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# Group Antenatal Care in Rwanda: Examining Successes and Challenges in Implementation

By

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A dissertation submitted in partial satisfaction of the

requirements for the degree of

Doctor of Public Health

in the

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University of California, Berkeley

Committee in Charge:

Professor Ndola Prata, Co-Chair
Professor Dilys Walker, Co-Chair
Professor Jane Mauldon

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ABSTRACT

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Doctor of Public Health

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Increasing access to quality maternal health services for women in low and middle income countries (LMICs) is crucial in improving maternal and child health outcomes. Antenatal care (ANC) serves as an opportunity to provide clinical care and may be associated with an increased odds of delivering in a health institution.[1–3] To address the utilization and quality of ANC, in 2016 the World Health Organization (WHO) provided updated recommendations for health systems interventions. Group antenatal care (group ANC) provided by qualified health-care professionals was highlighted as a promising intervention warranting implementation in the context of research.[4] Traditional ANC models are centered around one-on-one visits between a pregnant woman and her health care provider. The visit focuses on the woman's physical health, with the provider communicating clinical information and self-care recommendations. In contrast, group ANC uses an integrated approach, combining a physical assessment with group education and support.

The Preterm Birth Initiative (PTBi) – Rwanda conducted a cluster randomized controlled trial of group ANC to assess the impact of this care model on preterm birth. This dissertation assesses Community Health Workers' (CHWs) experiences in piloting group ANC, the impact of introducing ultrasound in the context of individual ANC, and successes and challenges in implementing the program with fidelity to the program design.

Using focus group data, paper 1 explores the successes and challenges CHWs experienced in implementing the group ANC pilot program. Successes included effective training, collaboration between nurses and CHWs and perceived complementarity of group ANC with CHW's existing community based responsibilities. Challenges included a need for additional training on various clinical topics, financial barriers to CHW engagement and problems in scheduling.

There is limited research on how the introduction of a technological intervention, such as ultrasound, can affect the delivery of other critical services when working in low resource settings. Paper 2 utilizes patient data from 8,910 women from 18 health centers to measure the association between the provision of ultrasound and the number of ANC screening factors assessed. There was no significant association between the provision of ultrasound and number

of ANC risk factors assessed. Given the several limitations in conducting this study, we recommend further studies to assess the impact of ultrasound on ANC services.

Through the analysis of qualitative Activity Reports and quantitative Model Fidelity Assessments, paper 3 examines whether the program was implemented with fidelity. Results found implementing group ANC with model fidelity required: group ANC scheduling, preparing the room for group ANC sessions, provider capacity to co-facilitate group ANC, and facilitator knowledge and skills regarding group ANC content and process. Duration of program implementation was associated with improvements in implementation fidelity. Results illustrate the importance of monitoring implementation fidelity through the use of quantitative and qualitative tools and providing consistent training and mentorship throughout program implementation.

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# INTRODUCTION

Preterm birth is the birth of a baby before 37 weeks of pregnancy.[5] Globally, preterm birth complications are the leading cause of death in children under 5 years of age, as well as disability and poor health later in life.[5] Pregnancy provides a critical opportunity during which to address maternal health and risks for preterm birth complications. Providing access to antenatal care (ANC) for pregnant women can help ensure a healthy pregnancy, while allowing for the screening and management of women at risk of preterm birth.

In 2016, the Rwanda Health Management Information System recorded 21,099 preterm births. While 99% of pregnant women were documented as having attended at least one ANC visit with skilled medical personnel, only 56% attended the first ANC visit before four months of pregnancy and 44% attended the recommended four or more standard ANC visits.[6] Targeted interventions are required to improve the ANC system, ensuring Rwandan women have access to effective and timely antenatal care.

To address the utilization and quality of ANC, in 2016 the World Health Organization (WHO) provided updated recommendations for health systems interventions. Group antenatal care (group ANC) provided by qualified health-care professionals was highlighted as a promising intervention warranting implementation in the context of research.[4] In contrast to the traditional model of one-on-one ANC, group ANC offers a more holistic approach, combining a physical assessment of the mother with education, skill building and peer support.[4]

The Preterm Birth Initiative East Africa (PTBi EA) is a partnership between the Bill & Melinda Gates Foundation (BMGF) and the University of California, San Francisco (UCSF). PTBi EA implemented a randomized controlled trial to measure the effect of group ANC on perinatal outcomes. This dissertation will investigate the process of group ANC to assess successes and challenges in the implementation of group ANC in five districts in Rwanda.

First, I analyze Community Health Workers' (CHW) perceptions and experiences in piloting group ANC. Second, I address the issue of potential opportunity cost, by examining whether the introduction of ultrasound during standard ANC effects the provision of ANC services. Third, I assess implementation fidelity, investigating whether the program was implemented in adherence with the original protocol. Measurement of implementation fidelity will provide an understanding of why the program did or didn't work and how the process can be addressed to improve program outcomes. This research addresses the gap in literature on the implementation of group ANC in low and middle income countries.

# PAPER 1

## Innovating in Rwanda's Antenatal Care programs: CHW Experiences leading Group Antenatal Care Pilot Programs


## Abstract

### Background
The Preterm Birth Initiative East (PTBi) – Rwanda conducted a cluster randomized controlled trial of group Antenatal Care (group ANC) and group postnatal care (group PNC), to assess the impact of this care model on preterm birth. The Rwandan group ANC model consisted of groups of women with similar due dates attending four group ANC and one group PNC session. Group sessions were co-facilitated by health center providers (nurses or midwives) and Community Health Workers (CHWs).[7] The objective of this study is to assess the successes and challenges CHWs encountered in implementing group ANC.

### Methods
We conducted one focus group of nine CHWs involved in co-facilitating group ANC/PNC. The focus group discussion was transcribed and translated from Kinyarwanda to English. Thematic analysis was conducted in Dedoose: two coders independently reviewed and coded transcripts, followed by joint consensus coding.

### Results
CHWs typically viewed group ANC as successful, citing three key reasons for success: effective training, strong collaboration between nurses and CHWs and the complementarity they perceived of group ANC with their existing community based responsibilities. They identified several ongoing challenges for improvement, including: a need for further training on specific clinical topics, financial barriers to CHW engagement and problems in scheduling.

### Conclusions
Continued success in implementing group ANC requires additional training, allowing CHWs to more comprehensively address the needs of women and further reduce the burden on nurses. Further operational and administrative improvements are necessary in enabling CHWs to fulfill their dual roles within the community and as group ANC co-facilitators.


## Introduction

### Maternal and Neonatal Mortality in Rwanda
Rwanda has made significant progress in improving maternal and child health outcomes. From 2005 to 2015, the maternal mortality ratio decreased from 750 maternal deaths per 100,000 live births to 210 maternal deaths per 100,000 live births. During this same period, the neonatal mortality rate declined from 37 neonatal deaths per 1000 live births to 14 neonatal deaths per 1000 live births, while the infant mortality rate decreased from 86 deaths per 1000 live births to 32 deaths per 1000 livebirths.[6,8] Despite these gains, substantial efforts are required to achieve the Sustainable Development Goals of 2030. These goals include reducing the maternal mortality ratio to 70 maternal deaths per 100,000 live births, reducing the neonatal mortality rate to 12 deaths per 1000 live births and reducing the under-5 mortality rate to 25 deaths per 1000 live births.[9]

## Rwanda's Public Healthcare Delivery System and the Role of CHWs

The Rwandan health system consists of a network of five referral hospitals, 42 district hospitals, 466 health centers, 60 health posts and 45,000 CHWs.[10] In 2013, there were 678 doctors and 9,448 nurses and midwives working in Rwanda. This results in a low provider to patient ratio, with one doctor per 16,046 inhabitants, one midwife per 18,790 inhabitants and one nurse per 1,227 inhabitants.[10]

To ensure stronger and more efficient management and resource allocation, the MOH decentralized the health system. In 2004, villages were identified as the lowest administrative level, allowing for community ownership and participation within the healthcare system. The MOH also introduced an integrated community health services package, shifting the responsibility for specific maternal and child health services from health facility staff to CHWs. The CHW program initially began in 1995, with 12,000 CHWs responsible for educating the community on healthy behaviors, conducting community mobilization and providing basic services.[11]

Since 1995, the MOH has scaled the CHW program nationwide, with three CHWs present in all 14,837 villages, with approximately 100-150 households per village.[11] The three CHWs consist of a male-female CHW pair, referred to as binômes, as well as a CHW responsible for maternal health, referred to as an Agent de Sante Maternelle (ASM). Binômes provide integrated community case management of childhood illness (including diarrhea, pneumonia, malaria, and malnutrition in children under the age of 5) as well as community-based provision of contraceptives and other preventive and behavior change activities. The ASM identifies pregnant women, conducts follow-up visits during and after pregnancy, and ensures deliveries take place in health facilities providing skilled health workers.[11]

## Gaps in the Provision of Antenatal Care in Rwanda

While health outcomes in Rwanda have improved, maternal and neonatal mortality rates remain high. Based on the Rwanda National Health Facility Survey, it appears the improvement in health outcomes is due to increased attendance at ANC services as well as an increase in births taking place at a health facility.[12,13] The 2015 Rwanda Demographic and Health Survey (RDHS) found approximately 91% of deliveries occurred in a health facility and were attended by a skilled provider.[6,14] However, further achievements in maternal and child health require improved quality of ANC services.

A study assessing practices of health care providers in Rwanda suggests inadequate care may stem from limited knowledge and skills on performing interventions or counseling women.[14,15] These findings are corroborated by evidence from the Rwanda National Health Facility Survey. A section of the survey assessed key components of focused ANC, including health promotion (including counseling on pregnancy danger signs), birth preparation counseling (including asking the client about place of delivery and using a skilled birth attendant) and postpartum family planning. The survey found only 14% of facilities addressed health promotion, 26% addressed birth preparation counseling and 34% addressed postpartum family planning. The survey also found that, on average, providers asked clients about danger signs and complications in previous pregnancies only 12% and 38% of the time, respectively. In addition, a woman's temperature, pulse and blood pressure were taken, on average, 48%, 50%, and 73% of the time, respectively.[14] In addition, a facility based, cross-sectional study of 312 ANC providers in Rwanda, 25.3% of ANC visits were less than or equal to 15 minutes and 73.7% were greater than or equal to 16 minutes.[15]

The initial assessment of mothers serves as the basis for planning how to best manage the

labor and delivery process. Specifically, the assessment provides an opportunity for health workers to gather critical information regarding risk classification and what kind of care and monitoring are required. It is clear from the Rwanda National Health Facility Survey, that while some components of ANC are being adequately provided, others are being almost completely overlooked. Reasons for these oversights may include limited understanding of the significance of certain tasks, varying levels of emphasis on different tasks and limited time and competing priorities due to which providers focus only on immediate health conditions as opposed to longer term management of care. These gaps allow for the opportunity to assess the impact of new strategies, such as restructuring ANC services to a format allowing women to receive appropriate, quality care with sufficient time to address their individual concerns.[14]

**Background**

Increasing access to quality maternal health services for women in low and middle income countries (LMICs) is crucial in improving maternal and child health outcomes. Antenatal care (ANC) serves as an opportunity to provide clinical care and may be associated with an increased odds of delivering in a health institution.[1–3] To address the utilization and quality of ANC, in 2016 the World Health Organization (WHO) provided updated recommendations for health systems interventions. Group antenatal care (GANC) provided by qualified health-care professionals was highlighted as a promising intervention warranting implementation in the context of research.[4] Traditional ANC models are centered around one-on-one visits between a pregnant woman and her health care provider. The visit focuses on the woman's physical health, with the provider communicating clinical information and self-care recommendations. In contrast, group ANC uses an integrated approach, combining a physical assessment with group education and support.

The concept of group ANC began as the CenteringPregnancy® model in the United States in 1993.[16] The model aims to promote behavior change and improve pregnancy outcomes, in part, by including group patient education and peer support. Group sessions include eight to ten women of similar gestational age. Group visits in CenteringPregnancy® commence in the second trimester and continue for ten sessions, following the standard prenatal visit schedule. Each session is 90 minutes to two hours long and begins with women assessing their own weight and blood pressure. Following a brief period of time to speak one on one with the provider in private, the health care providers facilitate discussions and activities around topics including nutrition, preparation for labor and delivery, breastfeeding and infant care.[16]

The Rwandan Ministry of Health group ANC/PNC model, Ibaruke Neza Mubyeyi, was developed by a Technical Working Group comprised of ten Rwandan stakeholders, the Rwanda-based PTBI co-Principal Investigator and a group ANC technical expert from outside Rwanda.[17] Compared to the original CenteringPregnancy® model in the United States, the Rwandan model included four group ANC visits, based on the WHO recommended focused ANC model being utilized by Rwanda at the time of program implementation. Groups were scheduled to meet every 8 weeks over the course of 24 weeks, for a total of four group ANC visits, followed by one group PNC visit. Each group ANC session was led by two co-facilitators, an ANC provider (midwife/nurse) and one CHW in charge of maternal health (Agent de Santé Maternelle, ASM). Community Health Workers and ANC providers attended three days of training on how to deliver group ANC. The curriculum guided co-facilitators to commence each session with open-ended questions about how women were feeling as well as desired topics of discussion. Training included sessions on adult learning and facilitated discussion of topics including pregnancy danger signs, mental health, birth spacing and family planning. In total, 217 CHWs and 70 nurses and midwives

received training to become group ANC/PNC co-facilitators.

ANC sessions began with women conducting their own health assessments, including taking their weight and blood pressure, in a semi-private area. During this time, women also received routine assessments, screening, and treatments in addition to care for special conditions.[17] Brief individual consultations were followed by a one hour group session including learning activities utilizing principles of adult and peer education. Previously published results suggest that providers displayed increased satisfaction with their provision of care while women valued the opportunity to engage, ask questions and share concerns in a group setting.[18]

Thirty-six health centers were selected for inclusion in the primary study addressing preterm birth in Rwanda, in which the outcome of interest was gestational age at birth. Eighteen health centers were randomly selected to provide group ANC/PNC and 18 pair-matched health centers continued providing individual ANC/PNC. This study assesses the successes and challenges CHWs experienced in implementing group ANC, potentially holding implications for the way forward if group ANC is to be scaled up at a national level or in other contexts.

## Methods

A single focus group of 9 CHWs was conducted in March of 2019. The objective of the focus group was to assess successes and challenges affecting CHW implementation of group ANC. Convenience sampling was used to select nine CHWs from among the 18 health centers conducting group ANC/PNC. Based on PTBi's initial qualitative research in Rwanda, nine to 12 participants was found to be the most effective size for focus groups. The nine CHWs represented seven different health centers, of which four were rural and three were urban. CHWs ranged in age from 30 years to 52 years, with a mean age of 42.7 years. CHWs had four to 13 years of work experience, with a mean of 8.8 years of work experience.

## Data Collection and Analysis

The focus group was conducted by a facilitator and note taker from the University of Rwanda School of Public Health. Both data collectors came with previous experience in qualitative research, facilitation and note taking. The focus group guide included open-ended questions about CHWs' experiences in implementing group ANC/PNC and was conducted in Kinyarwanda. Focus group participants were each assigned a number. The focus group facilitator asked each question from the guide, after which participants raised their hands to share their answers. The facilitator ensured no single participant dominated responses to a specific question and encouraged responses from all participants. The audio recording was transcribed in Kinyarwanda and translated into English by a trained research assistant and verified by the facilitator. Data were coded by a UC Berkeley graduate student and the PTBi Data Manager in Rwanda.

Through the process of data reduction, the coders individually reduced the initial data set to sections perceived as relevant in answering the proposed question.[19,20] Pre-coding was used to highlight pertinent lines and quotes that could prove significant in subsequent rounds of coding. The coders discussed and agreed upon the reduced data set to be coded. Based on the reduced data set, a codebook was created by a single coder and discussed with the second coder until consensus was reached on codes and definitions.[21] Coders used initial coding to discover and develop categories.[22] Specifically, structural coding was used to label data based off of questions in the focus group guide.[23,24] Subcodes were attached to initial structural codes when data required an additional level of categorizing.[23] In the subsequent round of coding, axial coding was used to make connections between categories and identify broader themes.[25,26] Both coders compared and

discussed codes until consensus was reached.[27] Dedoose software was used to organize and attach codes to the data.

**Informed Consent**

Written informed consent was obtained from all participants prior to conducting the focus group. Ethical approval was obtained from the Rwanda National Ethics Committee (No.0034/RNE/2017) and University of California, San Francisco Institutional Review Board (16–21177).

**Results**

Focus group findings elucidate, among others, the operational, logistical and financial challenges and successes CHWs encountered in implementing group ANC. Themes emerging from the focus group include challenges in providing sufficient training, financial barriers to transportation and ineffective scheduling processes. Successes include strong collaboration between nurses and CHWs and synergies between the work of CHWs in group ANC and within the community.

**Perceptions on Training**

CHWs reported high satisfaction with the training. Increased knowledge and confidence in clinical and facilitation skills were reported as key benefits of the training program. In particular, CHWs felt competent in speaking and disseminating information in group settings. CHWs noted a strong sense of self-efficacy and felt well equipped to carry out their new responsibilities.

> *We were surely equipped with special skills whereby we did a lot of practicals regarding to how we will be carrying out our responsibilities in our respective health centers. I was always the first to do these exercises and was really happy because I realized that it was a new skill that we were being equipped with. Indeed, we were satisfied and we concluded that we were very well trained as we gained additional skills. (Respondent 1)*

> *The way we built self confidence in ourselves made us feel less complex and speaking proudly about what we know in front of the public. After we had learnt various lessons, we had time to practice and as a result we don't have any complex at all. (Respondent 9)*

Areas requiring additional training include mental health, gender based violence and specific clinical skills. CHWs reported inadequate training in these areas, posing a challenge in addressing women's concerns and implementing a holistic approach to group ANC/PNC. Providing adequate mental health support proved to be particularly challenging, given women's varied experiences, including abuse, adolescent pregnancy and lack of parental responsibility from partners.

> *Three lessons are taught concurrently, namely one about balanced diet, then danger signs and lastly a lesson about mental health. But when learning the latter, there are a lot of challenges. In groups, there are various categories of women, like girls who got unplanned pregnancies of which they usually feel guilty. Elsewhere in these groups there are wives conflicting with their husbands. So, when we start teaching them about mental health, we try to convince them to accept all that happened and tell them that they are responsible for the lives of the babies they have in their wombs. This topic is very challenging! (Respondent 1)*

*We need to be trained again in details about this lesson for more skills as we did not go deep in our groups especially at [location removed]. So far, mothers trained in our group know well about preparing a balanced diet and protection of children against malnutrition. But we did not understand well the lesson about the women oppression including that of young lady suffering from heart wounds besides other mothers who spent nights being beaten outside and putting on the neighbor's loincloth when she has the health care provider's appointment. We would request you to come back to that point so that we can be well equipped with more skills to help mothers. (Respondent 1)*

CHWs felt group ANC sessions could be more productive and efficient if they were taught pregnancy assessment skills, including monitoring fetal heart rate, measuring symphysis-fundal height and conducting tests for hemoglobin levels, HIV and Syphilis. The inability to perform certain tasks hindered group ANC facilitation, particularly if the nurse was occupied by other responsibilities. CHWs desired training in measuring the length of the womb, measuring fetal heart rate, using the pregnancy wheel and carrying out a full health assessment. CHWs felt confident, that provided appropriate training, they could quickly learn and apply their new skills.

*I can manage any group activity except testing the length of the womb and fetal heart beat which I do not know because I was not trained on it. (Respondent 8)*

*There are things I can do when the nurse is not there like blood pressure checking, measuring the weight, holding a discussion and if trained, I can carry out a health assessment simply because community health workers are quick learners. (Respondent 6)*

Intensive training on group ANC content and facilitation provided CHWs with confidence in their abilities to implement various components of group ANC, including facilitating discussions, providing health education and conducting certain clinical practices. Development of competencies in mental health and gender based violence, as well as pregnancy assessment skills, may allow for more effective and efficient implementation of group ANC.

**Financial Barriers to Transportation**

Within Rwanda's community performance-based financing scheme, CHW Cooperatives receive funds from the Ministry of Health (MOH) if they achieve defined targets provided by the MOH.[8] In compliance with this mechanism, CHWs were not provided a salary for implementing Group ANC. CHWs were instead provided with a transportation stipend of 3,000 Rwandan Francs ($3.16 USD) for each day of Group ANC/Group PNC facilitation by the parent study. The lack of timely disbursement of transportation stipends was one of the most significant barriers for CHWs in implementing group ANC. In some cases, CHWs used their own money to transport themselves from their villages to health centers, creating greater stress on their financial situations at home. If using their own funds was not an option, CHWs asked their colleagues to serve as possible substitutes. This dynamic created frustration among CHWs missing opportunities to facilitate, while placing an additional burden on the CHWs asked to substitute.

*I did not have any money for transport; at least two thousand. I wondered what I could do. "What shall I do? How shall I leave my children alone at home? What shall I do?" I asked myself, because I had no money with me. (Respondent 4)*

*From my home to that place, one hires a motorcycle at five hundred francs, going and coming, you pay a thousand francs. You may improvise me therefore while I don't have this money. So I will have to go and talk with [name removed] to see whether she may be having any money. You can understand that my chance is gone, isn't it? I will ask her to go there on my behalf.*

*But at least, if we can have this allowance on time, we can solve some family financial problems. (Respondent 3)*

CHWs were unclear on whether the stipend was intended solely for transportation or was provided in lieu of payment. CHWs perceiving the stipend as a form of payment, felt the stipend should be commensurate with the amount of time contributed and therefore provided for each group ANC session facilitated. However, CHWs were later informed that the stipend was not in lieu of payment and would be provided per day of group ANC facilitated.

*I don't know whether my colleagues have the same problem whereby you are called in one group care but finally find that there are many groups. Is the 3,000 francs transport fee intended for only one group? (Respondent 9)*

*Yes, it happened to us to facilitate two or more groups while one expected to facilitate one group. Before, at the beginning, one would be paid for each group she facilitated; and then when people in charge of community health workers attended a meeting they later told us that we are paid transport fees. One is not supposed to serve two groups so that he/she could be paid twice as each group would have its responsible community health worker. She/he added that in case one facilitated more than one group, this is taken as assistance to someone in charge of the second group which does not necessarily mean that the transport fee would exceed 3,000. (Respondent 7)*

As stipends were disbursed intermittently and for uneven periods of activity, CHWs expressed concerns regarding when and for what duration of work they would be paid.

*My question concerns my peer community health workers who sent to me the message about the report we compiled. They are not sure whether they will be paid either for January up to February report or the one of December to February. They are wondering whether they will be paid or not while some people said that the project has closed its activities. (Respondent 5)*

Challenges pertaining to the distribution of transportation stipends persisted for the duration of the program. CHWs were either unable to attend group ANC/PNC sessions or found transportation at their own expense. Operational challenges regarding the timely disbursement of stipends must be resolved to ensure CHWs are able to arrange for transportation to health centers and facilitate group ANC/PNC as scheduled.

**Scheduling Challenges and Successes**

Advanced scheduling for group ANC appeared to be fairly well coordinated, however, communicating specific dates and times to CHWs proved to be challenging. At the beginning of each round of four group ANC and one group PNC session, health center providers were responsible for informing CHWs of dates for the next session. Advanced scheduling helped CHWs coordinate facilitation with their other responsibilities within the community.

> *The community health worker was also expected to follow the same appointment. She would check the date they were given and make sure to attend with the members of that group she was supposed to facilitate. Before the end of the session they give us, women and CHWs, the dates of next follow up visits. (Respondent 1)*

However, CHWs also reported difficulties in coordinating their group ANC responsibilities with their other work. A key reason was that they did not always know in advance the times and dates of the group ANC sessions they were expected to lead. Unpredictable scheduling made it difficult for CHWs to plan around their other activities. While the provider was responsible for planning dates and times for all sessions, in several cases, this did not occur. CHWs facilitating the first group of the day had to remain at the health facility until the last group was completed, in order to find out from the provider when they were next scheduled to return.

> *As for our case it was difficult. On the same day, we could have two or three groups: one in the morning at 8:00, another at 11:00, and the last in the afternoon at 2:00. This is a challenge because you have to wait until when the last group has finished. To know that you are the person to facilitate the group care, it was done on telephone. (Respondent 7)*

Given that several group ANC sessions were scheduled at the last minute, CHWs often found it difficult to make themselves available for the requested sessions. CHWs worked in a collaborative manner, ensuring coverage for their colleagues who were unavailable to facilitate on a certain date or time. Despite scheduling challenges, mutual supported allowed CHWs to feel well equipped in balancing facilitation with their remaining CHW responsibilities.

> *Sincerely speaking, when [name removed] called me and told me that I had to attend "Ibaruke neza Mubyeyi" program, I usually asked her about the time and she replied that it would take place by eleven. I would immediately tell her that I could not and request her to shift my time to eight so that my colleague could start at eleven. We work collaboratively without any problem. Know that there is one time when two people worked together when necessary to help a colleague who might not be available due to some reasons including going to work from the headquarters, one could fill this gap without any complain. It is our culture to help among ourselves in a bid to render a good service to mothers when they are there. (Respondent 8)*

While the program planned for CHWs to receive dates and times of all subsequent visits requiring their facilitation, this did not always take place. When providers were overwhelmed with responsibilities, other staff members were asked to make schedules, often last minute. Additional challenges were present at the facility level. For the most part, health centers providing standard ANC maintained their original schedule, providing ANC services twice a week. Health centers

selected to provide group ANC/PNC, faced challenges in adapting to the group model. Health centers have a limited number of providers who are responsible for other services, particularly on days that ANC is not provided. Adapting to the group ANC model often required scheduling up to three group sessions on a single day. This proved to be logistically challenging for some health centers.

Despite scheduling challenges, CHWs ensured a co-facilitator was present for each group ANC session by substituting for each other. However, substitutions may also have contributed to a lack of continuity of care from a single provider. Continued efforts are required, including coordination among CHWs, providers and relevant staff at health centers. Improved scheduling is crucial, permitting CHWs to ensure their availability in advance, provide continuity of care and better balance their duties within the community.

**Synergies between Group ANC and CHWs' Community-Based Roles**

CHWs noted two key benefits of group ANC in relation to their primary responsibilities within the community: group ANC provided additional opportunities to follow up with mothers as well as further knowledge and skills in addressing maternal and infant health. . CHWs used group ANC as an opportunity to share information with their colleagues (CHWs facilitating group ANC as well as CHWs within the community, who were not involved with group ANC), allowing them to cater to women's specific needs either during the group ANC session or during community visits. By documenting women who hadn't attended the group ANC session, CHWs were able to flag individuals to follow up with within the community.

> *As you have asked us how we do our group activities, they don't interfere with the work of a community health worker; it is our voluntary normal work. Those group activities have added some facilitation to the work of a community health worker and other ASM with whom we work together. The first one: it helped us to know information about the mothers we are supposed to assist. We shared information about the mothers who have attended, and those who didn't from various villages so that you may arrange to visit them before the end of the term in order to cater for each of them. I can see that they didn't disturb anything in our normal working because it is normally what a voluntary work requires. (Respondent 9)*

Group ANC was viewed as complementary to and strengthening the work of CHWs. The additional knowledge and skills CHWs gained through group ANC training provided a knowledge base complementing their work as ASMs. CHWs felt empowered to use their knowledge in providing services for and educating pregnant women within the community.

> *As for me I saw that the work of serving as a community health worker and that of facilitating group care have complemented each other. I have said that we collected a lot of knowledge from group care. We receive many mothers from various villages, so you take all this knowledge to your own village. With all this knowledge collected from group care, you are able to go and help those mothers from your own village, the ones you are expected to cater for. As for me I saw that they are complementary; they don't interfere each with another. (Respondent 1)*

CHWs were able to use group ANC as a platform to strengthen their knowledge and skills

regarding maternal and infant health. CHWs felt the education they received through group ANC training and facilitation made them better prepared in their roles as ASMs. Furthermore, their roles within group ANC and as ASMs within the community, complemented each other by allowing for better coordination and follow-up with women.

**Nurse-CHW Collaboration**

Successful facilitation and coordination of group ANC/PNC requires effective collaboration between nurses and CHWs. Before the introduction of group ANC/PNC, CHWs recalled being viewed and treated as unskilled volunteers, as opposed to being valued for their knowledge and skills. CHWs recollected instances of occasionally having negative, even competitive interactions with nurses. Training together as well as co-facilitating sessions, gave nurses the opportunity to view and value CHWs' contributions to group ANC/PNC as well as their broader roles within health centers and the community. CHWs also perceived positive reinforcement from mothers observing improved cooperation between nurses and CHWs.

> *Nurses had in their mind the idea that the community health workers have very little knowledge. But the situation as it stands today, we are working together as we were trained together, meaning they are now sure we can do something. We work together and cooperate as we help them carry out their responsibilities. By and large, when mothers see how we are serving them together, they realize that there are strong ties between nurses and the community health workers and that in "Ibaruke neza Mubyeyi" program do some things they didn't use to do in the past. (Respondent 9)*

> *What I can tell you about the cooperation between nurses and community health workers is this, with the former program, we were disregarded, not so? We were like the road signs which direct passengers. I am sorry to say it even some nurses neglected us. But thanks to "Ibaruke neza Mubyeyi" program, we are now recognized by many people. Nurses, even the health center manager knows me due to this program. In our village, when I say that I take a mother to the health center, they say that "Ibaruke neza Mubyeyi" has come, they believe that everything must be ready with her. (Respondent 4)*

Strong collaboration between nurses and CHWs allowed for efficient co-facilitation, while allowing nurses to have flexibility in managing their workload. As CHWs had certain clinical skills, they were able to help nurses conduct physical assessments, such as measuring mid-upper arm circumference, in addition to alleviating their responsibilities by co-facilitating group ANC/PNC. CHWs felt that by creating an effective partnership, nurses were better able to carry out their responsibilities while establishing improved work-life balance, having ample time for rest between shifts.

> *It has helped very much, the community health worker and the nurse worked together. She could find in CPN (consultation prénatale/comprehensive prenatal care) service about twenty mothers maybe at 8:00. She could worry about the time it can take her to finish measuring the blood pressure, measuring their height and the length of uterus, taking the MUAC measures and many other services provided by nurses. Then she could find it impossible to finish all that and facilitate discussions. She might also think how she would take time for lunch break and possibly spending some time at home to rest because she may*

*also work at night that very same day. But through the collaboration between the nurse and the community health worker, the program became very nice. (Respondent 1)*

*Just to illustrate, one nurse has very recently told me that she is wondering whether they will manage in case the program stops. She revealed to me that community health workers play an important role by helping nurses to carry out their responsibilities effectively and in due time. If we were trained in a more advanced way so that we can keep on helping them even in more difficult tasks requiring more skills, but they really sweat while carrying out mothers' health assessment, measuring their weight and then holding related discussion. (Respondent 2)*

CHWs also expressed a desire for learning additional clinical skills and leading (versus co-facilitating) group ANC/PNC. CHWs believed increasing their knowledge and skills could further reduce the burden on nurses, within the context of group ANC/PNC and extending to their other responsibilities.

*To me, there has been a strong relationship and effective collaboration between us and nurses in the sense that we thought we had the same workload. They really appreciated our assistance to the extent that they worry about losing our support. Truly speaking, if means should be devised to train us more and equip us with advanced skills so that we can keep on assisting them, it would be better. (Respondent 5)*

*We wished to take part in discussion facilitation, and maybe have the nurse supplement us, as we would also supplement her. We being the main facilitators and having her supplement us. (Respondent 9)*

The implementation of group ANC/PNC appears to have positively impacted the relationship between nurses and CHWs. Perceptions improved from sometimes negative attitudes and competition, to that of mutual respect and appreciation for each other's contributions. Nurses felt the support of CHWs was crucial for group ANC/PNC to operate efficiently, while also giving them greater flexibility in addressing their other responsibilities. CHWs were enthusiastic about their ability to contribute and were eager to learn additional clinical skills, allowing them to provide greater contributions within the scope of group ANC/PNC and their broader roles within the healthcare system.

**Discussion**

The results of our study are in line with the findings of PTBI's qualitative study of nurses' and midwives' experiences of providing group ANC/PNC in Rwanda.[18] Themes arising in both studies include increased provider/CHW satisfaction based on the opportunity to connect with mothers, pride in newly acquired knowledge and skills and the need for improved scheduling processes. Key challenges specific to this study include the need to expand training content for CHWs and ensure the timely disbursement of travel stipends, while successes include strengthened relationships and collaboration between nurses and CHWs and complementarity of group ANC/PNC with CHWs' work within the community.

CHWs had positive perceptions of the training received prior to commencing their roles as co-facilitators of group ANC/PNC. The holistic format of the training, focusing on topical areas as

well as facilitation skills, significantly impacted CHWs perceptions of self-efficacy in carrying out all components of group ANC/PNC. Facilitation skills proved to be a strong suit, with CHWs reporting high levels of confidence in speaking in front of groups and engaging mothers in discussions. As some mothers presented with instances of abuse, additional content areas were requested, including mental health and gender based violence.

While their responsibilities focused on facilitation, CHWs desired further clinical training, allowing group sessions to be run more efficiently. CHWs observed that group sessions were sometimes disrupted, due to nurses' workloads, making it challenging for nurses to simultaneously address both group ANC/PNC and other urgent tasks. These results are supported by PTBi's study of nurses, which found staffing shortages resulted in nurses being required to attend to other services during group ANC.[18] This theme was reinforced when discussing collaboration between nurses and CHWs. CHWs initially viewed nurses as perceiving them in a negative light, questionable about CHWs' abilities to contribute to group ANC/PNC. Through the duration of the program, nurses' perceptions shifted to a more positive view, as they found CHWs essential in running the program. CHWs provided excerpts of nurses expressing their inability to implement the program without the support of CHWs, given their extensive work responsibilities.

Transportation challenges appear to be common, as results from studies of Peer Health Workers (PHWs) and CHWs in Uganda, Ethiopia and Kenya, are consistent with our findings.[28–31] PHWs and CHWs found it challenging to fulfill their responsibilities, citing the lack of transportation as an obstacle. The studies cited multiple reports of PHWs and CHWs personally covering the cost of transportation and/or fuel and expressing frustration regarding insufficient transport refunds. It is recommended the program offers complete transparency in informing CHWs on what is covered by the transportation stipend and at what intervals it will be disbursed. Relevant program staff must coordinate with all parties involved to ensure CHWs receive stipends in a timely manner.

CHWs shared both the challenges and successes of the scheduling process. CHWs appreciated being provided group ANC/PNC dates in advance. Prior scheduling allowed them to have a general idea of their monthly schedule while also coordinating their work within the community. However, on a day-to-day basis, scheduling was unpredictable. Throughout the duration of the program, CHWs received notice of which specific session to facilitate on a given day, very close to the time for the specific session. Given a strong culture of collaboration, CHWs were able to find substitute CHWs trained in group ANC, if they were unable to facilitate. Last minute changes in scheduling in this manner, however, were not preferred, negatively affecting continuity of care within Group ANC, while adding further challenges for CHWs in coordinating their dual workload within the community.

PTBI's study of nurses and midwives implementing group ANC/PNC, discovered similar scheduling challenges.[18] The study found one of the most common implementation problems to be that of scheduling several group visits over just one to two days a week. Nurses provided suggestions, including presenting their scheduled activities to the manager at the beginning of each month, allowing the manager to prepare a timetable based on each nurse's availability. Our findings support the idea that a monthly timetable could be extremely beneficial for CHWs, providing the opportunity to coordinate their group care and community responsibilities in advance.

Though group care facilitation added to their workload, CHWs viewed group ANC/PNC as complementary to their existing work within the community. CHWs felt group sessions served as an added opportunity to engage with mothers, while allowing for more in-depth follow up during

community visits. CHWs valued their new knowledge and skills, feeling empowered to educate and provide services to mothers within health centers and in community settings.

**Limitations**

Given logistical constraints, only a single focus group of nine CHWs was conducted. As 217 CHWs were trained to provide group ANC/PNC services at 18 health centers, various viewpoints may not be represented. This study is qualitative in nature and provides rich insights into the experiences of CHWs, however, we do not have quantitative measures to support our findings. Though we were unable to verify focus group content directly with participants, our results have been shared with relevant program staff, ensuring reliability of the data presented.

**Conclusion**

Our study aims to contribute to the limited body of research on group ANC/PNC in LMICs, by providing an in-depth look at the experiences of CHWs. As an evolving model of ANC, with the potential for scale-up at the national level, it is critical to gain further insight into the implementation process. Our results seek to inform strategies with the potential to contribute to more effective implementation of group ANC/PNC.

Rwandan CHWs who acted as co-facilitators of group ANC/PNC report that the experience increased their knowledge base, provided important insights into the needs of women they serve and improved their collaborative relationships with facility-based providers. Results suggest that in order for this promising intervention to proceed, CHWs must be provided a timely allowance for transportation and a pre-planned group care visit schedule. In addition, further training on topics including mental health and pregnancy assessment skills is necessary, in the face of provider shortages. Taking into account the unique role of CHWs serving as a link between communities and health centers, we offer recommendations that may be considered in Rwanda and similar country contexts.

# PAPER 2

## Does Introduction of Antenatal Ultrasound by Providers, Impact Provision of Antenatal Care Screening Services?


### Abstract

#### Background

The use of ultrasound during antenatal care can contribute to the detection and management of pregnancy complications.[32,33] However, there is limited research on how the delivery of ultrasound in low resource settings can affect the delivery of other critical services. This study analyzes data from 18 health centers included in the UCSF Preterm Birth Initiative (PTBi)-Rwanda trial, which compared preterm birth outcomes between health centers offering group antenatal care (group ANC) and individual antenatal care (individual ANC). We examine how the provision of ultrasound in health centers offering individual ANC, affects the assessment of ANC risk factors.

#### Methods

The PTBi-Rwanda trial is a pair-matched cluster randomized controlled trial of 36 health centers. Within each pair, one health center was randomized to receive group ANC while the control health center continued to provide individual ANC. We focused on the 18 control facilities providing individual care of which, half were randomly selected to provide early US at first ANC visit. Data from 8,910 women clustered within the 18 health centers offering individual ANC were included in this analysis. Mixed-effects linear regression was used to measure the association between the provision of US and the number of ANC risk factors assessed.

#### Results

No significant association was found between the provision of ultrasound and number of ANC services provided in the per protocol analysis. A significant negative association between the assignment of ultrasound at health centers and number of ANC services provided was found in the intention-to-treat (ITT) analysis. Both models found a significant negative association between the amount of time required to conduct ultrasound and number of ANC risk factors assessed. The interaction of time required to conduct ultrasound with the clinic's average monthly deliveries was significantly negatively associated with the number of ANC services provided in the per-protocol analysis and significantly positively associated with the number of ANC services provided in the ITT analysis.

#### Conclusions

Given the increasing use of ultrasound in low and middle income countries (LMICs), we recommend additional studies be conducted to assess the impact of ultrasound on other critical health services, such as antenatal care, particularly in terms of time and human resource allocation.

## Introduction

Every day, approximately 7,000 newborns and 810 women die as a result of pregnancy and childbirth related complications, with Sub-Saharan Africa accounting for the highest mortality rates.[34,35] Within the region, Rwanda has a maternal mortality ratio of 210 maternal deaths per 100,000 live births and a neonatal mortality rate of 14 neonatal deaths per 1000 live births.[6,8] The majority of these deaths are preventable or treatable through access to quality healthcare throughout pregnancy and during and after childbirth.[34,36] Antenatal care serves as one such opportunity to identify risk factors, such as malnutrition, anemia and hypertension, which may contribute to maternal and neonatal mortality.[37–39]

Antenatal care often serves as an entry point into the health system for a pregnant woman and her family, allowing for early identification and management of risk factors. The World Health Organization (WHO) 2016 ANC model recommends a minimum of eight ANC contacts, one contact in the first trimester (up to 12 weeks of gestation), two contacts in the second trimester (at 20 and 26 weeks of gestation) and five contacts in the third trimester (at 30, 34, 36, 38 and 40 weeks).[40] Critical elements of ANC include risk factor identification, provision of vaccines and supplements, screening and treatment for infections, education related to pregnancy, childbirth and the postpartum period, and counseling and assistance with family planning decision making.[41]

The WHO 2016 ANC model includes the new recommendation of one ultrasound scan before 24 weeks gestation. Provision of ultrasound at this stage can be used to estimate gestational age, increase detection of fetal anomalies and multiple pregnancies, reduce induction of labor for post-term pregnancy and potentially improve a woman's pregnancy experience.[42–44] In LMICs, ultrasound throughout pregnancy can assist in managing and identifying risks related to some of the top causes of maternal and neonatal mortality, including unsafe abortion, multiple birth, prematurity, low birth weight and birth asphyxia.[45] It is important to note, however, there is no conclusive evidence on the impact of routine ultrasound during ANC in reducing maternal and neonatal mortality.[42,46]

This paper explores the hypothesis that the introduction of obstetric ultrasound during ANC affects the provision of ANC screening factor assessments, in the context where they are offered together by the same service provider without additional human resources. There is currently limited research measuring the opportunity cost of incorporating technology into low resource settings. In the Rwandan health system, which faces workforce shortages and limited training opportunities, implementation of such technologies can potentially compromise the provision of other clinical services. This is particularly significant, as conducting ANC assessments serves as an indication of provider behavior as it pertains to the prioritization of clinical tasks. Specifically, this study addresses three key questions:

1) Does providing an ultrasound to a patient affect the number of ANC screening factors assessed for her during her initial ANC visit?
2) Does the amount of time required to conduct ultrasound affect the number of ANC screening factors assessed? This hypothesis investigates why there might be a crowding-out effect of ultrasound on providing the full set of standard ANC assessments.
3) When the clinic workload is heavier (for example, there are many deliveries), does the time needed for an ultrasound have a larger crowd-out impact on the number of ANC factors assessed?

## Background

### *Human Resource Capacity to Implement Ultrasound in Rwanda*

Currently, the use of ultrasound in sub-Saharan Africa is largely limited to urban settings, with a lack of trained personnel and adequately resourced health facilities serving as key barriers to healthcare delivery.[47] While statistics regarding trends in the utilization of obstetric ultrasound are limited, according to a report published by the WHO Study Group, in 1998, 60% of the world did not have access to any diagnostic radiological services.[48] A 2013 systematic review of the use of ultrasound in low resource settings found throughout sub-Saharan Africa, on average, 30% of pregnant women in urban areas and only 6% of women in rural areas, received an obstetric ultrasound.[33]

Rwanda has a population of over 12.7 million people, with a health care system whose infrastructure, capacity and human resources were drastically depleted by the 1994 genocide.[49,50] In 2018, there were approximately 394,620 births in Rwanda.[51] Rwanda has made significant progress in improving maternal health outcomes, through a multi-pronged approach including a community-based health insurance program, nationwide community health worker program and strategies to improve medical education and bolster the health work force.[50,52,53] However, the country continues to have insufficient capacity in providing diagnostic imaging.[50,54,55]

As of 2015, there were 118 radiographers and 11 radiologists providing US services in Rwanda.[56] To address workforce shortages, in 2011, Rwanda's technical working group on Human Resources for Health created a long-term strategy to increase the number of health professionals in the country, while also improving the quality of their training.[54,55] The strategy included training over 500 physicians in specialty areas, including radiology.

### *Health Care Workers' Perceptions and Experiences in Implementing Ultrasound*

While the Human Resources for Health program has had success in addressing Rwanda's health workforce shortage, gaps in capacity building remain.[54] A study exploring Rwandan midwives' perceptions of the role of obstetric ultrasound in relation to clinical management found that most midwives expressed a need for more formal ultrasound training for physicians. Given the shortage of physicians in maternity care, midwives also requested ultrasound training for themselves, allowing them to share the burden of responsibility and better meet patient needs.[41]

A study of physicians' views on ultrasound found similar results. Several physicians had limited or no formal training in providing ultrasound, learning informally from more experienced colleagues.[32] The prospect of training midwives in ultrasound was presented in several interviews. Physicians believed training midwives could be a key strategy in improving care for pregnant women, reducing the burden on physicians as well as reducing delays in decision-making.

The results presented in these studies exhibit, that while appropriate use of obstetric ultrasound may provide health benefits, there may be opportunity costs in how other services are affected. A study in Malawi examined how CHWs prioritized tasks after being delegated additional responsibilities due to task-shifting.[57] The study found that many CHWs prioritized their newly assigned responsibilities over their usual tasks. Other CHWs felt overloaded, noting reduced quality of work in their normal duties. The Malawi study provides an example of how

the introduction of addition responsibilities can affect provider behavior, subsequently impacting the delivery of other health services. Considering physical and human resource constrains, it is critical to assess the impact of introducing technology based interventions in health centers with limited capacity.

## Methods

### *Parent Study*

The PTBi-Rwanda study was designed chiefly to compare group ANC to individual ANC. It pair-matched 36 facilities on factors including location (urban vs rural), quality of ANC, ANC patient to staff ratio, potential lost-to-follow-up (LTFU) rate and other factors. Within each pair, one health center was randomly selected to implement group ANC and the other to provide individual ANC. Each pair was then matched with another pair, within which one pair was assigned to implement ultrasound at the health center (as well as in-community early pregnancy testing by CHWs). The data for the present study come only from the individual-ANC centers only, half of which implemented ultrasound while the other half continued to implement individual ANC, with no additional interventions.

As Figure 2 shows, this sub-analysis includes 8,910 women from 18 health centers. 6,764 women are included from the control group. 2,146 women who received ultrasound early in their ANC care, are included from the intervention group.

### *Participant Recruitment and Data Collection Process*

A detailed description of the participant recruitment process has been described elsewhere.[58] Women attending the 18 individual care facilities meeting the following criteria were invited to participate in the study:

- Minimum age of 15 years at the time of enrollment
- Attend ANC1 before 24 completed weeks of pregnancy at one of the 36 study facilities
- Consent to participate in the study and follow up

Data were collected by ANC providers. Information from every ANC visit through the course of a woman's pregnancy was entered into the ANC register. Providers documented ultrasound results on a paper report form which was attached to either the woman's ANC file or medical record. The field coordinator for each health center extracted data from the ANC register and medical records and uploaded it to the Redcap server.

As per WHO recommendations, ultrasound screening took place at the first ANC visit usually during the late first or early second trimester of a woman's pregnancy. Members from the Rwanda Society of Radiologists created training materials, implemented a 10 day training on how to conduct basic obstetric ultrasound and developed a quality assurance plan.[58] Two to three ANC providers (nurses and midwives) from health centers implementing individual ANC and a radiography technician from each of six district hospitals participated in the ultrasound training course. Post-training, the technicians served as hands on mentors visiting providers on a monthly basis

Women receiving ANC at health centers randomized to provide ultrasound were offered a basic screening obstetric ultrasound at the same time or on the same day as their first ANC

visit. Specific components of ANC care included measuring blood pressure, proteinuria and weight, testing for anemia, HIV and syphilis and providing iron and folic acid supplementation.[7] The ultrasound assessed gestational age (important in correctly tracking pregnancy milestones and preterm birth), and was used to identify any fetal abnormalities, multiple pregnancy, or abnormal placentation The ultrasound and ANC assessment were conducted by either a nurse or midwife, with either the same or different individuals providing both services.

***Variables***

**Dependent Variable**

**Antenatal care services provided** is a count variable comprised of eight critical actions to assess ANC risk factors during the first ANC visit: mid-upper arm circumference, hemoglobin, weight, blood pressure, albumin, HIV, syphilis and ferrous plus folic acid supplementation.

**Main Independent Variable**

**Study Arm** is a dichotomous variable indicating whether a health center was randomized to the control group (arm 1) or the intervention group receiving ultrasound (arm 2).

**Covariates**

**Location Urban** is a dichotomous variable indicating whether a health center is based in an urban (as opposed to rural) district.

**Patient to Staff Ratio** is a continuous variable calculated using District Health Information Software 2 (DHIS 2) data as well as health center data. The following calculation was used: (Average monthly ANC new registrations + Average monthly deliveries) /Number of days per week ANC is offered/ Number of ANC providers per ANC day.

**Average Monthly Deliveries** is a continuous variable indicating the average number of deliveries per month at each health center, based on DHIS 2 data.

**Time** is a continuous variable, per health center, recording the average number of minutes spent per ultrasound in that health center, in these data.

**Age** is a continuous variable measuring the age of women in years.

**Parity** is a continuous variable measuring the number of times a woman has given birth to a fetus with a gestational age of 24 weeks or more

***Statistical Analysis***

We analyze the ANC services provided to women in individual ANC care at facilities randomized to provision of US or not during their first ANC visit. Our outcome measure is the number of ANC screening services provided; we assess whether there was an association

between the outcome and receiving an ultrasound on the same day and/or time as ANC, the amount of time required to conduct ultrasound and the potential interaction between time required to conduct ultrasound and average number of monthly deliveries.

Descriptive statistics were used to describe the characteristics of women in the sample. P values from Pearson's $\chi^2$ test and Welch's Two Sample t-test are presented to show group differences. Descriptive analysis of health center characteristics was performed to assess variation between individual health centers and specifically, between pairs of health centers. The primary outcome for this analysis of provision of ultrasound and number of ANC screening factors assessed was analyzed using per protocol analysis.

The primary outcome was analyzed as a count variable, measuring how many of these factors were assessed, with a maximum possible score of eight. The intra-cluster correlation coefficient (ICC) was calculated for the ANC outcome variable (as defined by the count of measurements taken) to assess variance within and between health centers. Based on the normal distribution of the ANC count variable and an ICC of .18, the study used a mixed-effects linear regression model. As 12,506 women were clustered within 18 health centers, prior to exclusions, the analysis accounted for the potential non-independence of outcomes by including a random intercept for health center, taking into account variability between health centers.

A block modeling approach was used to observe the effects of adding individual variables or groups of variables in the model. Among individual level predictors, age and parity were included based on their association with risks including maternal and infant mortality, pregnancy-related hypertensive disorders and small-for-gestational age infants.[59–61] Health center level predictors included location (rural versus urban) and patient to staff ratio. In addition, a provider level variable of time required to conduct ultrasound was included. These predictors were hypothesized to be associated with ANC risk factor assessments based on a previous study in both urban and rural areas of Rwanda, which found that the failure to provide some elements of ANC could be related to staff shortages.[31] This same study found that ANC providers often failed to spend adequate time with pregnant women due to understaffing.

The trial design for the primary study included matching health centers into pairs based on the key characteristics highlighted in the methods section. Despite pair matching, there was high variance in certain characteristics, such as patient to staff ratio, as a result it was not adjusted for in the final model. In addition, conducting per protocol analysis resulted in high variance in the number of women included per health center, creating greater variance within pairs.

Model 1 analyzes the unadjusted association between provision of ultrasound and number of ANC risk factors assessed. In model 2, individual level variables of age and parity were added, while model 3 adds health center level variables of location and patient to staff ratio. Additional models were used to analyze variables specific to women in the intervention group. Model 1 analyzes the association between minutes required to conduct US and number of ANC risk factors assessed. Model 2 analyzes a potential interaction between minutes required to conduct ultrasound and the number of average monthly deliveries. In model 3, the model 2 interaction is adjusted for by patient to staff ratio. These same models were run using ITT analysis. Statistical significance was set at $P < .05$ for all analyses.

**Results**

We reviewed 12,506 medical records, including 6,968 women in control group 5,538 women

who received ultrasound. The analysis excluded 204 women from the control group and 556 women from the intervention group who did not have a documented date for their first ANC visit as well as corresponding ANC assessment data. These data were required to verify if and when women attended their first ANC visit. An additional 2,836 women who did not receive a routine first or second trimester ultrasound on the same time and/or day as ANC were excluded from the intervention group (Figure 2). These were included in the intention to treat analysis. The final sample included 8,910 women, with 6,764 women from the control group and 2,146 women from the intervention group.

Table 1 provides characteristics of women found to be associated with antenatal care utilization. Women ranged from 13 to 53 years old with the greatest number of women in the 25 to 29 age group. The majority of women (67.4%) had health insurance, 84.8% resided within the health center catchment area and 66% either had some form of primary education or had completed their primary education.

Among women's socioeconomic status, measured by ubudehe category, 40.7% fell into categories 1 and 2 (defined as (1) homeless citizens unable to feed themselves without assistance or (2) those who can afford only the most basic type of accommodation) while 26.6% fell into categories 3 and 4 (defined as employed citizens, ranging from owners of small enterprises to large businesses).[62] Over half of the women (51.5%) had previously given birth to one to three children with a gestational age of 24 weeks or more. Average gestational age at first ANC visit was 18.8 weeks, with no significant difference between intervention and control groups. In the intervention group, women were more likely to have lower socioeconomic status (ubudehe categories 1 and 2) and lower levels of education ($p<.05$). In addition, these women had higher parity, a higher proportion with health insurance and a lower proportion residing outside of the district where the health center was located.($p<.05$).

Table 2 displays data from pair-matched health centers from the control and intervention groups. Eight out of nine pairs matched on location (rural or urban). The mean patient to staff ratios for health centers in the control and intervention groups were 9.96 (±3.78) and 12.86 (± 5.96) respectively. The range of women enrolled per health centers at baseline was 482 to 1076 in the control group and 369 to 849 in the intervention group. The percentage of women who received ultrasound in health centers in the intervention group ranged from 1.9% to 74.3%, with an average of 36%. On average, ultrasound took 13.44 minutes to complete, with a range of 1 minute to 32 minutes. The mean number of ANC services provided in health centers in the control and intervention groups was 6.73 (± .95) and 6.52 (± .84) respectively.

As displayed in Table 3, there was no significant association between the provision of ultrasound and the number of ANC services provided. The effect remained insignificant when controlling for the individual and health center level variables of age, parity, location and patient to staff ratio. Table 4 presents results for the analysis looking solely at the intervention group. Women who were excluded from the intervention group were comparable with those who were included on key characteristics including age, parity and health insurance status. Women from the intervention group who received ultrasound compared to women who did not receive ultrasound, came from health centers which had, on average, a patient to staff ratio of 14.55 versus 9.11 respectively ($p < .001$). There was a significant effect of time required to conduct ultrasound, with approximately .02 less ANC services provided for each additional minute required to conduct ultrasound (or one less ANC services provided for each additional hour required to conduct ultrasound). There was a significant interaction, with the time required to

conduct ultrasound and number of average monthly deliveries associated with a decrease of .0006 ANC services provided. The interaction remained significant when controlling for patient to staff ratio.

Given the large number of women excluded in the per protocol analysis, intention-to-treat analysis was conducted to compare results. A significant association was found between the assignment of ultrasound at health centers and the number of ANC services provided (Table 5). At health centers assigned to ultrasound, women were provided, on average, .57 less ANC services than women from health centers assigned to the control group. The effect remained significant when controlling for the individual and health center level variables of age, parity, location and patient to staff ratio. Table 6 presents results for the analysis looking solely at the intervention group. There was a significant effect of time required to conduct ultrasound, with approximately .04 less ANC services provided for each additional minute required to conduct ultrasound (or 2.35 less ANC services provided for each additional hour required to conduct ultrasound). There was a significant interaction, with the time required to conduct ultrasound and number of average monthly deliveries associated with an increase of .0005 ANC services provided. There was a significant interaction, with the time required to conduct ultrasound and patient to staff ratio associated with a decrease of .01 ANC services provided.

**Discussion**

The results of our analysis reveal that there is no association between the provision of ultrasound and number of ANC risk factors assessed. There was a small negative, significant effect when analyzing the relationship between time required to conduct ultrasound and number of ANC risk factors assessed. The effect was small, with each additional minute required to conduct ultrasound associated with .02 less ANC risk factors assessed ($p < .001$). While the effect may appear negligible, this negative association may lend itself to further consideration. In cases where several consecutive ultrasound examinations are conducted before providing other services, each hour dedicated to ultrasound would result in one less ANC risk factor assessment.

There was a small negative, significant effect of the interaction of time required to conduct ultrasound and number of average monthly deliveries. The negative association between time required to conduct ultrasound and number of ANC services provided became increasingly negative with an increase in the number of average monthly deliveries. It appears that a high workload (as measured by the number of average monthly deliveries) served as a competing priority when conducting ANC risk assessments. When adjusting for patient to staff ratio, this association remained significant, lending additional support to the idea that increased responsibilities place an additional burden on delivering ANC. These results are further supported by preliminary qualitative research from PTBi-Rwanda, which found that nurses were frequently called out of ANC visits to deliver babies. While the effect was very small, it may be beneficial for low resource health centers to consider workload and staff capacity when considering the introduction of new interventions.

Intention-to-treat (ITT) analysis was conducted to assess results when including women from the intervention group who did not receive ultrasound. The analysis found that health centers assigned to provide ultrasound provided an average of .57 less ANC services than the control group. Given these findings, it is important to further explore the implications of introducing ultrasound to understand how women who do not actually receive an ultrasound may be impacted by disruptions or alterations in workflow. As ITT analysis measures assignment of

ultrasound at the health center level, however, it is limited in its ability to measure the impact of providing ultrasound at the individual level.

The significant positive association between the number of ANC services provided and the interaction of time required to conduct ultrasound with the clinic's average monthly deliveries, was unexpected. These findings suggest when a woman attended a health center providing ultrasound, if there was a high number of deliveries, there was a very small likelihood she would be provided additional ANC services. This positive effect intensified with an increasing number of deliveries. A possible explanation may be that certain health centers had highly trained staff capable of attending to several services, however, additional exploration is required.

Due to the clustered structure of the data, limited number of health centers, unequal sample sizes and loss of randomization due to utilizing per protocol analysis, this study was limited in its ability to detect a true effect. The past decade has seen an increase in the number of studies of ultrasound application in LMICs, with a focus on rural health centers.[63] However, the relationship between the provision of ultrasound and its effect on ANC services in low resource settings has not been studied before. While there has been an effort to increase capacity through ultrasound training programs and task sharing, it is important to assess barriers to use, including provider skill level, workload and the availability of facility level resources. It is critical to assess how these barriers may result in potential opportunity costs affecting other key health care services.

**Limitations**

There were several limitations in conducting this study. In utilizing per protocol analysis, data from the intervention group was restricted to 38.8% of women who received ultrasound. This resulted in highly unequal sample sizes when comparing study arms, decreased statistical power and a limited ability to detect the true effect of provision of ultrasound on the number of ANC services provided. When comparing women within the intervention group who were included versus those who were excluded, it was found that women were selected into receiving an ultrasound if their health center had a higher patient-to-staff ratio. Including women primarily from health centers with a higher patient-to-staff ratio, which are presumably less equipped to implement additional services, may overestimate the impact of providing ultrasound on the provision of ANC services.

In addition, due to the manner in which data was collected, it was not possible to include provider level data. As such, it was not feasible to adjust for potentially significant variables such provider education level and experience. The availability of supplies, such as blood pressure monitors and HIV tests, may also have affected the number of ANC screening factors assessed, subsequently impacting the associations found in this study.

**Conclusion**

Our study did not find a significant association between the provision of ultrasound and number of ANC services provided. Among women who received ultrasound, significant associations were found between time required to conduct ultrasound and the interaction of time and number of average monthly delivers, with number of ANC risk factors assessed. However, these effects were small and should be interpreted with caution. ITT analysis found that the assignment of ultrasound at health centers was associated with a decrease in the number of ANC services provided. These results suggest the introduction of ultrasound may impact all women receiving

care at a health center, regardless of whether they were provided an ultrasound. Given the limitations present in this study as well as the increasing use of ultrasound in LMICs, we suggest further studies on the potential opportunity cost of implementing ultrasound in low resource settings.

**Figure 1.1 Flow Diagram of the Sample of Women Included in the Analysis**

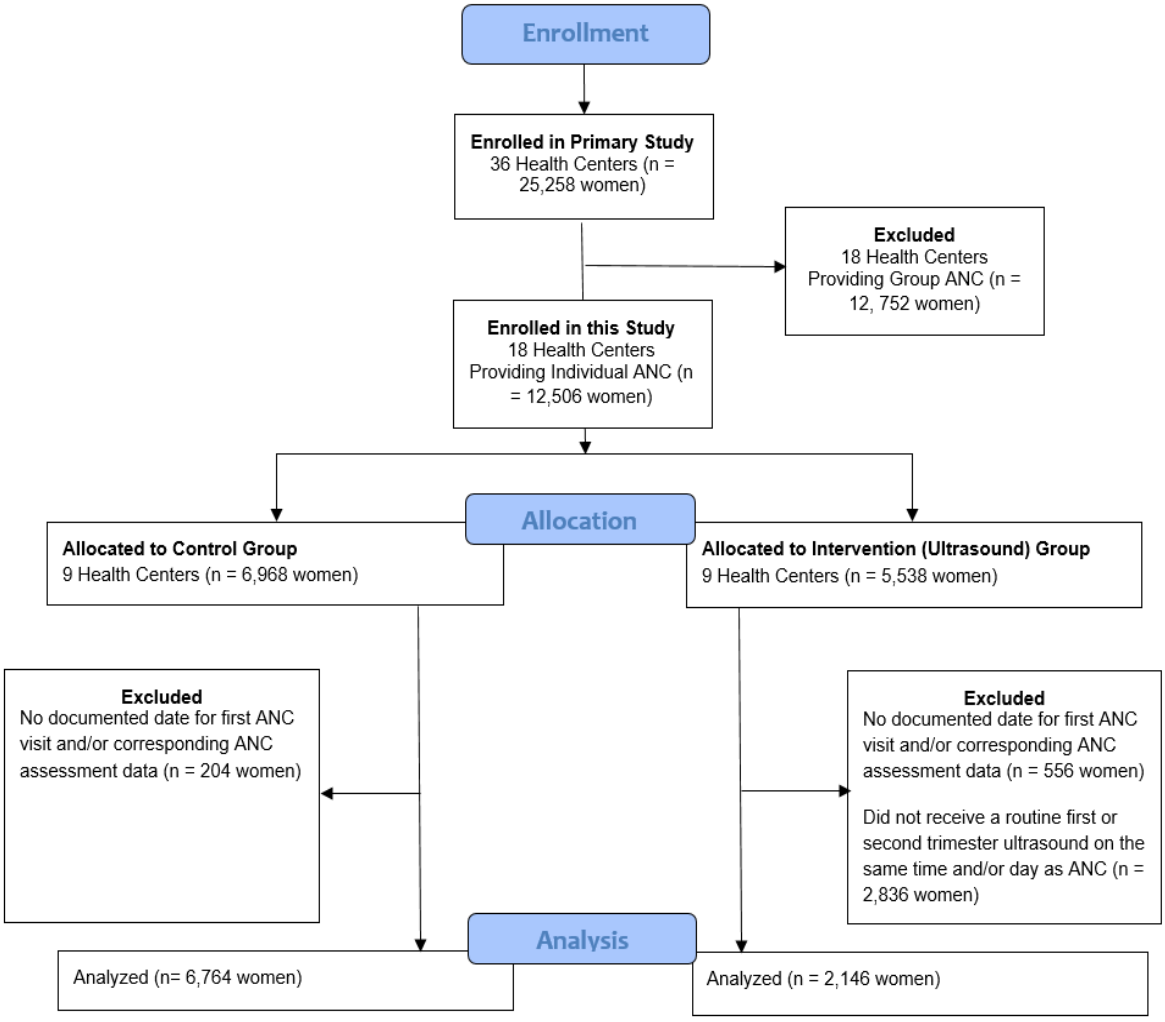



**Table 1.1 Baseline Characteristics of Women**

| | Overall | Control | Intervention | p-value |
|---|---|---|---|---|
| N | 8910 | 6764 | 2146 | |
| Characteristic (% in category) | | | | |
| Age | -- | -- | -- | 0.210 |
| Younger than 20 | 5.9 | 6.1 | 5.2 | |
| 20-34 | 72.2 | 72.2 | 72.0 | |
| 35 or older | 21.5 | 21.3 | 22.4 | |
| Missing | .4 | .4 | .4 | |
| | | | | |
| Education | -- | -- | -- | <0.001 |
| None | 11.4 | 10.6 | 14.0 | |
| Some Primary/Completed Primary | 66.0 | 66.0 | 66.3 | |
| Some Secondary/Completed Secondary | 20.4 | 21.4 | 17.4 | |
| Some University/Completed | 1.8 | 1.9 | 1.6 | |

| | | | | |
|---|---|---|---|---|
| University | | | | |
| Missing | .4 | .1 | .7 | |
| | | | | |
| SES/Ubudehe | | | | <0.001 |
| Don't Know | 3.7 | 3.6 | 4.1 | |
| Category 1-2 | 40.7 | 38.4 | 47.9 | |
| Category 3-4 | 26.6 | 27.1 | 25.1 | |
| Missing | 29.1 | 31.1 | 22.8 | |
| | | | | |
| Health Insurance Status | | | | .014 |
| Yes | 67.4 | 64.0 | 78.0 | |
| No | 7.4 | 6.5 | 9.9 | |
| Missing | 25.2 | 29.4 | 12.1 | |
| | | | | |
| Parity - Mean, (SD) | 2(1.94) | 1.96(1.92) | 2.13(2.02) | <0.001 |
| Missing | .19 | .12 | .42 | |
| | | | | |
| Catchment Area | | | | .029 |
| Within Health Center Catchment Area | 84.8 | 84.8 | 84.8 | |
| Outside Health Center Catchment area but within district | 13.8 | 13.8 | 13.7 | |
| Outside of District | 1.0 | 1.2 | .5 | |
| Missing | .4 | .2 | 1.1 | |
| | | | | |
| Time in minutes required to complete Ultrasound – Mean, (SD) | 13.4(5.24) | NA | 13.4(5.24) | -- |
| Gestational age in weeks at time of first ANC visit – Mean, (SD) | 18.8(6.84) | 18.7(6.6) | 19.1(6.6) | .091 |

**Table 1.2 Baseline Characteristics of Pair Matched Health Centers from Control/Arm 1 (N = 9) and Intervention/Arm 2 (N=9)**

| Health Center | Arm | Loc. | Patient to Staff Ratio | Percent Getting Ultra-sound | Number Enrolled in Health Center at Baseline | Number Included In this Study | ANC Services Provided per Woman – Mean, (SD) | Deliveries Per Month – Mean | Time in Minutes Required to Complete Ultrasound – Mean, (SD) |
|---|---|---|---|---|---|---|---|---|---|
| Cyanika | 1 | Rural | 8.08 | N/A | 719 | 719 | 6.80 (.62) | 47 | |
| Mwezi | 2 | Rural | 5.87 | 24.5 | 686 | 168 | 6.88 (.35) | 46.92 | 15.9 (4.40) |
| Kirambo | 1 | Rural | 8.53 | N/A | 992 | 992 | 7.04 (1.43) | 59.42 | |
| Kibingo | 2 | Rural | 9.97 | 64.3 | 614 | 395 | 6.74 (.54) | 40.67 | 16.2 (3.23) |
| Nyamasheke | 1 | Urban | 9.12 | N/A | 507 | 507 | 6.45 (.98) | 54.67 | |
| Mugera | 2 | Rural | 7.23 | 8.5 | 375 | 32 | 6.06 (.56) | 42.17 | 17.7 (6.66) |
| Murara | 1 | Rural | 12.81 | N/A | 749 | 749 | 6.88 (.90) | 72 | |
| Karambo | 2 | Rural | 14.19 | 1.9 | 369 | 7 | 6.00 (1.00) | 100.17 | 16.8 (6.50) |
| Nyakiriba | 1 | Rural | 6.35 | N/A | 698 | 698 | 6.45 (.87) | 32.50 | |
| Busasamana | 2 | Rural | 22.81 | 74.3 | 830 | 617 | 6.25 (.81) | 123.67 | 14.6 (5.85) |
| Ruhuha | 1 | Rural | 8.38 | N/A | 781 | 781 | 7.38 (.57) | 70 | |
| Ngeruka | 2 | Rural | 18.49 | 35.18 | 614 | 216 | 6.58 (.63) | 68.33 | 13.9 (2.72) |
| Cor-unum | 1 | Urban | 17.67 | N/A | 1076 | 1076 | 6.68 (.80) | 91.92 | |
| Biryogo | 2 | Urban | 13.13 | 18.8 | 849 | 160 | 6.19 (1.00) | .25 | 6.55 (2.53) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Gakurazo | 1 | Rural | 6.71 | N/A | 760 | 760 | 6.28 (1.05) | 46.67 | |
| Kamabuye | 2 | Rural | 6.64 | 36.6 | 678 | 248 | 6.29 (.69) | 44.25 | 12.2 (4.72) |
| Gashora | 1 | Rural | 7.82 | N/A | 482 | 482 | 6.65 (.67) | 53.25 | |
| Ndongozi | 2 | Rural | 13.67 | 60.2 | 503 | 303 | 7.68 (.51) | 32.42 | 11.0 (4.39) |

**Table 1.3 Linear Mixed Effects Model of Number of ANC Services Provided, Regressed on Whether the Woman Received an Ultrasound, and other Health Center-Level and Individual Characteristics (N = 8,910 women)**

| Variable | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| **Intercept** | 6.92 (.31)*** | 6.95 (.31)*** | 6.68 (.39)*** |
| **US Received** | -.19 (.20) | -.19(.20) | -.24 (.20) |
| **Age** | | -.0008 (.01) | -.0006 (.01) |
| **Parity** | | -.01 (.007) | -.01 (.007) |
| **Location Urban** | | | .32 (.26) |
| **Patient to staff Ratio** | | | .008 (.02) |

Standard Errors in parentheses. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

**Table 1.4 Linear Mixed Effects Model of Number of ANC Services Provided, Regressed on Health Center's Average Time Spent to Provide an Ultrasound, and other Health Center-Level and Individual Characteristics, among Women who Received Ultrasound (Per Protocol Analysis) (N = 2,146 women)**

| Variable | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| **Intercept** | 6.80 (.17)*** | 6.60 (.16)*** | 6.63 (.16)*** |
| **Average Minutes per Ultrasound in Clinic** | -.02 (.003)*** | -.007 (.003)* | -.006 (.003) |
| **Average Monthly Deliveries** | | -.002 (.004) | -.005 (.006) |
| **Patient to Staff Ratio** | | | .02 (.34) |
| **Time*Average Monthly Deliveries** | | -.0006 (.00008)*** | -.0007(.0001)*** |
| **Time*Patient to Staff Ratio** | | | .02 (.34) |

Standard Errors in parentheses. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

**Table 1.5 Linear Mixed Effects Model of Number of ANC Services Provided, Regressed on Attending a Health Center Assigned to Provide Ultrasound, and other Health Center-Level and Individual Characteristics (Intention-to-Treat Analysis) (N = 11,746 women)**

| Variable | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| **Intercept** | 7.30 (.37)*** | 7.26 (.35)*** | 6.80 (.42)*** |
| **Clinic Assigned to Ultrasound** | -.57(.23)* | -.52 (.22)* | .63 (.21)** |
| **Age** | | .001 (.002) | .001 (.002) |
| **Parity** | | -.01 (.007) | -.01 (.007) |
| **Location** | | | .54 (.28) |
| **Patient to staff Ratio** | | | .01 (02) |

Standard Errors in parentheses. *** p < 0.001; ** p < 0.01; * p < 0.05

**Table 1.6 Linear Mixed Effects Model of Number of ANC Services Provided, Regressed on Health Center's Average Time Spent to Provide Ultrasound, and other Health Center-Level and Individual Characteristics, among Women Attending a Health Center Assigned to Provide Ultrasound (Intention-to-Treat Analysis) (N = 4,982 women)**

| Variable | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| **Intercept** | 6.17 (.21)*** | 6.16 (.22)*** | 6.13 (.22)*** |
| **Average Minutes per Ultrasound in Clinic** | -.04 (.004)*** | -.04 (.004)*** | -.03 (.004)*** |
| **Average Monthly Deliveries** | | .003 (.006) | .007 (.008) |
| **Patient to Staff Ratio** | | | -.03 (.05) |
| **Time*Average Monthly Deliveries** | | .0005 (.00009)*** | .002 (.0002)*** |
| **Time*Patient to Staff Ratio** | | | -.01(.001)*** |

Standard Errors in parentheses. *** p < 0.001; ** p < 0.01; * p < 0.05

# PAPER 3

## Utilizing a Mixed-Methods Approach to Assess Implementation Fidelity of a Group Antenatal Care Trial in Rwanda


## Abstract

### Background

The Preterm Birth Initiative (PTBi) – Rwanda conducted a cluster randomized controlled trial to assess the impact of group antenatal care (group ANC) on preterm birth, using a group ANC approach adapted for the Rwanda setting, and implemented in 18 health centers. This study utilizes a mixed-methods approach to study the fidelity with which the health centers' implementation followed the model specified for group ANC. We measure whether implementation fidelity improved over time, controlling for provider and health center characteristics.

### Methods

Implementation fidelity was measured using multiple tools, including repeated Model Fidelity Assessments (MFAs) and Activity Reports (ARs) completed by Master Trainers, who visited each health center between 7 and 13 times (9 on average) to provide monitoring and training. The MFA assesses each of 12 items on a 0-4 scale and calculates an overall score (the average of all items). Each center's MFA item and overall scores were regressed (linear regression) on the time elapsed since the center's start of implementation. The Activity Report (AR) is an open-ended template to record comments on implementation. For the qualitative analysis, the ARs from the times of each center's highest and lowest MFA score were analyzed using thematic analysis. Coding was conducted via Dedoose, with two coders independently reviewing and coding transcripts, followed by joint consensus coding.

### Results

A total of 160 MFA reports were included in the analysis. There was a significant positive association between elapsed time since a health center started implementation and greater implementation fidelity (as measured by MFA scores). In the qualitative analysis, Master Trainers identified key areas to improve fidelity of implementation, including: group ANC scheduling, preparing the room for group ANC sessions, provider capacity to co-facilitate group ANC, and facilitator knowledge and skills regarding group ANC content and process. Quantitative MFA results did not always align with themes arising in the qualitative analysis.

### Conclusions

We recommend continuous monitoring and mentoring throughout program implementation for group ANC. We suggest the use of quantitative tools to provide direct measures of implementation fidelity over time and qualitative tools to gain a more complete understanding of what factors influence implementation fidelity. Identifying areas of implementation requiring additional support and mentoring may ensure effective translation of evidence-based interventions into real-world settings.

## Introduction

Successful introduction of any new outpatient care strategy that disrupts the status quo to clinic flow and systems, poses numerous challenges, particularly in low-resource settings. One challenge is to ensure "implementation fidelity," which is defined as the degree to which an intervention is implemented as intended.[64] Implementation fidelity is affected by several factors, including the level of complexity of the intervention. Intervention components impacting complexity include: the number of sessions within an intervention, the number of participants and the incorporation of group level interventions.[65–68] Considering the many components involved in effectively carrying out an intervention, maintaining implementation fidelity is critical to successfully translate evidence-based interventions into practice.[6–8]

Implementation fidelity also serves to improve the internal validity of a study.[65,72–74] Internal validity is defined as the extent to which a study's findings can be attributed to the intervention.[65,73,75] This is particularly crucial in the case of non-significant findings that may not be due to program design but rather, the manner in which the program was implemented.[76] Measuring implementation fidelity has the potential to illuminate what specific factors affected program outcomes and how these factors can be adapted in future programs.[77,78]

The Preterm Birth Initiative (PTBi) – Rwanda conducted a cluster randomized controlled trial assessing the impact of group antenatal care (group ANC) on gestational age at birth, finding no impact (paper currently under review). The program previously conducted a process analysis of implementation fidelity.[79] The study analyzed and compared quantitative data from fidelity monitoring tools. This study analyzes quantitative data and explores additional information and insights from qualitative assessments. The study's aims are two-fold. First, we measure the association between the length of time since the program started and was initially assessed, and implementation fidelity. Second, we aim to identify what factors influenced implementation fidelity. We use our results to inform recommendations for monitoring of group ANC in similar contexts.

## Background

### *Rwanda Group ANC Model*

The Rwanda model for group care was aligned with the WHO four visit focused ANC visit model.[80] The recent updated recommendation to 8 contacts was not taken into account. Visits were spaced eight weeks apart, allowing women to have a predictable group visit schedule. Taking into account health care providers' other responsibilities, group sessions were limited to 60 minutes.[17]

The Rwanda group ANC model was adapted and designed by a Technical Working Group, comprised of ten Rwandan nurses, midwives and physicians.[17] Group care experts with global experience trained a group of ANC Master Trainers to train and support group ANC facilitators. One unique element of the Rwanda model is to have nurses and CHWs serve as co-facilitators. Nurses and CHWs were trained together in order to reinforce the egalitarian nature of the model. As co-facilitators of group ANC, CHWs and nurses were trained in facilitation, with a focus on adult learning. In addition, they reviewed contents of the Rwanda ANC/PNC packages of care, were trained on conducting health assessments and learned how to organize group visits, including preparing the room with assessment equipment, learning materials and drinking water. The Rwandan group ANC model includes several of the key components from

the original CenteringPregnancy model (Figure 1).

## Methods

### *Data Collection Process*

Implementation of the Rwanda group ANC model took place from July of 2017 to May of 2019. A total of 7 Master Trainers, 72 nurses and midwives and 216 CHWs underwent three days of training on group care facilitation.[18] Master Trainers were scheduled to visit each of the 18 health centers 1, 2, 3, 5, 7, 9, 12, 15, and 18 months after group ANC implementation began. At each of these visits, the Master Trainer completed two monitoring tools, the Activity Report and Model Fidelity Assessment. Occasionally separate MFAs were completed on the same day, evaluating different group ANC meetings.

The assessment tool (the MFA) was developed by the Technical Working Group, UCSF's group ANC technical advisor and Rwandan Master Trainers. Items were based on elements from the CenteringPregnancy model that were found to be essential in providing a structure for effective group ANC. The MFA included 15 items: Items one through three recorded the date, observation site and provider code and were not included in the statistical analysis. One item (MFA 9), "Husbands and next-of-kin were engaged and participated in activities (if they were present)", was removed, as it was blank in 93% of MFAs. [79] We analyze below the remaining 11 items measuring model fidelity.

Each item was ranked using a 5-point Likert scale from 0 to 4. An overall score, ranging from 0 to 4, was calculated by averaging the score of all MFA items. Higher scores assumed the group session was implemented with greater fidelity. The breakdown of scores was:

- 0: Were not able to perform this skill even though the opportunity was present
- 1: Made attempts but need significant help and to be retrained
- 2: Have beginning skills but require more modelling, role-playing, and instruction
- 3: Require a few minor suggestions from the Master Trainer
- 4: Were fully competent

Upon the completion of each session, group ANC facilitators were provided with mentoring and support based on monitoring results. The Activity Report included open-ended questions on the group care process, lessons learned, best practices, challenges and recommendations.

### *Statistical Analysis of Model Fidelity Assessments*

Descriptive statistics were used to describe the characteristics of providers of group ANC, health centers, MFAs and MFA items. The intra-cluster correlation coefficient (ICC) was calculated, based on overall MFA score, to assess for clustering at the health center level. Given an ICC of zero, taking into account clustering via a mixed-effects model was not considered necessary for this analysis. Linear and ordinal regression were performed to measure the association between time since implementation and MFA item scores. Time was measured in days since the first monitoring and mentoring visit for each health center. Regression results are presented in years for ease of interpretation. Results were comparable between both models. While the outcome variable of MFA score is ordinal, as assumptions were met for linear regression, we present

those results for ease of interpretability. Individual level predictors included provider age, education level and years of experience working in ANC/PNC. Health center level predictors included location (urban versus rural, with rural as the reference group) and patient to staff ratio. Predictors were included based on their potential association with implementing with fidelity the model of group ANC.

***Qualitative Analysis of Activity Reports***

The objective of the qualitative analysis was to explore what factors influenced implementation fidelity. One Activity Report each was selected from the group sessions with the highest and lowest overall MFA scores, for a total of two Activity Reports per health center. This method of sampling was chosen to compare qualitative findings between each health center's lowest and highest levels of fidelity. In instances where no Activity Report for the highest or lowest MFA score was available, the next lowest or highest scoring Activity Report was used.

All Activity Reports were coded by a UC Berkeley graduate student and the PTBi Data Manager in Rwanda. As part of the data reduction process, only sections pertaining to implementation fidelity were coded.[19,20] The coders discussed and reached consensus on the reduced Activity Reports to be coded. The lead coder created a codebook based on the reduced Activity Reports. The codebook was discussed with the second coder until consensus was reached on codes and definitions.[21] Structural coding was used to map categories to relevant items from the MFA. Magnitude coding was used to note whether Master Trainers made positive or negative comments, allowing for the identification of which categories acted as facilitators (positive comments) or barriers (negative comments).[23] Axial coding was used to draw connections between initial categories and identify themes.[25,26] Both coders compared and discussed codes until reaching consensus.[27] Dedoose software was used to organize and code the data.

**Quantitative Results**

A total of 160 MFAs were completed for 18 health centers over the span of approximately 22 months. The number of MFAs completed per health center ranged from 7 to 13, with an average of approximately 9 ($\pm$1.68).

Between one and three nurses or midwives were involved in facilitating each group ANC session. When more than one provider was involved in a group session, the variables for provider age, education and years of experience were recorded only for the most senior provider. A total of 59 providers were included in this dataset. Providers ranged from 24 to 51 years old. The majority of providers, 77.1%, were nurses. Seventy-five percent of providers attended university. Previous experience working in ANC/PNC ranged from 0 to 29 years, with an average of 5.69 ($\pm$ 4.75) years. There were five urban and 13 rural health centers. Patient to staff ratio, on the days health centers offered ANC, ranged from 4.82 to 31.58, with a mean of 11.75 ($\pm$ 7.18). Table 1 displays the mean and standard deviation for all MFA items.

The averages of all but one of the MFA items were between 3.0 and 4.0 (the maximum possible score). MFA 14 (Kept Time) had the lowest average score of 2.76 and displayed the most variance, with a standard deviation of 1.11. Three health centers in particular appeared to pull down the score for timekeeping, with average MFA 14 scores of 1.9, 2.14 and 2.17. Other relatively low-scoring items were MFA 10 (Praised Group), at 3.06, while high-scoring items were MFA 5 (Facilitator Communication), 6 (Correct Assessments), 13 (Responsive), and 15 (Proper Screening).

Indeed, MFA 15 (Proper Screening) had the highest average score of 3.49.

Bivariate regression results displayed an inverse relationship between average MFA score at initial observation and expected improvements in MFA scores. MFAs 4 (Room Setup), 14 (Kept Time), and 12 (Curriculum Knowledge) had some of the lowest average scores at initial observation and highest expected increases in scores. MFAs 6 (Correct Assessments), 7 (Encouraged Participation), and 11 (Group Participation) had some of the highest average scores at initial observation and lowest expected increases in scores (Table 2).

Bivariate regression results showed that a twelve month increase in duration of implementation was associated with an average increase of .37 points in overall MFA score. The highest increases in scores were seen in MFA items 4, 5, 12 and 13 with increases of .49, .47, .55 and .47 respectively. The lowest increases in scores were seen in MFA items 7, 8 and 11, with increases of .23, .21 and .18 respectively (Table 2).

When adding in provider characteristics of age, education level and years of experience working in ANC/PNC, time remained significant for all items. For MFA 7, a one year increase in time was associated with an average increase of .26 points, while a one year increase in provider age was associated with a .04 decrease in points. Provider level predictors were not found to be significant for any of the other MFA items.

When adding in health center level predictors of location (urban versus rural) and patient to staff ratio, time remained significant for all items. For MFA 7, a one year increase in time was associated with an average increase of .28 points, while a one year increase in provider age was associated with a .04 decrease in points. Health center level predictors were only found to be significant for MFA 8. A one year increase in time was associated with an average increase of .28 points while a one year increase in provider age was associated with a .02 decrease in points. Urban health centers were associated with an average increase of .30 points, compared to rural health centers. A one person increase in patient to staff ratio was associated with an average increase of .02 points.

**Qualitative Results**

A total of 160 Activity Reports were expected, however, 134 were completed. On occasion, particularly at the beginning of program implementation, Master Trainers overlooked completing Activity Reports. Two Activity Reports were coded for each of 18 health centers: one for the visit with the highest MFA score (or, if not provided, for the next highest score) and the other for the visit with the lowest MFA score (or if not provided, for the next highest score).

Activity Report findings revealed key factors affecting implementation fidelity. Six themes emerged from the analysis, including group ANC scheduling, logistics of preparing the room for group ANC, provider capacity to co-facilitate group ANC, knowledge regarding specific content areas, facilitation skills and perceptions of women's experiences with the group ANC process.

Eligible health centers were required to have more than one ANC provider available on days when ANC was provided.[58] This requirement aimed to ensure the availability of a designated provider to conduct group ANC. In some facilities, providers had the capacity and were able to work collaboratively with the head of the health center to designate individual nurses for both group and individual ANC. However, in some instances, only a single provider was available to deliver both services. As a result, there were several scheduling challenges, sometimes resulting in the combination of services. On occasion, women visiting the health center for individual ANC (who were not enrolled in the trial), participated in group ANC.

The Technical Working Group recommended group visits be conducted in the interior of the health center, where sessions could be conducted privately. Preparation of the group ANC room included providing weight and blood pressure equipment, learning materials, clean drinking water and indicated medications (such as iron tablets, deworming medication or antimalarial medication). In the absence of functioning equipment, health center staff were successful in adapting to the situation and preparing the room as per the group ANC model, adhering to guidelines for maintaining the group format while respecting women's privacy. In some occasions, high patient volume, in addition to staff unaware that group ANC was being conducted, made it difficult to adequately prepare the room and resulted in individual assessments being conducted in a separate room.

Several challenges were present regarding shortages of trained staff. Nurses responsible for co-facilitating group ANC were also in charge of other services, making it extremely challenging to adequately deliver group care. In some instances, not only were nurses occupied with providing other services, CHWs were also unavailable to co-facilitate. Such staff shortages made it difficult to implement group ANC and also disrupted continuity of care, as the same provider was not always available to co-facilitate at subsequent sessions.

While nurses and CHWs underwent training on clinical skills, certain topics, such as pre-eclampsia, were not well understood and required clarification by the Master Trainer. Measuring fundal height in order to assess gestational age, as well as taking blood pressure, were other skills requiring additional training.

Group care facilitators were also trained on leading women through semi-structured activities, with the purpose of creating cohesiveness and trust while generating productive discussion.[17] Many facilitators exceled in leading all aspects of group care. However, group sessions were difficult to continue when providers were unable to create a safe space for women. Some facilitators spoke more than women and did not allow them time to share their thoughts, approached the group with an attitude of judgement and blame and were disorganized and controlling in discussing content. As a result, Master Trainers perceived that women felt intimidated, refrained from participating in discussion and expressed hesitation to return for subsequent sessions.

**Discussion**

Measuring fidelity throughout program implementation is critical in assessing which components of group care require additional training and support. Utilizing monitoring results to provide focused mentorship can potentially improve fidelity and strengthen the internal validity of the study. Strong implementation fidelity and internal validity are especially useful in cases such as the PTBi-Rwanda parent study, which found no impact of group ANC on gestational age at birth. In ensuring the trial was implemented with fidelity, study results can be attributed to the group ANC intervention, as opposed to extraneous factors or processes.

Group ANC implementation fidelity in low and upper middle income countries has only been measured in four other studies, in Malawi and Tanzania, Rwanda, Nepal, and Mexico.[79,81–83] At the time of this study, there is an active randomized clinical trial in Malawi measuring the degree of implementation success and associated contextual factors.[84] The Nepal trial included a component measuring the effect of time on process fidelity. The study used observations from a pre-study pilot to assess fidelity and re-train facilitators on topics, mainly regarding peer-discussion. During the intervention period, fidelity data was collected after every group visit and

analyzed quarterly. The study found significant improvements over time for women supporting each other and facilitators providing dedicated time to group sessions instead of engaging in other clinic activities. No time effect was found for women sharing and actively engaging in group sessions. Study results are similar to our study, which found only small significant effects for MFAs 7, 8 and 11, pertaining to group participation and discussion.

This study found that group ANC was delivered overall with high fidelity (mean overall MFA score of 3.18 (±.52)). Regression results found a significant positive association between elapsed time since implementation and fidelity for all MFA items. These findings suggest that monitoring and mentoring visits were successful in improving group ANC implementation over time.

The MFA items with the lowest average scores at initial observation (MFAs 4, 12 and 14) showed the highest expected improvements over time in the regression analysis. As this trial was a group ANC pilot, we were not surprised by the initial low scores and subsequent room for improvement, related to room preparation, keeping time and demonstrating mastery of the curriculum. MFA items 6, 8 and 11, measuring clinical assessments, facilitation and participation, had the highest average scores at initial observation and the least expected improvements over time in the regression analysis. High initial scores for clinical assessments were expected, due to providers' prior clinical experience. However, high initial scores for facilitation and participation were unexpected. These findings demonstrate that differences in the rates of improvement over the monitoring period appeared to be related to the amount of improvement possible from initial observation. We suggest initially high-scoring items may require less frequent mentoring while initially low-scoring items may require more frequent monitoring and mentoring.

Certain items displayed variations in trends over time. The trend line for the average score of keeping time of group ANC sessions (MFA 14) showed a steady increase through the first four monitoring and mentoring visits, followed by a steady decrease. These results are in line with PTBi-Rwanda's previous study, which found that at least 25% of group care visits were not implemented with fidelity to the intended one hour session, lasting more than two hours.[79] The tool analyzed in the previous study included two distinct open-ended questions for how much time was spent conducting health assessments and on group discussion. These findings may be more useful than MFA results in informing which component of timekeeping needs to be addressed. Comparing results from both studies displays the potential utility of using monitoring tools with different modes of data collection.

While quantitative results were largely corroborated by qualitative findings, this was not always the case. Regression results for MFAs 5 and 13 showed a significant expected increase in average scores over time. These results appear to suggest that facilitation styles and responsiveness to women's needs were well addressed during group care sessions.

Similar to this study, the group ANC study in Mexico found the lowest levels of fidelity for facilitators introducing her/himself in a friendly non-hierarchical way and guiding but not controlling the conversation.[83] The study noted these challenges allude to the hierarchical medical culture in Mexico and its effects on the provider-patient relationship. In the Nepal study, nurse-midwives often had years of experience providing individual ANC and found it difficult to depart from their traditional style of communicating medical information without considering patients' understanding or beliefs.[82]

A unique component of the Rwanda model of group ANC was co-facilitation by CHWs

and providers. The MFA and fidelity tools analyzed in the previous PTBi – Rwanda study included measures of the facilitation process. However, the tools did not assess the specific role of CHWs, the interaction between CHWs and providers, and subsequent effects on the group process. We recommend further exploration into the CHW-provider interaction as well as other factors potentially impacting facilitation, such as provider age and experience, and potential gender norms and interactions between male facilitators and female participants.

> *After he left women expressed also their worries as they told me that they can't really talk when he is the one around because he is always nervous and shout at them. When asked if they will come back for GPNC [group postnatal care], they were clear and told me if he is the one in there they won't bother coming back.* (Health Center 12)

Based on large expected improvements in scores for MFA items with low scores at initial observation, we recommend future group ANC programs include intensive monitoring and mentoring at program onset, followed by periodic monitoring through the remainder of the program. It is important to note, however, that certain components of the group process may require greater support than others, such as, preparing the room for group ANC, completing the group session within one hour, and strengthening facilitator knowledge of group ANC content. We recommend the use of both quantitative and qualitative monitoring tools to provide a complete assessment of implementation fidelity. While the MFA has several strengths, solely focusing on quantitative results can fail to capture critical elements affecting implementation fidelity.

We also recommend implementation fidelity monitoring take place at every level of the program, in the context of group ANC, this includes the level of the health center, providers and women. This is particularly important in addressing more challenging components of group care, such as the impact of facilitator gender on active participation from women. We suggest program implementers consider contextually appropriate mechanisms for measuring factors influencing fidelity at the participant level, such as an exit interview or complaints and feedback hotline. In ensuring the involvement of women, these mechanisms serve as a participatory approach to monitoring implementation fidelity while informing recommendations for improving fidelity of the group ANC process.

**Limitations**

Seven Master Trainers conducted observations and completed MFAs, however, due to financial and logistical constraints, inter-rater reliability for MFAs was not measured.[79] As a result, the degree of agreement between raters is unknown and it is possible the relationship between time and MFA scores presents a limited view of the results. A single Master Trainer was assigned to complete Activity Reports and MFAs for their designated health centers for the duration of the program. Due to Master Trainers' workloads and scheduling challenges, continuity was not always maintained. Master Trainers occasionally completed Activity Reports and MFAs for health centers other than what they were assigned to, potentially contributing to variance in perceptions of fidelity and MFA scores. In addition, due to a small sample size of 160 MFAs, there is an increased likelihood of Type 2 error.

**Conclusion**

This study aims to contribute to the limited body of research on monitoring group ANC

implementation fidelity, in the context of low and middle income countries. Our study found the impact of monitoring and mentoring on implementation fidelity to be greatest within the first three monitoring visits. We suggest a greater investment in monitoring and mentoring at program onset, with periodic visits thereafter. Our study's findings also display the importance of using both quantitative and qualitative measures to assess implementation fidelity. This is particularly significant in identifying areas of implementation requiring greater support, such as room preparation, keeping time and curriculum knowledge. Future programs must consider contextual factors as well as innovation and flexibility in program monitoring and implementation when designing group ANC programs.

**Figure 2.1 Comparison of Key Components: Ibaruke Neza Mubyeyia and CenteringPregnancy**[17]

| CenteringPregnancy Essential Elements[19] | Does *Ibaruke Neza Mubyeyi* Include This Component? | Notes |
|---|---|---|
| Health assessment occurs within the group space. | Yes | Facilitators teach women in the first group antenatal care visit to assess weight and blood pressure (using an electronic cuff) with one another. |
| Women are involved in self-care activities. | Yes | |
| A facilitative leadership style is used. | Yes | |
| Each session has an overall plan. | Yes | The facilitator's manual contains a plan for each session but encourages discussion of women's special concerns and questions. |
| Attention is given to the core content; emphasis may vary. | Yes | |
| There is stability of group leadership. | Mixed | A single community health worker attends all longitudinal visits and acts as a cofacilitator.<br>The other cofacilitator is the antenatal care provider (nurse or midwife) on duty the day of a scheduled group visit; this person is not consistent across all of a distinct group's visits because of the needs of the health center's rotating staff schedule. |
| Group conduct honors the contribution of each member. | Yes | |
| The group is conducted in a circle. | Yes | |
| Group composition is stable but not rigid. | Yes | Women who miss scheduled group visits are encouraged to drop in and join other groups when they are able. |
| Group size is optimal to promote the process. | Yes | Recommended group size is 8-12; in practice, actual group size ranges from 2-16. |
| Involvement of family support people is optional. | Yes | Each group of women decides for themselves if they will invite husbands and next-of-kin to attend group visits. |
| Opportunity for socialization within the group is provided. | Yes | Some women continue to socialize outside of group antenatal care and have visited each other at home. |
| There is ongoing evaluation of outcomes. | Yes | Cofacilitators debrief after every group visit in a continuous learning and quality improvement process.<br>Master Trainers regularly observe group visits, assess for model fidelity, and mentor cofacilitators.<br>Health care provider and participant experiences will be measured in this study.<br>Outcomes of the trial will be reported in 2019. |

**Table 2.1 Average Scores of Model Fidelity Assessment Items on a scale of 0-4 (N = 160)**

| MFA Item Label | MFA Item Definition | Mean (SD) |
|---|---|---|
| Room Setup | MFA 4: During the group care visit today, the co-facilitators: Prepared the group care room | 3.13 (.85) |

| | | |
|---|---|---|
| | environment, including assessment equipment, learning materials, participant refreshment, and indicated medications | |
| Facilitator Communication | MFA 5: Communicated using language well understood by all participants, and responded appropriately to verbal and non-verbal cues | 3.38 (.74) |
| Correct Assessments | MFA 6: Performed assessments correctly and followed up on abnormal findings | 3.43 (.64) |
| Encouraged Participation | MFA 7: Encouraged active participation in group activities/discussions and payed particular attention to participants who presented as reserved | 3.21 (.69) |
| Promoted Discussion | MFA 8: Asked open-ended questions to promote discussion | 3.24 (.72) |
| Praised Group | MFA 10: Reinforced individual and group accomplishment | 3.06 (.92) |
| Group Participation | MFA 11: Participants spoke more than the co-facilitators spoke | 3.15 (.72) |
| Curriculum Knowledge | MFA 12: The co-facilitators demonstrated mastery (accurate knowledge) of the curriculum, including discussion topics and key message | 3.16 (.82) |
| Responsive | MFA 13: Followed the lead of the women and could flexibly adjust the visit agenda to better meet women's needs and interests | 3.35 (.73) |
| Kept Time | MFA 14: Kept time | 2.76 (1.11) |
| Proper Screening | MFA 15: Provided ANC/PNC screening, medications and referrals as indicated, consistent with the Rwanda FANC and PNC packages | 3.49 (.81) |
| | Overall Score | 3.18 (.52) |

**Table 2.2 Comparison of MFA Scores at Initial Observation with Expected Improvement in Scores (N = 160)**

| MFA Item | Average Score at Initial Observation | Bivariate Coefficient |
|---|---|---|
| MFA 4: During the group care visit today, the co-facilitators: Prepared the group care room environment, including assessment equipment, learning materials, participant refreshment, and indicated medications | 2.28 | .49 |
| MFA 14: Kept time | 2.35 | .47 |
| MFA 12: The co-facilitators demonstrated mastery (accurate knowledge) of the curriculum, including discussion topics and key message | 2.39 | .55 |
| MFA 10: Reinforced individual and group accomplishment | 2.50 | .45 |
| MFA 15: Provided ANC/PNC screening, medications and referrals as indicated, consistent with the Rwanda FANC and PNC packages | 2.71 | .42 |
| MFA 5: Communicated using language well understood by all participants, and responded appropriately to verbal and non-verbal cues | 2.72 | .47 |
| MFA 13: Followed the lead of the women and | 2.72 | .46 |

| | | |
|---|---|---|
| could flexibly adjust the visit agenda to better meet women's needs and interests | | |
| MFA 7: Encouraged active participation in group activities/discussions and payed particular attention to participants who presented as reserved | 2.78 | .23 |
| MFA 8: Asked open-ended questions to promote discussion | 2.89 | .21 |
| MFA 6: Performed assessments correctly and followed up on abnormal findings | 2.94 | .26 |
| MFA 11: Participants spoke more than the co-facilitators spoke | 3.06 | ..18 |

**Table 2.3 Multivariate Regression of Overall MFA Score and Individual MFA Items on Elapsed Time, Provider and Health Center Characteristics (N = 160)**

| MFA Label | | Average score | Room Setup | Facilitator Communication | Correct Assessments |
|---|---|---|---|---|---|
| MFA # | | | 4 | 5 | 6 |
| Elapsed Time | Coeff (SE) | .40 (.075) | 0.51 (.125) | .48 (.117) | .21 (.105) |
| | Significance | *** | *** | *** | * |
| Provider Age | Coeff (SE) | -.01 (.008) | -.01 (.013) | -.01 (.012) | -.003 (.011) |
| | Significance | NS | NS | NS | NS |
| Provider Education | Coeff (SE) | -.11 (.101) | -.19 (.172) | -.05 (.158) | -.12 (.143) |
| | Significance | NS | NS | NS | NS |
| Provider Experience | Coeff (SE) | .004 (.009) | .01 (.014) | .01 (.013) | .01 (.012) |
| | Significance | NS | NS | NS | NS |
| Urban (vs Rural) | Coeff (SE) | -.10 (.091) | -.12 (.153) | -.01 (.142) | -.30 (.128) |
| | Significance | NS | NS | NS | * |
| Patient to Staff Ratio | Coeff (SE) | -.005 (.006) | -.01 (.010) | -.01 (.009) | -.01 (.01) |
| | Significance | NS | NS | NS | NS |

| MFA Label | | Encouraged Participation | Promoted Discussion | Praised Group | Group Participation |
|---|---|---|---|---|---|
| MFA # | | 7 | 8 | 10 | 11 |
| Elapsed Time | Coeff (SE) | .28 (.106) | .28 (.114) | .47 (.154) | .23 (.113) |
| | Significance | ** | * | ** | * |
| Provider Age | Coeff (SE) | -.04 (.011) | -.02 (.012) | -.01 (.016) | -.02 (.011) |
| | Significance | *** | * | NS | NS |
| Provider Education | Coeff (SE) | -.15 (.143) | .06 (.155) | -.22 (.209) | -.15 (.153) |
| | Significance | NS | NS | NS | NS |

| | | | | | |
|---|---|---|---|---|---|
| Provider Experience | Coeff (SE) | .01 (.012) | -.02 (.013) | .003 (.018) | .004 (.013) |
| | Significance | NS | NS | NS | NS |
| Urban (vs Rural) | Coeff (SE) | .22 (.129) | .30 (.139) | -.01 (.188) | -.05 (.134) |
| | Significance | NS | * | NS | NS |
| Patient to Staff Ratio | Coeff (SE) | -.005 (.008) | .02 (.009) | -.004 (.012) | .004 (.009) |
| | Significance | NS | * | NS | NS |
| MFA Label | | Curriculum Knowledge | Responsiv e | Kept Time | Proper Screening |
| MFA # | | 12 | 13 | 14 | 15 |
| Elapsed Time | Coeff (SE) | .59 (.126) | .48 (.109) | .51 (.190) | .36 (.115) |
| | Significance | *** | *** | ** | ** |
| Provider Age | Coeff (SE) | -.01 (.013) | -.001 (.011) | .002 (.019) | .01 (.012) |
| | Significance | NS | NS | NS | NS |
| Provider Education | Coeff (SE) | -.03 (.171) | -.27 (.148) | -.07 (.253) | -.24 (.155) |
| | Significance | NS | NS | NS | NS |
| Provider Experience | Coeff (SE) | -.02 (.014) | -.01 (.012) | .03 (.021) | .003 (.013) |
| | Significance | NS | NS | NS | NS |
| Urban (vs Rural) | Coeff (SE) | .09 (.152) | -.07 (.134) | -.32 (.23) | -.35 (.140) |
| | Significance | NS | NS | NS | * |
| Patient to Staff Ratio | Coeff (SE) | -.01 (.010) | -.001 (.009) | -.02 (.015) | -.005 (.009) |
| | Significance | NS | NS | NS | NS |

Standard Errors in parentheses. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; NS if $p > .05$

**Table 2.4 Qualitative Themes, Details and Quotes**

| **Themes** | **Corresponding MFA Item** | **Details** | **Significant Quote** |
|---|---|---|---|
| Group ANC Scheduling | NA | Limited availability of providers resulted in mixed groups of women from group and individual ANC<br><br>Group ANC delayed to first accommodate women receiving individual ANC<br><br>Women arrived late or at incorrect appointment | *The provider was the same one to attend to ordinary ANC women, do ultrasound and group care that day. Ordinary ANC women were among group care women. I realized it when I noticed a certain woman looked to be term and that is when the FC (Field Coordinator) commented that she is not in group care. I inquired if there were more women not in group care and the provider said that they were.* (Health Center 2) |

| | | | |
|---|---|---|---|
| | | times, resulting in large groups of women of different gestational ages<br><br>Providers worked collaboratively to provide coverage for both individual and group ANC | |
| Room Preparation | Room Setup | Adequate room preparation among some health centers<br><br>Staff successfully adapted to prepare rooms in absence of adequate resources.<br>Provision of multiple services, high patient volume and unprepared staff, hindered room preparation. | *Had not yet prepared room nor had they decided on which room to use for group care as it was an ordinary day for subsequent antenatal visits. I assisted in arrangement of the room but because it was a walk in for many people coming in and going out, the abdominal assessments were done in close by side room.* (Health Center 4) |
| Provider Availability | NA | Nurses were in charge of several services, making it challenging to adequately deliver group care.<br><br>CHWs were sometimes unavailable to co-facilitate, making it difficult to implement group ANC.<br><br>Untrained staff occasionally facilitated group ANC when trained staff were unavailable or designated to provide other services. | *Scarcity of nurses was making the provider somehow not stable: She was also assigned to work in maternity and other trained providers were not available to facilitate the group care. There was no CHW to co-facilitate the GPNC session, (the MT (Master Trainer) intervened when the provider was performing the health assessment for mothers and babies).* (Health Center 4) |
| Facilitator Content Knowledge | Curriculum Knowledge | Certain content and skill areas were not well understood and required further training | *During recap of danger signs that were covered previously, I realized that they did not understand what pre-eclampsia or eclampsia (kugagara was). Neither the CHW nor the nurse could explain it. They both said it is when the mother is stiff and all the blood has stopped flowing in the body and the mother* |

| | | | |
|---|---|---|---|
| | | | *is almost dead. I had to intervene with the early and later signs and what could be the complications, in order to make them understand.* (Health Center 2) |
| Facilitation Skills and Process | Facilitator Communication, Correct Assessments, Encouraged Participation, Promoted Discussion, Praised Group, Group Participation, Responsive, Proper Screening | Several facilitators exceled in leading group ANC.<br><br>Some facilitators created an environment of judgement and blame, greatly hindering the group care process. | *He went in wrong direction blaming and requesting them to talk about what is wrong with their pregnancy. Women were intimidated and there was a total silence in the room. I intervened by providing signs of danger cards to women and helped in facilitation. The nurse was intervening talking more than women and kept being judgmental.* (Health Center 8) |

*NA= no corresponding item on the Model Fidelity Assessment.

# CONCLUSION

This dissertation contributes to the literature on the implementation of group ANC in low and middle income countries.

While group ANC is being implemented globally, there is a gap in research on the impact of group ANC on preterm birth outcomes. Although limited, evidence suggests that group ANC may have potential benefits for maternal health and birth outcomes. Before group ANC can be implemented as a strategy to address the inequities in maternal and neonatal health outcomes, rigorous research is required to establish an evidence base for group ANC. Research must further study the perspectives of providers, clients and community members, capture information on health outcomes and evaluate the barriers and facilitators to service delivery.

Paper 1 explored CHWs' successes and challenges in piloting group ANC. Results indicate CHWs experienced positive outcomes, including increased knowledge and skills regarding reproductive health, a more comprehensive understanding of women's healthcare needs and improved collaboration with health center providers. Multiple logistical challenges hindered CHWs from fulfilling their responsibilities. Inconsistent scheduling led to challenges in balancing group ANC co-facilitation with responsibilities within the community. The lack of timely disbursement of transportation stipends resulted in added financial stress as well as lack of continuity of care, due to CHWs substituting for colleagues unable to obtain transportation to the health center. Given the link CHWs provide between health centers and communities, they are uniquely positioned to serve as effective co-facilitators of group ANC. Results suggest strategies for scale-up and recommend additional research to provide effective, context-specific approaches for implementation.

Paper 2 analyzed the effect of introducing a new intervention, obstetric ultrasound, on the delivery of ANC services. Per-protocol analysis did not find an association between provision of ultrasound and number of ANC services provided. Intention-to-treat analysis found a small negative association between assignment of ultrasound at health centers and number of ANC services provided. Both per-protocol and intention-to-treat analyses found a small negative association between time required to provide US, as well as the interaction between time and number of average monthly deliveries, and number of ANC services provided. By potentially contributing to disruptions in other health services, women may be impacted by both assignment of ultrasound at health centers as well as provision of ultrasound at the individual level. Additional studies are recommended to measure the potential opportunity cost of introducing new approaches, such as obstetric ultrasound, particularly in low resource settings.

Paper 3 aimed to measure the association between program duration and implementation fidelity, while elucidating what factors influenced implementation of group ANC. Qualitative analysis found implementation to be affected by several factors, including: group ANC scheduling, preparing the room for group ANC sessions, provider capacity to co-facilitate group ANC, and facilitator knowledge and skills regarding group ANC content and process. Program

duration (time) was associated with an increase in implementation fidelity, as measured by Model Fidelity Assessment scores. The degree of improvement varied for different items, indicating certain components of implementation may be more challenging to improve than others. Quantitative results were somewhat corroborated by themes found in the qualitative analysis, however, this was not always the case. Results suggest the use of both quantitative and qualitative monitoring tools to gain a complete understanding of implementation fidelity.

This dissertation adds to the limited body of literature on program monitoring, process and adaptation required to implement group ANC in low and middle income countries. Results show that by leveraging efforts of CHWs, it is feasible to implement group ANC in Rwanda, with potential for replication in similar country contexts. Future research questions include: 1) Given resource constrains, what context specific strategies allow for effective implementation of group ANC in low and middle income countries? 2) Is task sharing among CHWs and providers a viable solution to address workforce shortages affecting group ANC implementation? It is critical to understand the multitude of factors affecting the group ANC process.

This dissertation also raises the key question: What are the potential opportunity costs or negative unintended consequences of introducing a new intervention in a limited resources setting? While the introduction of new interventions may be beneficial, it is critical to measure the intervention's effects on the delivery of other healthcare services and its potential impact on patients. Lastly, this dissertation contributes to filling the gap in literature on monitoring group ANC implementation fidelity. Results found group ANC implementation is further strengthened when both quantitative and qualitative tools are used to monitor the implementation process and are followed by mentoring and support. Future research questions include: 1) What monitoring tools and what kind of mentorship leads to the biggest improvements in implementation fidelity over the course of the program? 2) How can implementation fidelity be measured in a participatory manner, incorporating feedback from program beneficiaries?

Group ANC is an innovative model of care with the potential to improve health outcomes, particularly in populations at high risk for poor perinatal outcomes. However, literature on group ANC in low and middle income countries remains limited. Additional studies are required to elucidate group ANC implementation pathways, factors affecting implementation and context-specific adaptations necessary for successful scale-up. This dissertation is a meaningful contribution towards identifying effective group ANC monitoring and implementation strategies in low resource settings.

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