Assessing Health Care Resilience in Mozambique: A mixed methods analysis of COVID-19 impact on maternal and child health service delivery in urban districts of Manica and Maputo provinces.

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A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Public Health

University of Washington

2023

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Program Authorized to Offer Degree:

Global Health

University of Washington

Abstract

Assessing Health Care Resilience in Mozambique: A mixed methods analysis of COVID-19 impact on maternal and child health service delivery in urban districts of Manica and Maputo provinces.

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COVID-19 disrupted health care services around the world. Maternal and child health care is of particular concern in Mozambique, given that neonatal disorders are a leading cause of death and that studies from 2021 demonstrate significant reductions in maternal and child health services during the pandemic. This study aims to provide a sub-national assessment at how services were affected throughout the pandemic and characterize facilitators and barriers to service delivery.

We utilized a two-phased mixed methods explanatory-convergent design. In phase one, we extracted electronic routine data for 9 selected maternal and child health care indicators across all districts within Manica and Maputo provinces from 2018 to March 2022. Quantitative data were analyzed by time-series and LOESS regression graphs using R. In phase two, two districts and four health facilities were purposively selected for analysis involving semi-structured interviews (n=4) and focus group discussions (n=8). Qualitative data were analyzed by iterative coding and thematic analysis.

Our quantitative results demonstrated reductions in critical maternal and child health services during the pandemic, but impact varied across location and sector. First family planning visits showed the greatest reductions, dropping 14.7% in 2020-2021 from 2018-2019. Immunizations (Polio3 [-6.9%], and

DTP3 [-7.5%]) also dropped, while first and fourth antenatal visits (+3.6% and +17.0%) and institutional births (+0.9%) increased in average services delivered. Qualitative data revealed multiple perceived barriers to service delivery, including insufficient personal protective equipment, insufficient human resources, unmet heath facility infrastructure needs and isolation spaces, insufficient financial support of providers, and fear of contracting COVID-19 in health centers. Facilitators included bi-directional communication between health facility, district and province, adapted communication mechanisms, teamwork, and provider self-efficacy.

Reductions in many MCH services, particularly family planning, and immunizations were confirmed during 2020-2021 compared to pre-pandemic years, but with trends showing recovery in early 2022. Multiple system-level barriers to service delivery were identified by providers in urban districts of Manica and Maputo Provinces which affected perceived quantity and quality of care. Strengthening health system infrastructure, material and human resource support of providers may help to improve resilience to future pandemics or emergencies.

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Background:

Primary Health Care (PHC) is the structural foundation of the health system in Mozambique since independence in 1975. (1) Mozambique's Ministry of Health (MISAU – acronym in Portuguese Language) has prioritized strengthening the resilience of the PHC system, especially in the context of frequent threats to its operational capacity, such as flooding, epidemics, and the coronavirus pandemic.

The onset of the COVID-19 pandemic in March 2020 disrupted the delivery of primary health care services around the world.(2,3) In many countries, including Mozambique, pandemic-related shocks impacted recent progress in for Maternal and Child Health (MCH) indicators such as maternal and under-five (U5) mortality rates.(4,5) The imposition of lockdowns and emergency measures had diverse effects on the delivery of and access to MCH services.(6–8) For instance, WHO and UNICEF immunization coverage data shows that the number of children globally who did not receive any vaccine went up by 30% in 2020 because of the secondary effects of the pandemic.(9) WHO and UNICEF data also revealed that Mozambique was one of two countries globally with the highest relative increases in number of unvaccinated children vaccine between 2019 and 2021.(10) Evidence from one study in Nampula province, Mozambique also demonstrated decreases in several indicators in 2020: timely first antenatal visits (-26%), hospital deliveries (-4%), and children vaccinated (-20%).(11) Another study examining nationally aggregated data through the first quarter of 2021 demonstrated relative losses in various MCH indicators across Mozambique, with first family planning visits and U5 malaria treatment being the most affected (-29.8% and -29.6% losses respectively).(12)

These findings demonstrated the need to further assess the impact of COVID-19 on MCH services throughout the duration of the pandemic and to identify what factors facilitate improvements or act as barriers to PHC resiliency. To do this, we chose to (**Aim 1:**) assess the magnitude of impact of COVID-19

on 9 MCH indicators through March of 2022, as well as (**Aim 2:**) to identify the major barriers and facilitators to delivering MCH care throughout the pandemic, from the perspectives of MCH providers and managers. This study was motivated and led by the National Department of Public Health of the Ministry of Health in Mozambique (MISAU) and carried out by Comité para a Saúde de Moçambique (CSM) as a part of the Silk Road Labs project (S-Labs) of Southern Medical University (SMU) in China.

Methods:

Study Setting & Design

We chose a mixed methods explanatory-convergent design (quant → qual) approach for the purpose of complementarity and expansion of quantitative results by qualitative methods.(13,14) The quantitative portion of the study included statistical and graphical analyses of selected MCH indicators from March 2018 through March 2022, followed by in-depth semi-structured interviews and Focus Group Discussions (FGDs) with purposefully selected MCH providers and managers.

Study Population

The research team developed a conceptual model (Figure 1., Appendix A), based on similar PHC resiliency and MCH service delivery models and the Kruk framework for PHC resiliency,(15–17) to identify potential influencing factors and relevant populations. The Kruk framework defines health care resiliency as "the capacity of health actors, institutions, and populations to prepare for and effectively respond to crises; maintain core functions when a crisis hits; and, informed by lessons learnt during the crisis, reorganize if conditions require it".(17) These models demonstrated that PHC resiliency depended not only on the Health Facility (HF) but also the policies, action plans, and decision-making processes of the local health system. Thus, the team determined that multiple levels of the health system, namely community health, HF, district, and provincial levels should be included in our study population, particularly for qualitative data collection. So, we chose to purposefully sample districts rather than individual HFs.

For qualitative data collection, we identified two urban districts based on high and low Covid-19 incidence and death rates from publicly available data, as well as accessibility from CSM offices. Data were only available at the provincial level, thus Maputo province (which had the highest Covid-19 incidence and death rates), and Manica province (which had the second lowest Covid-19 incidence and death rates) were selected.(18) Maputo City was excluded due to its minimal comparability to other provinces in Mozambique.(19) Only one major urban district existed in each selected province and were included in the study: district of Matola and district of Chimoio.(20) In each district we then randomly selected two HFs which met the following criteria:

(1) HF offers primary health care services (level B or C in Mozambique health system structure meaning it is the first point of contact for patients receiving care).(21)
(2) HF offers all 5 areas of MCH services, including a maternity ward, and PMCTC care via community health workers, which supply an important part of PMTCT care within the country. (22)
(3) HF typically has a high flow of patients (confirmed by key informants within the MISAU).

In Chimoio, there were 7 public HFs, excluding the provincial hospital, while Matola had 20. Due to feasibility constraints, no more than 2 HFs were selected per district. For quantitative data, we selected the two provinces selected for qualitative data collection and included all districts within these provinces (Manica and Maputo provinces).

Data Collection

Quantitative: Routine, aggregated monthly data from the Health Information System for Monitoring & Evaluation (SIS-MA – acronym in Portuguese Language) database was extracted, for all districts in Manica and Maputo Provinces from March of 2018 through March of 2022. This time period was selected based on availability of SISMA data, and in order to capture all major COVID-19 waves in Mozambique, and to compare an equal number of pre-pandemic months to pandemic months (e.g., 2 years of pre-pandemic

data and 2 years of pandemic data). Data from SIS-MA was provided with authorization by the National Directorate of Planning and Cooperation.

Data was requested from SIS-MA for the following 9 MCH indicators, identified by the research team and MISAU as key indicators of Maternal and Child Health service delivery in Mozambique:

1. Number of pregnant women who completed at least one pre-natal visit (ANC1)
2. Number pregnant women who completed all four pre-natal visits (ANC4)
3. Number of institutional births in a maternity ward
4. Number of timely postpartum visits, between 1- 42 days after partum (CPP)
5. Number of first family planning visits, any age (PF1)
6. Number of DTP(diphtheria, pertussis, and tetanus)/HepB/Hib third dose vaccinations administered (DTP3)
7. Number of polio third dose vaccinations administered (P3)
8. Percent of HIV seropositive Pregnant Women who are still in treatment after 1 year
9. Percent of HIV seropositive pregnant women who get a viral load taken

Qualitative: In-depth individual semi-structured interviews were conducted with (1) the Provincial MCH managers for each province (Manica and Maputo), and (2) the district-level MCH managers in the selected districts. At each selected health facility, two focus group discussions were conducted, one with MCH nurses, and one with Mentor Mothers, who are community health workers and an important component of HIV-related MCH work.(22)

Table 1: Interview and Focus Group Discussions (FGDs)

Type of Data Collection	**Type of Provider**	**Number of Individual Interviews/ Focus Group Discussions**
Interviews	Provincial Managers	2
	District Managers	2
FGDs	MCH Nurses	4

	Mentor Mothers	4
Total		12

Focus group discussions with MCH nurses included at least one and no more than two nurses who worked in each of the five sectors of MCH at these HFs: (1) antenatal, (2) maternity, (3) post-partum, (4) family planning, and (5) children at risk. The inclusion of these sectors enabled the research team to capture multiple experiences within MCH for which the quantitative indicators selected in this study measure. FGDs conducted with mentor mothers included 4 – 10 participants, with at least two who were stationed within the health facility and two who worked in the community. Only managers, nurses, and mentor mothers who had greater or equal to six months of experience providing MCH services prior to March 2020 and greater or equal to six months of experience during the pandemic (through time of data collection) were selected for participation to ensure their ability to provide meaningful insight regarding COVID-19 impact on MCH service delivery.

All interviews and focus groups were conducted in Portuguese language, led by a Mozambican researcher, and accompanied by the author, an American graduate student who had previously lived and worked for one year in a rural district of Manica province, Mozambique and speaks Portuguese. Interview and FGDs were conducted in closed, private spaces within health clinics, district and provincial offices, and questions focused on the experience of MCH providers and managers throughout the Covid-19 pandemic and their perceptions of the barriers and facilitators to delivering MCH care throughout the pandemic (Appendix C). The interview and FGD guides were reviewed and revised by Mozambican co-investigators to ensure language and cultural appropriateness. All interviews and focus groups were audio-recorded and transcribed in Portuguese.

Data Analysis and Management

Quantitative analyses explored percent change to monthly averages from pre-pandemic to pandemic years and examined the trends for the 9 selected MCH indicators at provincial and district levels across all districts in Maputo and Manica provinces from March 2018 through March 2022. Descriptive statistics, time-series and LOESS trend graphs were produced using R software. (23–25) Health facility level data was also examined to flag potential data quality issues at the district-level but was not utilized in the final analysis. Across all data, zeros were removed given inability to distinguish true zeros versus those that were written to signify lack of reporting at the HF level in Mozambique. Thus, graphical representations and analyses may underestimate reductions to selected indicators, particularly for small and rural HFs or stockouts.

Qualitative: A thematic analysis and an iterative coding process was selected to capture themes based on the research questions as well as unexpected themes which emerge from the data.(26–28) A preliminary codebook was developed based on the Kruk resiliency model and interview guides (Appendix B). Then, four transcripts were preliminarily coded by two coders, followed by revisions to the codebook. The revised codebook was used to code the rest of the transcripts. All coding was conducted in Portuguese language using Dedoose software, and intercoder agreement was reached through a consensus approach. (29,30) Final thematic analysis and selected quotes were translated into English language.

Mixed Methods Integration

After all analyses were complete, perceived barriers and facilitators to MCH service delivery were integrated to help explain and complement quantitative results. (14)

Ethics Approval

Ethical Approval for this study was obtained from the Mozambique National Committee for Bioethics in Health (Ref No: 145/CNBS/2022) and received exempt status from the Institutional Review Board of the University of Washington, USA, (Ref No: STUDY00016782). In addition, the use of research data collection sites and received administrative approval by the Mozambican Ministry of Health. Individuals who participated in the study did so voluntarily and provided written informed consent. No financial awards were provided to participants, however nurses and mentor moms who participated were provided lunch, as FGDs frequently fell during their lunch hour.

Results:

Quantitative results:

For **Aim 1**, we obtained and analyzed data for Manica and Maputo Provinces across all districts, for all indicators except the two HIV-related indicators which were not accessible to MISAU at the time. Overall, reductions were noted in all but two of the seven remaining MCH indicators.

First family planning visits (-14.72%), post-partum visits (-4.87%), DPT3 (-8.13%) and polio 3rd dose (-8.07%) vaccines all demonstrated reductions for the year of 2020 compared to the previous two years, and for 2020-2021 combined compared to the two pre-pandemic years for aggregated data from Manica and Maputo provinces. However, first and fourth antenatal visits (+3.98% and +12.83%) demonstrated increases in monthly average per year from 2018-2019 to 2020 and from 2018-2019 to 2020-2021 (Figure 1). Reported institutional births dropped only in aggregated Manica Province data and post-partum visits remained stable in Chimoio City.

Except for several indicators in Manica Province, the magnitude of percent reductions diminished between 2020 and 2020-2021 combined, demonstrating recovery in 2021 (Figure 1). The magnitude of

change from pre-pandemic to pandemic years was generally greater in aggregated Manica Province compared to the district of Chimoio, whereas it was generally greater in the district of Matola compared to aggregated Maputo province. First family planning visits showed the greatest reductions for a single indicator, with a drop in Manica Province of -20.4% for 2020-2021 compared to 2018-2019.

Figure 1: Percent change from pre-pandemic monthly average (2018-2019) to pandemic average (2020; and years 2020-2021 combined)

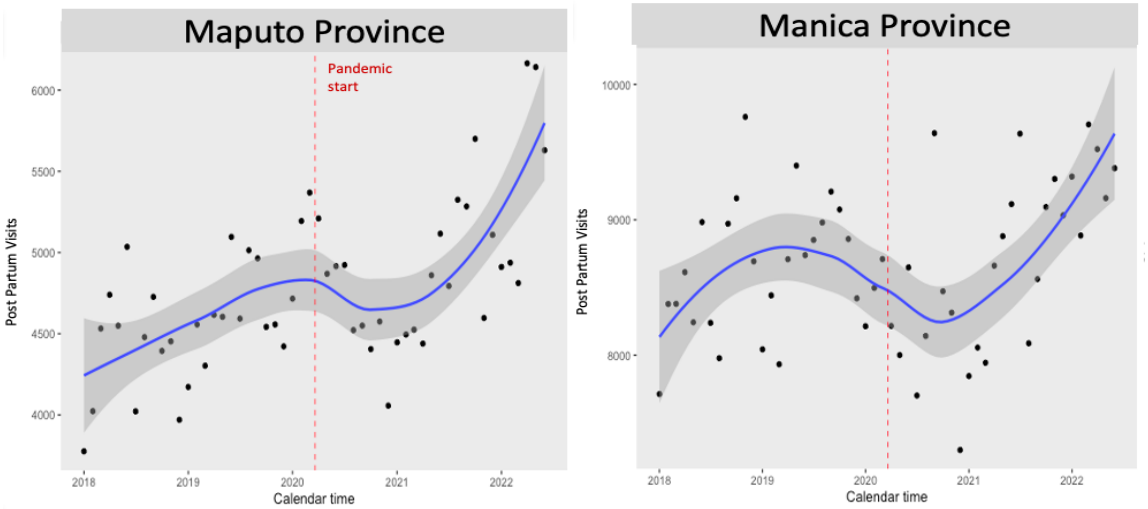
	1st Antenatal Visit		4th Antenatal Visit		Inst. Births		Post-Partum Visit		1st Family Planning		Polio3 Vaccine		DPT3 Vaccine	
Location	20'	20'-21'	20'	20'-21'	20'	20'-21'	20'	20'-21'	20'	20'-21'	20'	20'-21'	20'	20'-21'
Manica Province	1.5%	-0.3%	8.4%	10.0%	-5.1%	-3.9%	-5.7%	-4.7%	-18.9%	-20.4%	-10.3%	-10.4%	-10.3%	-11.2%
District of Chimoio	11.0%	9.1%	3.1%	7.9%	1.7%	5.7%	6.4%	13.2%	-14.7%	-6.4%	-15.4%	-8.4%	-6.5%	-1.7%
Maputo Province	10.1%	12.4%	21.7%	30.9%	3.5%	5.9%	-1.7%	-0.6%	-5.7%	-2.5%	-4.5%	-1.2%	-4.7%	-1.6%
District of Matola	21.8%	23.3%	41.2%	56.8%	2.7%	5.3%	-1.2%	-4.1%	-14.9%	-14.6%	-7.8%	-2.7%	-7.8%	-3.1%
Provinces, Total	**4.0%**	**3.6%**	**12.8%**	**17.0%**	**-2.6%**	**-0.9%**	**-4.9%**	**-3.8%**	**-14.7%**	**-14.7%**	**-8.1%**	**-6.9%**	**-8.1%**	**-7.5%**

% Increase from pre-pandemic average

% Reduction from pre-pandemic average

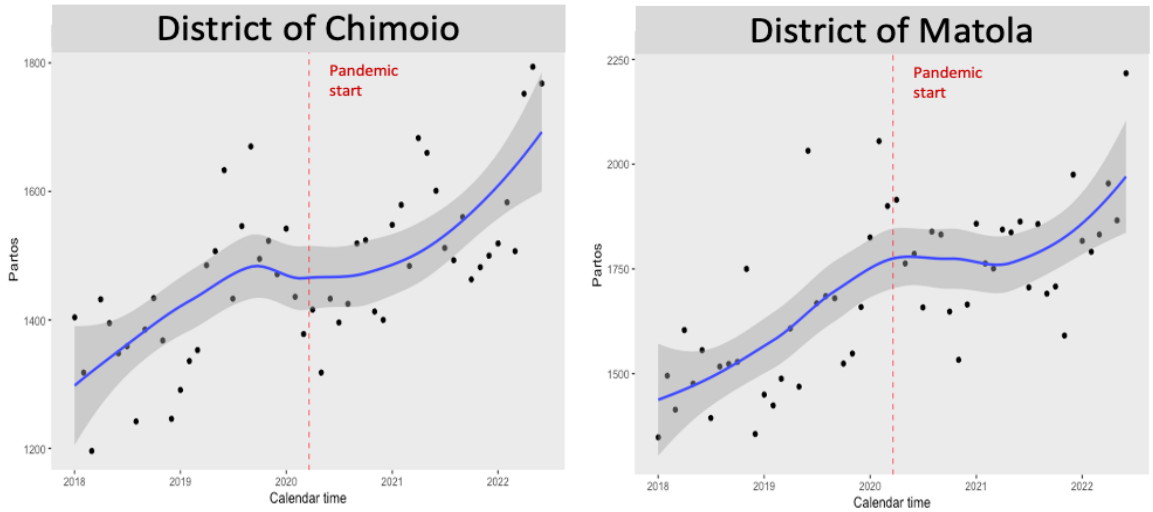
Estimated trends for first family planning visits, institutional births, post-partum visits, first antenatal visits, Polio3 and DPT3 in multiple locations showed reductions around the beginning of the pandemic and recovery in late 2021 and early 2022. For example, estimated trends for post-partum visits demonstrate this pattern in both Manica and Maputo Provinces (Figures 2-3), and in the district of Matola, but *not* in the district of Chimoio. All estimated trend lines include 95% confidence intervals.

Figures 2-3: Estimated trend lines (95% CI) for number of post-partum visits in Maputo (left) and Manica (right) provinces; 2018 – March 2022.



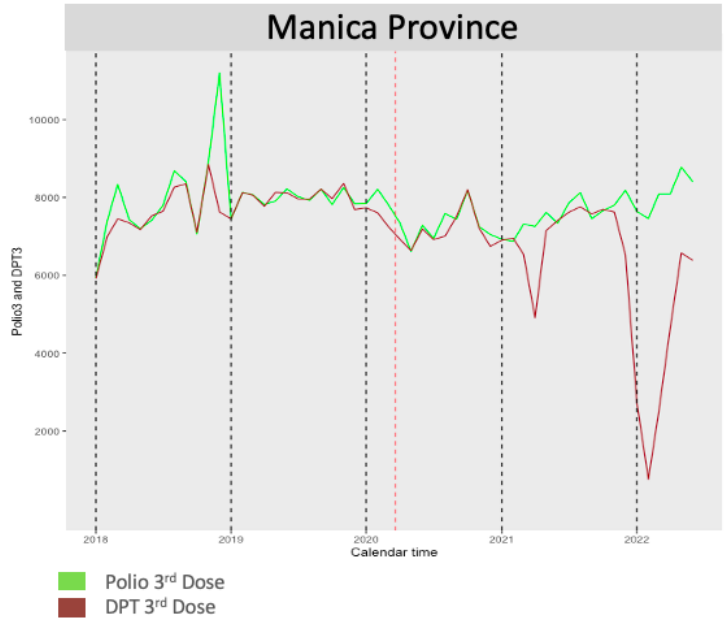
Although first antenatal visits and institutional births increased on average from pre-pandemic to pandemic years, these indicators demonstrated temporary reductions at the start of the pandemic for the districts of Matola and Chimoio (Figures 4-5), and Manica Province. Similarly, despite increases in fourth antenatal visits from pre-pandemic to pandemic years, estimated trend lines showed temporary reductions at the start of the pandemic in Manica Province and in the district of Chimoio.

Figures 4-5: Estimated trend lines (95% CI) for number of institutional births in the district of Chimoio (left) and district of Matola (right); 2018 – March 2022.



Polio3 and DTP3 vaccinations showed drops in estimated trends around beginning of the pandemic and in some cases showing reductions which began prior to March 2020 and persisted after the start of the pandemic. In addition, reductions in DTP3 occurred in Manica Province and the district of Chimoio (Figure 6), without similar reductions in DTP3, suggesting possible supply chain issues or stockouts for DTP3 vaccine.

Figure 6: Time series graph of Polio3 and DTP3 vaccines in Manica Province; 2018 – March 2022.



Trend graphs for all indicators and locations are available in Appendix D.

Qualitative Results:

A total of 55 individuals participated in interviews (n=4) and FGDs (n=51). Qualitative analysis revealed 11 major themes which were divided into barriers (7) and facilitators (4) to MCH service delivery during the pandemic:

Table 2: Perceived barriers and facilitators to MCH service delivery during the pandemic

Barriers	Facilitators
1. Fear of catching Covid-19 in health facilities (providers and patients)	1. Public health communication campaigns with community, and community leaders
2. Insufficient Personal Protective Equipment (PPE) in health facilities	2. Self-efficacy and belief in importance of their work
3. Insufficient preparedness and training in relation to new responsibilities, pandemic strategies and knowledge.	3. Communication networks and rapid inter-level communication
4. Poor health facility infrastructure	4. Teamwork and colleague support
5. Insufficient Human Resources in health facilities	
6. Insufficient financial support for phone credit and transportation	
7. Patient socio-economic situation	

Barriers to MCH service delivery during COVID-19:

1. Fear of catching Covid-19 in health facilities (providers and patients) was a common barrier across all qualitative data groups (nurses, managers, mentor mothers). This fear was described as having affected both the quality of MCH service provision, such as in the quote by an MCH nurse below:

> *We no longer spent much time with the patient. We didn't give all that attention anymore, right. Maybe we should have, but with a limit because you think 'the longer I stay with this patient I'm going to contract [Covid-19], so we didn't stay there for long.* - Nurse

Also in quantity, such as the quote below by a Mentor Mother:

> *Our work was affected because we had many missed appointments, poor adherence, we even had [HIV-ART] drop-outs … the population in general was afraid to come to the health center because it was here where Covid-19 was tested.* - Mentor Mother

Although providers described fear as affecting the care-seeking habits of patients, they also described how this behavior was temporary, corroborating the reduction and recovery pattern of many indicators assessed in our quantitative results:

> *The influx of patients was very reduced. But then when we started to adopt that appointment marking situation [trimestral instead of monthly, by appointment], the influx was kind of a thing… people started coming again knowing that the hospital wasn't very full.* - Nurse

> *When the first cases occurred, many [people] didn't leave the house, they didn't leave, because of fear. Because of this, we had a lot of missed appointments, but afterwards, sensibilizing over the phone, that yes you can come to the health facility, enter with a mask and there is a bucket to wash your hands. The moms came.* – Mentor Mother

Notably, fear of catching Covid-19 as a provider in the workplace was discussed more often among MCH managers and nurses compared to Mentor Mothers.

2. Insufficient Personal Protective Equipment (PPE) in health facilities

Insufficient PPE was described often and across all interviews. Specifically, this insufficiency was described as occurring in the workplace for providers in health facilities, and sometimes with regards to patient access to PPE. The phenomenon of insufficient PPE was much more common among the nurse and manager groups compared to the Mentor Mother group.

> *There were problems with materials, alcohol, gloves, masks. We had a lot of difficulty in the beginning. Principally alcohol (gel), and bleach. I don't know how long it's been since I've seen bleach. Since the [start] of the pandemic until now… or more years… or before the pandemic… we work with a lot of difficulties. Like my colleague said, it's love of the uniform… We didn't risk anything, but still in this case all of us here got Covid-19.* - Nurse

Mentor Mothers described receiving material support in PPE more frequently than nurses and managers, and their descriptions for lack of material were more often concerned with the ability to support their patients (e.g., provide their patients with masks, alcohol, or food).

> *I have a mask [provider], and they don't [patient]… and you feel bad. The feeling is then to take off that mask. So, if there were an opportunity for us … to be able to give [to] people in the community*… - Mentor Mother

3. Insufficient preparedness and training in relation to new responsibilities, pandemic strategies and knowledge was a common barrier, but particularly among nurses and managers. Nurses and managers

described feeling uninformed in how to manage Covid-19 patients and ill-prepared when the first cases of Covid-19 arrived, particularly regarding COVID-19 isolation space for maternity ward patients. They described receiving some virtual trainings relating to Covid-19 in the early months of the pandemic but noted these as insufficient.

4. Poor health facility infrastructure was discussed across all groups in a variety of ways, from basic needs like electricity, flooding, and roads near the HF, to number of ambulances, isolation spaces, social distancing, and the number of beds and chairs for providers and patients. Generally, these issues were described as existing problems but which, in the context of Covid-19, were exacerbated. Participants illustrated how a small room in the HF might have 2-3 nurses, a mentor mom, patients and the partners of patients. They recounted isolating suspected Covid-19 patients in maternity wards with a curtain. They also detailed structural problems:

> *For example, at night, it's not possible to work with a candle on one side, the other side you're attending a mother, so I think we need a generator… [it's] not just energy blackouts, [also] running out of credilec…* (paid energy service in Mozambique). - Nurse

> *On days with rain we don't have the conditions to work… When we arrive, we have to first clean up [water] and only after that we can attend [patients]. If it continues to rain, the flooding doesn't stop, and we can't work well.* - Nurses

5. Insufficient Human Resources in health facilities were reported as having negatively affected provider ability to deliver quality care. For example, multiple rooms within the HF attended by 1-2 nurses, who had to prioritize and cut short time spent with patients. In some cases, this insufficiency was exacerbated by insufficient space, where nurses and mentor mothers worked at the same time, in the same room with the same patient, but due to nurse desire to attend the next patient quickly, Mentor Mother time spent with patients was cut short (such as conversations after a positive HIV test). Further, insufficient human resources impacted provider ability to stay home while sick. Nurses

described the normality of an entire shift being positive with COVID-19 but having to work if their symptoms weren't grave.

> *There, it's just one nurse. So the quality of these services… leave you wanting… [for example] the baby that comes back in less than 24 hours with eyes totally inflamed, but he just left the maternity ward… But she [the nurse] wasn't able to pay attention because she was busy with that pregnant women sitting over there screaming…* - Manager

6. Insufficient financial support for phone credit and transportation was a common theme among participants, who explained how they often had to adapt, borrow from others, and/or use limited personal funds for work-related communication, such as between managers and head nurses and mentor moms for contacting patients. The same was discussed in terms of work-related transportation, particularly for mentor mothers who worked in the community and had to travel (by bus) to see their patients. Existing subsidies for communication and transportation were mentioned but proclaimed insufficient.

> *It was 15 [meticais] to go and get off [the bus]. After, the patient tells you "catch another bus and get off at site X", so then adding from there I've already gotten on two buses, then from there to here… it's more money. Monthly, the money [subsidy] never lasts.* – Mentor Mother

7. Poor patient socio-economic situation was described as having affected the provider-patient relationship and thus the ability to deliver quality MCH care. This issue was especially voiced among Mentor Mothers. For example, while their objective was to achieve proper adherence to ARTs among patients, requesting adherence when the patient didn't have food to accompany the medication was described as inappropriate and damaging to the patient-provider relationship. Thus, Mentor Mothers expressed the necessity, and difficulty of using personal money to purchase food or transport for their patients.

> *The truth is she isn't [adhering to medication], not because she doesn't want to, but because she doesn't have anything to eat to be able to adhere to that medication…* – Mentor Mother

Facilitators to MCH service delivery during COVID-19:

1. Public Health Communication strategies with community, and community leaders were commonly expressed as important for relaying information to the population during the pandemic and for understanding population concerns and knowledge of COVID-19. These existing mechanisms included public radio announcements, megaphone announcements, and a leadership committee for each HF made up of health professionals, community leaders, religious leaders, and traditional healers ("Comité de Cogestão" in Portuguese).

2. Self-efficacy and belief in importance of their work was described as critical among providers for achieving their daily tasks and ensuring population health didn't deteriorate during the pandemic. Nurses spoke of "the love of the uniform" despite great challenges, and Mentor Mothers discussed their personal connection to their patients and determination to not let other mother's health or lives deteriorate due to HIV. Managers spoke of finding ways to adapt and manage stressful or limited resource situations in order to prioritize the health of patients most in need. Although this was a common facilitator among all groups, mentor moms spoke more frequently regarding the believe in value of their work compared to other groups.

> *We have that courage to face, even with fear, face and go to her house and encourage her too… in order to not [let her] miss [ART medication] because we are in a pandemic and must continue to medicate… yes! – Mentor mother*

3. Communication networks and rapid inter-level communication were perceived as facilitators of continued service delivery throughout the pandemic, particularly among managers and nurses. WhatsApp groups were described as helpful for quickly relaying new information, policies, and procedures, as well as assessing resource needs and addressing provider uncertainties. These WhatsApp groups were explained as existing mechanisms adapted for Covid-19 purposes, and as one strategy for, but not a solution to, the barrier of insufficient phone credit for work-related communication. Inter-level

(provincial, district, HF) communication, often by phone call or text, was described as helpful for rapidly addressing work-related concerns brought by the pandemic thus leaving providers more confident in their tasks.

> *So, this closeness with colleagues, this security left the colleagues firmer [with more courage] to advance and to lose the fear of being in front of a patient with Covid.* – Manager

4. Teamwork and colleague support, typically within same-level teams (e.g., MCH nurses at a HF or the team of Mentor Mothers at a HF) was a common facilitator across all participant groups. Types of support included emotional encouragement and working together to manage limited resources for the benefit of the team. For mentor moms, this was described as prioritizing and sharing transportation subsidies to ensure that mentor moms with patients who lived farthest could get to those patients early in the month before subsidies ran out. For nurses and managers, this was support in lending limited material resources or phone credit to colleagues or other HFs in immediate need. One manager gave the following example:

> *There were times we managed to call to another health facility, I call, I say for example "HF A is without, for example, doesn't have Oxytocin, for example, who can help in this moment?" One health facility says that "I can give 5", another says "I can donate 3", another "2".* - Manager

Discussion:

The quantity of most MCH services we measured were reduced during the COVID-19 pandemic in Manica and Maputo provinces, Mozambique, and in Matola and Chimoio cities specifically. Quality of MCH service delivery was also likely reduced in these cities. The biosafety of patients and providers due to insufficient PPE or health facility infrastructure was likely compromised, and reduced time spent between patients and providers due to fear and human resource deficiencies may have negatively affected the quality of services during the pandemic. Perceived barriers such as lack of PPE and

infrastructure, as well as providers actively working while sick may have contributed to widespread fear of health facilities.

Qualitative findings offer some explanation to reductions in quantity of services, such as patient fear of going to the health center. However, lack of reduction to antenatal services and institutional births suggests that Mozambican mothers in urban areas of Manica and Maputo Provinces may have viewed these services as more necessary compared to family planning and infant vaccinations. Stockouts may offer another explanation for reductions in infant vaccinations. Differences in magnitude of impact to MCH services by province or district may be explained by factors such as distances to HF's in Manica versus Maputo province, (19) higher incidence rates of Covid-19 in Maputo province, (18) cultural differences, and possible variation in presence of NGO's. Results showing that mentor mothers expressed discontent less often than nurses and managers regarding insufficient PPE suggest that the NGO's who oversaw mentor mother programs may have had greater access or capacity to provide their staff with PPE than the national health system, which oversaw HF resources and district and provincial offices. Further research is necessary to assess factors which contributed to PPE deficiencies, including potential power and/or resource imbalances between the Mozambican state and NGOs in Mozambique within the global supply chain.

Our results aligned with previous studies in Mozambique and sub-Saharan Africa, demonstrating reductions in first family planning visits and infant (Polio3 and DTP3) vaccinations during the pandemic.(4,10) However, in contrast to the Augusto et. al. study of MCH service delivery in Mozambique, which estimated at least 10% losses during the pandemic for first antenatal visits, institutional births, and post-partum visits, (12), our study demonstrated increases in average counts for similar indicators. Several factors may contribute to these differences, namely 1.) methodology: our

study compared actual counts of pre-pandemic to pandemic years while Augusto et al. utilized a model to compare predicted and actual counts; 2.) our study included data through March of 2022 while previous studies assessed data through March of 2021; and 3.) the nine provinces excluded in our study may have varied significantly from Manica and Maputo provinces.

Increases in first and last ANC visits, and institutional births shown in our results may have still been relative losses compared to what was predicted. Further, relative losses shown in previous studies may have been concentrated within the first year of the pandemic, followed by recovery in late 2021 and 2022. Additionally, the lack of reduction in multiple MCH indicators during the pandemic and trends demonstrating recovery in late 2021 to early 2022, paired with perceived facilitators described by MCH providers and managers suggest high individual, team-level, and district-level resiliency and adaptability during the pandemic. High self-efficacy and adaptive solutions to share limited resources and to communicate information quickly may have minimized potentially greater reductions in quantity and quality of MCH service delivery, thus limiting potential impact on morbidity and mortality of women and children.

Limitations:

Neither quantitative or qualitative data utilized representative samples and thus are not generalizable to a wider population. Even within the urban districts selected, health facilities vary in size, type, and culture, thus limiting the extent to which qualitative findings can represent the entire district. Given that Mozambique has a vast rural population and much of PHC delivery is conducted in rural HFs, (19) this is a key perspective missing from this study. Future research should include rural, as well as patient perspectives. Further, unexpected delays in receiving quantitative data prevented researchers from including questions relating to quantitative findings in individual interviews and FGDs.

Another limitation was the lack of data for two HIV service indicators (% of HIV-positive pregnant women who are still in treatment after 1 year; and % of HIV-positive pregnant women who get a viral load taken). PEPFAR (U.S. President's Emergency Plan for AIDS Relief) had this data and was not accessible to MISAU at the time. Additionally, data for this study included only two years prior to the pandemic therefore limiting assumptions for trends. Trend calculations used LOESS regression models, which are most accurate when data sets are large and densely sampled.(25) At the district level, fewer HF data points and high variability limited effectiveness of the models.

Additional limitations include two instances where MCH manager interviews were conducted with a substitute while the original manager was on leave. In these instances, we elected to continue the interview given the substitute had worked closely with the true manager for 6 months prior to the pandemic and had worked as substitute for at least 6 months during the pandemic. However, this inclusion may limit validity of managerial perspectives regarding early pandemic barriers and facilitators. Secondly, interviewees at multiple levels demonstrated hesitancy in discussing work conditions and about their superiors, which may have limited honesty and contributed to information bias during data collection. Despite these limitations, we believe our study provides new, in-depth, and important insights on the impact of COVID-19 on MCH service delivery and on the barriers and facilitators to achieving health care resiliency in Mozambique.

Conclusion:

Results from this study demonstrate high resiliency among individuals and teams of MCH providers, driven by self-efficacy, adaptive solutions and communication networks. However, achieving greater health system resiliency in urban areas of Manica and Maputo provinces will require a focus on improving basic

health facility infrastructure, ensuring equitable and coordinated NGO support of health programs (including government-run services), and meeting the material and human resource needs of health providers.

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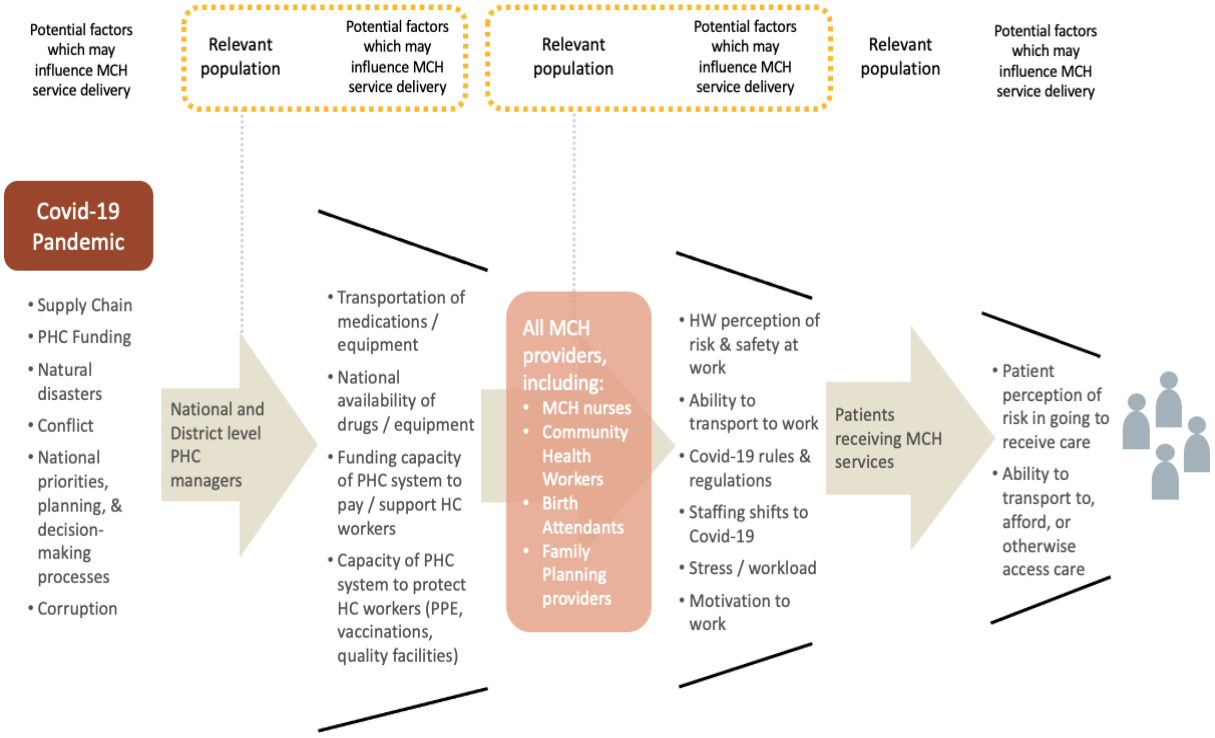
APPENDECES

Appendix A: MCH Service Delivery, Covid-19 Resiliency – Conceptual Model

Figure 1. MCH Service Delivery, Covid-19 Resiliency - Conceptual Model



Appendix B: Kruk Resiliency Model

This conceptual model is adapted from Kruk, et al [15]. This model identifies specific **characteristics of a resilient system** which measure the degree to which governments and ministries of health officials and managers are:

1. **Aware** (know their health system capacity; risks, population; communication plans),
2. **Diverse** (effectively respond to a diverse range of health needs, with adequate financing),
3. **Self-regulating** (isolate threats and maintain core functions; leverage outside capacity),
4. **Integrated** (coordinate with non-health actors & engaged citizens to build trust);
5. **Adaptive** (shift resources to meet needs; promote rapid local decision making; evaluate/ improve)

Appendix C: Interview and Focus Group Discussion Guides

Interview and Focus Group Guides were written in Portuguese language and utilized in Portuguese language. English translations are not available at this time.

Guia de Entrevista em Profundidade: Gestores Distritais e Províncias (45 minutos)

O investigador se apresentará e explicará os objetivos de estudo e esclarecerá quaisquer dúvidas que o participante possa ter sobre a pesquisa antes de começar a entrevista. A entrevista será realizada após obtenção e documentação do consentimento do entrevistado.

I. Perguntas de introdução

1. Pode descrever o seu trabalho e como está envolvido na gestão/supervisão da prestação de serviços de Saúde Materno-Infantil (SMI)?

2. Pode me-falar sobre sua experiência na gestão/supervisão dos serviços SMI durante a pandemia da COVID-19?

3. Pela sua própria experiência ou pelo que ouviu de outros, quais foram alguns dos fatores durante a pandemia da COVID-19 que afetaram a prestação de serviços de SMI?

II. Perguntas sobre como a geração e implementação de serviços de SMI durante o Covid-19

4. Como ocorreu a tomada de decisão e a comunicação durante a COVID-19?

5. Até que ponto e quando estava a par dos planos de emergência, da mudança de responsabilidade, e dos planos de comunicação?

6. De que forma o distrito/província foi capaz de dar apoio aos profissionais de saúde do programa de SMI para garantirem a continuação do trabalho durante a pandemia da COVID-19?

III. Perguntas sobre recursos e mecanismos para continuação de serviços de SMI durante Covid-19

7. Como classificaria a capacidade e recursos a nível distrital ou provincial para interpretar os dados locais e tomar decisões operacionais rápidas durante a COVID-19? O que poderia ter melhorado tal capacidade e tais recursos?

8. Como fazem para saber se as atividades que fazem no âmbito da oferta dos serviços de SMI (Novas diretrizes, regras, atividades adicionais) estão sendo feitas como esperado?

8. Quão adequado foi o financiamento para apoiar a prestação de serviços de SMI durante a pandemia a nível provincial, distrital e das unidades sanitárias?

    a. Quais foram as disposições realocar os fundos em situação de emergência? (disposições formais OU informais de realocar fundos)

9. Quão bem a sua província/distrito compreendeu e respondeu às necessidades da comunidade local durante a vigência das medidas para responder à COVID-19? Que plataformas de comunicação usou com a população / líderes comunitários?

10. Como geriu as mudanças de responsabilidades de trabalhadores durante a Covid-19 ou a colaboração com clínicos privados ou ONGs?

IV. <u>Perguntas sobre os possíveis passos / soluções para alcançar resiliência</u>

11. Se você pudesse fazer algo que garantir o funcionamento normal de SMI durante a pandemia, o que você teria feito?

    a. Quais mudanças você acha que o programa de SMI deve seguir para ser mais preparado?

12. Na sua opinião, quais são as principais barreiras para alcançar a resiliência a potenciais perturbações ao sistema de saúde no distrito X/ província Y?

13. Quais foram os facilitadores? O que correu bem que ia repetir numa futura pandemia em relação de garantir a continuação dos serviços de SMI?

<u>Guia de Discussão do Grupos Focais:</u> Enfermeiras e Mães Mentoras

Um Grupo Focal incluirá de 4 até 10 participantes (4-8 mães mentoras e 5-10 enfermeiras). O investigador se-apresentará e explicará os objetivos de estudo e esclarecerá quaisquer dúvidas que o participante possa ter sobre a pesquisa antes de começar a entrevista. A entrevista será realizada após o consentimento do entrevistado em participar.

I. <u>Perguntas de introdução</u>

1. Pode descrever sobre os seus trabalhos em prestar serviços de SMI aqui?

2. Na vossa opinião, o que, em geral, ajuda no vosso trabalho e na capacidade de fornecer serviços de SMI de alta qualidade neste centro de saúde?

3. Na vossa opinião, o que em geral dificulta ou limita a vossa capacidade de oferecer serviços de qualidade?

II. <u>As suas experiências no seu ambiente de trabalho durante a pandemia de Covid-19</u>

4. Em Moçambique, a COVID-19 teve **3 ondas**, com a primeira em Janeiro e Fevereiro de 2021, a segunda em Julho até Agosto de 2021, e a terceira em Dezembro até Janeiro de 2022. Também, tive vários períodos em que escolas, e alguns serviços e lojas foram fechados. Podem falar da vossa experiência em prestar serviços de SMI durante a essas ondas ou tempos que tinha restrições ou fechamento?

5. O que vocês passaram para oferecer serviços de SMI que foi diferente durante a pandemia do que passaram antes da pandemia?

6. Tiveram mudanças na vossa capacidade de oferecer serviços de SMI durante a pandemia da COVID-19?

   Aprofundar:
   - Se sim, que serviços específicos da SMI foram afetados?
   - Como e por que estes serviços foram afetados e não outros?

7. Tiveram alguma mudança na vossa motivação para oferecer serviços de SMI quando a pandemia começou?

   Aprofundar: (se sim) O que acham que causou a sua mudança de motivação para a realização de serviços de SMI?

8. Notaram alguma alteração na quantidade ou tipo de serviços de SMI **procurados pelos pacientes** durante a pandemia Covid-19?

   Aprofundar: Se sim, o que acham que contribuiu para estas mudanças?

9. *(Se não tiver sido abordado em respostas anteriores):* Tiveram alguma mudança de responsabilidades de trabalho durante a pandemia?

10. De que forma foram apoiados pelos gestores/supervisores na para que pudessem continuar com o vosso trabalho de SMI durante a pandemia da COVID-19?

    Aprofundar: De onde vem esse apoio? U.S / do distrito / ONG? Como se sentiram sobre esse apoio? Poderia ter mais?

11. Peço para pensarem no início da pandemia. Sabiam sobre planos de comunicação ou estratégias na vossa unidade sanitária para como responder às novas problemas trazidos pela pandemia?

12. E agora, têm conhecimento de planos ou protocolos de emergência atualmente para responder a potenciais emergências futuras (por exemplo, epidemias ou calamidades naturais)?

III. Suas perspectivas sobre as barreiras os facilitadores de fornecer serviços de saúde materno-infantil durante a pandemia

13. Com base no que viveram ou no que ouviram dos outros, o que mais limitou a prestação de serviços de SMI ou o acesso a esses serviços durante a pandemia?

14. Com base no que viveram ou ouviram dos outros, o que ajudou nos seus trabalhos durante a pandemia? O que correu bem que ia repetir numa futura pandemia em relação de garantir a continuação dos bons serviços de SMI?

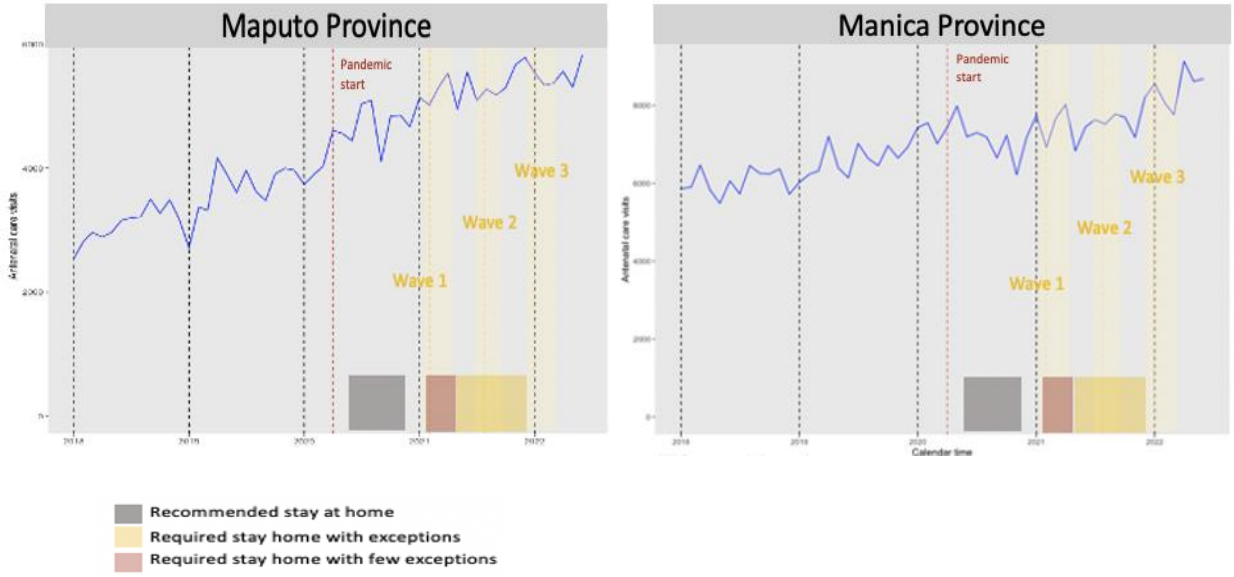
15. Na vossa opinião, quais mudanças devem ser feitas para o programa de SMI e/ou este Centro de Saúde ficar mais preparado?

Appendix D: Quantitative Graphs

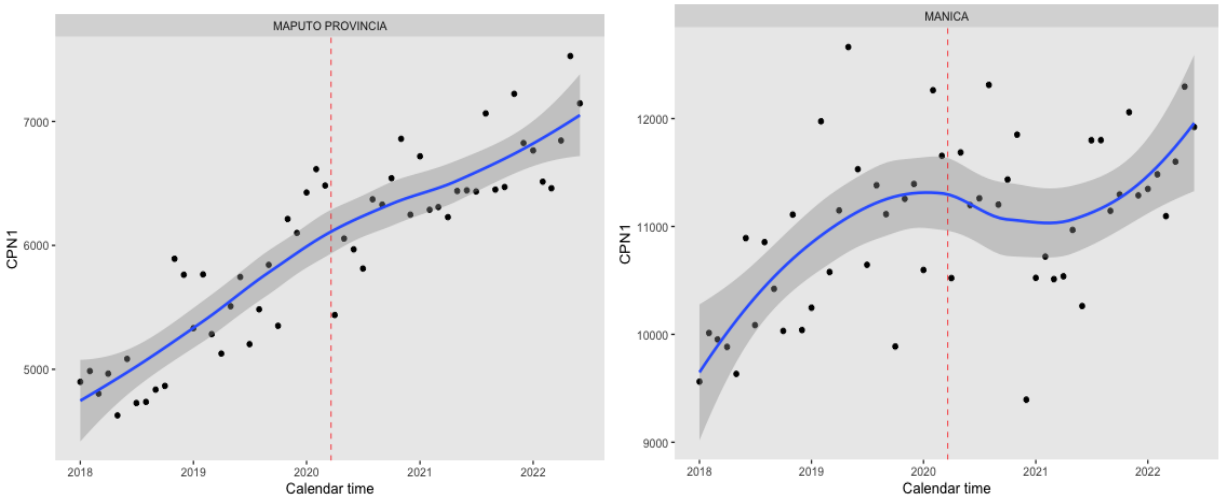
Dashed red vertical lines in graphs represent March 11, 2020, the date that the WHO declared COVID-19 a global pandemic.(31)

First Antenatal Visits:

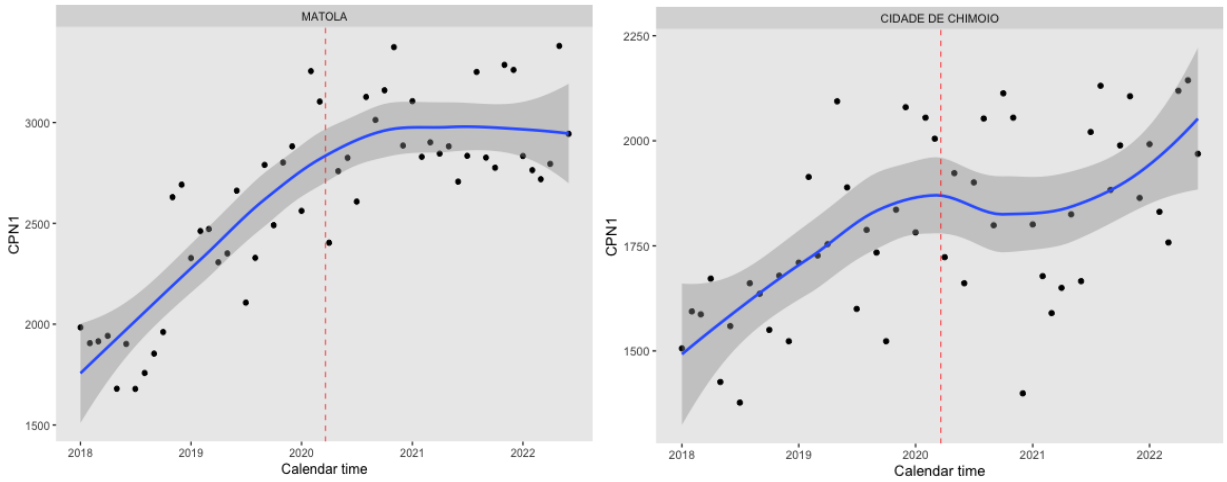
Monthly provincial aggregates for number of ANC1 visits in Maputo province (left) and Manica province (right) over time, 2018-March of 2022



LOESS regression model for ANC1 visit trends in Maputo province (left) and Manica province (right) over time, 2018-March of 2022; 95% C.I.

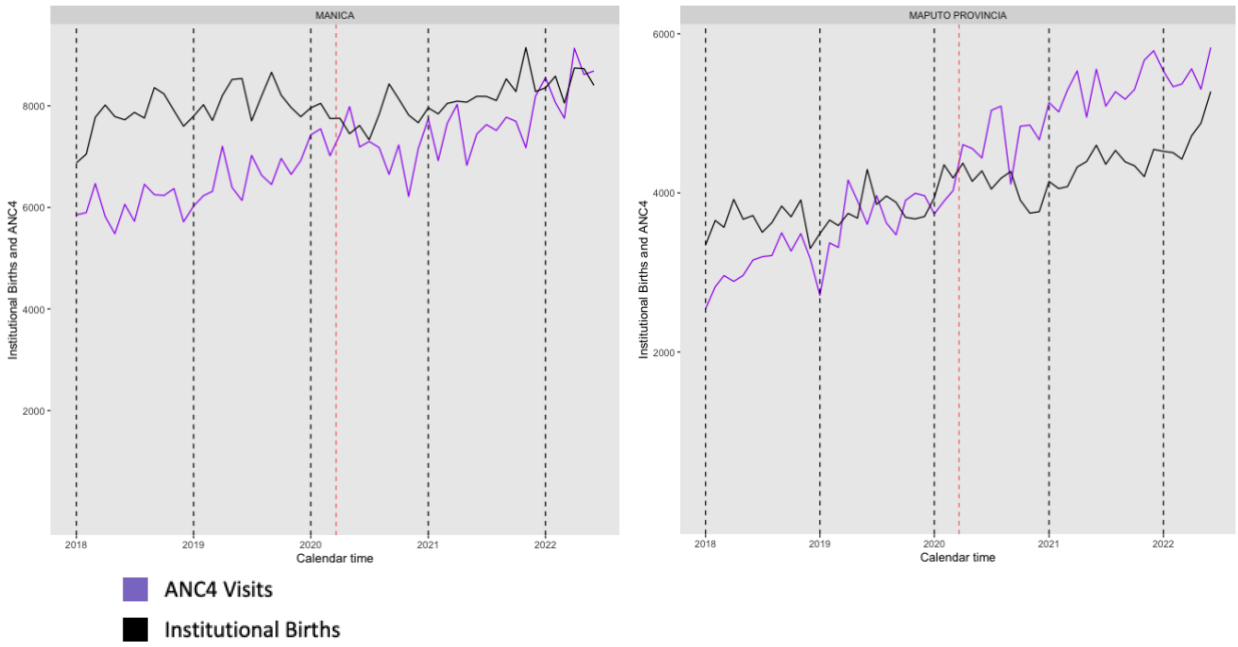


LOESS regression model for ANC1 visit trends in the district of Matola (left) and district of Chimoio (right) over time, 2018-March of 2022; 95% C.I.

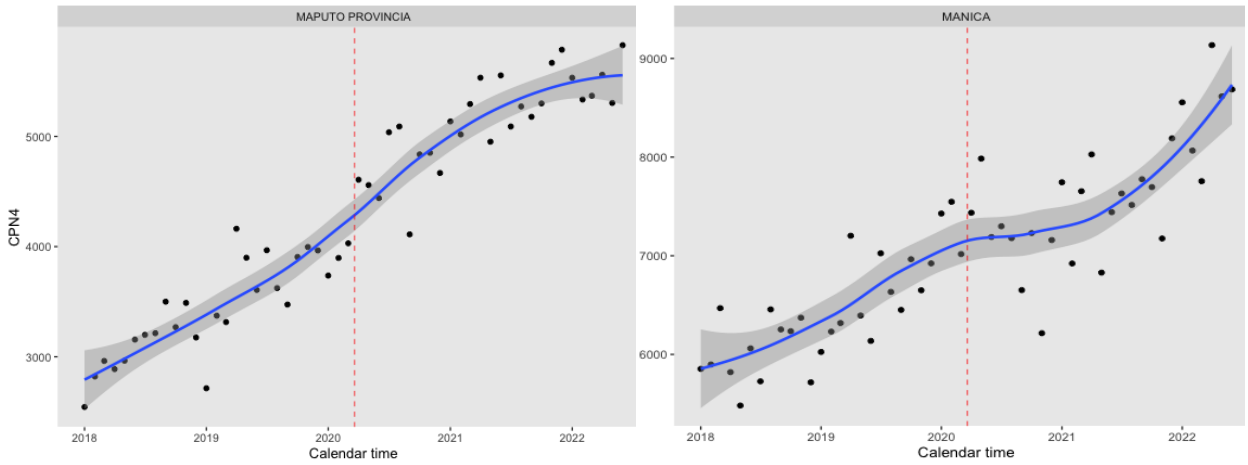


Fourth Antenatal Visits:

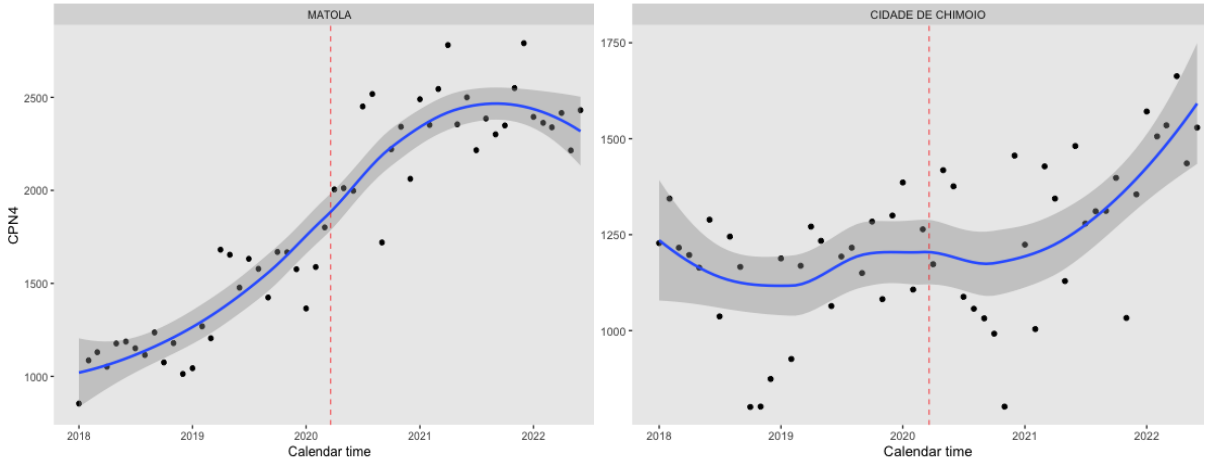
Monthly provincial aggregates for number of ANC4 visits and institutional births in Maputo province (left) and Manica province (right) over time, 2018 - March of 2022



LOESS regression models for ANC4 visit trends in Maputo province (left) and Manica province (right) over time, 2018-March of 2022; 95% C.I.

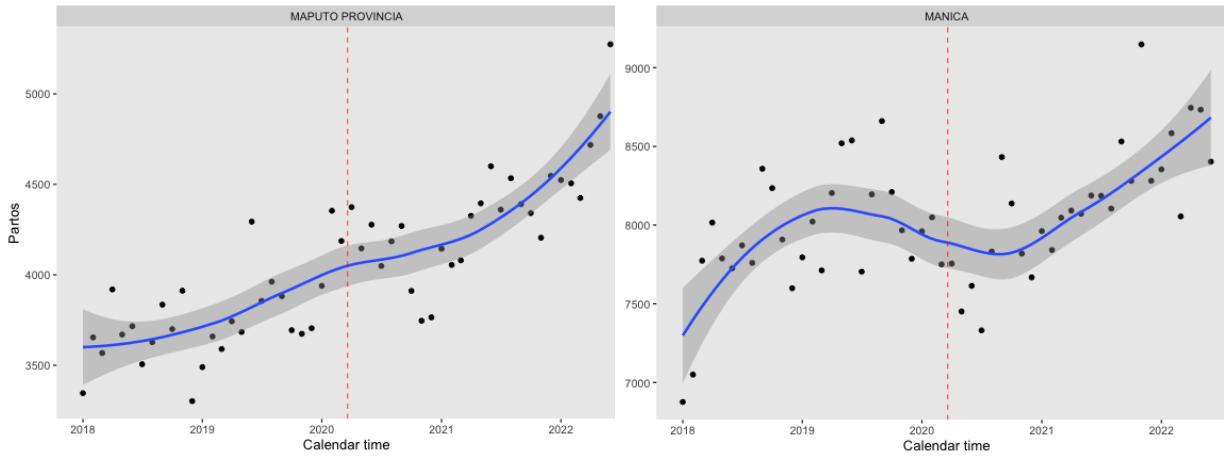


LOESS regression models for ANC4 visit trends in the district of Matola (left) and district of Chimoio (right) over time, 2018-March of 2022; 95% C.I.

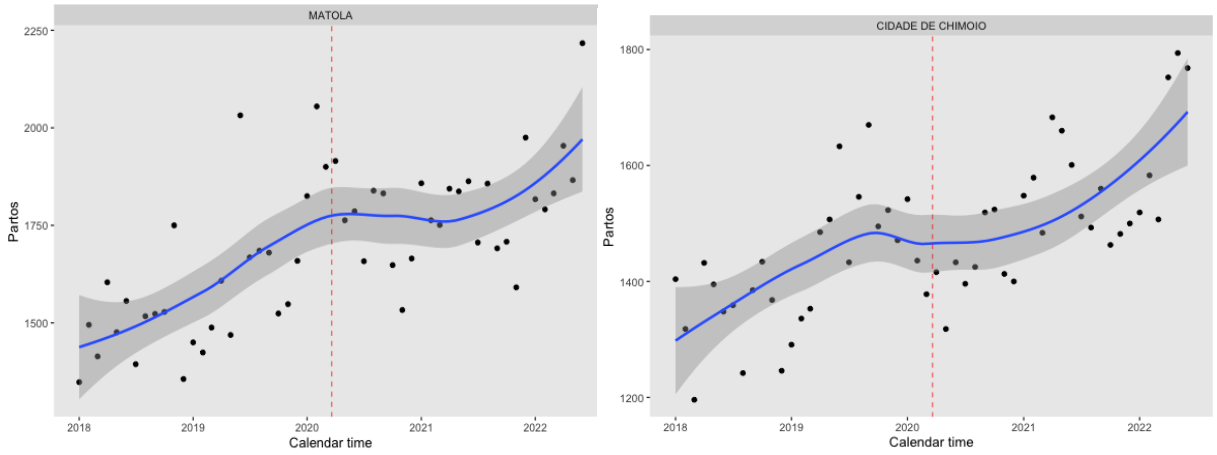


Institutional Births:

LOESS regression models for institutional birth trends in Maputo province (left) and Manica province (right) over time, 2018-March of 2022; 95% C.I.

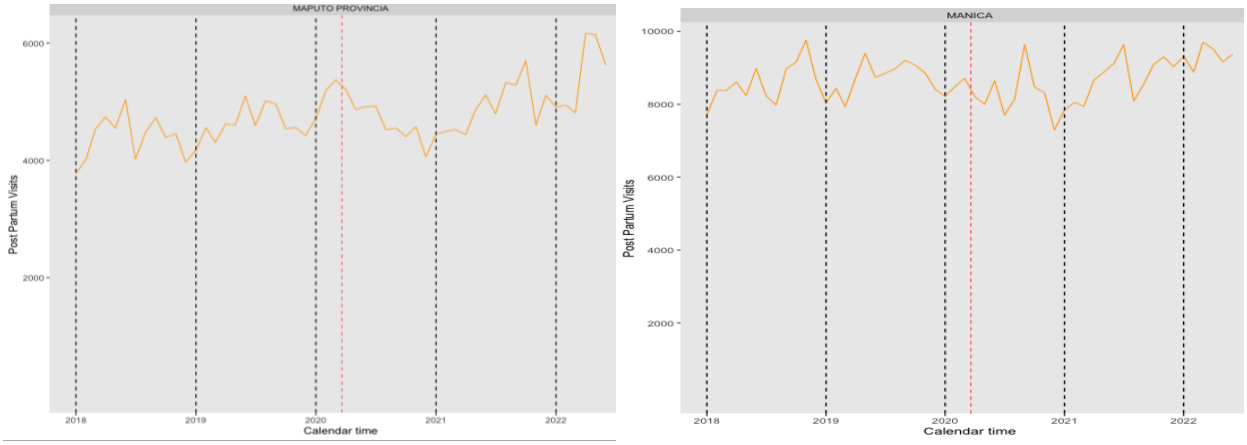


LOESS regression model for institutional birth trends in the district of Matola (left) and district of Chimoio (right) over time, 2018-March of 2022; 95% C.I.

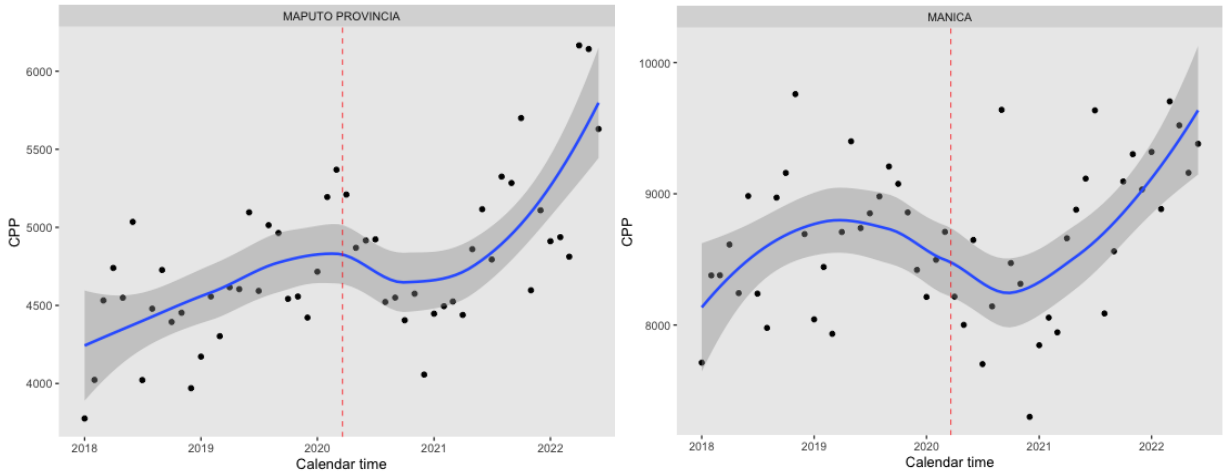


Post-Partum Visits:

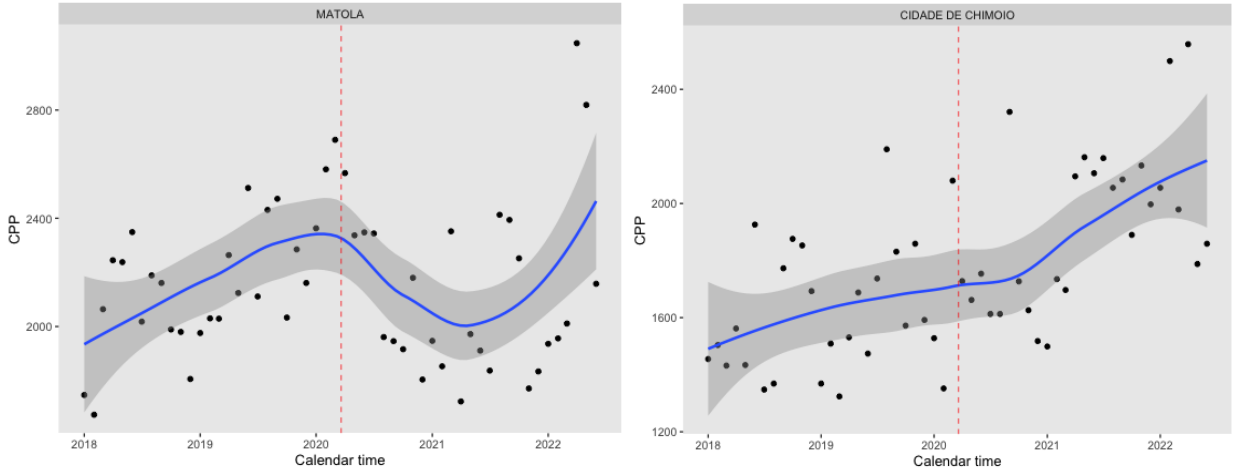
Monthly provincial aggregates for number of post-partum visits and institutional births in Maputo province (left) and Manica province (right) over time, 2018 - March of



LOESS regression models for post-partum visit trends in Maputo province (left) and Manica province (right) over time, 2018-March of 2022; 95% C.I.

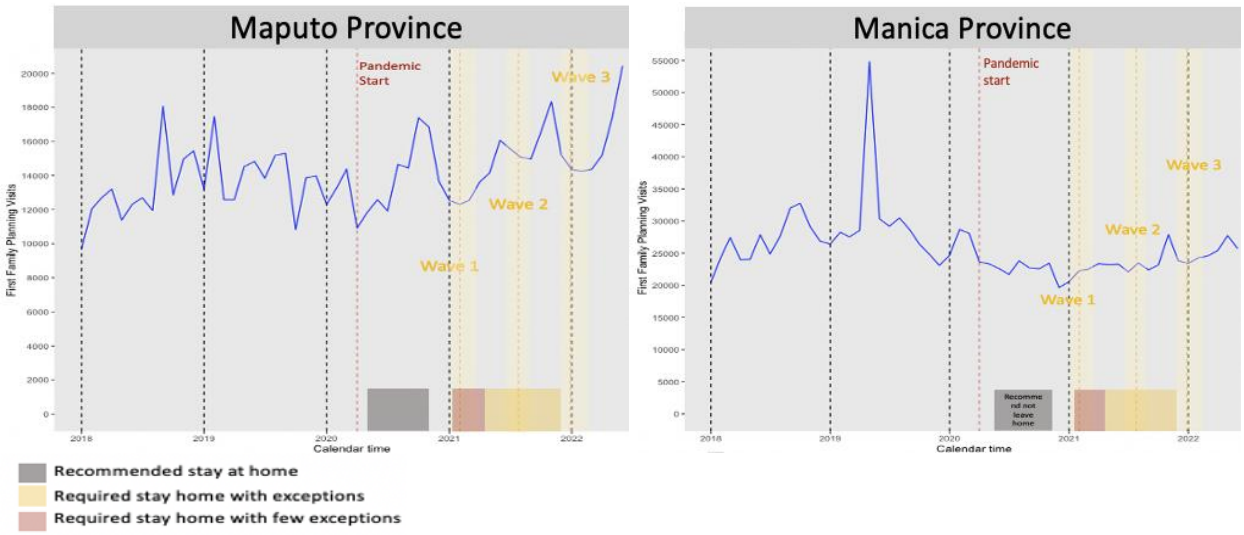


LOESS regression model for institutional birth trends in the district of Matola (left) and district of Chimoio (right) over time, 2018-March of 2022; 95% C.I.

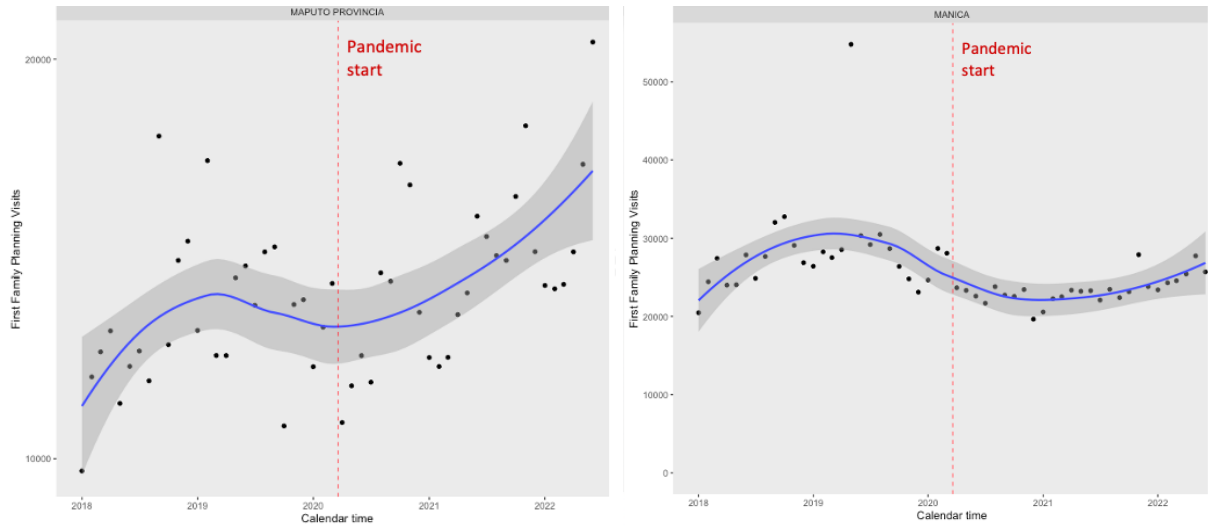


First Family Planning Visits:

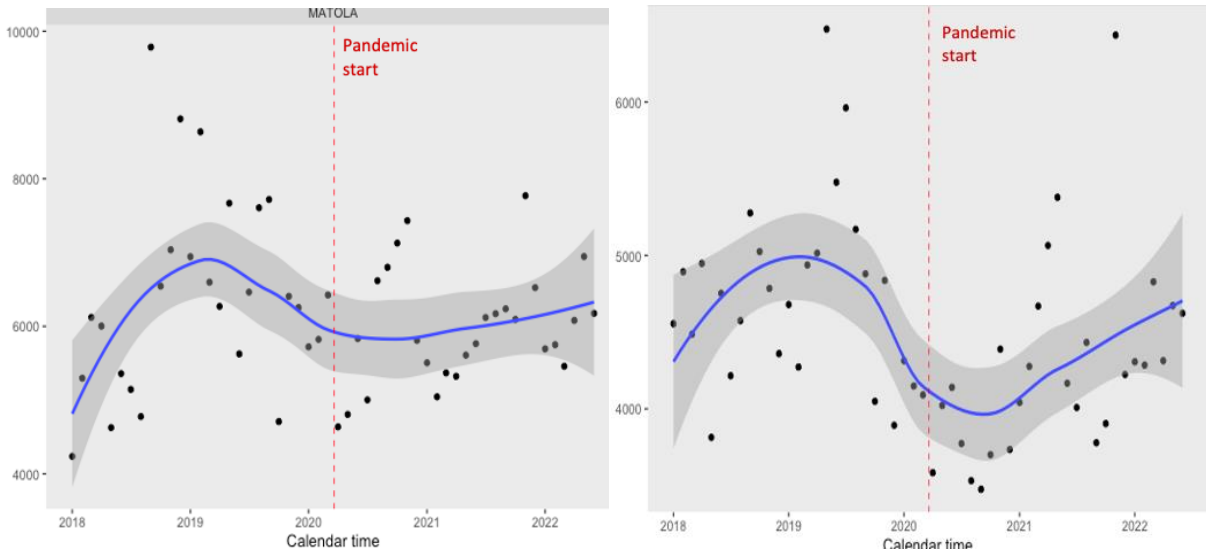
Monthly provincial aggregates for number of first family planning visits in Maputo province (left) and Manica province (right) over time, 2018 - March of 2022



LOESS regression models for first family planning visit trends in Maputo province (left) and Manica province (right) over time, 2018-March of 2022; 95% C.I.

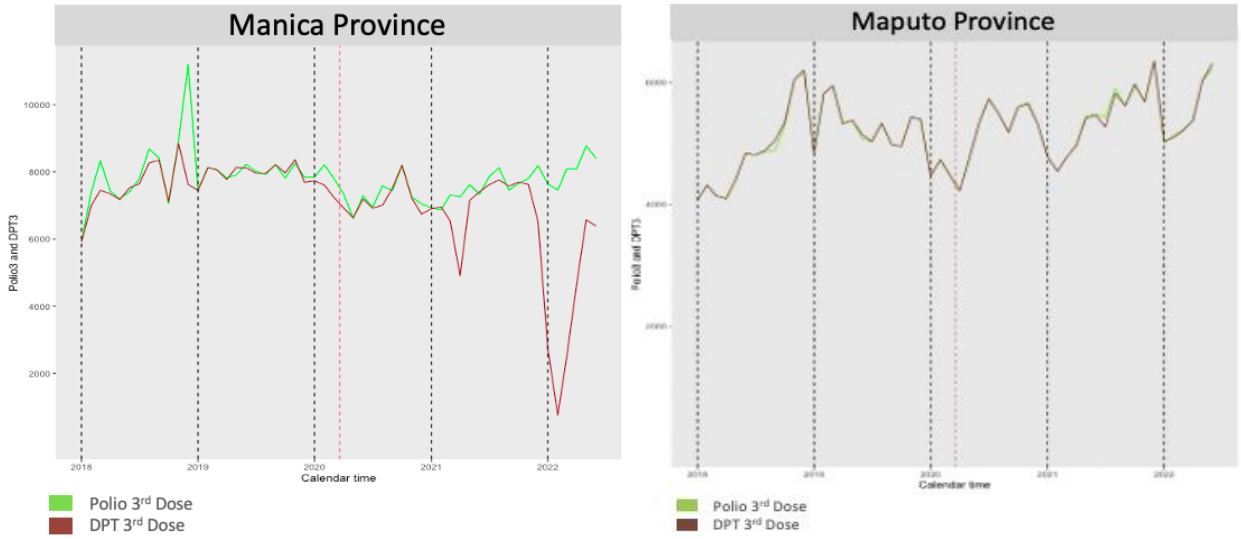


LOESS regression model for first family planning visit trends in the district of Matola (left) and district of Chimoio (right) over time, 2018-March of 2022; 95% C.I.

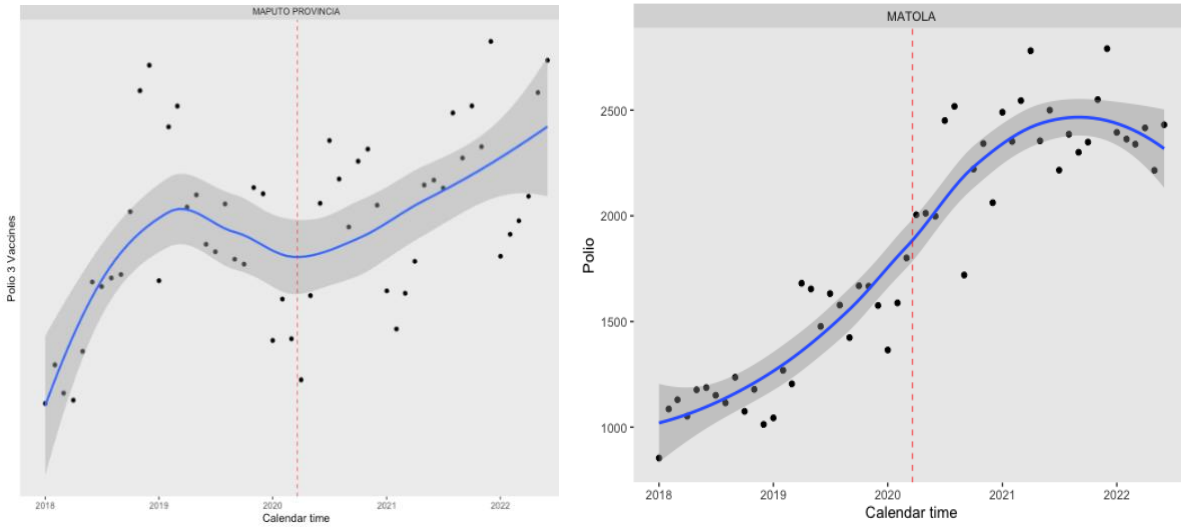


Polio3:

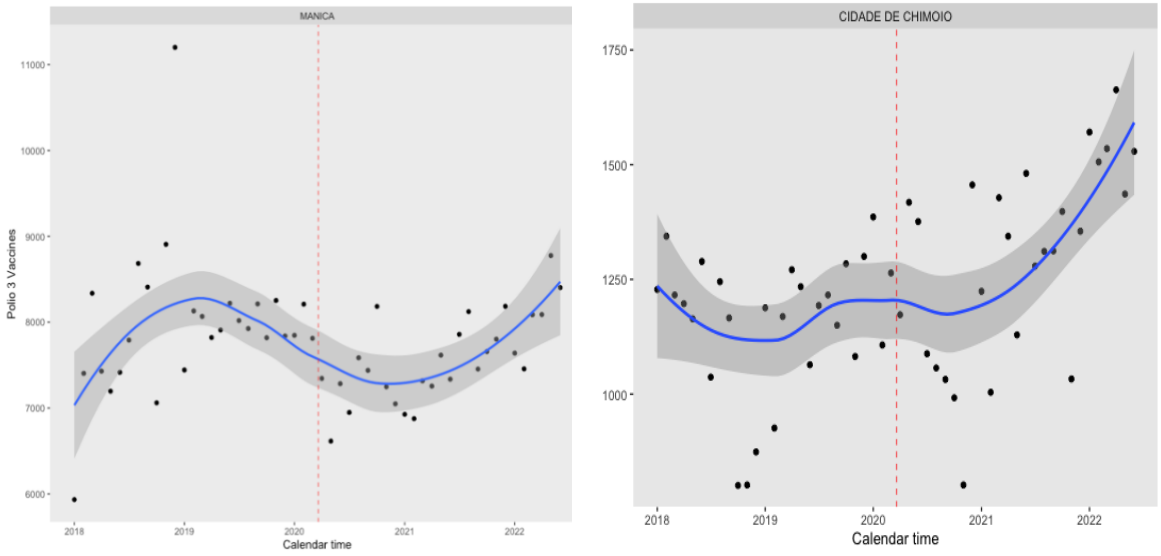
Monthly provincial aggregates for number of Polio3 and DPT3 vaccinations in Maputo province (left) and Manica province (right) over time, 2018 - March of



LOESS regression models for first family planning visit trends in Maputo province (left) and Manica province (right) over time, 2018-March of 2022; 95% C.I.

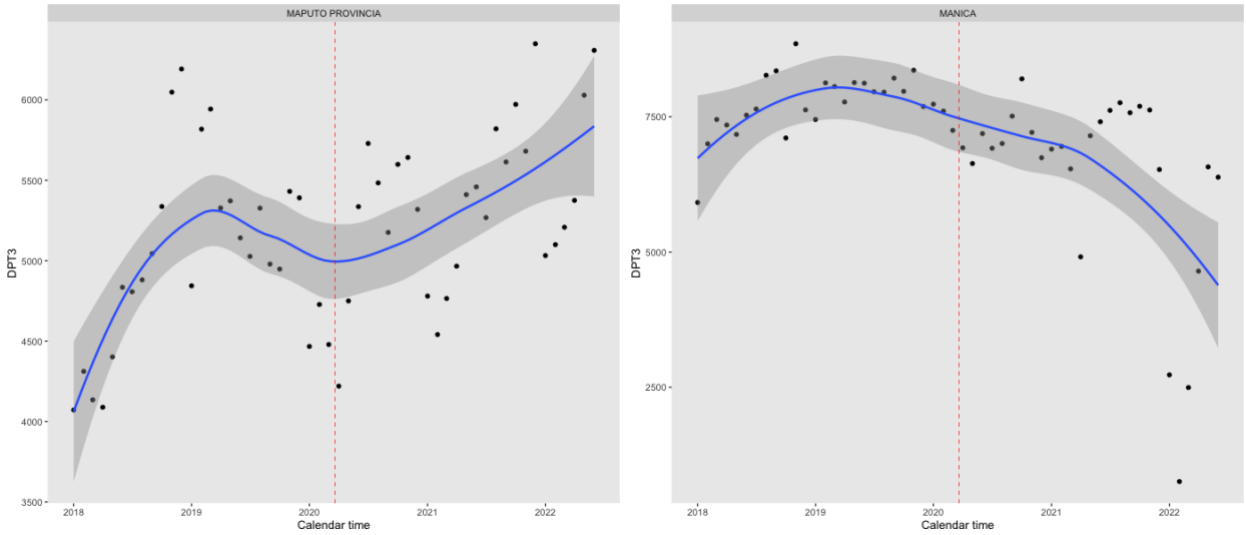


LOESS regression model for Polio3 trends in the district of Matola (left) and district of Chimoio (right) over time, 2018-March of 2022; 95% C.I.

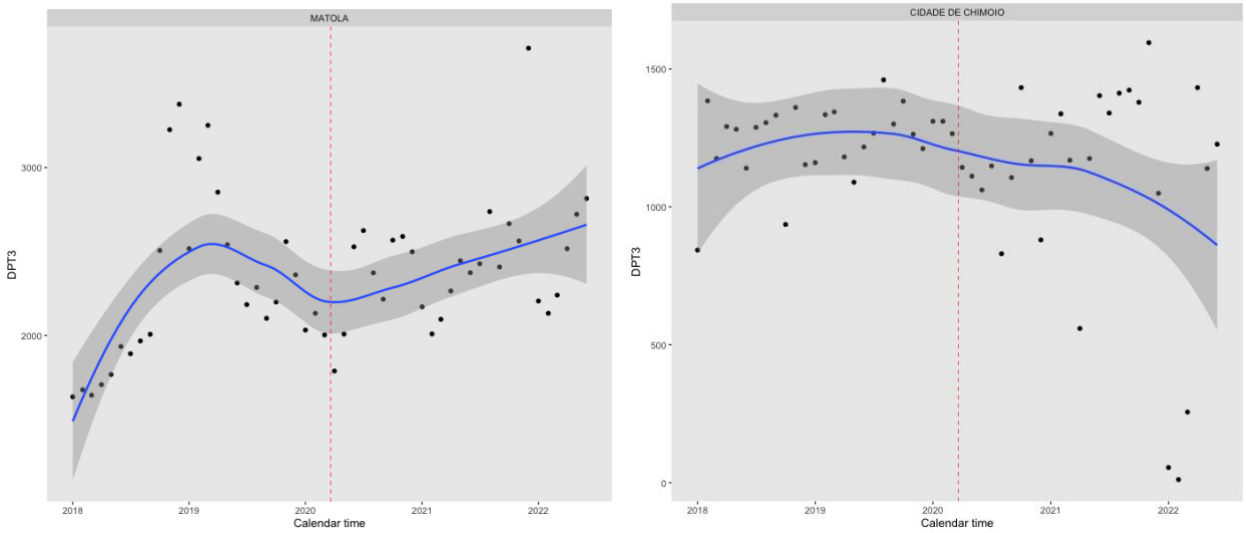


DTP3:

LOESS regression models for DTP3 trends in Maputo province (left) and Manica province (right) over time, 2018-March of 2022; 95% C.I.



LOESS regression model for DTP3 trends in the district of Matola (left) and district of Chimoio (right) over time, 2018-March of 2022; 95% C.I.



Appendix E: Data Repository & Access Statement

The National Department of Cooperation and Evaluation of MISAU requested that the routine aggregated data analyzed in the quantitative portion of this study not be shared outside of the research team. Thus, raw data will not be made publicly available at this time.