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"Now that they come to our doorsteps to teach us these things…" – Postpartum contraception outcomes from a pre-post effectiveness-implementation study of an integrated community health worker intervention in rural Nepal

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Abstract

Background Postpartum contraceptive counseling and access are challenging in Nepal's remote, hilly areas, driving a disproportionately high unmet need for contraception. Community health workers (CHWs) play an important role in delivering healthcare in difficult to reach places, but there is limited evidence from professionalized CHW models and their impact over time in Nepal. We implemented a pilot program in two rural districts in Nepal where full-time, salaried, and supervised CHWs delivered a bundled reproductive, maternal, newborn, and child health (RMNCH) intervention. This included contraceptive counseling adapted from the *Balanced Counseling Strategy*. Here we describe postpartum contraceptive outcomes associated with the integrated RMNCH intervention over a five-year period.

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Methods Applying a type 2 hybrid effectiveness-implementation approach, we conducted a non-randomized pre-post study with repeated measurements and nested qualitative data collection to study the intervention's reach, effectiveness, adoption, implementation, and maintenance.

Results Compared to the pre-intervention period, we observed higher ward-level post-intervention postpartum contraceptive prevalence, stratified by early postpartum (RR: 2.20; 95% CI: 1.96, 2.48) and late postpartum (RR: 1.70; 95% CI: 1.50, 1.93), after adjusting for district and intervention site. Lactational amenorrhea method (LAM) was the most common method during early postpartum in most intervention sites. The proportion of women who switched to other effective methods after LAM was relatively low. Qualitative data indicated that CHWs' longitudinal engagement with participants helped facilitate contraceptive counseling and uptake despite challenges such as participants' fear of side effects, limited autonomy for women, and peer influence.

Conclusions Our findings suggest the integrated RMNCH intervention's potential to increase modern contraceptive uptake in low-resource community settings and underscore CHWs' ability to help drive longer-term change in their communities, especially around sensitive topics. This study contributes to the implementation research literature on community-based interventions to improve postpartum contraception use and may inform other CHW programs in similar contexts.

Trial registration ClinicalTrials.gov Identifier: NCT03371186, registered 04 December 2017, retrospectively registered.

Plain English Summary

Women in Nepal's remote, hilly areas often lack access to contraceptive counseling despite not wanting another pregnancy soon after giving birth. Community health workers (CHWs) play a key role in delivering healthcare in difficult to reach places. We tested out a program in two rural districts in Nepal where CHWs visited women in their homes to offer reproductive, maternal, newborn, and child health (RMNCH) care. The program included counseling individuals on contraception based on their family planning needs and values. We studied how modern contraception use changed in the area after this RMNCH program was introduced, compared to before. We found that, on average, the proportion of women who used a modern method of contraception increased in the local areas where CHWs visited women to provide RMNCH care. We also learned through conversations with CHWs, others involved in the program, and those who received care from CHWs, that CHWs' regular visits helped them build relationships within their community, which likely helped women feel more comfortable being counseled and choose contraceptive methods. Women in the community hesitated to use modern contraceptives because they were afraid of side effects, were often unable to make decisions for themselves without their partners or families' approval, or because the contraceptives they wanted were not available. We found that CHWs can help drive longer-term change in their communities, especially around sensitive topics like contraception.

Keywords Postpartum contraception, Nepal, Community Health Workers, Implementation research

Background

Contraceptive access is an important precursor that supports women and girls in making decisions about their sexual and reproductive health [1–4]. The postpartum period is a particularly critical time to provide women with quality contraceptive counseling and services. Since short interval pregnancies may be associated with adverse maternal and child outcomes, the World Health Organization (WHO) recommends at least 24 months spacing between births [5, 6]. However, the unmet need for postpartum contraception remains high globally [7–9] despite postpartum family planning being an important strategy to prevent unintended pregnancies in low and middle-income countries (LMICs) [10].

In Nepal, an estimated 52% of women had an unmet need for modern contraception in the first two years postpartum [11, 12]. Over 40% of women in Nepal do not attend any postnatal visit, a critical opportunity for counseling, initiation, and continuation of voluntary postpartum contraception [13]. Only an estimated 13% of women who had live births reported being counseled on family planning after delivery [14]. Contraceptive counseling and access are especially challenging in Nepal's remote, hilly areas where the nearest health facility can be hours away on foot, driving a disproportionately high unmet need for contraception [15, 16].

Nepal's cadre of Female Community Health Volunteers (FCHVs) has historically helped address barriers to maternal and child care [17, 18]. Such community health workers (CHWs), who typically belong to the communities they serve, can help expand access through home-visits and connect communities with facility-based resources [19]. As "volunteers", FCHVs have faced issues with a fragmented program and lack of adequate supervision and training, financial incentives, and access to necessary supplies that can result in inconsistencies in quality of care [17, 20]. The Government of Nepal endeavors to design, implement, and evaluate improved

CHW models in pursuit of universal health care [21]. In recent years, increasing evidence advocates professionalizing CHWs through training, salaries, and supervisory support to optimize their role [22]. There is limited evidence, however, assessing the impact of professionalized CHW models in Nepal at scale and over time.

To address this evidence gap, *Nyaya Health Nepal*, a Nepali non-governmental organization and *Possible*, a US-based non-profit organization, partnered with the Government of Nepal Ministry of Health and Population to design, implement, and evaluate a pilot integrated reproductive, maternal, newborn, and child health (RMNCH) intervention delivered by CHWs [23]. The intervention sought to reach an estimated population of 300,000 in two rural districts. Consistent with WHO recommendations [22], CHWs were local and professionalized: full-time, salaried, trained and supervised employees who used a mobile smartphone platform to facilitate counseling and longitudinal data collection while delivering the intervention [23, 24]. Contraceptive counseling was integrated into this bundled intervention since substantial evidence supports the effectiveness of integrated contraception interventions over stand-alone ones [8, 25, 26]. In a prior pilot of a sub-population receiving this RMNCH intervention, postpartum women had twice the odds of using modern contraception one-year post-intervention compared to pre-intervention [27].

We studied both the implementation process and effectiveness of this integrated RMNCH intervention using a type 2 hybrid effectiveness-implementation study design and conducted a non-randomized, single arm, pre-post study with repeated measurements [28]. We have previously reported the bundled intervention's outcomes on antenatal and postnatal care [24]. In this paper, we focus on postpartum contraceptive outcomes and implementation barriers and facilitators associated with the intervention over a five-year period in two districts in rural Nepal.

Methods

Study setting

We conducted this study in Achham and Dolakha districts, located in two different regions of Nepal. Achham is an economically disadvantaged district in the far western region [29]. Dolakha, located about six hours by road from Kathmandu, had its infrastructure devastated by a major earthquake in 2015 [30]. Achham and Dolakha share similar challenges to healthcare access due to hilly terrain, long distances to health care facilities, and poor road infrastructure.

During the study period, *Possible/Nyaya Health Nepal* managed a government hospital in each district through public–private partnerships. In addition to these two hospitals, each ward (the smallest administrative unit) had a health post that provided basic primary care services. Larger primary health care centers staffed by a medical officer or physician existed every few wards. Travel to health facilities could take up to five hours and be longer during the monsoon. Based on the *Possible/Nyaya Health Nepal* teams' experience in the study sites, modern contraceptive availability varied in both districts; condoms, pills, and injectables were relatively consistently available at health posts, primary health care centers, and the hospitals. Long-acting methods, including intrauterine devices and implants, were available at a few facilities with trained staff. Sterilization procedures were only performed at the hospitals.

We implemented the RMNCH intervention in clusters of 2 to 14 wards that we refer to as "hubs" throughout this paper. The intervention was rolled out step-wise in 11 non-random steps between 2015 and 2019, implementing from one hub to another. Intervention expansion was determined by buy-in from local stakeholders (district and ward level government officials) and was subject to real-world implementation constraints including unanticipated delays depending on their priorities. In 2017, following Nepal's constitutional transition to federalism, the districts were restructured into municipalities. Since implementation "hubs" were defined by the study team prior to this restructuring, they do not completely align with current municipal boundaries.

Study design

Guided by the RE-AIM framework [31], we employed a non-randomized, single arm, pre-post study design with repeated measurements and assessed the implementation's reach, effectiveness, adoption, implementation, and maintenance pertaining to postpartum contraception (Table 1), and used nested qualitative data collection to further contextualize our results. The RMNCH intervention could not be randomized as it was pragmatic and step-wise, given the need for local stakeholder buy-in. With data collection built into CHWs' regular care delivery to participants, it was practically infeasible and unethical to include comparison sites without providing healthcare services. We thus only collected pre-implementation data in a hub when we were ready for intervention enrollment and service delivery. The integrated RMNCH intervention included five components: (i) home-based antenatal and postnatal care counseling and care coordination, (ii) continuous and active pregnancy screening for all married women of reproductive age (MWRA), (iii) community-based integrated management of newborn and childhood illness for children under age two, (iv) group antenatal and postnatal care, and (v) person-centered contraceptive counseling using the *Balanced Counseling Strategy* (BCS).

Table 1 Reach, Effectiveness, Adoption, Implementation and Maintenance (RE-AIM) metrics for postpartum contraception through bundled RMNCH intervention

RE-AIM Construct	Metric
Reach	Proportion of all women with live births who (i) were offered and (ii) completed balanced counseling (BCS) at least once within their first year postpartum
Effectiveness	Primary contraception outcome: Ward-level postpartum modern contraceptive prevalence rate (PPCPR), stratified by early postpartum (0–5 months) and late postpartum (6–11 months) Secondary outcomes (descriptive): 1. Proportion of all women with live births who chose a contraceptive method among those who completed BCS within one year postpartum 2. Contraceptive method mix among all women with live births, stratified by early postpartum (0–5 months) and late postpartum (6–11 months) 3. Proportion of postpartum women using lactational amenorrhea who switched to another modern contraception method 4. Proportion of infants (0–5 months) who were exclusively breastfed
Adoption	1. Proportion of trained CHWs who offered balanced counseling (BCS) each year 2. Time from end of enrollment period to implementation of postpartum BCS within each implementation step (hub)
Implementation	Fidelity to workflow, measured as timing of first BCS session (median days postpartum when first BCS session was offered)
Maintenance	No quantified metric; anecdotal description

Study population

All married women of reproductive age (15–49 years) and children under two years old in the implementation hubs were eligible to receive the integrated RMNCH intervention. Given the cultural stigma around extramarital sex and that the intervention included pregnancy screening and contraceptive counseling, the local implementation team decided not to enroll unmarried women to avoid any potential negative consequences (such as ostracism) for them in the community. Employing a census approach, CHWs attempted to visit all homes in implementation hubs to enroll all eligible individuals into the integrated RMNCH intervention [32]. Individuals were excluded from the study if they declined enrollment into the intervention or enrolled but declined consent to use data for research. Study participants for qualitative data included a subset of enrolled postpartum women and the team that implemented the intervention, including community health nurses (who supervised CHWs), CHWs, and program managers.

Integrated RMNCH intervention

CHWs delivered the bundled RMNCH intervention using CommCare, an open-source, mobile platform that guided counseling, provided decision support, and allowed for offline data collection. More details of the intervention and its implementation, and sociodemographic characteristics of the study site are published elsewhere [23, 24, 27]. CHWs received training on CommCare use, data collection, informed consent, and clinical topics. For the contraceptive counseling component, CHW training focused on best practices such as shared decision-making with participants, respecting their autonomy, and addressing concerns about potential side effects [27, 33–35]. CHWs typically served one ward (smallest administrative unit in Nepal) with a population range of 1000–6000 individuals; two CHWs were assigned to larger wards. Depending on ward size and the number of eligible MWRA, each CHW completed approximately 85–100 home visits every month.

CHWs visited enrolled MWRA every three months to actively screen for pregnancy using urine pregnancy tests. Women reporting undesired pregnancies were referred for options counseling and abortion care. Pregnant women with desired pregnancies received monthly home visits where CHWs provided gestational age-specific counseling and screened for pregnancy danger signs. Pregnant women also received four group antenatal care sessions at local health posts that were co-facilitated by CHWs and government nurse midwives. CHWs then routinely visited women after they gave birth and visited all children monthly until two years of age, conducting screening and referrals for early childhood illnesses [23].

The contraceptive counseling intervention component

General counseling on available contraceptive options was integrated into the eighth month antenatal home visit and in at least one of four group antenatal care sessions for pregnant women. For postpartum women, CHWs offered interactive, person-centered contraceptive counseling using adapted BCS during home visits. BCS is a toolkit to facilitate high-quality, individualized contraceptive counseling [36–38]. It guides the individual through a series of questions to narrow method choices to those most consistent with their reproductive needs, values, and preferences. BCS uses visual aids that illustrate the relative effectiveness of contraceptive methods. BCS is aligned with person-centered counseling as it emphasizes developing a supportive counseling relationship, respect for individual choice, and promotes informed decision-making [37]. In Nepal, BCS has been used in facility-based post-abortion care settings to help women select a contraceptive method aligned with their needs [39]. In an earlier sub-study, we found BCS was non-coercive, interactive, and facilitated contraceptive

decision-making based on individual women's circumstances [27].

We adapted BCS for CHW-delivered postpartum contraceptive counseling and built CommCare modules to guide counseling sessions. We also adapted BCS to include materials on lactational amenorrhea (LAM) and given local cultural norms, trained CHWs to involve husbands and mothers-in-law, if desired by postpartum women. CHWs referred women who selected a contraceptive method through BCS to the closest health facility that offered that method. At follow-up home visits, they inquired whether women had initiated any method chosen at a preceding visit, offered guidance about potential side effects, and helped address access barriers. CHWs typically did not provide contraceptives during home visits. CHWs referred women with self-reported high-risk medical conditions (such as hypertension) to the local health post or asked their community health nurse supervisor to visit them to further assess contraceptive safety [27]. CHWs also encouraged breastfeeding and emphasized transitioning from LAM to another effective contraceptive method at six months postpartum for participants not wanting another pregnancy.

During the first year of implementation, CHWs visited postnatal women every month until one year postpartum and offered BCS at postpartum months 1, 5, and 10. However, CHWs provided feedback that contraceptive counseling was less relevant in the first month postpartum since most women were exclusively breastfeeding. CHWs preferred to focus on screening for high-risk postpartum conditions and newborn care counseling during that initial visit. In response, we modified the CHW schedule to offer BCS starting at month 3 postpartum and then every three months. Women could opt to decline any of the initial or follow-up BCS counseling sessions during the CHW visits. Although the intervention originally focused on contraception for postpartum women, after the first year of implementation, the program team felt that contraceptive counseling would be beneficial to all women regardless of postpartum status. This led to an expansion of BCS to *all* enrolled MWRA in the study sites. By design, women were not offered BCS when they did not need contraception, such as during pregnancy, post-menopause, or if they had hysterectomies or sterilization.

Implementation strategies

We employed several implementation strategies to optimize the intervention. These included aspects of professionalization for CHWs, such as training and supervision. We trained 65 CHWs across 7 hubs, all of whom participated in regular meetings and received close, ongoing supervision from community health nurses, who helped plan and oversee their tasks and problem-solve any challenges. Further, the CommCare tool provided a standardized workflow and algorithm for care-delivery and CHWs engaged longitudinally with intervention recipients through regular home visits. The overall implementation process was iterative, with adjustments made to workflow based on feedback from those implementing it. Further, as described above, we adapted intervention components to fit local needs and norms.

Data collection

Quantitative data

CHWs recorded data on contraceptive use in CommCare, except during pre-intervention in hub 1 where they used SurveyCTO, a different mobile platform. In addition to built-in data validation within CommCare, the research team regularly conducted data quality checks. During enrollment in each hub, CHWs collected pre-intervention data for all enrolled women. This included family demographics and a birth history for the preceding two years. CHWs also asked about current contraceptive use and type, which served as pre-intervention data for our main effectiveness outcome for postpartum contraception (PPCPR). Following enrollment, CHWs prospectively recorded data on self-reported postpartum contraceptive use and balanced counseling during postnatal or pregnancy screening home visits. Since the integrated RMNCH intervention included breastfeeding education, CHWs recorded data on exclusive breastfeeding during follow-up visits with infants up to six months of age. These data on contraception and breastfeeding served as our post-intervention data.

Although we originally planned for data collection through December 2020, Nepal underwent a national lockdown because of the COVID-19 pandemic at the end of March 2020. Given this constraint, our analysis includes hubs that had both: i) pre-intervention data, and ii) at least one year of post-implementation data before April 2020. Based on intervention roll out timing, seven of total 11 hubs had at least one full year of post-implementation data before the lockdown, so our analysis spans these seven hubs (50 wards) across Achham and Dolakha districts. For all seven included hubs, we used data available through December 31, 2020. The duration between implementation in one hub to another depended on the local government and pragmatically varied from 1 to 13 months, with some delays. At the time we conducted data analysis, the earliest hub had four years of data following the start of the intervention; newer hubs had one year of data.

Qualitative data

A female qualitative researcher (co-author RK), who was not part of the care delivery team, used an ethnographic approach including interviews and focus group

discussions (FGDs), to better understand the implementation process and context, including enablers and barriers in delivering the integrated RMNCH intervention. Program team members were purposively selected, considering the length of their engagement with the intervention and representation from different intervention sites. We used convenience sampling to choose intervention participants who had given birth during the study period to learn about their experiences of engaging with CHWs from pregnancy through postpartum. FGDs with CHWs were conducted at site offices in respective hubs with no other program team members present to ensure privacy and confidentiality. Interviews with program team members were also conducted at site offices and virtually during the pandemic. Interviews with postpartum women were conducted at their homes after ensuring they felt comfortable and nobody else was present. All interviews were audio recorded, transcribed, and translated into English by a professional transcription service. All qualitative data were securely stored in a Dropbox folder with access limited to the research team.

Data analysis

Quantitative data

We first determined one-year observation periods following intervention roll-out for each hub (Fig. 1). For example, in one hub, the postpartum contraceptive counseling component started in February 2017, so we defined the first post-intervention year as February 2017-January 2018, and so on. Given the step-wise implementation, the post-intervention periods for each hub corresponded to its intervention roll-out timing. In hub 1, BCS counseling was implemented closer to post-intervention year 2 and as the first implementing hub, issues with data collection modules had to be addressed. We thus report on BCS outcomes starting with year 2 for hub 1.

Reach To assess the *reach* of postpartum contraceptive counseling through BCS in each hub, we identified all women with live births who were within one year postpartum during each time period. We then calculated the proportion of postpartum women who had at least one CHW visit where (i) BCS was offered, and (ii) BCS session was completed. Prompted by CommCare, CHWs asked postpartum women whether they desired contraceptive counseling during a visit – we classified this as "BCS offered". If the woman agreed for counseling during that visit and the CHW completed all the questions in the BCS module, we classified this as "BCS completed". We excluded CHW visits where women were pregnant, postmenopausal and/or had sterilization or hysterectomies because they were not offered contraceptive counseling.

Effectiveness We calculated the main *effectiveness* outcome for postpartum contraception (PPCPR) at the ward level (i.e. the smallest administrative unit in Nepal), disaggregated by 0–5 months and 6–11 months postpartum. For pre-intervention data (during enrollment) in all hubs, we summarized the proportion of women in each ward who were within 0–5 or 6–11 months postpartum (denominator) and reported using a modern method of contraception (numerator). Modern contraceptive methods include: sterilization, intrauterine device, implant, injectable, oral contraceptive pill, condom, and LAM [40, 41]. We considered self-reported LAM an effective modern contraceptive method only if reported by those within six months postpartum. We classified anyone reporting LAM use after six months postpartum as contraceptive non-users. Withdrawal and rhythm methods were considered traditional methods. We calculated post-intervention PPCPR at subsequent annual cross-sections for each hub. For each cross-section, we used the last six months of data, where we identified the most recent, non-missing self-reported contraceptive record for each postpartum woman. We chose six month-long cross-sections to

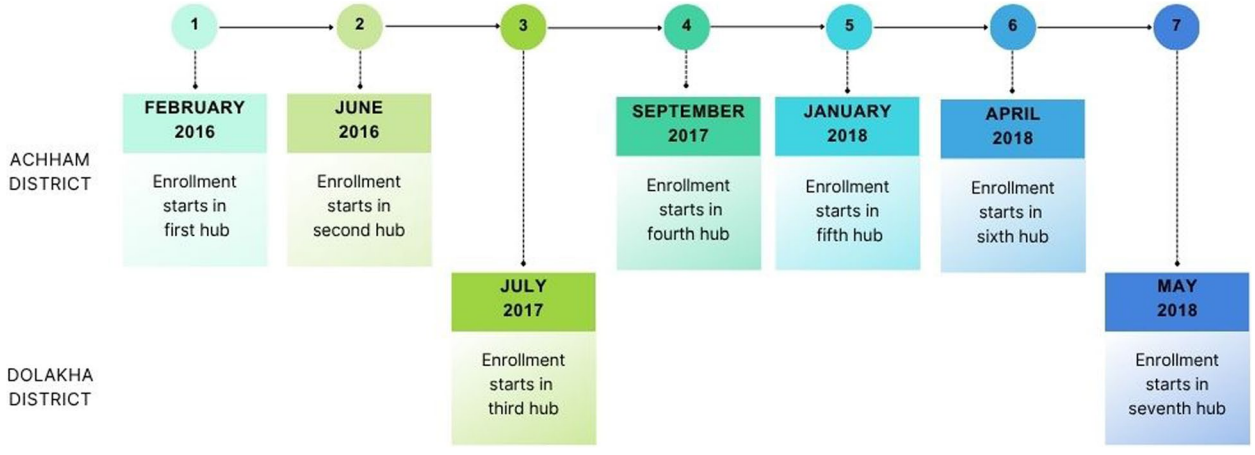

Fig. 1 Step-wise implementation timeline (not to scale)

ensure adequate time for CHWs to visit all the women in their catchment since postpartum visits were conducted at three-month intervals. In the two oldest hubs, some non-responses were recorded in the pre-intervention contraception data – these comprised 9% and 10.5% of all responses so we conservatively assumed that these women did not use modern contraception. In one hub (comprising eight wards), due to a change in workflow, postpartum women were not asked about contraception during enrollment. For this hub, we calculated a proxy pre-intervention PPCPR using the first available, non-missing self-reported contraception use data recorded in the four months after enrollment.

We fitted a mixed-effects Poisson regression model to assess changes in ward-level PPCPR post-intervention compared to pre-intervention, stratified by early (0–5 months) and late (6–11 months) postpartum sub-populations. Since the analysis was ward-level, each ward served as its own comparison pre-and post-intervention and we assumed there were no major changes to ward-level sociodemographic characteristics during the study period. We used *intervention* as a binary independent variable, representing pre-intervention (0) or post-intervention (1). We adjusted for random effects of *hub*, assuming implementation variations between hubs. We also included *district (Achham* or *Dolakha)* to account for all measured and unmeasured differences across both implementing contexts. Our models thus assessed the association between *intervention* and PPCPR, adjusting for district, and random effects of hubs. We also generated estimated marginal rates, i.e. the expected count (rate) of women using modern contraception in each ward, adjusted for other model variables.

In a second set of models (also stratified by early and late postpartum sub-populations), we used a discrete *time period* variable representing the number of years of intervention implementation (0 for pre-intervention, or intervention years 1, 2, 3, and 4) instead of the binary *intervention* variable to assess whether PPCPR was associated with duration of intervention. We exponentiated coefficients from all models to obtain rate ratios.

We calculated the following descriptive, secondary effectiveness metrics using *only* post-intervention programmatic data for each available time period (except contraceptive method mix, which had pre-intervention data). Among all women with live births who had at least one "BCS completed" session within one year postpartum, we summarized the proportion who indicated a chosen contraceptive method through counseling. We summarized the contraceptive method mix among all women with live births, stratified by early postpartum (0–5 months) and late postpartum (6–11 months), to show the distribution of methods. Methods included pills, injectables, long-acting reversible and permanent methods (intrauterine devices, implants, and male and female sterilization procedures), condoms, LAM, and traditional methods.

Given the importance of transitioning from LAM to another modern method for those wanting to continue avoiding pregnancy, we identified the subset of women who reported using LAM at any point within their first six months postpartum. Among these individuals, we identified the first non-missing, non-LAM contraceptive within their first year postpartum to calculate the proportion who switched to another modern method. If no contraception data were recorded during postpartum months 6–11 for those previously on LAM, we assumed they did not switch to a modern method. Since BCS included counseling on lactational amenorrhea, we also summarized the proportion of infants (0–5 months) who were exclusively breastfed using the last available exclusive breastfeeding status for each child under six months old.

Adoption We used programmatic data to summarize the proportion of trained CHWs who provided BCS each year. Additionally, we originally anticipated six months for the complete implementation of the integrated intervention in any hub [23] and summarized the actual time (in months) from the end of enrollment to the start of postpartum contraceptive counseling with BCS in each hub using programmatic data.

Implementation We calculated the median days postpartum when women were first offered BCS in each hub to assess fidelity to intervention workflow. In hubs 1 and 2, BCS should have been offered within the first month or at the first CHW visit postpartum. After updating the workflow based on CHW input, this changed to offering BCS starting at three months postpartum across all hubs.

We conducted all quantitative analyses using SAS 9.4 and used PowerBI and Microsoft Office to generate graphics. We used R to fit the mixed effects Poisson regression models.

Qualitative data

For qualitative data analysis, all transcripts were uploaded into Dedoose Version 9.0.17. Author RK developed codes using an inductive content analysis approach to qualitatively understand the implementation of the integrated intervention, including facilitators and barriers to CHWs' provision of care and the experiences of enrolled participants. Given the focus of this paper, we extracted themes and subthemes relevant to the implementation of contraceptive counseling and postpartum contraception uptake. Themes related to other aspects of the RMNCH intervention are published elsewhere [24].

Ethics approval

The institutional Review Committee of Kathmandu University School of Medical Sciences/Dhulikhel Hospital (81/14), the Nepal Health Research Council (461/2016), the Brigham and Women's Hospital (2015P000058/BWH and 2017P000709/PHS), and Mount Sinai institutional review boards (MSSM IRB-18–01091) provided human subjects approval for the study. The Boston Medical Center (H-38196) institutional review board exempted the study since co-first author WW had moved to Boston Medical Center after data collection was already complete and only de-identified data were being used for analysis and manuscript preparation. CHWs obtained verbal informed consent to enroll individuals into the intervention and use their programmatic data for research. Mothers provided verbal consent to enroll children under two years into the integrated intervention. Consent was documented electronically in CommCare. Participants could choose to receive care and decline data use for research, in which case their data were excluded from this study. For interviews and FGDs, the qualitative researcher read a structured script and obtained verbal informed consent, including the use of de-identified quotes for publication purposes. We opted for verbal consent since illiteracy was a concern in our study population, making it infeasible and unethical to ask for written consent. Further, in our study sites, fingerprinting on paper had election/political connotations and participants may have been wary of participating if asked to provide fingerprints. We considered local IRB regulations at the time, which did not require written consent, and deemed verbal consent appropriate given the study's low risk and use of routine care data.

Results

Reach

Most women (83%–97%) who had live births in each hub were offered BCS by CHWs at least once within their first year postpartum (Table 2). The actual completion of BCS, however, was lower and ranged from 33 to 81% across the hubs. In hubs with more than one year of intervention data, the proportion of women who were offered BCS remained relatively constant but the proportion

Table 2 Balanced counseling (BCS) within one year postpartum for women with live births

District	Hub		Intervention year (hub-specific)			
			Year 1	Year 2	Year 3	Year 4
Achham	1	*Women who had a live birth (n)*	-	637	560	546
		Offered BCS (n, %)	-	530 (83%)	508 (91%)	509 (93%)
		Completed BCS at least once (n, %)	-	373 (59%)	361 (64%)	300 (55%)
		Chose contraceptive method (n, %)*	-	325 (87%)	341 (94%)	285 (95%)
	2	*Women who had a live birth (n)*	486	455	395	-
		Offered BCS (n, %)	449 (92%)	428 (94%)	380 (96%)	-
		Completed BCS at least once (n, %)	318 (65%)	260 (57%)	153 (39%)	-
		Chose contraceptive method (n, %)*	278 (87%)	250 (96%)	151 (99%)	-
	4	*Women who had a live birth (n)*	493	460	-	-
		Offered BCS (n, %)	443 (90%)	408 (89%)	-	-
		Completed BCS at least once (n, %)	397 (81%)	359 (78%)	-	-
		Chose contraceptive method (n, %)*	290 (73%)	259 (72%)	-	-
	5	*Women who had a live birth (n)*	134	125	-	-
		Offered BCS (n, %)	125 (93%)	121 (97%)	-	-
		Completed BCS at least once (n, %)	82 (61%)	41 (33%)	-	-
		Chose contraceptive method (n, %)*	82 (100%)	41 (100%)	-	-
	6	*Women who had a live birth (n)*	553	-	-	-
		Offered BCS (n, %)	511 (92%)	-	-	-
		Completed BCS at least once (n, %)	402 (73%)	-	-	-
		Chose contraceptive method (n, %)*	347 (86%)	-	-	-
Dolakha	3	*Women who had a live birth (n)*	263	300	-	-
		Offered BCS (n, %)	256 (97%)	286 (95%)	-	-
		Completed BCS at least once (n, %)	183 (70%)	172 (57%)	-	-
		Chose contraceptive method (n, %)*	182 (99%)	171 (99%)	-	-
	7	*Women who had a live birth (n)*	254	-	-	-
		Offered BCS (n, %)	247 (97%)	-	-	-
		Completed BCS at least once (n, %)	102 (40%)	-	-	-
		Chose contraceptive method (n, %)*	98 (96%)	-	-	-

*Among those who completed a counseling session

who completed BCS within their first year postpartum seemed to decline over time.

Effectiveness

In the box plots of unadjusted ward-level postpartum contraceptive prevalence rates by intervention time period (Fig. 2), post-intervention PPCPR was higher on average compared to pre-intervention PPCPR in both 0–5 and 6–11 months postpartum sub-populations. The unadjusted mean ward-level post-intervention PPCPR was 56.5%, compared to 29.6% in the pre-intervention period among women who were 0–5 months postpartum. Among those who were within 6–11 months postpartum, the unadjusted mean ward level post-intervention PPCPR was 37.2% compared to 25.5% in the pre-intervention period.

Across the 50 wards included in our analysis, 1,451 women were between 0–5 months postpartum and 1,487 women were between 6–11 months postpartum in the pre-intervention periods. In the post-intervention periods (comprising intervention years 1–4), 2,713 women were between 0–5 months postpartum and 3,502 were between 6–11 months postpartum in our data. Adjusting for district and random effects of hubs, the ward-level PPCPR for women between 0–5 months postpartum was higher in the entire post-intervention period compared to pre-intervention (Rate ratio: 2.20; 95% CI: 1.96, 2.48). Similarly, adjusting for district and random effects of hubs, the ward-level PPCPR for women between 6–11 months postpartum was higher post-intervention compared to pre-intervention (RR: 1.70; 95% CI: 1.50, 1.93). Please see Table 3 for details.

There was also an association between PPCPR in both early and late postpartum groups and the number of years of the bundled intervention (Table 3). In year 4 (which we observed only in hub 1), the ward-level PPCPR for women between 0–5 months postpartum was 3.16 times the pre-intervention PPCPR (95% CI: 2.63, 3.79). The ward-level PPCPR in Dolakha also tended to be higher compared to that in Achham, especially among late postpartum women (Table 3).

Other effectiveness outcomes

Among postpartum women who completed at least one BCS session, nearly all chose a contraceptive method they wanted to start using (Table 2). Table 4 presents descriptive statistics for contraceptive method mix for each hub (including the category "none" for those not using contraception) for each available year of data. Since it includes pre-intervention data, Table 4 offers an exploratory sense of the change in method mix over the course of the intervention. Given the small numbers within each category and descriptive statistics, we interpret any "trends" with caution. In the pre-intervention years for all hubs (except hub 3), contraceptive non-use was high, ranging from 50% (97/196) in hub 2 in early postpartum to 93% (223/240) in hub 4 in late postpartum. Consistent with our observed increase in modern postpartum contraceptive prevalence (Table 3), the corresponding proportions of contraceptive non-users appeared to decrease from pre- to post-intervention in all hubs among both early and late postpartum groups (Table 4). The largest decrease was among early postpartum women in hub 1, where non-use fell from 84% (222/263) pre-intervention to 24% (77/327) in year 4.

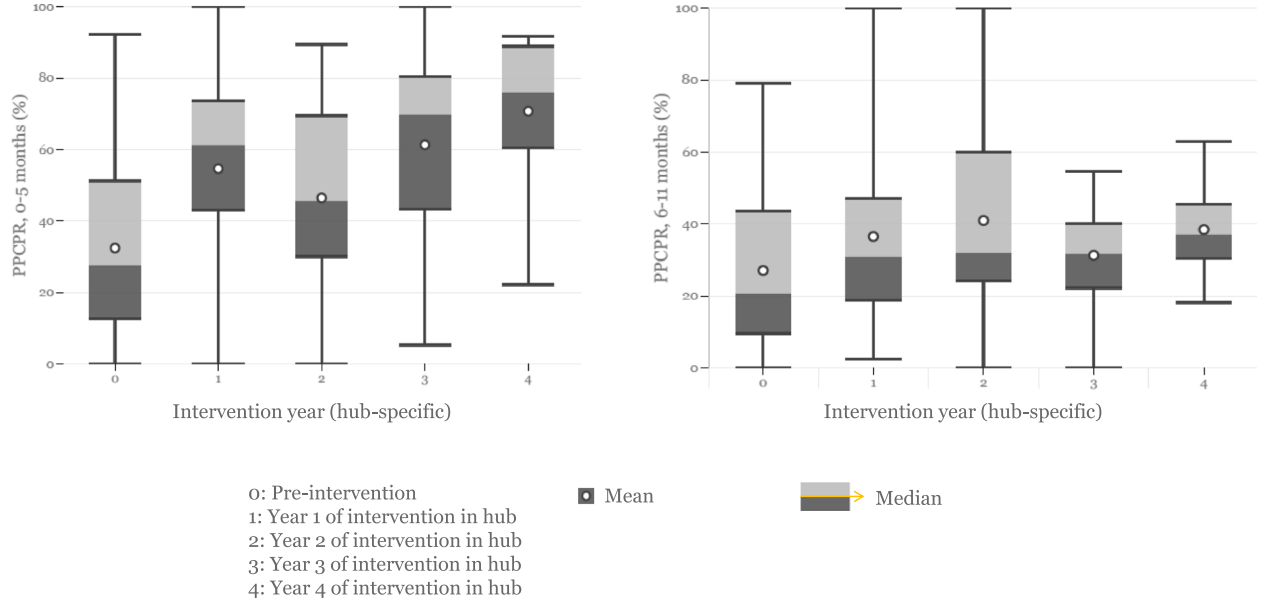

Fig. 2 Unadjusted ward-level postpartum contraceptive prevalence rates by intervention time period

Table 3 Associations between RMNCH intervention and ward-level postpartum contraceptive prevalence rate

Model 1	Postpartum contraception prevalence rate			
	Early postpartum (0–5 months)		Late postpartum (6–11 months)	
	Rate Ratio (95% CI)	*p*-value	Rate Ratio (95% CI)	*p*-value
Pre-intervention (Year 0)	1.00		1.00	
Post-intervention	2.20 (1.96, 2.48)	< 0.001	1.70 (1.50, 1.93)	< 0.001
District—Achham	1.00		1.00	
District—Dolakha	1.33 (1.06, 1.69)	0.006	2.60 (1.69, 3.99)	< 0.001
	Model estimated marginal rate			
	Rate (95% CI)		Rate (95% CI)	
Pre-intervention (Year 0)	2.44 (2.13, 2.79)		1.73 (1.40, 2.14)	
Post-intervention	5.37 (4.83, 5.98)		2.94 (2.44, 3.55)	
Model 2	Postpartum contraception prevalence rate			
	Early postpartum (0–5 months)		Late postpartum (6–11 months)	
	Rate Ratio (95% CI)	*p*-value	Rate Ratio (95% CI)	*p*-value
Pre-intervention (Year 0)	1.00		1.00	
Year 1	2.17 (1.91, 2.47)	< 0.001	1.51 (1.31, 1.74)	< 0.001
Year 2	1.93 (1.67, 2.23)	< 0.001	1.80 (1.55, 2.11)	< 0.001
Year 3	2.50 (2.09, 2.97)	< 0.001	2.01 (1.64, 2.46)	< 0.001
Year 4	3.16 (2.63, 3.79)	< 0.001	2.24 (1.77, 2.82)	< 0.001
District—Achham	1.00		1.00	
District—Dolakha	1.40 (1.15, 1.69)	< 0.001	2.76 (1.90, 3.98)	< 0.001

For those within 0–5 months postpartum, LAM was the most common contraceptive method (compared to other methods) in all hubs and time periods, ranging from 3% (7/253) in hub 4 pre-intervention to 61% (199/327) in hub 1 in year 4. The exception to this was hub 3 in Dolakha, where injectable use was the most common contraceptive in early postpartum and appeared to increase from 20% (34/173) pre-intervention to 35% (52/150) in year 2. LAM use in early postpartum appears to have generally increased post-intervention compared to pre-intervention in all hubs. The highest increase in LAM use was observed in hub 1, increasing from 11% (29/263) pre-intervention to 61% (199/327) in year 4. The lowest LAM increase was in hub 2: from 38% (74/196) pre-intervention to 40% (91/227) in year 3.

Contraceptive use among 6–11 months postpartum women varied by hub and intervention year. Condom use was highest in hub 1, up to 15% (50/338) in year 4. Injectable use was particularly high in Dolakha with up to 57% (118/208) of 6–11 month postpartum women using injectables by year 2 in hub 3. There appeared to be increases in the proportion of 6–11 month postpartum women using long acting and permanent methods in all hubs with a notable increase from 0% (0/82) pre-intervention to 24% (20/84) in year 2 in hub 5. The use of traditional methods also appears to have increased from 4% (5/133) pre-intervention to 22% (38/173) in year 1 in hub 7 among 6–11 month postpartum women.

The proportion of early postpartum women using LAM who switched to another modern contraceptive method afterwards remained quite low, ranging from 10 to 30% in most hubs, except for hub 3 where it was over 60%. Exclusive breastfeeding among infants (0–5 months old) was quite high (Fig. 3) in all hubs and appeared to increase over time post-intervention.

Adoption

All (100%) of the 65 CHWs who were trained for the integrated intervention offered and provided BCS every year because it was a required part of their workflow using the CommCare tool. The intervention's postpartum BCS component was implemented in all hubs within the anticipated six months [23]. In fact, BCS was implemented as part of postnatal care almost immediately after enrollment ended in most hubs, except in the two initial implementation hubs 1 and 2. In hub 2, postnatal care and BCS started four months after enrollment completion because the team needed additional time to refine and update workflows and CommCare modules based on our implementation experience in hub 1.

Implementation

Table 5 summarizes fidelity to intervention workflow in terms of timing when BCS was first offered to postpartum women (in median days). In the original workflow during post-intervention year 2 for hub 1 and year 1 for hubs 2 and 3 (which were in the same calendar year), postpartum women received monthly visits from CHWs. Consistent with this schedule, we see that women were about two–three weeks postpartum when CHWs first offered BCS counseling in that calendar year in hubs 1, 2 and 3. After the change in home visit workflow to once every three months postpartum, we see that CHWs offered BCS counseling closer to 90 days postpartum in all hubs.

Maintenance

At the time of analysis, contraceptive counseling through BCS continued to be delivered by CHWs in the study

Table 4 Postpartum contraceptive method mix

			Early (0–5 months) postpartum							
	Hub	Time period	Post-partum women (n)	Method mix: proportion (n, %) of postpartum women using various methods in each hub						
				Lactational amenorrhea	Long acting and permanent methods^	Condoms	Injectables	Pills	Traditional methods	None
Achham	1	Pre-intervention	263	29 (11%)	1 (0.4%)	10 (3.8%)	0 (0%)	0 (0%)	1 (0.4%)	222 (84.4%)
		Year 1	287	117 (40.8%)	6 (2.1%)	25 (8.7%)	9 (3.1%)	0 (0%)	3 (1%)	127 (44.3%)
		Year 2	226	46 (20.4%)	2 (0.9%)	24 (10.6%)	9 (4%)	0 (0%)	7 (3.1%)	138 (61.1%)
		Year 3	170	92 (54.1%)	9 (5.3%)	14 (8.2%)	5 (2.9%)	0 (0%)	5 (2.9%)	45 (26.5%)
		Year 4	327	199 (60.9%)	17 (5.2%)	11 (3.4%)	8 (2.4%)	0 (0%)	15 (4.6%)	77 (23.5%)
	2	Pre-intervention	196	74 (37.8%)	2 (1%)	10 (5.1%)	9 (4.6%)	0 (0%)	4 (2%)	97 (49.5%)
		Year 1	187	77 (41.2%)	7 (3.7%)	5 (2.7%)	16 (8.6%)	0 (0%)	3 (1.6%)	79 (42.2%)
		Year 2	154	39 (25.3%)	16 (10.4%)	1 (0.6%)	13 (8.4%)	1 (0.6%)	2 (1.3%)	82 (53.2%)
		Year 3	227	91 (40.1%)	15 (6.6%)	1 (0.4%)	11 (4.8%)	1 (0.4%)	7 (3.1%)	101 (44.5%)
	4	Pre-intervention	253	7 (2.8%)	4 (1.6%)	5 (2%)	4 (1.6%)	2 (0.8%)	3 (1.2%)	228 (90.1%)
		Year 1	175	66 (37.7%)	4 (2.3%)	2 (1.1%)	5 (2.9%)	0 (0%)	1 (0.6%)	97 (55.4%)
		Year 2	258	101 (39.1%)	14 (5.4%)	6 (2.3%)	7 (2.7%)	0 (0%)	3 (1.2%)	127 (49.2%)
	5	Pre-intervention	76	11 (14.5%)	0 (0%)	1 (1.3%)	0 (0%)	0 (0%)	0 (0%)	64 (84.2%)
		Year 1	60	19 (31.7%)	9 (15%)	0 (0%)	0 (0%)	1 (1.7%)	0 (0%)	31 (51.7%)
		Year 2	78	26 (33.3%)	3 (3.8%)	1 (1.3%)	7 (9%)	0 (0%)	1 (1.3%)	40 (51.3%)
	6	Pre-intervention	304	74 (24.3%)	5 (1.6%)	8 (2.6%)	3 (1%)	2 (0.7%)	15 (4.9%)	197 (64.8%)
		Year 1	234	89 (38%)	15 (6.4%)	13 (5.6%)	3 (1.3%)	0 (0%)	20 (8.5%)	94 (40.2%)
Dolakha	3	Pre-intervention	173	13 (7.5%)	5 (2.9%)	5 (2.9%)	34 (19.7%)	0 (0%)	6 (3.5%)	110 (63.6%)
		Year 1	85	10 (11.8%)	4 (4.7%)	15 (17.6%)	39 (45.9%)	0 (0%)	4 (4.7%)	13 (15.3%)
		Year 2	150	20 (13.3%)	9 (6%)	17 (11.3%)	52 (34.7%)	0 (0%)	2 (1.3%)	50 (33.3%)
	7	Pre-intervention	137	27 (19.7%)	7 (5.1%)	2 (1.5%)	14 (10.2%)	2 (1.5%)	2 (1.5%)	83 (60.6%)
		Year 1	97	28 (28.9%)	9 (9.3%)	3 (3.1%)	13 (13.4%)	1 (1%)	5 (5.2%)	38 (39.2%)
			Late (6–11 months) postpartum							
Achham	1	Pre-intervention	355	-	6 (1.7%)	47 (13.2%)	14 (3.9%)	1 (0.3%)	2 (0.6%)	285 (80.3%)
		Year 1	251	-	11 (4.4%)	32 (12.7%)	19 (7.6%)	8 (3.2%)	10 (4%)	171 (68.1%)
		Year 2	225	-	5 (2.2%)	30 (13.3%)	28 (12.4%)	1 (0.4%)	17 (7.6%)	144 (64%)
		Year 3	264	-	11 (4.2%)	32 (12.1%)	44 (16.7%)	1 (0.4%)	13 (4.9%)	163 (61.7%)
		Year 4	338	-	34 (10.1%)	50 (14.8%)	40 (11.8%)	4 (1.2%)	25 (7.4%)	185 (54.7%)
	2	Pre-intervention	194	-	10 (5.2%)	11 (5.7%)	14 (7.2%)	2 (1%)	12 (6.2%)	145 (74.7%)
		Year 1	205	-	8 (3.9%)	4 (2%)	42 (20.5%)	2 (1%)	13 (6.3%)	136 (66.3%)
		Year 2	305	-	26 (8.5%)	2 (0.7%)	61 (20%)	3 (1%)	9 (3%)	204 (66.9%)
		Year 3	279	-	55 (19.7%)	1 (0.4%)	35 (12.5%)	4 (1.4%)	3 (1.1%)	181 (64.9%)
	4	Pre-intervention	240	-	4 (1.7%)	1 (0.4%)	8 (3.3%)	1 (0.4%)	3 (1.3%)	223 (92.9%)
		Year 1	267	-	9 (3.4%)	9 (3.4%)	13 (4.9%)	6 (2.2%)	8 (3%)	222 (83.1%)
		Year 2	279	-	34 (12.2%)	9 (3.2%)	25 (9%)	2 (0.7%)	11 (3.9%)	198 (71%)
	5	Pre-intervention	82	-	0 (0%)	2 (2.4%)	3 (3.7%)	0 (0%)	0 (0%)	77 (93.9%)
		Year 1	92	-	6 (6.5%)	1 (1.1%)	11 (12%)	1 (1.1%)	0 (0%)	73 (79.3%)
		Year 2	84	-	20 (23.8%)	3 (3.6%)	5 (6%)	1 (1.2%)	1 (1.2%)	54 (64.3%)
	6	Pre-intervention	290	-	5 (1.7%)	7 (2.4%)	28 (9.7%)	1 (0.3%)	37 (12.8%)	212 (73.1%)
		Year 1	335	-	40 (11.9%)	14 (4.2%)	32 (9.6%)	2 (0.6%)	40 (11.9%)	207 (61.8%)
Dolakha	3	Pre-intervention	129	-	4 (3.1%)	8 (6.2%)	60 (46.5%)	4 (3.1%)	10 (7.8%)	43 (33.3%)
		Year 1	201	-	18 (9%)	41 (20.4%)	102 (50.7%)	0 (0%)	9 (4.5%)	31 (15.4%)
		Year 2	208	-	9 (4.3%)	41 (19.7%)	118 (56.7%)	3 (1.4%)	9 (4.3%)	28 (13.5%)
	7	Pre-intervention	133	-	9 (6.8%)	5 (3.8%)	41 (30.8%)	2 (1.5%)	5 (3.8%)	71 (53.4%)
		Year 1	173	-	16 (9.2%)	9 (5.2%)	43 (24.9%)	3 (1.7%)	38 (22%)	64 (37%)

Note: Excludes non-responses from pre-intervention data in hubs 1 and 2

^Includes intrauterine devices, implants, and male and female sterilization procedures

Fig. 3 Proportion of infants (0–5 months) who were exclusively breastfed

Table 5 Timing of offering BCS counseling (in days postpartum)

District	Hub	Intervention year (hub-specific)			
		Year 1 Median [Q1, Q3]	Year 2 Median [Q1, Q3]	Year 3 Median [Q1, Q3]	Year 4 Median [Q1, Q3]
Achham	1	-	15 [7, 27]	92.5 [17, 126.5]	81 [20, 119]
	2	13 [5, 48]	80 [10, 113]	80 [45, 106]	-
	4	86 [10, 123]	78 [29, 122]	-	-
	5	103 [68, 124]	66 [6, 114]	-	-
	6	90 [74, 110]	-	-	-
Dolakha	3	27.5 [8, 103]	78 [37, 108]	-	-
	7	80 [66, 117]	-	-	-

sites after the study period for all MWRA including postpartum women. *Nyaya Health Nepal* led implementation in Achham, while implementation in Dolakha had transitioned to the community health program of the Dhulikhel Hospital-Kathmandu University Hospital. In Achham, the team continued to use CommCare while CHWs in Dolakha used another similar smartphone platform. Further, the integrated RMNCH intervention served as the foundation for a similar pilot delivered by community health nurses in two other municipalities in Nepal [42].

Qualitative results

Co-author RK conducted 17 semi-structured individual interviews in Nepali with intervention recipients ($n=5$), community health nurses ($n=3$), and other program staff ($n=9$), and three FGDs each with 10–11 CHWs. Below, we summarize key themes from qualitative data to help contextualize barriers and facilitators that affected the implementation of the intervention with regard to postpartum contraception.

Implementation barriers

Although CHWs were generally able to visit women every three months, program staff mentioned some challenges to completing home visits for all women in their catchment areas within the intervention's designated time frames. These included the distances and challenging physical terrains CHWs had to traverse to reach remote communities and longer travel times during the monsoon. Social issues such as caste also posed a barrier for CHWs in reaching women to deliver care. Some CHWs reported not being permitted in certain spaces to counsel women because of their caste.

> *For me, they made it difficult to walk around in village as I am a Dalit [lower caste]... They won't let me in the courtyard as well. Postnatal women and baby were inside, and I had to register and do the counselling from outside [because people from lower*

caste are not allowed to inside the houses of upper caste people]. FGD with CHWs, Achham.

Most CHWs reflected that implementing family planning counselling was challenging as many participants had pre-existing negative perceptions and feared potential side effects including cancer and infertility from contraceptive use. In addition, CHWs noted that participants were not inclined towards permanent sterilization as they associated it with "weakness" and inability to do physical work and dissuaded their partners. Experiences of their peers also contributed to these negative perceptions.

Sometimes, people are heavily influenced by others in their community. For example, if a woman gets an implant and experiences mild bleeding, she might say she had heavy bleeding and would rather have an abortion than use it again. Other women tend to believe it. FGD with CHWs, Achham.

Some CHWs highlighted women's lack of autonomy as a challenge to implementing the intervention – some needed permission from their family for counseling. CHWs occasionally encountered resistance and faced negative reactions when attempting to counsel women. One CHW recounted an incident where a woman had consented to contraceptive counseling, but her husband disrupted the process:

I laid out the counselling cards in front of the woman, but just then, her husband arrived. He's usually polite, but that day he seemed angry for some reason. I invited him to join the counselling session, but he didn't…Later, he said that they know what they are doing and I don't have to tell them anything. FGD with CHWs, Achham.

While contraceptive counseling may have helped participants select a preferred method, women's actual access to contraception depended on their ability to reach the health facility, and contraceptive availability and services at the facility, which depended on factors outside the scope of our intervention. Aside from bringing condoms occasionally, CHWs did not provide contraception at home visits. In Dolakha, CHWs noted instances where women chose a method during BCS but were unable to access it when they went to the health facilities. Distance to the facilities likely also hindered access to contraceptive methods.

Some women say their husbands return from India, but they can't visit the hospital because it's too far, and they ended up with unwanted pregnancies. FGD with CHWs, Achham.

Implementation facilitators

Almost all CHWs reflected on the importance of the relationships they fostered with participants in their communities. CHWs shared proudly that they had earned the trust of the women over time, which facilitated their interactions and service delivery, including contraception counselling. In contrast to their initial reactions when CHWs mentioned family planning, women eventually started to share sensitive information with CHWs that they normally hesitated to share with others.

Initially, they hesitated to answer and wouldn't open up when asked about family planning but now they treat us as their friends and openly tell us. Some of them will not tell others in the village about their contraceptive use but will tell us what they are using. FGD with CHWs, Achham.

Intervention participants appreciated learning from CHWs during repeated home visits and for some, this facilitated their contraceptive decision-making.

Who understands the plight of women? Earlier, our life was like that of cattle…got married, gave birth but we knew nothing. Now that they [CHWs] come to our doorsteps to teach us these things, we can't explain how happy we are. Intervention participant, Dolakha.

Some women would also ask CHWs to bring them condoms to the home, as they felt uncomfortable asking directly at the health facilities.

The FCHVs [Female Community Health Volunteers] are older, so the women feel shy to talk to them or visit the health post. Instead, they ask us to bring condoms. They also tell us how many they need. By opening up like this, they make us close to them. FGD with CHWs, Achham.

Discussion

We studied postpartum contraceptive outcomes of a CHW-delivered integrated RMNCH intervention in two districts in rural Nepal using a pre-post effectiveness-implementation design and observed an overall increase in modern postpartum contraceptive use after implementing the intervention. The post-intervention postpartum modern contraceptive uptake was higher compared to pre-intervention in both early and late postpartum sub-populations. Qualitative data helped contextualize the factors affecting the implementation of the intervention and highlighted CHWs' longitudinal engagement in the community as an important facilitator for contraceptive counseling and uptake.

While our study did not offer a direct comparison, our intervention attempted to address some of the previously identified challenges associated with the FCHV model through employing professionalized CHWs who were supported by training, salaries, routine supervision, and mobile technology. Although not directly evaluated in this study, a possible explanation for our observed results is that these strategies may have facilitated CHWs' ability to regularly visit and engage longitudinally with participants. CHWs offered BCS counseling at least once to nearly all women who gave birth within their first year postpartum despite some of the barriers mentioned in the qualitative findings. These high rates were mostly supported by the standardized decision support built into the CommCare app that prompted all CHWs to offer BCS during their visits and was "required" by the algorithm. Although qualitative data did not specifically delve into supervision for CHWs, community health nurses and program managers helped CHWs address challenges in reaching women and implementing contraceptive counseling through routine supervision meetings. Further, by being responsive to programmatic feedback, we aimed to build a workflow and home visit schedule that were more likely to be maintained even after the study period, which may also have contributed to the high fidelity to workflow we observed in terms of timing of the first BCS session offered to postpartum women.

In contrast to the high rates of *offering* BCS to postpartum women, *completion* of BCS depended on participants' decision and was lower, ranging from 40–81% in year 1 and 33–78% in year 2. As noted in the qualitative results, multiple factors including limited autonomy in making reproductive decisions and peer influence determined whether women accepted contraceptive counseling from CHWs during home visits. However, the relationships CHWs built over time with women helped mitigate some of these challenges. CHWs' longitudinal follow-up and provision of contraceptive counseling into the extended postnatal period were also important as women's pregnancy intentions and desire to use contraception are dynamic and change over time [43]. Our previous sub-study in one hub and multiple other studies have suggested that women's self-perceived risk for pregnancy in rural Nepal is influenced by their husbands' absence due to migrant work, which may also have affected perceived need and the observed uptake of contraceptive counseling [27, 44–47]. Despite CHWs' consistency in offering BCS (every three months) and the increase in postpartum PPCPR post-intervention, BCS completion rates appeared to decrease over time across hubs, which may indicate saturation in contraceptive counseling. Further, since BCS was programmatically expanded to all MWRA, it is possible that while postpartum BCS completion decreased, overall exposure to BCS in the community increased over time.

Our integration of counseling services within a larger RMNCH intervention may have also contributed to acceptance and uptake despite participants' initial hesitation. This is consistent with evidence from a review of 35 interventions in LMICs which concluded that incorporating contraceptive counseling and services across the reproductive health care continuum is ideal for improving postpartum contraception [26]. Our key results are consistent with those from a quasi-experimental trial in Bangladesh with over 4,000 women that integrated family planning counseling into an existing maternal and newborn health intervention delivered by CHWs [48]. Similar to our intervention, CHWs in the intervention arm visited women regularly at home through antenatal and postnatal periods and tailored family planning counseling to women's reproductive intentions. Unlike our study, CHWs in this intervention distributed condoms, oral contraceptive pills, and later provided follow-up doses of injectable contraceptives in the community. PPCPR in the Ahmed et al. study in Bangladesh was 15% higher in the intervention arm than in the control arm at 12 months postpartum [49]. The intervention arm also had lower risks for short interval pregnancies of < 24 months and preterm births [48]. Since CHWs in our intervention did not distribute contraceptives, actual access and uptake of contraception in our study were also affected by facility-level factors, as indicated by qualitative data.

While we do not have pre-intervention data on exclusive breastfeeding, our data suggest high rates of exclusive breastfeeding for children under 6 months ranging from 79–97% post-intervention, which is higher than national estimates of 56% [50]. We saw relatively low rates of transition from LAM, except in hub 3 where 60% of women switched to other modern contraceptives. Interestingly, unlike other hubs, hub 3 had low LAM use and high other modern contraceptive use among early postpartum women. In areas where early adoption of modern contraception is the norm, hub-specific factors such as easier facility access and more local acceptability may make it easier for women to switch from LAM to other modern contraception. Hub 3 also had the highest injectable use in both early and late postpartum groups and all time periods, suggesting that women who initiated a non-LAM method in early postpartum were likely to continue using it in late postpartum. Additional research is needed to better understand and address the low transition rates from LAM for women who do not desire pregnancy, as it did not appear that CHW counseling and follow-up alone were adequate.

Finally, while we did not study the maintenance of the intervention beyond the study period, the intervention continued to be implemented in both districts at the time

of analysis, albeit within the context of transitions such as leadership changes. Anecdotally, there were adjustments to the focus and frequency of CHW visits especially during the COVID-19 pandemic and in the post-pandemic period. In addition to their RMNCH responsibilities, for example, CHWs received training and information necessary to support test and trace and vaccination campaigns aligned with government priorities. Funding also has implications for maintenance, and a previous costing analysis of this integrated CHW intervention found the average per capita annual cost was $3.05 USD, however, additional information is needed on the cost-benefits [51].

Limitations

As described previously, it was infeasible to employ randomization or have a separate comparison group of hubs in our study. There were also several data-related limitations. While we attempted to account for variations in districts and hubs in our main analysis, we did not have the necessary data to account for any sociodemographic changes or secular trends. Thus, we cannot make causal inferences about observed increases in contraceptive uptake. While we report descriptive data on contraceptive method mix, given the small numbers in each contraceptive category, we are unable to comment on how any changes in specific methods may have driven the overall observed increase in modern PPCPR.

Some courtesy bias may have been introduced since CHWs delivered care and simultaneously collected data. Social desirability may have affected self-reported data, including breastfeeding and LAM use. We did not confirm whether women who reported using LAM in the early postpartum period were amenorrheic and exclusively breastfeeding. CHWs may have felt their performance was measured by their success in being able to "convince" women to adopt modern contraception, though they did not report this in qualitative data. In addition, since implementation in some originally planned hubs was delayed for various reasons, we only included data from seven hubs that had at least one year of post-intervention data before the national COVID-19 lockdown. It is possible that the included hubs had fewer barriers to implementation and that we would have seen different results in other hubs.

Since qualitative data collection was limited by pandemic travel restrictions and was collected for the overall RMNCH intervention, it did not always yield specifics about the contraceptive counseling component. BCS also has limitations – while it aligns with person-centered counseling, the counseling algorithm is guided by tiered effectiveness where the most effective methods are presented first [36]. Effectiveness, however, may not be the priority for every woman. Our main effectiveness indicator in this study (PPCPR) is not a person-centered outcome and does not consider women's satisfaction with their method [52]. Evaluating program success based on contraceptive prevalence may thus inadvertently incentivize providers to prioritize method uptake and lead to coercive practices [53], though we do not have evidence of this occurring. Finally, our intervention did not address broader structural and socio-cultural factors that impact access to and use of contraception including poverty, gender inequality, weak supply chains, and poor road infrastructure [15, 32, 54, 55]. For instance, while CHWs facilitate community-facility linkages, additional efforts are needed to improve physical access to facilities and quality of care at facilities, as indicated by our qualitative results.

Conclusions

This study assessed the real-world implementation of a CHW-delivered integrated RMNCH intervention with a person-centered contraceptive counseling component in a low-resource setting where contraception is underutilized. Our findings suggest the intervention's potential to increase modern contraceptive uptake in community settings. Perhaps more importantly, our results underscore the importance of longitudinal engagement and trust-building that position CHWs to drive longer-term change in their communities, especially around sensitive topics. This study contributes to the implementation research literature on community-based interventions to improve postpartum contraception use and may inform other CHW programs in similar contexts.

Abbreviations

BCS	Balanced Counseling Strategy
CHWs	Community health workers
FCHVs	Female Community Health Volunteers
FGD	Focus group discussion
LAM	Lactational amenorrhea method
LMICs	Low and middle-income countries
MWRA	Married women of reproductive age
PPCPR	Postpartum modern contraceptive prevalence rate
RE-AIM	Reach, Effectiveness, Adoption, Implementation and Maintenance
RMNCH	Reproductive, maternal, newborn, and child health
RR	Rate ratio
WHO	World Health Organization

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Authors' contributions

NC and WJW led the writing and production of the manuscript as co-first authors. NC, A Tiwari, VB, LDB, NM, and KRM were responsible for data curation and management, with NC and A Tiwari performing statistical analysis. R Khatri conducted qualitative data analysis and led the writing for the

qualitative methods and results. DM, SM, NC, WJW, RK, SA, DC, SH, IN, and PT contributed to developing the methodology for the intervention and study. SM and S Sapkota, as co-senior authors, oversaw the entire process and provided guidance on the study's design and execution. A Thapa, WJW, VB, AB, BB, LDB, DC, SH, SK, YK, LKBK, KRM, NM, DM, IN, RP, R Schwarz, R Shrestha, DS, PT, HR, SM, and S Saud were involved in project implementation. All authors, including BR and GDN, participated in the review and/or editing process.

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Data availability
De-identified, ward-level data used for the primary analysis are publicly available at: [https://osf.io/24smk/] (https://osf.io/24smk). Requests for participant level (human subjects) data can be sent to the corresponding author.

Declarations

Ethics approval and consent to participate
The institutional review committee of Kathmandu University School of Medical Sciences/Dhulikhel Hospital (81/14), the Nepal Health Research Council (461/2016), the Brigham and Women's Hospital institutional review board (2015P000058/BWH and 2017P000709/PHS), and Mount Sinai institutional review board (MSSM IRB-18–01091) provided human subjects approval for the study. The Boston Medical Center (H-38196) institutional review board exempted the study since the first author W. Wu had moved from Brigham and Women's Hospital to Boston Medical Center after the data collection process was already complete. At that point, only de-identified data were being used for analysis and manuscript preparation. Since the study already had approval from the Nepal Health Research Council and Brigham and Women's institutional review boards, the primary author's scope of work was not considered human subjects research that the Boston Medical Center was engaged in and was considered exempt.
During enrollment into the RMNCH intervention, CHWs read the consent form and obtained verbal informed consent to enroll households and individuals into the CHW program, provide care, and use their programmatic data for research. Consent was documented electronically in CommCare. Households and individuals could choose to participate only in the care program and decline use of their data in research activities. Their data were excluded from this study. For the children who were under two years, their mothers provided verbal consent for enrollment into the care program and use of their data for research. For the qualitative interview and FGD participants, the research team member read a structured script and obtained verbal informed consent. Consent included use of de-identified quotes for publication purposes.

Consent for publication
Not applicable.

Competing interests
All authors declare that we have no competing financial interests. NC is a PhD candidate at a private university (NYU Grossman School of Medicine) and was employed by the non-profit Possible and a private medical school (Icahn School of Medicine at Mount Sinai) when most of this work was completed. WW, SM, and DM are employed by, and WW, SM, DC, DM, and S. Sapkota are faculty members at a private medical school (Icahn School of Medicine at Mount Sinai). NC, WW, SM, DC and SH serve as advisors to the US-based non-profit organization Possible, for which they receive no compensation. S. Sapkota is employed by a Nepal-based non-governmental organization, Possible that operates with support from US-based Possible. RK, A. Tiwari, A. Thapa, VB, AB, BB, LDB, DC, SH, SK, YKBK, LBK, KRM, NM, IN, R. Paudel, S. Saud, R. Shrestha, PT, HJR were employed by the non-profit organizations Nyaya Health Nepal/Possible at the time of this work. S. Saud is employed by a government hospital of Nepal (Civil Service Hospital). R. Shrestha is a student at the School of Health and Allied Sciences, Pokhara University. IB is a board chair of Nepal-based Possible. DC is a faculty member at the University of Washington and SH is employed by the Washington State Department of Children, Youth & Families (Olympia, WA). R. Schwarz is employed at an academic medical center (Brigham and Women's Hospital) and is a faculty member at a private medical school (Harvard Medical School) and an academic medical center (Massachusetts General Hospital). SA is a faculty member at a private medical school (NYU Grossman School of Medicine). LBK is employed by a non-profit (Medic). PT is currently a postdoctoral fellow at School of Population and Global Health, McGill University, Quebec, Canada. KRM is employed by Transcultural Psychosocial Organization Nepal (TPO Nepal). DS is employed by Possible Nepal. GNS is director of and BR is Senior Hospital Nursing Administrator Chief of the Nursing and Social Security Division under the Government of Nepal Ministry of Health and Population.

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