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Evaluating the relationship between an intervention to schedule care and waiting time and utilization of antenatal care in Mozambique

Maria Steenland,[1*] Janeth Dula,[2] Amanda de Albuquerque,[3] Quinhas Fernandes,[5] Rosa Marlene Cuco,[5] Sergio Chicumbe,[2] Eduardo Samo Gudo,[2] Sandra Sequeira,[4] and Margaret McConnell[6]

[1]Population Studies and Training Center, Brown University, Providence, USA
[2]*Instituto Nacional de Saúde, Ministério da Saúde*, Maputo, Mozambique, dulajaneth@gmail.com, chicumbe@gmail.com, esamogudojr@gmail.com
[3]Pontifical Catholic University of Rio de Janeiro, Rio de Janeiro, Brazil, amandaajr@gmail.com
[4]Department of International Development, London School of Economics, London, United Kingdom, smgsequeira@gmail.com
[5]National Directorate of Public Health, Ministry of Health, Maputo, Mozambique, quinhasf@yahoo.com.br, marlene.cuco@gmail.com
[6]Department of Global Health and Population, Harvard T.H. Chan School of Public Health, Boston, USA, mmcconne@hsph.harvard.edu

*Corresponding author. Maria Steenland, Population Studies and Training Center, Brown University, 68 Waterman Street, Providence, RI 02912. Email: maria_steenland@brown.edu

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ABSTRACT:

Background: Poor patient experience, including long waiting time, is a potential reason for low health care utilization. In this study, we evaluate the impact of appointment scheduling on waiting time and utilization of antenatal care.
Methods: We implemented a pilot study in Mozambique introducing appointment scheduling to three maternity clinics, with a fourth facility used as a comparison. The intervention provided women with a return date and time for their next antenatal care visit. Waiting times and antenatal care utilization data were collected in all study facilities. We assessed the effect of changing from first-come first-serve to scheduled antenatal care visits on waiting time and complete antenatal care (≥ 4 visits during pregnancy). Our primary analysis compared treatment facilities over time; in addition, we compared the treatment and comparison facilities using difference-in-differences.
Results: We collected waiting time data from 6,918 women seeking antenatal care during the study period, and antenatal care attendance over the course of pregnancy from 8,385 women whose first antenatal care visit occurred during a one-year period that included the study implementation. Scheduling appointments reduced waiting time for antenatal care in treatment facilities by 100 minutes (95% CI: -107.2, -92.9) compared to baseline. Using administrative records, we found that exposure to the scheduling intervention during pregnancy was associated with an approximately 16 percentage point increase in receipt of four or more antenatal care visits during pregnancy.
Conclusions: Relatively simple improvements in the organization of care that reduce waiting time can increase utilization of health care during pregnancy.

Trial registry: This study is registered at ClinicalTrials.gov NCT02938936 (October 19, 2016)

KEY QUESTIONS:

What is already known?
► Long waiting time for care is a commonly reported problem in public health facilities in sub-Saharan Africa, and may reduce utilization of health care
► This study is the first to evaluate the effect of an appointment scheduling intervention on both waiting time and completion of recommended care

What are the new findings?
► Appointment scheduling decreased waiting time for antenatal care by over one hour (100 minutes), and increased the percent of women who completed four or more antenatal care visits during pregnancy

What do the new findings imply?
► Relatively simple improvements in the organization of care that reduce waiting time may increase utilization of health care during pregnancy

BACKGROUND:

Antenatal care (ANC) represents a critical introduction to the continuum of maternal and newborn health care (1). High quality ANC informs women about potential danger signs during pregnancy and provides treatment and prevention for illnesses that adversely affect infant health. With adequate ANC coverage, an estimated 283,000 lives could be saved annually (2). World Health Organization (WHO) guidelines published in 2002 recommended that women receive at least four ANC visits during pregnancy. In Mozambique, only 55% of pregnant women receive complete ANC (four visits over the course of their pregnancy), and only 13% of women start ANC in the first trimester of pregnancy (3, 4). In 2016, new WHO guidelines recommending that women attend at least eight ANC visits during pregnancy replaced the earlier recommendation (5). In 2015 in Mozambique, only 3% of women obtained eight or more visits. Meeting these new coverage targets will require a better understanding of barriers to utilization and the effectiveness of interventions to address these barriers.

It is increasingly recognized that high quality health care, in addition to improved coverage of maternal and child health services, is necessary to achieve the Sustainable Development Goal's target reductions in maternal and child mortality (6). The on-going "quality revolution" (7) in global health emphasizes the need for successful health systems to deliver on various dimensions of quality, including providing patient-centered care, or care that is responsive to the preferences of users (8).

Abundant evidence has shown that public clinics in Sub-Saharan Africa are not organized around the preferences of patients (9-15) in particular with respect to the amount of time spent waiting at facilities (16). In Mozambique, attending ANC typically involves arriving early in the morning only to spend most of the day waiting for care. Previous studies have shown that

waiting time for ANC is perceived as a significant burden to seeking care and is associated with decreased satisfaction with ANC (17-19). Long queues and the resulting crowded facilities may also decrease technical quality if health workers rush through key procedures.

Recent evidence demonstrates that comprehensively improving technical and non-technical quality can influence choice of delivery location (20). Furthermore, non-technical quality care (including patient responsiveness) has been shown to influence utilization decisions (21). However, more evidence is needed to understand whether improving patient experience alone can drive changes in utilization of care. We partnered with the Ministry of Health in Mozambique to conduct a pilot study of a scheduling intervention in three high-volume public health clinics in Mozambique with a fourth high volume facility serving as a comparison. We examine the relationship between the introduction of the scheduling system and changes in waiting time and utilization of ANC. While one previous study demonstrated that scheduling systems can reduce waiting times even in contexts of limited state capacity (22), our study is the first to analyze the relationship between introduction of a scheduling system and health care utilization.

Local Context: ANC Scheduling

The large majority (almost 99%) of women in Mozambique receive antenatal care in public health facilities (4). Before the study intervention, women were assigned their next antenatal appointment 30 days from the date of their visit in public clinics, without any specified time. Pregnant women typically arrived early in the morning to wait for ANC and consultation

order was determined by type of visit (first versus follow-up) and the order of patient arrival (first-come first-served).[1]

METHODS

Study population:

Scheduling interventions were implemented in three clinics. Two intervention clinics were located in urban Maputo (Boane and Malhangalene). A third intervention clinic, Quissico, located in rural Inhambane Province, was included to test scheduling in a rural environment where employment and transportation might differ. A fourth clinic, Machava II, located in urban Maputo, was used as a comparison. We selected clinics with high ANC volume and accessibility to a main road.

Scheduling intervention design:

The evaluation study took place between September 2016 through July 2017. All of the study health facilities were high-volume (i.e. 21 to 40 ANC patients per day) public health facilities. In treatment clinics, patients receiving ANC were asked to select a return time on the date of their next appointment. Patients were informed that if they returned at their scheduled date and time they would be seen within one hour by clinic staff. Nurses recorded the appointment date and time on a scheduling card provided to patients and in an appointment book provided to facilities.

[1] Facility organization varied, in some facilities, women coming for their initial ANC visit were seen first, while in others priority was given to follow-up visits.

Theory of change:

The intervention could decrease waiting time by more evenly distributing patient arrival throughout the day. The intervention could increase utilization if decreased waiting time makes it easier for patients to attend their appointment, if having a specific time makes the patient feel more responsible for returning on their scheduled date, or if the appointment serves as a signal that the health system is responsive to patients. The intervention could improve technical and non-technical quality if scheduling reduced the strain on health workers of managing long queues or increased visit duration, which could give nurses more time to complete recommended tests and counseling. Alternatively, appointment scheduling could decrease quality if nurses dislike the new system, or if needing to see patients at specific times increased health worker stress.

Figure 1. Intervention logic framework

Study outcomes:

The primary study outcomes were 1) waiting time for ANC as measured by survey data, and 2) receipt of complete ANC defined as four or more ANC visits during pregnancy. The number of visits was obtained from administrative data contained in facility registers. The secondary outcomes were 1) an index of technical quality and 2) an index of non-technical quality of care measured using variables collected in survey data. Technical quality was measured using an index of the technical components of ANC recommended by the WHO for all ANC visits (abdominal examination, measurement of uterine height, provision of folic acid, provision of malaria prophylaxis, and discussion of signs of pregnancy complications). Non-

technical quality was defined by an index of patient satisfaction with interpersonal quality including an indicator for any experience of disrespect or abuse, as well as Likert scales for the communication skills, friendliness, and respectfulness of health workers. Supplementary Table 2 describes the definition and data source for each outcome.

Waiting time data collection:

Starting at 7:30 am, enumerators recorded the time that all ANC patients arrived, the time their consultation began and the time their consultation ended.[2] As many women arrive before 7:30am, and the enumerator can only record information from one woman at a time, study enumerators also recorded the patient's self-reported arrival time. Four consecutive weeks of baseline waiting time data was collected in all four study facilities with staggered start dates. Following the introduction of the scheduling intervention, waiting time was measured bimonthly for a period of two weeks in all intervention and control facilities. Finally, four weeks of data were collected at endline (round 5) (see Figure 2 for a general timeline, Supplementary Appendix for detailed waiting time data collection procedures, Supplementary Table 1 for a detailed timeline).

As the same nurses providing ANC also provide family planning and postpartum care, it is possible that ANC scheduling affected the amount of time health workers spent seeing other types of patients. To examine whether appointment scheduling for ANC had the unintended consequence of diverting resources away from other services, we tested whether scheduling appointments for ANC resulted in nurses spending less time with patients seeking family planning. To do this, enumerators collected waiting time from five randomly selected women

[2] Waiting time data was collected using an electronic application at baseline, and all subsequent rounds of waiting time data collection used paper forms

who received family planning services. Finally, enumerators also recorded the number of staff providing ANC on each day of waiting time data collection.

Antenatal care and delivery exit interviews:

We conducted baseline and endline exit surveys in Boane (T) and Machava II (C). We collected ANC exit interview data to obtain detailed demographic data and information on the quality of antenatal care from a sample of women attending the study clinics for antenatal care. We used delivery exit interview data to obtain addition information on quality of care, and to document the percent of women who attended all ANC visits in the same health facility. This allows us to validate the use of clinic level administrative data as an outcome measuring all ANC utilization. ANC exit interviews recorded patient demographics and the self-reported content of, and satisfaction with, the ANC visit that occurred on the day of data collection. Delivery exit interviews recorded the self-reported content of, and satisfaction with, the most recent ANC visit before delivery. For ANC exit interviews, study enumerators recruited women attending ANC who were ≥ 18 years old and whose gestational age was between 16 – 22 weeks. For the delivery exit interviews, all women ≥ 18 years of age who delivered during the weeks of enrollment were invited to participate.

Administrative data collection:

We recorded the dates of all ANC visits from all women whose first ANC visit took place between April 2016 and April 2017 from facility registers. We restricted the data to this date range as a new ANC register began to be used in public health facilities in April 2016, and so that we could observe all ANC visits over the course of pregnancy for all women receiving ANC

in study facilities. We used this data to construct a variable measuring exposure to the scheduling system by 1) subtracting 40 weeks of pregnancy from the gestational age during the first ANC visit as recorded in facility registers and then, 2) identifying the number of weeks of pregnancy remaining after the start of the scheduling system.

Figure 2: Study timeline

Pre-post analysis within treatment facilities:

Our main analyses are conducted with data only from treated facilities. In order to visualize changes in waiting time over the study period, we graphically present average waiting time in each of the five rounds of waiting time data collection in all of the study facilities. In this graph, the x axis measures study round by facility, and the y axis measures average waiting time pooling individual level data from each facility's data collection round. We also graph the distribution of arrival times at baseline and in the four rounds of post-intervention follow-up. We then regressed waiting time on a post indicator variable identifying observations after the start of appointment scheduling and four day of the week dummy variables (regression equation 1 in the Supplementary Appendix). We use self-reported arrival time since some patients arrived at the facility before the enumerator in the morning. We present several robustness checks including estimating waiting time with observed instead of self-reported waiting time, adjusting the waiting time outcome for censoring and accounting for clustering in standard errors (23) in Supplementary Tables 3 – 5.

To check patients' adherence to the new scheduling system, we calculated the difference between patient arrival time and the time of the scheduled appointment. To check providers'

compliance with the scheduling system, we calculated the difference between the patient's appointment time and the time they were seen by a nurse.

To examine utilization, we tested whether exposure to scheduling, defined as the number of weeks of pregnancy remaining after the start of the scheduling intervention, increased the likelihood that women obtained complete ANC (regression equation 2 in the Supplementary Appendix). We used a generalized linear model for a binomial outcome with an identity link function. The model included facility fixed effects, and robust standard errors. The results of this analysis using wild bootstrap standard errors is presented in Supplementary Table 3. To examine changes in the utilization outcome over time, we also plot the percent of women with complete ANC by month of the first ANC visit (Supplementary Figure 4).

Difference-in-differences analysis in intervention and comparison facilities:

To understand whether our findings were driven by changes unrelated to scheduling during the study period, we conducted a difference-in-differences analysis to compare the change in the study outcomes in the three intervention clinics with the change in the comparison clinic. We use difference-in-differences regression analysis to assess the effect of scheduling on waiting time for ANC, ANC utilization, waiting time for family planning, and technical and non-technical quality of ANC. We present findings for these analyses excluding Quissico, the only rural health facility, in Supplementary Table 6. For the two quality outcomes, and the analysis of waiting time for family planning, we include only Boane (treatment) and Machava II (comparison) in the difference-in-differences analysis as data collection for these outcomes only took place in these two facilities. Waiting time and quality regressions used ordinary least squares and the utilization regression used a generalized linear model for a binomial outcome

with an identity link function. All analyses included a post variable identifying observations after scheduling and an indicator of exposure to scheduling. An interaction term between these two variables was used to assess the effect of scheduling on the study outcomes (regression equations 3 & 4 in the Supplementary Appendix). We also present findings from the same regression for the individual components of the quality scores in Supplementary Table 7.

Human subjects approval and study registration:

This study received human subjects approval from the authors institutes. The study has been registered at ClinicalTrials.gov.

Patient and Public Involvement statement:

The study was informed by previous research showing that waiting time is perceived by patients as an important barrier to health care receipt in low-income countries. Patients were included in antenatal care and delivery care exit surveys but were not directly involved in the design of this study. Information on appointment scheduling and the results of this study may be distributed to patients by the Ministry of Health through media announcements.

RESULTS:

Table 1 displays baseline levels of facility and patient characteristics. The average number of nurses and auxiliary nurses providing ANC visits at baseline ranged from 1.6 – 2.6, and 1.2 – 4.1 respectively. The average age of women seeking ANC who were sampled in the baseline exit interview was 24.6 years old, the average household size was 5.2 residents, and 80% of women were married. On average 33.6 percent of women worked for pay. Average

baseline waiting time for ANC was 195.2 minutes and 59.4 percent of women received complete ANC.

Table 1: Health facility and patient characteristics at baseline

Facility characteristics[a]	Boane (T) Urban n (%)/ mean (sd)	Malhangalene (T) Urban n (%)/ mean (sd)	Quissico (T) Rural n (%)/ mean (sd)	Machava II (C) Urban n (%)/ mean (sd)
Mean ANC nurses[b]	2.4 (1.0)	1.6 (0.5)	1.9 (0.4)	2.6 (0.9)
Mean ANC auxiliary nurses	2.2 (0.6)	1.2 (0.4)	4.1 (0.9)	2.3 (0.5)
Number of ANC visits per day	25.4 (7.9)	21.2 (8.7)	22.9 (12.9)	40.0 (19.0)
N	20	18	20	20
Patient characteristics[c]				
Mean age	23.4 (5.0)	24.5 (5.5)	26.6 (5.5)	23.5 (4.1)
Mean travel time to facility (mins)	47.8 (29.9)	33.6 (35.7)	70.5 (39.8)	36.2 (23.2)
Mean household size	5.2 (2.6)	6.0 (3.0)	5.1 (2.8)	4.7 (2.2)
Percent married	26 (90)	21 (75)	26 (81)	22 (73)
Percent worked for money	8 (28)	8 (29)	17 (53)	7 (23)
Percent responsible for child care[d]	16 (55)	13 (46)	23 (72)	11 (37)
N	29	28	32	30
Study outcomes at baseline				
Mean waiting time	281.6 (126.3)	178.8 (87.1)	128.2 (86.7)	175.6 (93.0)
N[e]	505	377	433	432
Percent with ≥ 4 ANC visits	490 (52)	236 (39)	528 (58)	1,380 (70)
N[f]	941	605	911	1,976

[a]Staff and ANC visit numbers collected during round 1 of waiting time data collection
[b]Included both nurses employed by the Ministry of Health who are permanently based at the health facility and temporary staff employed by non-governmental organizations
[c]Data from women ≥ 18 years old between 16 – 22 weeks pregnant surveyed during round one of ANC exit interviews
[d]Survey question included both the respondent's own children and other children
[e]Round 1 of waiting time data among women who received antenatal care in September/October 2016 in Malhangalene and in October/November 2016 in Boane, Machava II & Quissico
[f]Administrative data from facility records documenting the number of antenatal care visits obtained during pregnancy among women who came for their first antenatal care visit between April 1, 2016 – October 31, 2016

Scheduling system implementation:

Appointment scheduling shifted the distribution of arrival times for ANC towards later arrival (Figure 3). Before scheduling, 62% of women seeking ANC in treatment facilities arrived before 8 am, when the facility opened. During follow-up rounds, this percentage declined to 22%

(Figure 3). Forty eight percent of patients arrived before their hour-long appointment window (Supplementary Figure 2). However, 58% of patients overall, and 51% who arrived on time, were seen by nurses after the end of their window (Supplementary Figure 3).

Figure 3: Distribution of patient arrival times for antenatal care before and after scheduling

Source: Waiting time data collection rounds 1 – 5. White bars capture rounds 2 – 5.

The average of mean daily waiting time across the three facilities at baseline was 182 minutes. Average waiting time after scheduling ranged from 85 – 107 minutes, a decrease of between 41 and 53 percent from baseline (Figure 4).

Figure 4: Waiting time for antenatal care visits

Source: waiting time data collected from September 19 – November 18, 2016 (round 1), December 12, 2016 – January 20, 2017 (round 2), February 6 – March 10, 2017 (round 3), March 27—April 28, 2017, (round 4) and May 22 – July 14, 2017 (round 5)

Impact on utilization:

Pre-post analysis within treatment facilities:

Our regression analysis, which controls for day of the week effects, shows that waiting time declined by 100.0 minutes after scheduling (95% CI: -107.2, -92.9, $p<0.0001$) (Table 2, Panel A). The decline in waiting time was largest in Boane (-144.8 , 95% CI: -156.9, -132.8), where baseline waiting time was longest. The decrease in waiting time was more modest in Quissico (-47.1 95% CI: -56.0, -38.3), the rural treatment facility with the shortest baseline waiting time. These results remain consistent when using observed waiting time and censored waiting time in place of self-reported arrival time (Supplementary Tables 4 & 5).

We find that exposure to scheduling increased receipt of complete ANC by 0.004 percentage points each week in the pooled treatment facilities (95% CI: 0.004, 0.005, p<0.001) (Table 2, Panel B). This coefficient is equivalent to a 16-percentage point or 32% increase among women who were exposed to scheduling during all 40 weeks of pregnancy. The trend in complete ANC increased dramatically in treatment facilities after the start of scheduling but began to decline in January 2017 (Supplementary Figure 4). Qualitatively similar results for waiting time and ANC utilization from the same regressions using wild bootstrap standard errors are presented in Supplementary Table 3.

Table 2: Pre-post analysis examining change in waiting time and ANC utilization among treatment facilities

	Boane (T)	Malhangalene (T)	Quissico (T)	Pooled treatment facility results
Panel A: Waiting time[a,b]				
	β (95% CI)	*β* (95% CI)	*β* (95% CI)	*β* (95% CI)
Post indicator	-144.8*** (-156.9, -132.8)	-88.9*** (-98.6, -79.2)	-47.1*** (-56.0, -38.3)	-100.0*** (-107.2, -92.9)
Baseline mean	281.6	178.8	128.2	201.6
N	1,709	1,579	1,702	4,990
Panel B: ≥ 4 ANC visits[c,d]				
	β (95% CI)	*β* (95% CI)	*β* (95% CI)	*β* (95% CI)
Weeks exposed	0.004*** (0.003, 0.006)	0.008*** (0.006, 0.009)	0.003*** (0.001, 0.004)	0.004*** (0.004, 0.005)
Constant	0.504*** (0.467, 0.542)	0.294*** (0.248, 0.340)	0.570*** (0.535, 0.605)	0.499*** (0.469, 0.528)
N	1,742	1,201	1,921	4,864

* p < 0.1, ** p < 0.05, *** p < 0.01

[a] *Source:* five rounds of waiting time data collection (1 round pre-treatment, and 4 rounds in post-treatment)

[b] Ordinary least squares regression models comparing baseline waiting time with waiting time during four rounds of follow-up waiting time data collected after the start of the scheduling intervention. 95% confidence intervals in parentheses. Regressions are adjusted for day or the week.

[c] *Source:* Administrative data from facility records documenting the number of antenatal care visits obtained during pregnancy among women who came for their first antenatal care visit between April 1, 2016 and April 30, 2017.

[d] Generalized linear model for a binomial outcome with an identity link function. 95% confidence intervals in parentheses.

Difference-in-differences analysis in intervention and comparison facility pair:

We find that appointment scheduling decreased waiting time and increased ANC utilization in our difference-in-differences analysis, confirming the results we found in the pre-post analysis (Table 3, Panel A). The results of these analyses are very similar after excluding Quissico, the intervention facility located in a rural area (Supplementary Table 6). Furthermore, ANC scheduling did not affect waiting time for other services offered in the same health unit such as family planning (0.94, 95% CI: -37.64, 35.76, p=0.515) (Table 3, Panel B).

Scheduling did not change the technical quality of ANC visits (-0.01, 95% CI: -0.08, 0.06, p-value = 0.689) or non-technical quality of care (0.07, 95% CI: -0.03, 0.16, p-value = 0.178) (Table 3, Panel B). Regression results for the individual components of the technical and non-technical indices are shown in Supplementary Table 7.

Table 3: Difference-in-difference analysis examining change in waiting time, ANC utilization and service quality in all study facilities

Panel A: Analysis in all study facilities	Waiting Time for ANC[a,d] (minutes)		≥ 4 ANC visits[c,d]
	β (95% CI)		β (95% CI)
Treatment*post	-80.03*** (-92.12, -67.94)	Treatment*exposure weeks	0.004** (0.002, 0.005)
Treatment	26.15*** (15.14, 37.15)	Treatment	-0.175** (-0.210, -0.141)
Post	-19.78*** (-29.55, -10.00)	Exposure weeks	0.001 (-0.001, 0.002)
Baseline control mean	175.5	Baseline in control group	0.60
N	6,918	N	8385
Panel B: Analysis in Boane (treatment) & Machava II (control) only	Technical quality index[b,d,e]	Non-technical quality index[b,d,f]	Waiting time for Family Planning[a,d]
	β (95% CI)	β (95% CI)	β (95% CI)
Treatment*post	-0.01 (-0.08, 0.06)	0.07 (-0.03, 0.16)	-0.94 (-37.64, 35.76)
Treatment	0.05** (0.00, 0.11)	-0.01 (-0.09, 0.07)	-20.04 (-54.44, 14.37)
Post	0.03 (-0.02, 0.08)	0.00 (-0.07, 0.07)	-18.80 (-45.12, 7.53)
Baseline control mean	0.74	0.89	140.1
N	315	315	425

* p < 0.1, ** p < 0.05, ***p<0.01

[a] *Source:* Five rounds of waiting time data collection (1 round pre-treatment, and 4 rounds in post-treatment) among women waiting to receive antenatal care in treatment facilities (Boane, Malhangalene, Quissico) and the comparison facility (Machava II), and women waiting to receive family planning in Boane (treatment) and Machava II (comparison)

[b] *Source:* round 1 (pre-treatment) and round 2 (post-treatment) antenatal exit interviews conducted among women who attended antenatal care in Boane (treatment) and Machava II (comparison) on the day of the survey, and round 1 (pre-treatment) and round 2 (post-treatment) delivery exit interviews conducted among women who delivered in Boane (treatment) and Machava II (comparison).

[c] *Source*: Administrative data from facility records documenting the dates of all antenatal visits among women who came for their first antenatal care visit between April 1, 2016 and April 30, 2017 in treatment facilities (Boane, Malhangalene, Quissico) and the comparison facility (Machava II)

[d] Ordinary least squares regression model. Difference-in-differences analysis controlling for day of the week. 95% confidence intervals in parentheses

[e] The technical quality index was constructed using the mean of the non-missing values of the following variables: 1) abdominal exam, 2) measurement of uterine height, 3) provision of folic acid, 4) provision of malaria prophylaxis, and 5) discussion of the signs of pregnancy complications.

[f] The non-technical quality index was constructed using the mean of the non-missing values of the following four variables: 1) respectfulness of health workers, 2) good communication skills of the healthcare workers 3) good friendliness of healthcare workers and 4) never felt humiliated or disrespected at any point during antenatal care.

DISCUSSION:

This study presents evidence that scheduling appointments reduced waiting time for ANC. The decline in waiting time was largest where baseline waiting time was longest (Table 2).

Despite concerns that even after scheduling, patients might continue to arrive early in the morning to guarantee a place in line, we found that most patients arrive before or during their scheduled time. We found that waiting time decreased more after the intervention in higher-volume facilities, and that baseline waiting time was lower in the single rural health facility. While a larger sample would be needed to better understand heterogeneity in treatment effects, it may be that the intervention would be more effective in facilities closer to urban areas that are likely to have high patient volumes.

We estimate that scheduling increased receipt of complete ANC during pregnancy by 16 percentage points, a 32% increase. Though one previous study demonstrated that scheduling can reduce waiting time (22), our study provides the first evidence that appointment scheduling can increase service utilization, suggesting that poor patient experience may not only be unpleasant but may also contribute to poor health outcomes by decreasing utilization.

We do not find evidence that reducing waiting times changes the technical and non-technical content of an ANC visit. While it is reassuring that we do not find that exposure to a scheduling system reduced the likelihood of receiving key elements of care, our findings suggest that a more significant investment is needed to improve the content of ANC, and without this investment, changes in utilization may not yield better health.

We find that the effect of the intervention on ANC utilization decreases over time (Supplementary Figure 4). This may be due to poor compliance among nurses who often saw patients over an hour after their scheduled visit hour. More evidence is needed to understand whether the potential benefits of the intervention attenuate over time and whether attenuation could be mitigated by better management and supervision of nurses to more closely adhere to scheduled times.

This study has several limitations. Though we observe no change in patient volume over the study period (Supplementary Figure 5), it is possible that other changes occurred at the same time as our intervention, confounding our results. To address this concern, we conducted a difference-in-differences analysis. While this analysis is consistent with findings from our main specification, the comparison clinic had important baseline differences, including higher volume and a lower staff-to-patient ratio, than the intervention clinics. Differences in baseline waiting time and patient volume between the facilities remains a limitation and we are unable to evaluate the assumption of parallel trends in the study outcomes because of a limited period of data collection prior to the intervention. Therefore, despite the inclusion of a comparison facility to control for changes affecting the study outcomes that were not due to the intervention, it is possible that the observed increase in ANC utilization resulted from other changes in the treatment clinics after the start of the intervention.

Another limitation is that administrative records used to assess utilization only document care that was obtained in that facility. While it is possible that women could have visited other facilities during their pregnancy, 96% of women responding to our exit survey report receiving all ANC at the same facility. Finally, our sample size for quality outcomes is relatively small and outcomes are based on patient reports and is therefore likely to overstate the technical quality of care received and patient satisfaction responses may be upwardly biased if patients were worried that their responses will not remain confidential (24).

Interventions that re-organize the process of care may have important unintended consequences, such as decreased resources to non-targeted services or adverse changes to intra-facility relationships or health worker motivation. We find no negative relationship between ANC scheduling on waiting time for family planning, another health service offered in the

Maternal and Child Health unit. We also find that scheduling did not adversely affect the technical quality of care provided by health workers. However, there are other potential negative side effects of scheduling that we cannot address. For example, in some health facilities, group counseling occurs before the start of ANC consultations. In future research, it will be valuable to consider the impact of scheduling on patient knowledge of key health information during pregnancy.

The quality of health care has recently taken central stage in the international health systems agenda with the 2017 announcement of the Lancet Global Health Commission on High-Quality Health Systems (25), which aims to ensure that the quality of health care increases alongside global coverage targets set by the Sustainable Development Goals. Future interventions targeting health care quality should consider incorporating improvements in the management of patient flows as they may offer a low-cost, high impact avenue for improving patient experience.

CONCLUSION:

We demonstrate that relatively simple improvements in the organization of care that reduce waiting time can increase utilization of health care during pregnancy. Our evidence suggests that not only is patient experience an important consideration for its own sake, it may also pay an important role in shaping utilization patterns.

Ethics and consent to participate: This study received human subjects approval from Harvard T.H. Chan's Institutional Review Board (IRB16-0344), the London School of Economics Ethics Committee and from the Mozambican Ministry of Health's Comité Institucional de Bioética do Instituto Nacional de Saúde. Study participants who completed interviews provided written consent. A waiver of consent was approved for the administrative data collected in this study as this data contained no individual identifying information and was considered minimal risk. This study was registered at ClinicalTrials.gov (ID:NCT02938936).

Availability of data and material: The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests

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Contributions: MM and SS co-led the study design and supervised data analysis. MS, JD, AA, SC, ESG, SS and MM contributed to the study design. MS conducted data analysis and drafted the manuscript. All authors contributed to the interpretation of the data, reviewed and approved the final version of the manuscript.

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