a permanent contraceptive method in the previous period, because field educators stopped visiting women who switched to a permanent method. We expected that the estimated odds ratios for being in the study sample would be greater among women who had been prioritized for visits in accordance with the Willows protocols than among those who had not.

Next, we calculated the inverse probabilities of being in the sample. To account for oversampling of priority groups in the data, IPW assigns higher weights to observations from underrepresented groups to make them representative of the whole group. In our study, this means that women who were not prioritized for visits, such as those using modern contraceptive methods, were given greater weights than those in priority groups. We then used the inverse probability weights assigned to each participant in each period in weighted linear regressions to generate unbiased estimates of the CPR and mCPR for each period. In all regressions, we used robust standard errors.

We compared our IPW-based results with estimates generated using the LOCF and CCA methods. Our CPR and mCPR calculations using these methods entailed performing unweighted linear regressions. In LOCF analyses, we used the last information available for each observation from a previous period to impute the value of the missing information in subsequent periods. We expected that this approach might bias our estimates upward because women with missing information were disproportionately likely to be modern method users, which would likely cause the LOCF method to underestimate discontinuation. In the CCA analysis, we used only the information that was available in each period. We expected that the CCA method would bias our estimates downward, since the Willows project gave priority to women who were not using modern methods.

We also performed robustness checks. We assessed whether every observation in our logistic regressions to derive inverse probability weights had a nonzero probability of being in the sample, and confirmed that the predicted probabilities did not include any zeros or extreme values, indicating that the sample did not include any observations with an infinite or extremely low probability of being in the sample in each period (Appendix Table 1 and Appendix Figure 1). In addition, we repeated our main analysis using data from the first client visit a woman received in each period (Appendix Table 2). Although the resulting coefficients differed slightly from those from our main analysis, the substantive results remained robust. This difference in the coefficients may have been due to method discontinuation or switching between the first and last client visits in a period. All statistical analyses were performed using Stata version 15.1.

RESULTS

On average, women who participated for the full duration of the Willows project were aged 32, had been married for 13 years and had four living children (Table 1). Thirty-three percent of participants had no formal education, 64% spoke Urdu and 94% were Sunni Muslims. Only about 5% were employed outside of home. Fifty-one percent of women were using some method of contraception at baseline; a greater proportion was using short-acting methods, especially male condoms (15%), than permanent methods (10%) or long-acting reversible methods (3%). About 11% of women reported being past users of male condoms, and a similar proportion had used an injectable.

Women who were visited by a field educator tended to differ in some respects from those who were not visited (Table 2). Notably, the average age of women who were visited declined from 30.4 to 28.9 between periods 1 and 4, and their mean duration of marriage decreased from 11.0 to 9.2 years; among women who were not visited, average age rose from 33.7 to 34.4 and mean duration of marriage rose from 14.4 to 15.3 years. In addition, throughout the study, the educational attainment of women who were visited tended to be higher than that of women who were not visited. However, no meaningful differences were evident between groups in terms of religion, ethnicity and past use of contraceptive methods.

In analyses that adjusted for woman-level covariates, the probability that a woman received a visit in a given period was highest among women who had been categorized by Willows as ineffective users of calendar or withdrawal methods in the preceding period (range, 73%–85%; Table 3). Women who had not used any method of contraception in the preceding period also had a high probability of receiving a visit; their probability increased from 47% in period 1 to 67% in period 2 before declining to 53% and 46% in the last two periods. The probability of visits was initially low among users of modern methods, but it increased substantially among women who had used the implant (from 24% to 76%) or IUD (from 8% to 40%).

Logistic regression analyses revealed that in all periods, women who had used traditional or no contraceptive methods in the previous period had greater odds of receiving a

TABLE 1. Selected baseline characteristics of married women aged 15–49 who participated in entire Willows project intervention, Korangi District, Pakistan, 2013–2015

Characteristic	% or mean (SD) (N=33,162)
Mean age	32.3 (7.8)
Mean duration of marriage	13.0 (8.7)
Mean no. of living children	4.1 (2.8)
Had pregnancy in last two years	
Yes	38.7
No	61.3
Education level	
None	33.5
Primary	15.1
≥secondary	51.5
Ethnicity	
Urdu speaking	63.6
Sindhi	4.9
Punjabi	13.0
Balochi	0.5
Pashtun	2.7
Saraiki	3.2
Bengali	3.4
Memon	0.1
Other	8.6
Religion	
Muslim (Sunni)	93.8
Muslim (Shia)	0.6
Christian	5.1
Hindu	0.4
Employed	
Yes	4.5
No	95.5
Current contraceptive method	
Pill	1.8
Male condom	15.2
Injectable (1 mo.)	0.9
Injectable (2 mos.)	0.7
Injectable (3 mos.)	2.2
Implant	0.2
IUD	2.6
Tubal ligation	10.4
Vasectomy	0.0
Effective traditional method	4.9
Ineffective traditional method	12.4
None	48.6
Past use of contraceptive methods	
Pill	6.5
Male condom	10.5
Injectable	10.6
Implant	0.4
IUD	5.1

Notes: All values are percentages unless otherwise specified. SD=standard deviation.

TABLE 2. Selected baseline characteristics of married women aged 15–49 who participated in entire Willows project intervention, by study period and whether they were visited by a field educator

Characteristic	Period 1		Period 2		Period 3		Period 4	
	Visited (N=14,037)	Not visited (N=19,125)	Visited (N=18,210)	Not visited (N=14,952)	Visited (N=14,567)	Not visited (N=18,595)	Visited (N=12,795)	Not visited (N=20,367)
Mean age (SD)	30.4 (6.9)	33.7 (8.1)	30.4 (7.1)	34.7 (8.0)	29.6 (6.8)	34.4 (7.9)	28.9 (6.4)	34.4 (7.8)
Mean duration of marriage (SD)	11.0 (7.7)	14.4 (9.2)	10.7 (7.8)	15.7 (9.1)	9.9 (7.4)	15.3 (9.0)	9.2 (7.0)	15.3 (8.9)
Had pregnancy in last two years								
Yes	52.8	28.3	45.7	30.2	49.3	30.4	52.5	30.0
No	47.2	71.7	54.3	69.8	50.7	69.6	47.5	70.0
Education level								
None	30.1	35.9	30.5	37.0	30.1	36.0	29.6	35.9
Primary	15.4	14.9	15.1	15.1	14.9	15.2	14.9	15.2
≥secondary	54.5	49.3	54.4	47.9	54.9	48.8	55.5	49.0
Ethnicity								
Urdu speaking	65.5	62.2	64.5	62.5	64.1	63.2	62.6	64.2
Sindhi	4.7	5.1	4.8	5.1	5.0	4.9	5.2	4.8
Punjabi	11.7	14.0	12.1	14	11.5	14.1	11.6	13.8
Balochi	0.4	0.5	0.5	0.4	0.5	0.4	0.5	0.4
Pashtun	2.6	2.7	2.7	2.7	2.7	2.6	3.1	2.4
Saraiki	2.6	3.6	2.6	3.9	2.5	3.7	3.0	3.3
Bengali	4.1	3.0	4.0	2.8	4.4	2.7	4.5	2.8
Memon	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.1
Other	8.3	8.8	8.8	8.3	9.0	8.2	9.3	8.1
Religion								
Muslim (Sunni)	94.4	93.4	94.4	93.2	94.7	93.4	94.6	93.3
Muslim (Shia)	0.5	0.7	0.6	0.7	0.6	0.7	0.5	0.7
Christian	4.8	5.4	4.7	5.6	4.5	5.5	4.6	5.5
Hindu	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5
Past use of contraceptive methods								
Pill	5.9	6.8	5.3	7.8	5.2	7.4	4.9	7.5
Male condom	9.6	11.1	8.4	13.0	7.4	12.9	7.3	12.5
Injectable	10.9	10.4	10.2	11.1	10.2	10.9	10.1	10.9
Implant	0.3	0.5	0.4	0.4	0.3	0.5	0.3	0.5
IUD	4.2	5.8	4.0	6.5	3.7	6.2	3.5	6.2

Notes: All values are percentages unless otherwise specified. SD=standard deviation.

TABLE 3. Probability (with 95% confidence interval) that a woman received a field educator visit during a study period, by the contraceptive method she had used in the previous period

Method	Period 1	Period 2	Period 3	Period 4
Male condom	26.0 (22.5–29.5)***	38.6 (34.7–42.4)***	23.5 (20.1–26.9)***	22.0 (18.7–25.3)***
Pill	37.2 (35.9–38.5)***	41.2 (39.9–42.4)***	29.8 (28.6–30.9)***	31.6 (30.4–32.7)***
Injectable (1 mo.)	8.5 (5.3–11.7)***	21.0 (16.4–25.7)***	6.6 (3.7–9.6)***	3.4 (1.2–5.6)**
Injectable (2 mos.)	11.8 (7.8–15.9)***	28.6 (23.1–34.0)***	18.8 (14.1–23.6)***	22.6 (17.7–27.5)***
Injectable (3 mos.)	11.4 (9.1–13.7)***	33.6 (30.3–36.8)***	27.6 (24.7–30.5)***	27.2 (24.5–30.0)***
Implant	23.5 (13.4–33.6)***	38.8 (29.1–48.4)***	81.3 (78.2–84.4)***	75.8 (72.8–78.7)***
IUD	8.3 (6.4–10.1)***	31.8 (28.9–34.8)***	30.3 (27.8–32.9)***	40.0 (37.5–42.4)***
Effective traditional method	51.9 (49.5–54.3)***	82.0 (80.0–84.0)***	70.4 (67.9–73.0)***	22.8 (20.3–25.3)***
Ineffective traditional method	80.4 (79.2–81.6)***	85.2 (84.0–86.4)***	82.9 (81.5–84.2)***	72.6 (71.0–74.2)***
None	47.2 (46.5–48.0)***	67.2 (66.5–68.0)***	52.9 (52.1–53.7)***	46.4 (45.6–47.3)***

**p<.01. ***p<.001. *Notes:* Probabilities are based on linear regression analysis. Women who had undergone tubal ligation or whose partner had had a vasectomy were dropped from the regression analysis to derive inverse probability weights.

visit than did participants who had used male condoms (Table 4). For instance, in period 1, the odds of receiving a visit were higher among women who had used traditional methods effectively (odds ratio, 3.9) or ineffectively (6.9) at baseline than among those who had used condoms at baseline. The odds that a traditional method user received a visit peaked in period 3 (15.5 among effective users and 12.3 among ineffective users) before declining in period 4.

Conversely, the odds of being visited in a particular period were generally lower among women who used a modern contraceptive other than male condoms in the previous period. For example, the odds of receiving a visit were lower among women who had used the pill than among those who had used male condoms in three of the four study periods (odds ratios, 0.5–0.7). However, although women who were using long-acting methods

TABLE 4. Odds ratios (and 95% confidence intervals) from logistic regression analysis assessing the relationship between selected characteristics and whether a woman received a field educator visit during a study period

Characteristic	Period 1	Period 2	Period 3	Period 4
Contraceptive used in previous period				
Male condom (ref)	1.00	1.00	1.00	1.00
Pill	0.53 (0.43–0.65)***	0.90 (0.75–1.09)	0.67 (0.54–0.83)***	0.57 (0.46–0.70)***
Injectable (1 mo.)	0.12 (0.07–0.18)***	0.30 (0.22–0.41)***	0.11 (0.07–0.19)***	0.05 (0.03–0.11)***
Injectable (2 mos.)	0.18 (0.12–0.27)***	0.46 (0.35–0.62)***	0.41 (0.29–0.58)***	0.47 (0.35–0.64)***
Injectable (3 mos.)	0.17 (0.13–0.22)***	0.60 (0.51–0.71)***	0.69 (0.59–0.82)***	0.62 (0.52–0.72)***
Implant	0.55 (0.31–0.97)*	0.81 (0.53–1.24)	8.31 (6.67–10.35)***	5.22 (4.36–6.26)***
IUD	0.14 (0.10–0.18)***	0.64 (0.55–0.75)***	0.93 (0.81–1.08)	1.30 (1.15–1.47)***
Effective traditional method	3.89 (3.43–4.42)***	15.40 (13.14–18.04)***	15.54 (13.37–18.07)***	1.56 (1.32–1.84)***
Ineffective traditional method	6.93 (6.24–7.70)***	8.47 (7.52–9.54)***	12.31 (10.90–13.90)***	6.14 (5.52–6.83)***
None	2.27 (2.11–2.45)***	4.20 (3.90–4.53)***	4.06 (3.76–4.39)***	2.87 (2.66–3.09)***
Age	0.96 (0.96–0.97)***	0.96 (0.95–0.97)***	0.95 (0.94–0.95)***	0.94 (0.94–0.95)***
Duration of marriage	0.97 (0.96–0.97)***	0.95 (0.94–0.96)***	0.94 (0.93–0.95)***	0.94 (0.94–0.95)***
Had pregnancy in last two years	2.17 (2.04–2.30)***	1.27 (1.19–1.35)***	1.37 (1.29–1.46)***	1.38 (1.29–1.46)***
Education level				
None (ref)	1.00	1.00	1.00	1.00
Primary	1.17 (1.08–1.27)***	1.09 (1.00–1.18)	1.03 (0.95–1.12)	1.07 (0.99–1.16)
≥secondary	1.10 (1.03–1.18)**	1.00 (0.94–1.07)	1.00 (0.93–1.07)	1.05 (0.98–1.12)
Ethnicity				
Urdu speaking (ref)	1.00	1.00	1.00	1.00
Sindhi	0.96 (0.85–1.08)	0.95 (0.83–1.08)	1.01 (0.89–1.15)	1.07 (0.94–1.21)
Punjabi	0.83 (0.75–0.92)***	0.97 (0.88–1.06)	0.89 (0.80–0.98)*	0.91 (0.82–1.00)
Balochi	0.80 (0.55–1.15)	0.99 (0.67–1.45)	1.17 (0.81–1.70)	1.27 (0.87–1.84)
Pashtun	0.81 (0.69–0.96)*	0.88 (0.74–1.04)	0.88 (0.74–1.04)	1.30 (1.10–1.52)**
Saraiki	0.75 (0.64–0.87)***	0.58 (0.50–0.68)***	0.58 (0.49–0.68)***	0.91 (0.78–1.06)
Bengali	0.90 (0.78–1.04)	1.10 (0.95–1.26)	1.31 (1.13–1.52)***	1.31 (1.13–1.51)***
Memon	1.03 (0.49–2.17)	0.78 (0.38–1.58)	0.68 (0.30–1.53)	0.86 (0.39–1.88)
Other	0.82 (0.74–0.90)	0.93 (0.84–1.02)	0.96 (0.87–1.06)	1.11 (1.00–1.22)*
Religion				
Muslim (Sunni) (ref)	1.00	1.00	1.00	1.00
Muslim (Shia)	0.73 (0.52–1.01)	1.20 (0.86–1.67)	0.77 (0.54–1.08)	0.66 (0.47–0.93)*
Christian	1.23 (1.06–1.43)**	0.98 (0.84–1.14)	0.97 (0.84–1.13)	1.08 (0.93–1.25)
Hindu	0.69 (0.44–1.08)	0.64 (0.42–0.98)*	0.58 (0.36–0.92)*	0.59 (0.37–0.97)*
No. of living children	1.28 (1.26–1.31)***	1.11 (1.09–1.13)***	1.17 (1.15–1.19)***	1.14 (1.11–1.16)***
Employed				
No (ref)	1.00	1.00	1.00	1.00
Yes	0.88 (0.77–1.00)	0.85 (0.75–0.96)*	0.98 (0.86–1.12)	0.88 (0.77–1.00)
Past use of contraceptive method†				
Pill	1.08 (0.96–1.22)	0.95 (0.85–1.06)	1.01 (0.90–1.14)	0.95 (0.85–1.07)
Male condom	0.99 (0.90–1.08)	0.88 (0.81–0.96)**	0.71 (0.65–0.77)***	0.67 (0.61–0.74)***
Injectable	1.20 (1.10–1.32)***	1.28 (1.17–1.40)***	1.24 (1.13–1.35)***	1.24 (1.14–1.36)***
Implant	1.04 (0.68–1.59)	2.12 (1.42–3.17)***	1.06 (0.69–1.63)	1.16 (0.75–1.79)
IUD	1.03 (0.91–1.18)	1.10 (0.97–1.25)	0.99 (0.87–1.12)	0.94 (0.83–1.07)

*p<.05. **p<.01. ***p<.001. †At baseline. *Notes:* Women who had undergone tubal ligation or whose partner had had a vasectomy were dropped from the analysis. All standard errors were robust. ref=reference group.

had reduced odds of receiving a visit during the first two study periods, this was not the case during the last two periods; for example, during the final study period, the odds of receiving a visit were elevated among both implant and IUD users (5.2 and 1.3, respectively). We also found that, in accordance with Willows project prioritization criteria, receipt of a visit was positively associated with having been pregnant in the last two years (1.3–2.2). In addition, the odds of receiving a visit increased with the number of living children and decreased with age and the duration of marriage.

All of our approaches for estimating CPR and mCPR found increases between baseline and the last period, though there were marked differences in the magnitude of coefficients (Table 5). In periods 1 and 2, the LOCF and IPW methods produced similar results: The CPR increased from 51–52% in period 1 to 54% in period 2. In the last two study periods, however, the IPW estimates were higher than LOCF estimates (60% vs. 57% in period 3, and 64% vs. 60% in period 4). The CCA estimates, however, were lower than estimates from the other two methods, and ranged from 46% in period 1 to 56% in period 4.

The mCPR was 34% at baseline, and like the CPR, consistently rose between periods 1 and 4 for all three estimation methods. Between periods 1 and 3, the LOCF estimates were slightly higher than IPW estimates, though

TABLE 5. Prevalence estimates (with 95% confidence intervals) for contraceptive use and modern contraceptive use among married women aged 15–49, by study period, according to estimation method

Estimation method/outcome	Baseline	Period 1	Period 2	Period 3	Period 4
Last observation carried forward					
Contraceptive use	51.4	51.3 (50.8–51.9)***	54.1 (53.5–54.6)***	57.2 (56.7–57.8)**	60.1 (59.5–60.6)***
Modern contraceptive use	34.1	36.9 (36.4–37.5)***	41.2 (40.6–41.7)***	44.8 (44.2–45.3)***	49.5 (49.0–50.1)***
Complete case analysis					
Contraceptive use	51.4	45.5 (44.7–46.3)***	45.2 (44.5–45.9)***	51.9 (51.1–52.7)***	55.8 (55.0–56.7)***
Modern contraceptive use	34.1	22.8 (22.1–23.5)***	25.7 (25.1–26.4)***	29.6 (28.9–30.4)***	41.6 (40.8–42.5)***
Inverse probability weighting					
Contraceptive use	51.4	51.5 (50.5–52.6)***	54.3 (53.5–55.1)***	59.7 (58.8–60.6)***	63.8 (62.9–64.7)***
Modern contraceptive use	34.1	36.0 (35.0–37.0)***	40.2 (39.4–40.9)***	43.9 (42.9–44.8)***	53.1 (52.1–54.0)***

***p<.001 for difference from baseline value. *Notes:* No woman-level covariates were used in the regression analyses. All standard errors were robust.

TABLE 6. Inverse probability weighting estimates (with 95% confidence intervals) of prevalence of contraceptive use and modern contraceptive use among married women aged 15–49, by study period, according to women's education level

Outcome/education level	Baseline	Period 1	Period 2	Period 3	Period 4
Contraceptive use					
No education	45.5	53.8 (52.4–55.1)***	52.8 (51.7–54.0)***	61.1 (59.8–62.3)***	67.1 (65.8–68.3)***
Primary	50.9	53.9 (52.0–55.9)***	55.0 (53.3–56.7)***	63.2 (61.4–65.0)***	67.0 (65.2–68.9)***
≥secondary	55.4	56.6 (55.5–57.7)***	56.5 (55.6–57.4)***	63.4 (62.4–64.4)***	67.0 (66.0–68.1)***
Modern contraceptive use					
No education	32.2	39.8 (38.5–41.1)***	40.4 (39.3–41.6)***	47.9 (46.6–49.2)***	58.8 (57.5–60.2)***
Primary	34.9	37.8 (36.0–39.7)***	39.3 (37.6–41.0)***	46.1 (44.2–48.0)***	57.6 (55.6–59.6)***
≥secondary	35.2	36.4 (35.4–37.5)***	37.8 (36.9–38.7)***	42.9 (41.9–43.9)***	54.6 (53.5–55.7)***

***p<.001 *Notes:* All results were generated by logistic regressions performed for each education level category and for each study period; no woman-level covariates were used. All standard errors were robust.

TABLE 7. Inverse probability weighting estimates (with 95% confidence intervals) of prevalence of contraceptive use and modern contraceptive use among married women aged 15–49, by study period, according to type of contraceptive method women used at baseline

Outcome/baseline method	Baseline	Period 1	Period 2	Period 3	Period 4
Contraceptive use					
No method	0.0	17.2 (16.4–18.1)***	26.7 (25.8–27.5)***	37.9 (36.8–38.9)***	44.7 (43.4–45.9)***
Traditional	100.0	71.9 (70.5–73.3)***	67.7 (66.4–69.0)***	70.6 (69.2–71.9)***	68.7 (67.1–70.3)***
Long-acting	100.0	99.2 (98.8–99.7)***	98.2 (97.7–98.8)***	98.6 (98.1–99.2)***	99.0 (98.5–99.5)***
Short-acting	100.0	80.1 (78.3–81.8)***	71.9 (70.0–73.7)***	69.1 (66.4–71.8)***	75.9 (73.3–78.4)***
Modern contraceptive use					
No method	0.0	9.8 (9.1–10.4)***	17.4 (16.7–18.1)***	24.9 (24.0–25.9)***	34.4 (33.3–35.6)***
Traditional	0.0	13.7 (12.6–14.7)***	20.2 (19.1–21.4)***	28.8 (27.5–30.1)***	44.3 (42.6–46.0)***
Long-acting	100.0	98.9 (98.4–99.5)***	97.9 (97.3–98.6)***	98.2 (97.6–98.9)***	98.7 (98.1–99.2)***
Short-acting	100.0	73.9 (71.9–75.8)***	64.4 (62.4–66.3)***	53.3 (50.3–56.3)***	66.5 (63.7–69.4) ***

***p<.001. *Notes:* All results were generated by logistic regressions performed separately for each contraceptive method category and for each study period; no woman-level covariates were used. All standard errors were robust.

the confidence intervals overlapped; the LOCF values increased from 37% to 45% between periods 1 and 4, while the IPW estimates increased from 36% to 44%. However, in the final period, the IPW estimate reached 53%, compared with 50% for the LOCF method. Once again, the CCA estimates were lower than the estimates from the other two methods. For both contraceptive use and modern contraceptive use, the LOCF and CCA estimates had tighter confidence intervals in all periods than did the IPW estimates.

In analyses by education level (Table 6), baseline CPR and mCPR were lowest among women with no education (46% and 32%, respectively) and highest among women with secondary or higher education (55% and 35%, respectively). Throughout the intervention period, the CPR and mCPR increased across all educational attainment categories, though increases were most pronounced among women with no formal education—from 54% to 67% for the CPR, and from 40% to 59% for the mCPR.

The final analysis provided prevalence estimates by the contraceptive method women had been using at baseline (Table 7). Among women who had not been using a method at baseline, the CPR increased substantially during the study, from 17% to 45%, and the mCPR more than tripled, from 10% to 34%. Moreover, a considerable portion of women who had been using a traditional method switched to a modern method, as the mCPR more than tripled, from 14% to 44%. However, considerable contraceptive discontinuation occurred among baseline traditional method users, such that the CPR declined from 72% to 69%. Declines were also apparent among users of short-acting methods; however, as expected, the CPR and mCPR were relatively stable among women who had been using a long-acting method at baseline.

DISCUSSION

In this study, we address estimation challenges that arise from using systematically sampled program data by comparing estimates from three methods. While all three approaches found statistically significant increases in the CPR and mCPR during the intervention period, there were marked differences among estimates. Our results suggest that the LOCF method was unable to pick up the substantial increase in the mCPR that IPW found during the last period, whereas CCA appears to have underestimated the CPR and mCPR in all study periods. We also found that the LOCF and CCA methods produced tighter confidence intervals than IPW did.

Our findings suggest that the LOCF and CCA estimates are biased, which we attribute to the methods' reliance on extreme assumptions. To be accurate, the LOCF approach assumes that the contraceptive method used by women who were not visited remains the same over time, while CCA assumes that those who were not visited are missing from the sample at random. Our results suggest that these assumptions are unlikely to hold. For instance, we observed that a considerable proportion of women switched from their baseline method of contraception to other methods throughout the study period. We also found marked differences between women who were visited and those who were not visited in each period, suggesting that, as per Willows protocol, the visits were not random. If the aforementioned assumptions are incorrect, not only are the point estimates biased, but the confidence intervals are invalid, since they are based on the same extreme assumptions. The relatively wide confidence intervals for the IPW estimates reflect real uncertainty regarding the contraceptive practices of women who were not visited (and who thus did not provide data) but whose contraceptive use we have to model; the confidence intervals for the CCA and LOCF methods make assumptions that mask this issue and give a misleading certainty to the resulting estimates.

We attribute the substantial increases in the CPR and mCPR estimates to several factors. First, the Willows project selected the intervention site because contraceptive prevalence was low in the area despite the wide availability of reproductive health services. The main role of field educators, therefore, was to increase women's awareness of available options for family planning methods and services. Field educators also provided referrals and facilitated women's access to services (though women's choices regarding contraceptive methods were made in consultation with facility-based providers). Because the field educators were trusted members of local communities, the Willows project's reliance on these individuals may have contributed to effective counseling and, in turn, to a rapid rise in contraceptive prevalence.

Another factor that may explain the rises in the CPR and mCPR relates to women who were pregnant or postpartum at baseline. These women, who were covered by the Willows project, were classified as nonusers at baseline, and their uptake of contraceptives after the postpartum period may explain some of the large increase in contraceptive prevalence we observed. However, women who became pregnant during the intervention were classified as nonusers during their pregnancy, and these new pregnancies may have partially counterbalanced the flow of women leaving the postpartum period. Nonetheless, if the intervention reduced the number of pregnancies, and hence the number of women categorized as nonusers because of pregnancy, this can be regarded as a success of the intervention rather than a bias in the results. However, we do not have reliable estimates of pregnancy outcomes from the Willows project during the study period to test this hypothesis.

Finally, because other community-based family planning initiatives were being implemented during the study period,[20] our results cannot be attributed solely to the Willows project.

Our analysis highlights the value of community-based counseling in realizing the latent demand for family planning. The Willows strategy of deploying field educators from the community they serve and prioritizing subgroups with the greatest unmet need seems to have led to increased use of modern contraceptives. Although the prioritization resulted in a study sample that was not representative of the general population of reproductive-aged women, we were able to estimate population-level outcomes through application of IPW.

As a large-scale, intensive reproductive health program, the Willows project was particularly suited to Pakistan, where unmet need for family planning is high and services are available but underutilized. However, randomized controlled trials are needed to determine whether the intervention has a causal impact. Moreover, future research will need to identify the program components (e.g., use of field educators from the community, provision of information and counseling, prioritization for visits) that are most effective in raising modern contraceptive use. In addition, process evaluation is needed to better understand the implementation of the intervention and further strengthen any impact.

Limitations

Our study has some limitations. As noted above, establishing causality was not the main purpose of the study, and our findings cannot be interpreted as providing estimates of the Willows project's impact. While IPW offers a powerful tool that allows for modeling the probability of selection into a study sample, it is not meant to replace impact evaluations of community-based reproductive health programs, and instead may be considered a second-best option when representative data collection is not possible. Second, we used information that was collected and reported by field educators, and thus may have been prone to errors. While the program supervisors were required to visit a sample of clients on an ongoing basis to validate the accuracy of information provided in the client information forms in prior weeks, we cannot rule out the possibility that mistakes in data entry occurred and cannot confirm the quality or consistency of the program's supervisory activities. Third, the validity of estimates from IPW relies on model specification, and while our results suggest that Willows project implementation closely followed the implementation protocols that informed our model selection, we cannot rule out residual confounding in the absence of statistical tests to assess other potential sources of confounding. For instance, we do not know the reasons for visits that were scheduled but not completed; women may not have been present in the household at the time of the visit, or they might have refused to take part in the intervention. Our results may be biased if the background characteristics of women who were not reached for visits differed from those of their peers who received visits.

Another limitation is that the study findings are based on a self-reported measure of contraceptive use, which may have led to overestimation of contraceptive prevalence.[39–41] In addition, we were unable to derive contraceptive prevalence estimates among unmarried women of reproductive age because our sample was restricted to married women. A sixth limitation is that our analysis attempted to measure change in contraceptive use only among women included in the baseline survey. However, our estimates may not be representative of the community as a whole if the baseline survey did not provide complete coverage of the population; moreover, our sample did not cover women who entered the reproductive age range or who migrated into the area after the baseline survey was conducted. Finally, we do not know the refusal rates at baseline registration; therefore, we are unable to make inferences about contraceptive use for the entire population of Korangi.

Conclusions

Many community-based reproductive health programs use data they collect during implementation to monitor progress toward programmatic goals and make course corrections. In programs that target certain population groups, appropriate methodological approaches are needed to address potential bias, because participants are selected purposefully in accordance with program goals and are not representative of the whole population. To our knowledge, this is the first study to apply IPW to assess progress toward program targets using purposefully sampled program data. While the LOCF and CCA methods are commonly applied because of their ease of use, both methods rely on assumptions that may not hold in models of contraceptive method preferences. Our results suggest that IPW offers a powerful alternative to the other methods because it can overcome the estimation challenges associated with use of nonrepresentative samples. The approach is particularly attractive when the prioritization schedule for visits is known and can be modeled. However, the approach still assumes that the model used to predict visits is correct, and thus the resulting estimates may not be as reliable as those based on representative samples of women. While our analyses were conducted retrospectively, results suggest that the IPW strategy may be useful in monitoring program progress and improving aspects of implementation in real time. Nonetheless, experimental or quasi-experimental studies are needed to assess the causal impact of community-based reproductive health programs.

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RESUMEN

Contexto: *Muchos programas comunitarios de salud reproductiva usan los datos de su programa para monitorear el progreso hacia sus metas. Sin embargo, el uso de tales datos para evaluar el impacto programático en resultados tales como el uso de anticonceptivos plantea desafíos metodológicos. La ponderación de probabilidad inversa (PPI) podría ayudar a superar estos problemas.*

Métodos: *Se usaron datos de 33,162 mujeres recolectados entre 2013 y 2015 como parte de una iniciativa comunitaria de salud reproductiva a gran escala para producir estimaciones de la tasa de prevalencia de anticonceptivos (TPA) y la tasa de prevalencia de anticonceptivos modernos (TPAm) a nivel de la población, entre mujeres casadas de 15 a 49 años de edad en el distrito de Korangi, Pakistán. Para tener en cuenta la inclusión no aleatoria de mujeres en la muestra, se hicieron estimaciones de la prevalencia del uso de anticonceptivos durante los cuatro períodos de siete meses de intervención* *del estudio utilizando PPI; estas estimaciones se compararon con las estimaciones realizadas utilizando el análisis de caso completo (ACC) y el método de la última observación llevada adelante (UOLA) –dos enfoques cuyos supuestos de modelado son menos flexibles.*

Resultados: *De conformidad con los protocolos de intervención, la probabilidad de que las mujeres fueran visitadas por el personal de intervención y por lo tanto incluidas en la muestra difería de acuerdo con su uso anticonceptivo pasado y actual. Las estimaciones realizadas con la PPI sugieren que, durante el estudio, la TPA aumentó del 51% al 64%; y que la TPAm aumentó del 34% al 53%. Para ambos resultados, las estimaciones fueron más altas que las estimaciones de ACC, en general fueron similares a las estimaciones de UOLA y produjeron intervalos de confianza más amplios.*

Conclusiones: *La PPI ofrece una metodología poderosa para superar los desafíos relacionados con las estimaciones, cuando se utilizan datos de programas que no son representativos de la población en entornos donde el costo impide la recolección de datos de resultados para un grupo de control apropiado.*

RÉSUMÉ

Contexte: *De nombreux programmes de santé reproductive à base communautaire utilisent leurs données pour suivre le progrès vers la réalisation de leurs objectifs. L'emploi de ces données pour évaluer l'impact programmatique sur les résultats tels que la pratique contraceptive pose cependant des problèmes de méthode. La pondération par l'inverse de la probabilité (PIP) peut être utile à la résolution de ces difficultés.*

Méthodes: *Les données relatives à 33 162 femmes, collectées en 2013–2015 dans le cadre d'une initiative de santé reproductive à base communautaire à grande échelle, ont servi à produire des estimations au niveau de la population du taux de prévalence contraceptive (TPC) et du taux de prévalence contraceptive moderne (TPCm) parmi les femmes mariées âgées de 15 à 49 ans dans le district pakistanais de Korangi. Pour rendre compte de l'inclusion non aléatoire des femmes dans l'échantillon, les estimations de la prévalence pendant les quatre périodes d'intervention de sept mois de l'étude ont été calculées selon la méthode PIP. Ces estimations ont été comparées à celles obtenues par analyse de cas complète (ACC) et selon la méthode de la dernière observation rapportée (LOCF) – deux approches à hypothèses de modélisation moins souples.*

Résultats: *Conformément aux protocoles d'intervention, la probabilité que les femmes aient reçu la visite du personnel d'intervention et soient donc incluses dans l'échantillon diffère suivant leur pratique passée et actuelle de la contraception. Les estimations obtenues selon la méthode PIP portent à croire que le TPC est passé de 51% à 64%, et le TPCm de 34% à 53%, pendant l'étude. Pour les deux résultats, les estimations PIP étaient supérieures à celles calculées selon la méthode ACC; elles étaient généralement similaires aux estimations LOCF et elles produisaient les plus larges intervalles de confiance.*

Conclusions: *La PIP offre une méthode efficace de résolution des difficultés d'estimation lors de l'utilisation de données de programme non représentatives de la population, dans les contextes où le coût entrave la collecte de données de résultat pour un groupe témoin approprié.*

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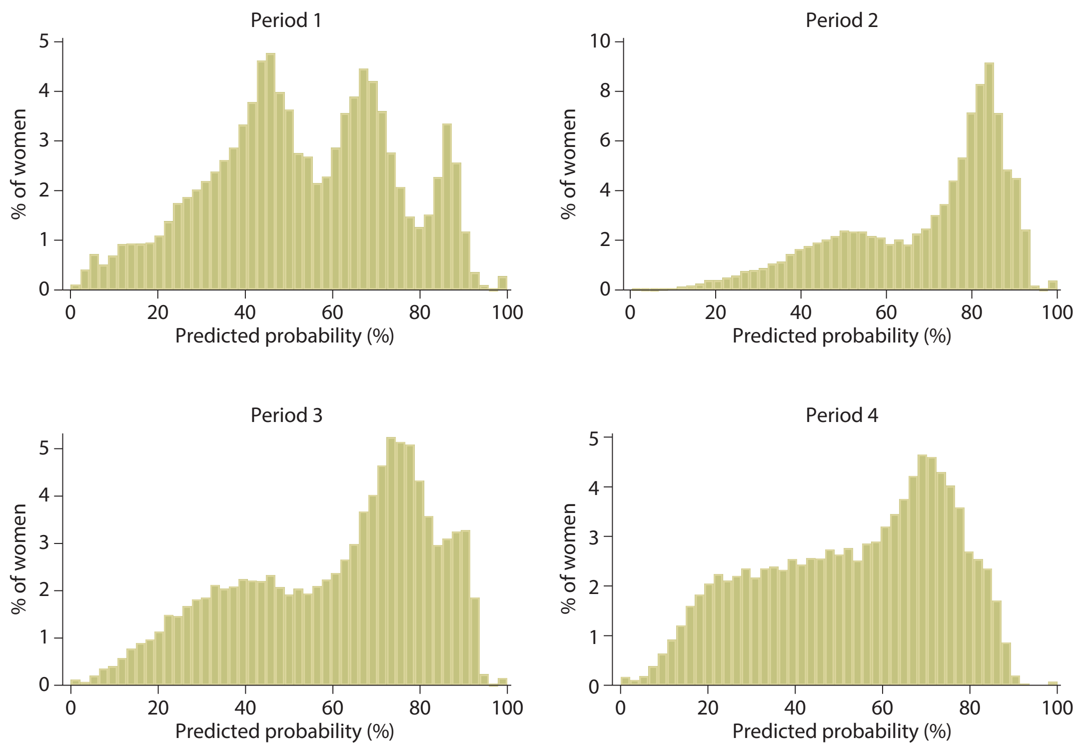
APPENDIX TABLE 1. Descriptive statistics of inverse probability weights, by period

Period	Mean (SD)	Minimum	Maximum	Median	5th percentile	95th percentile
1	1.92 (1.81)	1.00	78.27	1.49	1.00	3.98
2	1.54 (0.86)	1.00	24.82	1.25	1.00	2.96
3	1.81 (1.50)	1.00	38.17	1.37	1.00	4.01
4	1.99 (1.71)	1.00	54.91	1.49	1.00	4.62

Note: SD=Standard deviation.

APPENDIX FIGURE 1. Histograms of predicted probabilities from logistic regression analyses to predict inverse probability weights



APPENDIX TABLE 2. Prevalence estimates (with 95% confidence intervals) for contraceptive use and modern contraceptive use among married women aged 15–49 using information from women's first visit in the study period, by period, according to estimation method

Estimation method/outcome	Baseline	Period 1	Period 2	Period 3	Period 4
Last observation carried forward					
Contraceptive use	51.4	53.4 (52.9–53.9)***	55.8 (55.3–56.4)***	59.3 (58.7–59.8)***	62.2 (61.6–62.7)***
Modern contraceptive use	34.1	39.6 (39.0–40.1)***	43.5 (43.0–44.0)***	48.3 (47.8–48.9)***	52.5 (52.0–53.0)***
No. of women	33,162	33,162	33,162	33,162	33,162
Complete case analysis					
Contraceptive use	51.4	50.4 (49.6–51.2)***	48.2 (47.5–48.9)***	56.2 (55.4–57.0)***	61.1 (60.3–62.0)***
Modern contraceptive use	34.1	29.0 (28.3–29.8)***	29.7 (29.1–30.4)***	36.7 (36.0–37.5)***	47.7 (46.8–48.6)***
No. of women	33,162	14,030	18,149	14,565	12,795
Inverse probability weighting					
Contraceptive use	51.4	55.5 (54.5–56.5)***	56.3 (55.5–57.0)***	62.0 (61.1–62.9)***	66.4 (65.6–67.3)***
Modern contraceptive use	34.1	40.7 (39.6–41.7)***	42.6 (41.9–43.4)***	48.3 (47.4–49.2)***	56.2 (55.3–57.1)***
Sum of weights	33,162	33,516	33,301	32,971	32,845

***p<.001. *Notes:* No woman-level covariates were used in the regression analyses to estimate contraceptive prevalence and modern contraceptive prevalence. All standard errors were robust. All sums of weights are rounded to the nearest whole number.