Maternal and Infant Option B+ Outcomes in Zambézia Province, Mozambique: Retrospective Cohort Analysis (2013-2021)

Final Report

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Supplemental results related to Objective 4: Retention (continued)

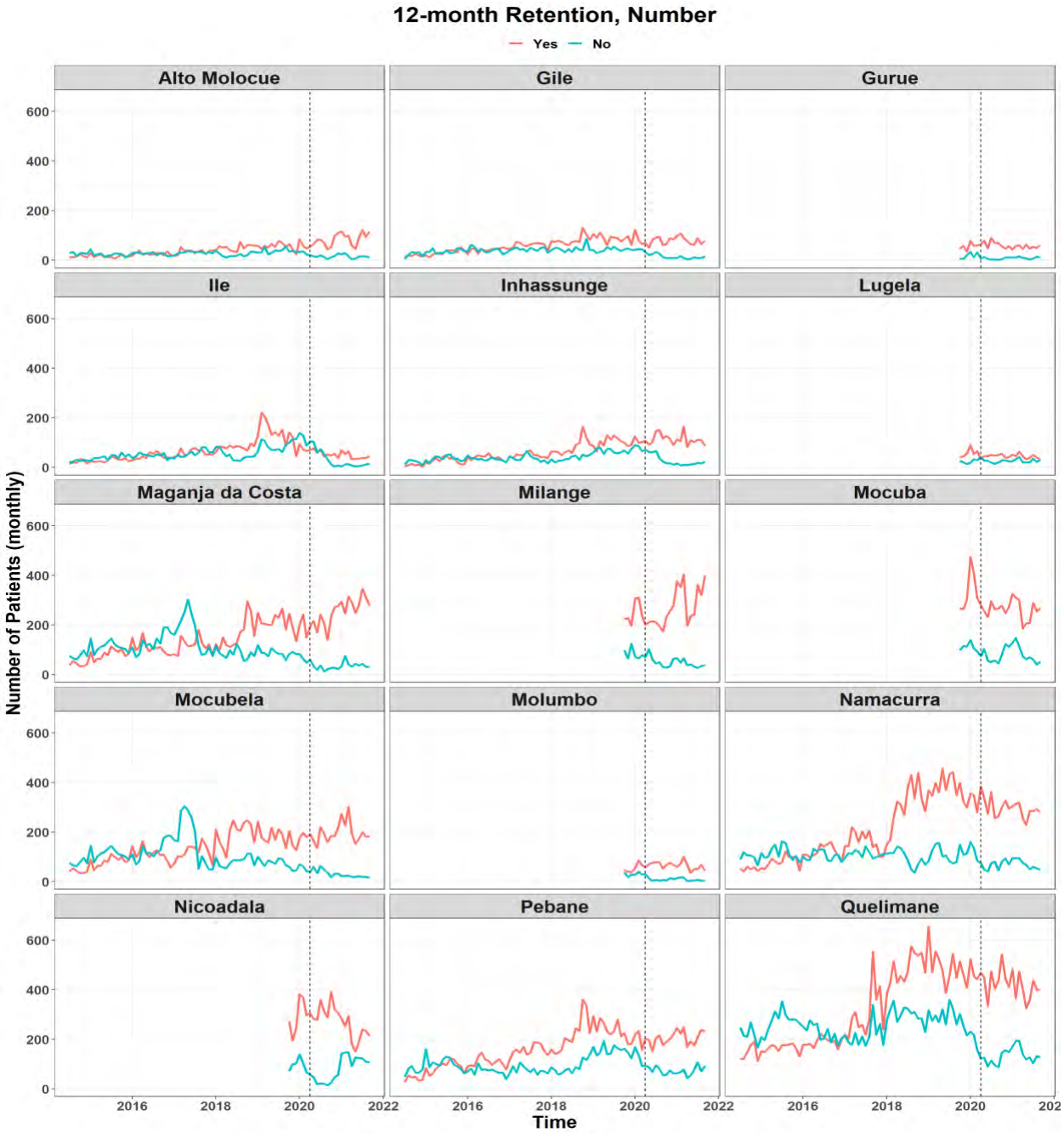

Figure S7. Number of patients with 12-month retention status, entire cohort, over time: red line indicates those who were retained at 12-months, blue line represents those who were not retained at 12-months. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

Table S8. Percentages at 12-month retention, by group (PW, non-PW, men), stratified by age category, over time.

		15-24 years of age							25-34 years of age							35-49 years of age						
District	Group	Min	Q1	Median	Q3	Max	Mean	SD	Min	Q1	Median	Q3	Max	Mean	SD	Min	Q1	Median	Q3	Max	Mean	SD
Alto Molócuè	PW	7.1	41.2	58.3	75	100	58.6	23.7	11.1	50	75	100	100	69.5	27.1	33.3	72.9	100	100	100	87.8	21.2
	Non PW	14.3	50	63	77.8	100	61.2	22.1	25	55.6	70	85	100	68.6	19.4	25	58.9	78.9	95.3	100	74.9	21.9
	Men	20	50	60	100	100	66	25.8	16.7	40	55	72.2	100	57.1	21	16.7	50	66.7	80	100	63.2	23.9
Gilé	PW	18.2	50	62.5	77.3	100	63.3	19.4	9.1	50	71	87.5	100	69.6	23.2	25	57.1	100	100	100	81.1	25.5
	Non PW	12.5	50	64.3	79.4	100	63.9	21.4	20	56.4	75	85.7	100	71.3	19.1	28.6	60	71.4	89.3	100	74.3	18.1
	Men	11.1	45.4	60.8	76.2	100	59.1	23.5	13.3	45	58.3	70	100	58.1	19.3	16.7	50.6	60.5	74.7	100	63.5	18.8
Gurué	PW	45.5	65.7	80.9	93.2	100	79.4	16.8	28.6	70.2	85.7	100	100	81.1	21.5	50	100	100	100	100	96.4	13.4
	Non PW	40	77.6	88.9	100	100	84	16.2	50	77.7	89.2	100	100	85.6	15.2	33.3	70.2	85.7	100	100	83.4	19
	Men	50	78.9	100	100	100	89.2	14.6	71.4	84.3	91.7	100	100	89.8	9.5	60	77.1	85.4	100	100	85.1	12.9
Ile	PW	17.6	38.9	51.6	67.4	100	55	20.4	14.3	41.9	60	77.8	100	59.2	22.6	25	50	66.7	100	100	67.7	25.1
	Non PW	9.1	37.9	51.7	66.7	100	54	20.7	15	40	60	75	100	59.8	21.3	25	54.7	69.2	81.8	100	67.6	19.6
	Men	22.2	33.3	50	64.6	100	54.3	24.7	11.1	38	50	66.3	100	52.1	19.5	14.3	41.8	59.5	73.4	100	58	21
Inhassunge	PW	10	54.8	70.3	81.6	100	66.8	20.2	20	57.7	71.4	83.9	100	70	20.9	33.3	75	100	100	100	84.8	21.9
	Non PW	11.1	37.5	50	72.2	100	55.6	22	14.3	50	59.1	71.4	100	60	20.3	12.5	60.3	72.1	85.7	100	70.8	19.6
	Men	16.7	42.9	52.9	75	100	58.5	23.1	16.7	42.9	52.4	67	96.4	55.9	19.2	11.1	42.9	54.8	73.3	100	57.2	22.2
Lugela	PW	33.3	53.4	72.5	80.3	100	69.2	20	20	71.4	80	86.5	100	76.5	19.5	25	50	83.3	100	100	73.2	29.3
	Non PW	40	48.9	62.5	71.9	100	62.2	15.7	44.4	56.7	66.7	78	90.9	67.8	13	40	65	80	89.2	100	76.6	17.4
	Men	12.5	28.6	40	50	80	40.9	16.3	35.7	49.2	58.5	67.9	88.9	58.5	13.7	16.7	58.6	73.8	80.4	100	70	18
Maganja da Costa	PW	20.9	38.8	62.5	82.9	96.3	61.7	23.3	13.6	42.2	60.3	83.3	100	62.3	23.1	11.1	47.2	68.3	97.5	100	67.6	26.8
	Non PW	9.1	42.5	57.9	78.4	97.1	57.8	23.2	25	45.5	64.1	80.8	97.5	62.1	19.8	20	54.1	70	83	97	67.1	20
	Men	12.5	33.3	53.8	75	100	54.8	25	5.3	39.2	55.3	71.2	98	56.3	22.8	11.1	42.2	56.2	72.5	100	57.6	22
Milange	PW	60	76.8	85.4	91.1	100	83.3	10.7	59.4	84.9	90.2	92.6	100	86.9	9.8	25	71.4	85.4	100	100	81.3	19.6
	Non PW	53.3	72.2	80	88.8	100	78.9	13.3	65.9	77.9	83.1	89.3	92.7	81.7	8.2	69.7	79.4	84.5	87.7	98.1	83.8	7.2
	Men	54.5	74.7	80	86.2	100	79.9	11.2	54.5	71.4	84.1	88.7	93.3	79.4	12	61.4	76.7	83.3	88.1	92.3	81.5	8.8
Mocuba	PW	60.5	72.3	80.2	84.5	95.1	78.5	9.1	69.6	78.6	83.3	89.5	94.1	83.4	7.1	33.3	66.7	78.9	100	100	79.9	20.2
	Non PW	62.2	67.5	73.2	78.9	89.6	73.7	8	63.6	69.8	75.2	81	92.3	75.7	7.6	70	76.1	81.1	86.1	92.9	81.3	6.6
	Men	41.7	61.1	72.7	78.6	82.4	68.8	12.1	57.5	65.8	72.8	77.1	91.7	73	9.3	60	72.4	80	82.3	92.9	77.5	8.8
Mocubela	PW	22	41.1	71.7	85.1	100	64.1	24.6	10	37.9	67.9	85	100	63.3	26.2	9.1	44.4	66.7	100	100	66.5	27.1
	Non PW	9.1	42.2	61.1	73.6	94.2	58.9	20.8	16.7	50.7	69.1	83.3	96.8	65.3	21	14.3	55.6	76.2	87.5	100	69.9	22
	Men	16.7	38.5	53.1	69.6	100	54.7	20.9	5.3	43.2	60	69.5	93.5	57.5	20	11.1	46.4	63.6	75.9	100	60.5	21.5
Molumbo	PW	46.2	66.7	86.6	100	100	81.8	19.6	42.9	70.2	88.9	100	100	84.1	18.1	50	100	100	100	100	94.3	14.2
	Non PW	12.5	61.1	76.4	91.9	100	72.8	22.6	55	77.7	86.2	91.9	100	83.8	11.9	41.7	74.1	90.2	100	100	83.8	18.5
	Men	25	56.4	78.6	87.5	100	72	22.2	50	72.7	83.9	92.9	100	82.3	14.2	50	77.8	85.7	100	100	85.1	13.8
Namacurra	PW	14.8	39.4	66.7	85.3	100	63	24.5	22.7	47.7	69.7	86.2	96.3	66.6	21.8	14.3	57.1	75	100	100	72.2	24.3
	Non PW	7.7	48.2	64.2	77.4	87.8	60.7	18.6	23.8	60	70	80	92.1	68.7	14.4	37.5	69.1	76.8	85.5	100	75.1	13.8
	Men	7.7	36.2	57.7	71.7	100	54.3	22.2	10	46.2	63.2	74.4	92.3	60	18.9	10	52	70.2	78.9	95.7	64.6	18.3
Nicoadala	PW	66.7	78.7	83.8	90.6	96.9	83.8	8.7	60	74.4	85.1	91.6	100	82.8	11.9	33.3	73.3	100	100	100	86.7	19.9
	Non PW	48.1	59.5	70.3	85.5	98	72.5	15	46	66.6	76.9	89.4	97.3	77.8	15	56	70.6	81.6	88.3	100	80	12.1
	Men	48.7	58.4	67.8	87.8	100	71.5	17.8	49.1	63.8	72.1	89.9	98.6	75.1	14.8	44.1	68.1	72.7	85.8	95.1	75.2	12.5
Pebane	PW	26	54.8	64.4	75.3	93.3	63.3	16.6	12.5	57.4	72.7	78.3	100	67.5	17.8	20	50	66.7	100	100	69.9	23.4
	Non PW	10	51.3	61.1	69.2	87.5	59.1	15.4	28.6	59.6	68.8	75.7	86.4	65.9	13.7	14.3	66.7	75	84.8	95.7	72.9	15
	Men	16.7	38.9	52.1	59.8	82.4	49.9	16.6	15.4	49.4	58.2	67.3	86.3	56.3	14.9	16.7	53.2	63.5	69.3	88.9	61.5	13.4
Quelimane	PW	22.1	38	60.6	75	91.9	57.6	20.7	25.9	52.6	67.2	79.8	96	64	17.9	14.3	50	75	86.2	100	71	21.5
	Non PW	18.9	40	50	63.2	83.8	51.8	16.7	32.8	48.8	60.3	67.7	87.3	60	13.1	38.2	57.8	70	77.2	89.8	67.3	13
	Men	12.5	34.8	48.3	59	81.4	46.8	17.1	21.6	45.7	54.8	63.9	83.5	54.4	14	20.8	49.5	63.4	68.4	86.5	60.3	13.2

Supplemental results related to Objective 5: Viral suppression

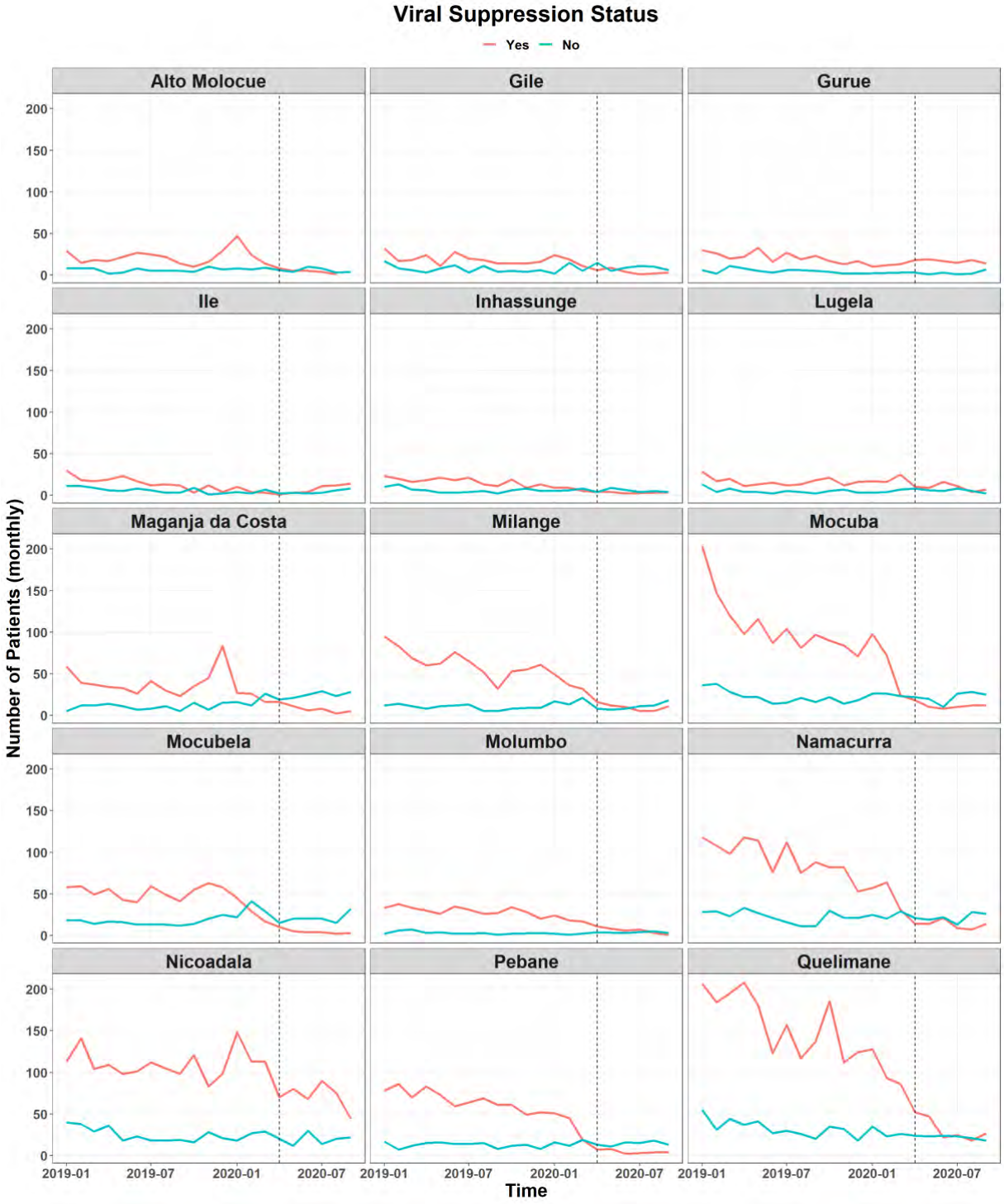

Figure S8. Number of patients with viral suppression status, among individuals who had a VL record within 3-12 months of ART initiation, over time: red line indicates those who had viral suppression (i.e., a VL < 1000 copies/mL), blue line represents those who did not have viral suppression (i.e., had a VL >= 1000 copies/ml). (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

Looking at viral suppression proportions among the three groups and by age category (**Figures S9a, S9b, S9c**), there was a great deal of variability seen in all three age categories, especially in the younger age group (15-24 years of age) and the 25-34 years of age category, and seemingly slightly higher overall viral suppression seen among those 35-49 years of age.

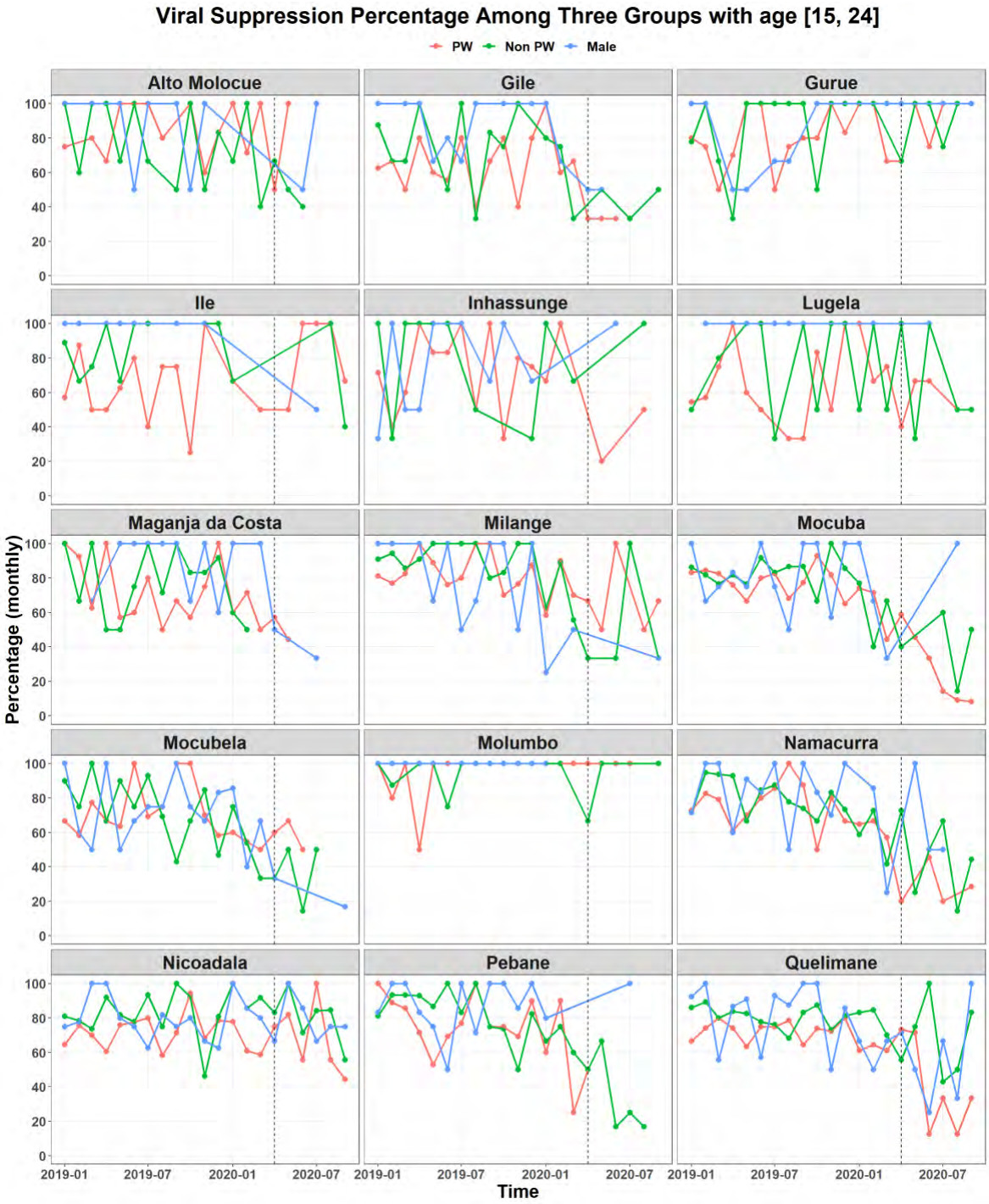

Figure S9a. Percentage of patients with viral suppression, by group (PW, non-PW, men), among those 15-24 years of age, over time. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

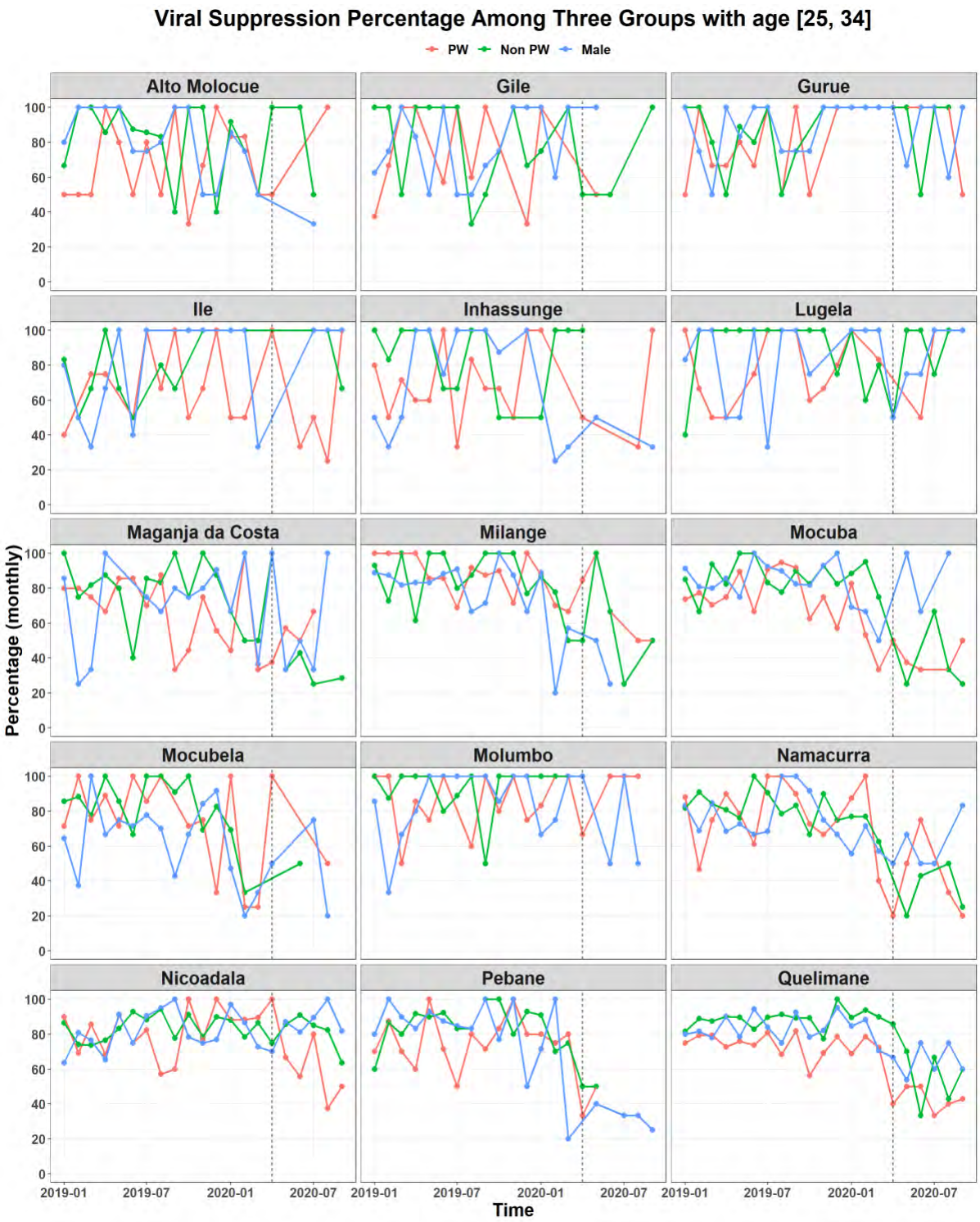

Figure S9b. Percentage of patients with viral suppression, by group (PW, non-PW, men), among those 25-34 years of age, over time. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

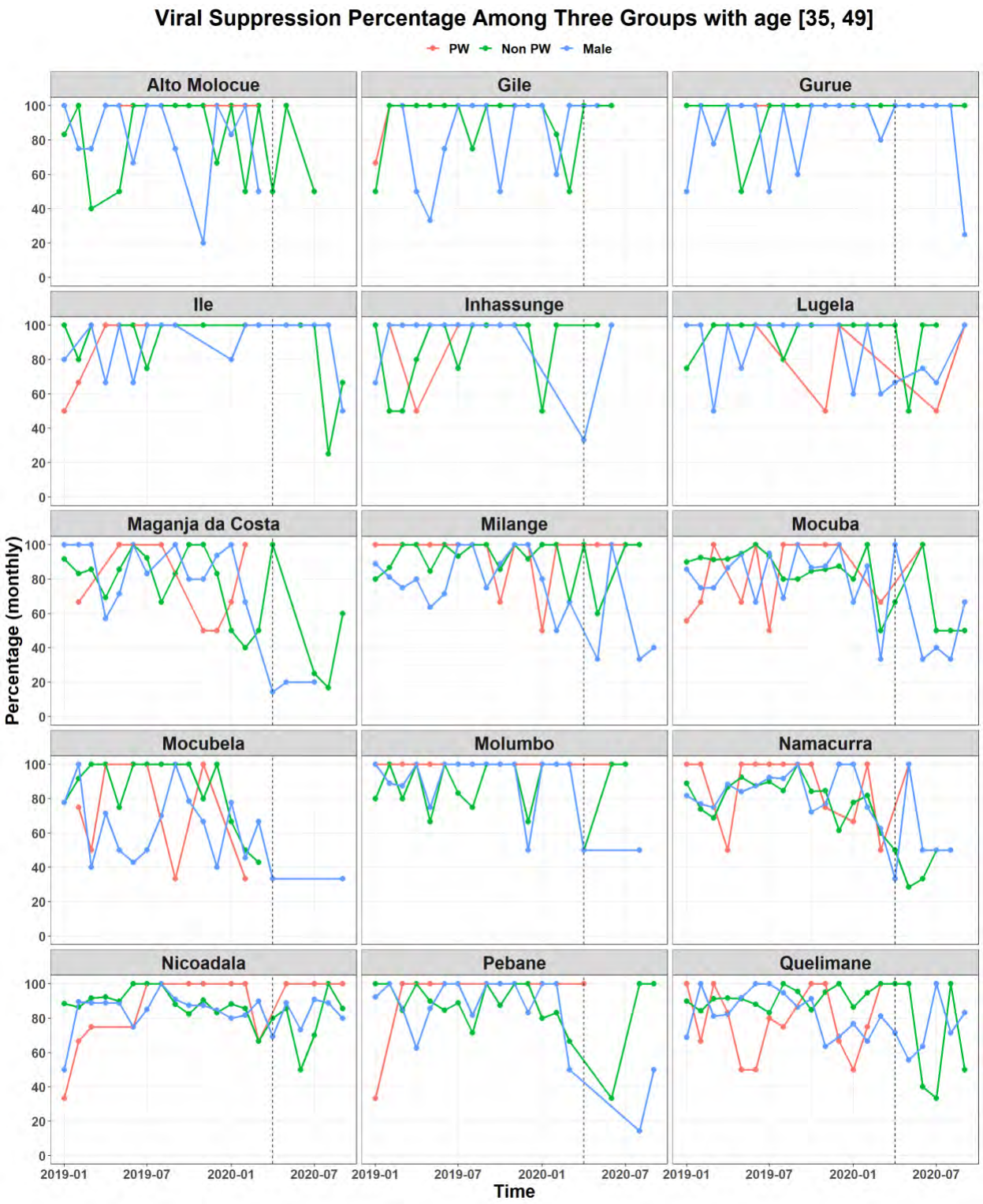

Figure S9c. Percentage of patients with viral suppression, by group (PW, non-PW, men), among those 35-49 years of age, over time. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

Supplemental results related to Sub-analysis: IIT

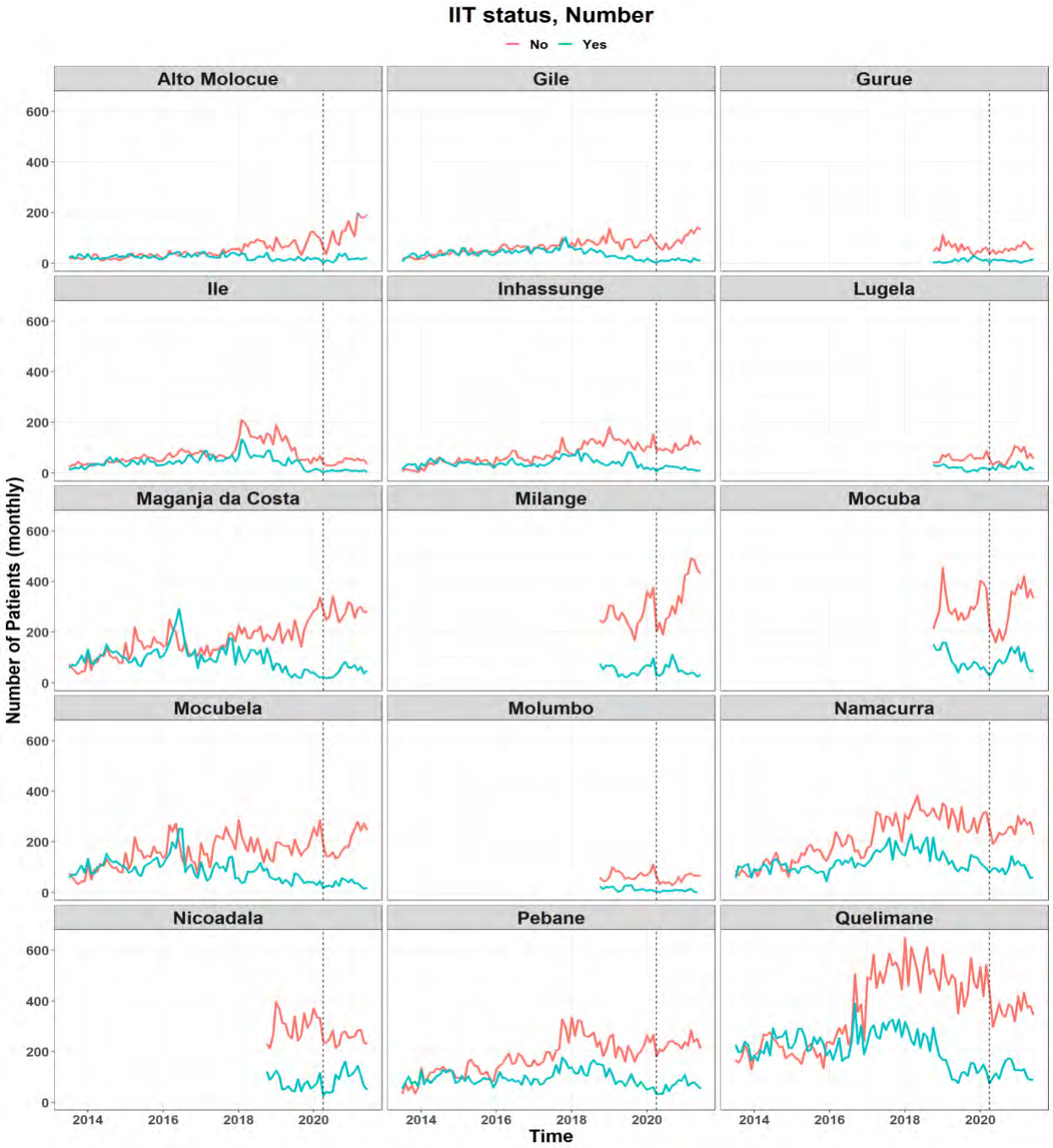

Figure S10a. Number of patients with IIT < 3 months status, entire cohort, over time: red line indicates those who were not experiencing an IIT < 3 months, blue line represents those who were experiencing an IIT. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

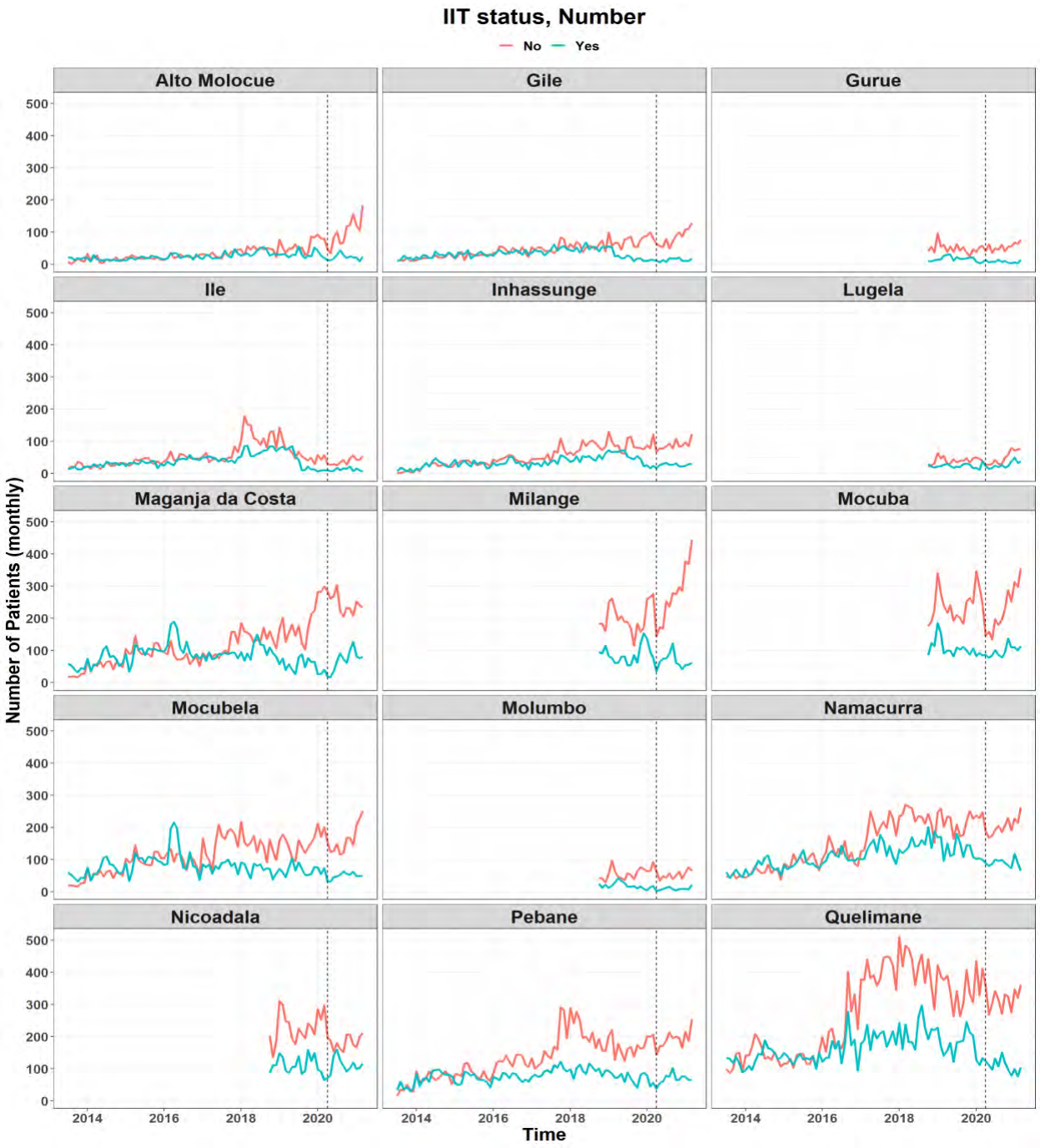

Figure S10b. Number of patients with IIT 3-5 months status, entire cohort, over time: red line indicates those who were not experiencing an IIT at 3-5 months, blue line represents those who were experiencing an IIT. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

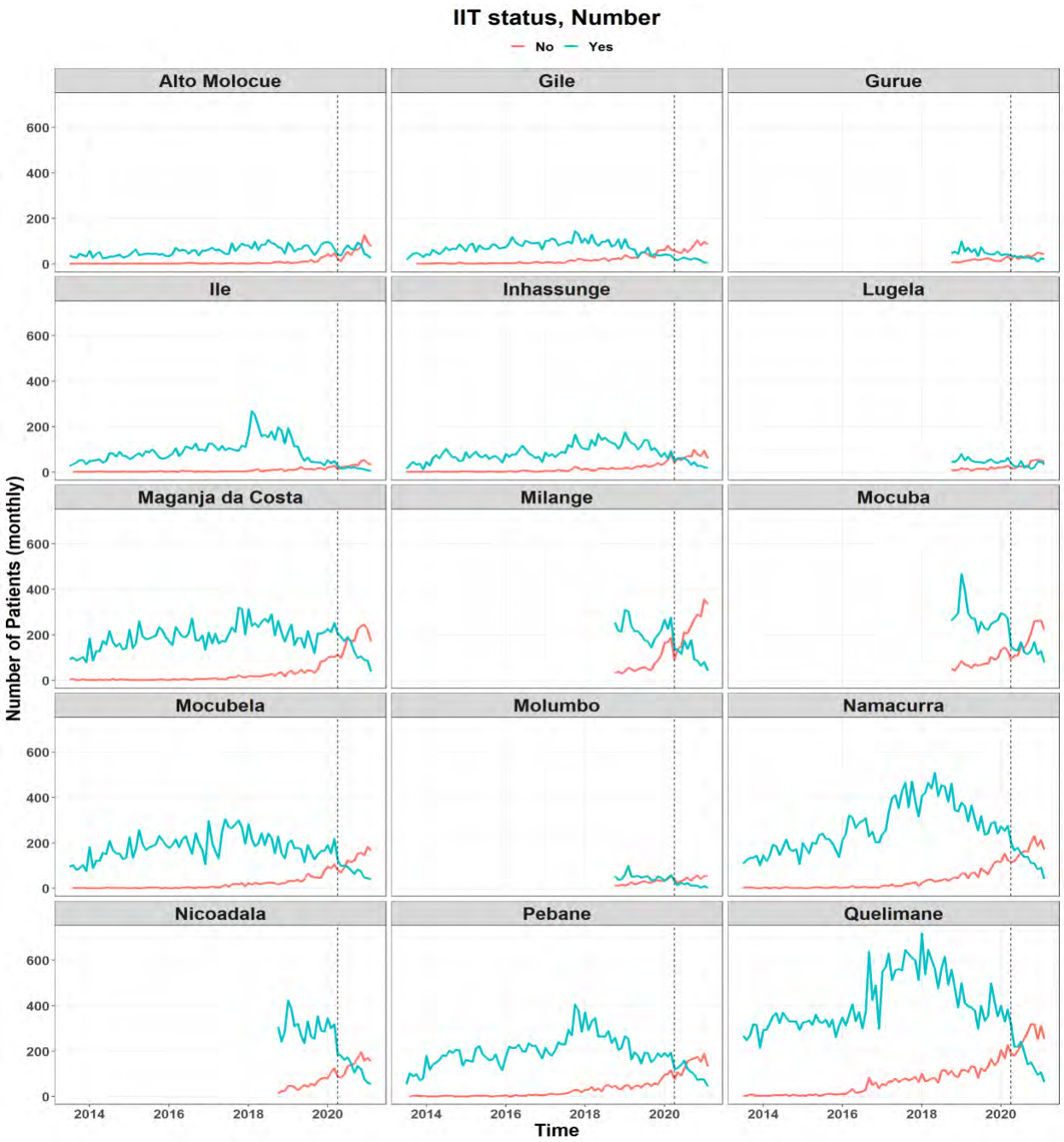

Figure S10c. Number of patients with IIT >= 6 months status, entire cohort, over time: red line indicates those who were not experiencing an IIT at >= 6 months, blue line represents those who were experiencing an IIT. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

We present here the comparison of trends in IIT percentages among all patients (not disaggregated by group or age category) at three separate time frames.

Table S9. Percentages of all patients without an IIT at three separate time frames (<3 months, 3-5 months, and >=6 months) after ART initiation, over time.

	Percentage without IIT < 3 months									Percentage without IIT 3-5 months									Percentage without IIT >= 6 months								
District	Min	Q1	Median	Q3	Max	Mean	SD	Start Time	Months	Min	Q1	Median	Q3	Max	Mean	SD	Start Time	Months	Min	Q1	Median	Q3	Max	Mean	SD	Start Time	Months
Alto Molócuè	32	51	61.4	83	98	64.6	18	2013-07	96	4.8	46	55.6	65	92	56.2	16	2013-07	93	1.2	2	7.2	24	75	15	19	2013-07	63
Gilé	30	53	59	81	96	63.7	17	2013-07	96	29	46	55	71	92	58.7	17	2013-07	93	1.2	4	11.6	40	95	24.9	28	2013-10	80
Gurué	50	79	85.2	92	99	83.8	10	2018-10	33	56	74	80.7	89	96	79.9	11	2018-10	30	9.1	20	33.3	53	83	36.2	19	2018-10	29
Ile	39	56	63.4	72	95	65.3	13	2013-07	96	31	50	57.4	68	91	59.4	13	2013-07	93	0.8	2	4	24	84	16	23	2013-08	73
Inhassunge	20	54	62.7	76	94	63.4	17	2013-07	96	5.6	52	59.4	68	84	58.6	14	2013-07	93	1	3	7.4	15	82	16.3	21	2013-07	83
Lugela	56	67	73.1	82	93	73.4	11	2018-10	33	42	57	64.2	69	80	63.3	9	2018-10	30	9.1	19	28.6	41	78	33.4	18	2018-10	29
Maganja da Costa	28	52	61.2	79	95	63.9	17	2013-07	96	23	46	53.7	70	94	57.1	17	2013-07	93	0.4	2	4.8	16	82	13.4	19	2013-07	88
Milange	73	82	83.8	90	95	85.3	6	2018-10	33	53	69	75	79	88	73.7	9	2018-10	30	11	19	33.6	56	89	39.5	24	2018-10	29
Mocuba	59	70	77.5	83	89	77.3	8	2018-10	33	61	66	69.2	72	81	69.3	5	2018-10	30	13	21	29.1	47	74	35.4	19	2018-10	29
Mocubela	28	55	65.4	80	95	65.7	16	2013-07	96	23	49	60.4	70	84	59	15	2013-07	93	0.4	2	6.3	22	81	15.7	21	2013-08	81
Molumbo	64	80	86.9	92	100	84.7	10	2018-10	33	52	76	82.5	87	97	79.1	12	2018-10	30	15	31	45.8	67	93	49.5	23	2018-10	29
Namacurra	35	58	62.8	69	83	63	10	2013-07	96	36	51	57.1	64	80	56.9	9	2013-07	93	0.6	2	4.4	16	80	13.3	19	2013-07	90
Nicoadala	64	71	78	85	91	77.6	8	2018-10	33	52	61	65.6	70	82	65.5	7	2018-10	30	4.6	12	21.4	43	74	29.5	22	2018-10	29
Pebane	30	57	65.1	71	86	64.5	11	2013-07	96	31	55	62.9	71	82	62.3	11	2013-07	93	0.5	2	6.7	22	75	15.4	19	2013-08	83
Quelimane	34	52	63.5	74	85	62.4	13	2013-07	96	39	52	62.1	70	81	61.3	10	2013-07	93	0.6	3	11	22	80	16.5	19	2013-07	92

During the first years of the evaluation period, despite some monthly variability seen across the districts, there was a modest but detectable trend of improvement seen in both the proportion of patients without an IIT within 3 months and between 3-5 months after ART initiation in all districts (see **Figures S11a** and **S11b** below). Though it appears there was a short-term decline in these improvement trends following the start of COVID-19 mitigation measures, there were recovering trends of improvement in all districts for both indicators by the end of the evaluation period.

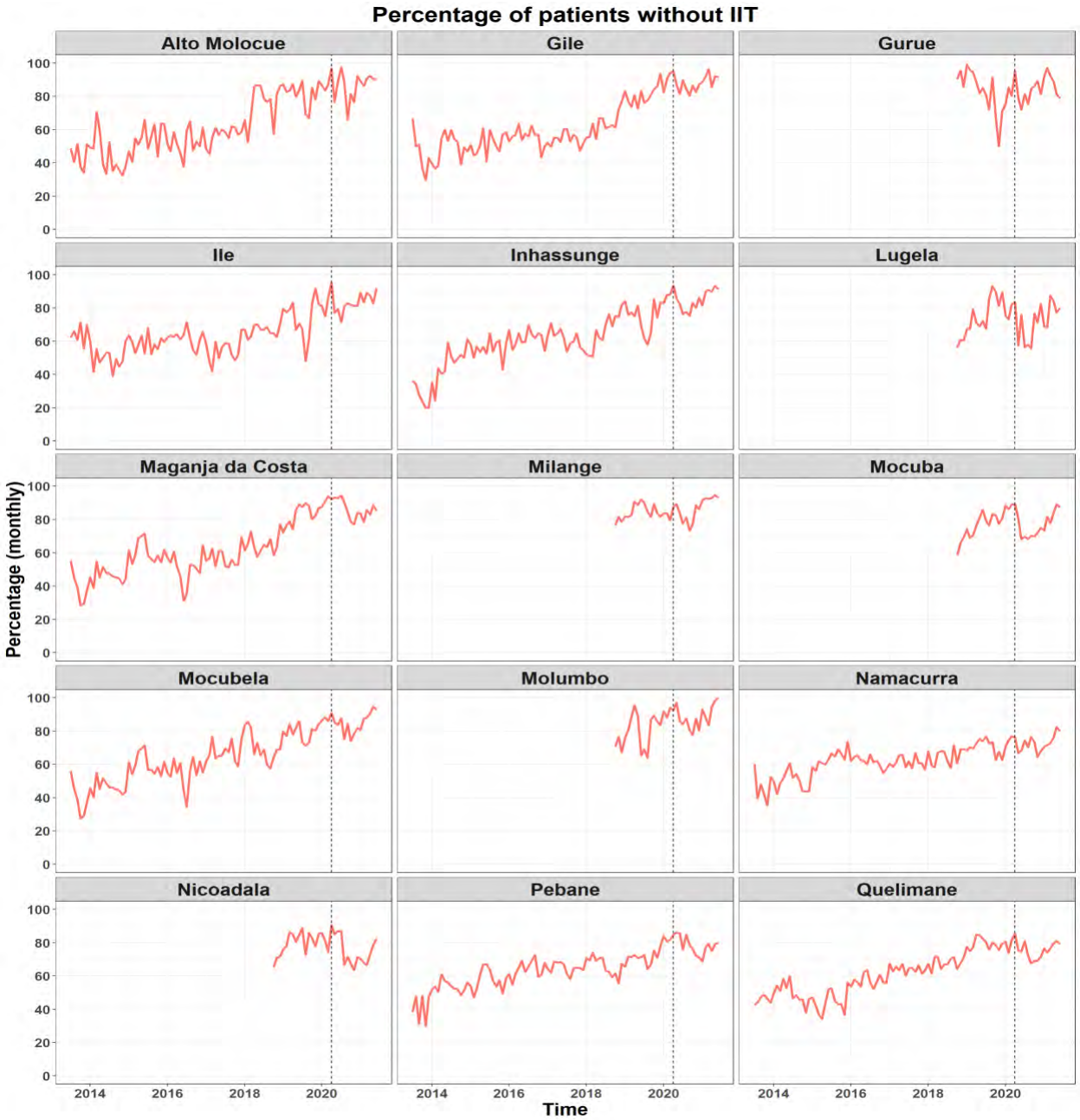

Figure S11a. Percentage of patients without an IIT less than 3 months after ART initiation, over time. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

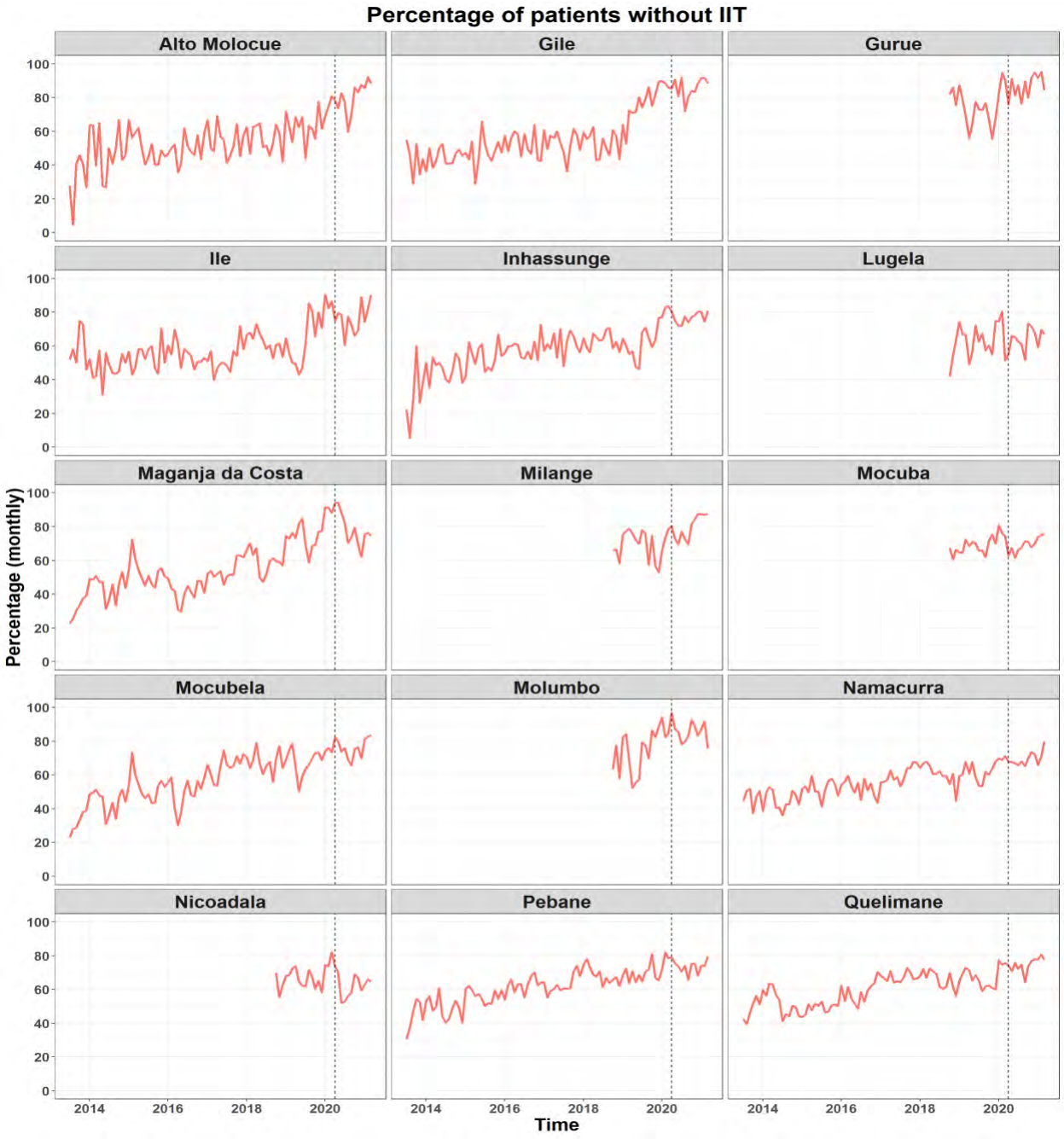

Figure S11b. Percentage of patients without an IIT 3-5 months after ART initiation, over time. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

During the first years of the evaluation period, there was negligible or very slow improvement seen in proportion of patients without an IIT at least 6 months after ART initiation in all districts (see **Figure S11c**). However, there was notable and rapid improvement seen for this indicator starting in approximately 2019 in all districts, with continuous improvement that did not seem negatively impacted by the start of COVID-19 mitigation measures.

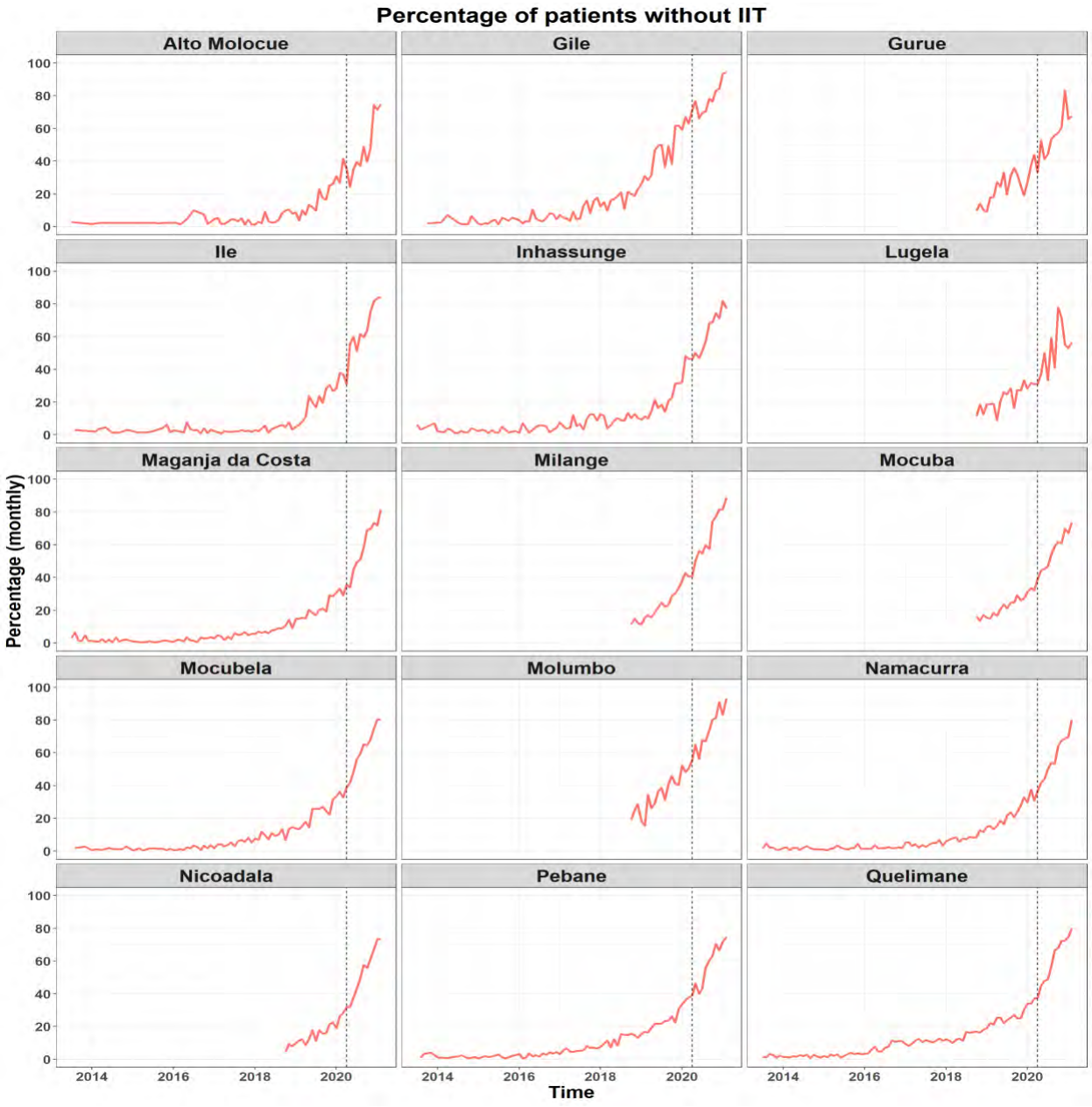

Figure S11c. Percentage of patients without an IIT >= 6 months after ART initiation, over time. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

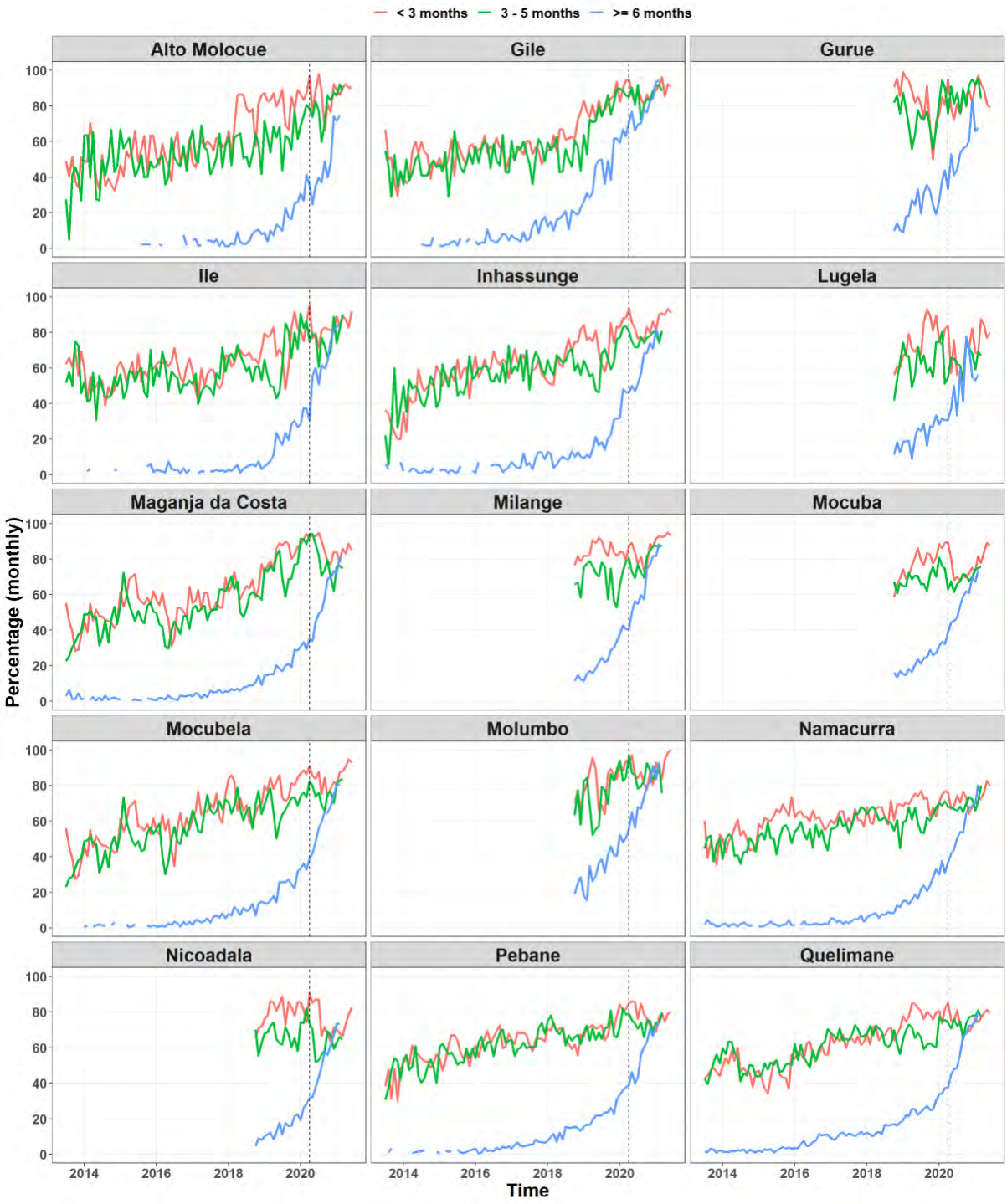

Figure S12. Comparison of percentages of patients without an IIT, over time: red line represents proportion of patients without an IIT within 3 months of ART initiation, green line represents proportion of patients without an IIT within 3-5 months of ART initiation, blue line represents proportion of patients without an IIT at least 6 months after ART initiation. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

In the next three figures below (**Figures S13a, S13b, S13c**), we present trends in percentages of patients without an IIT <3 months, by group, by district and by age category over the evaluation period.

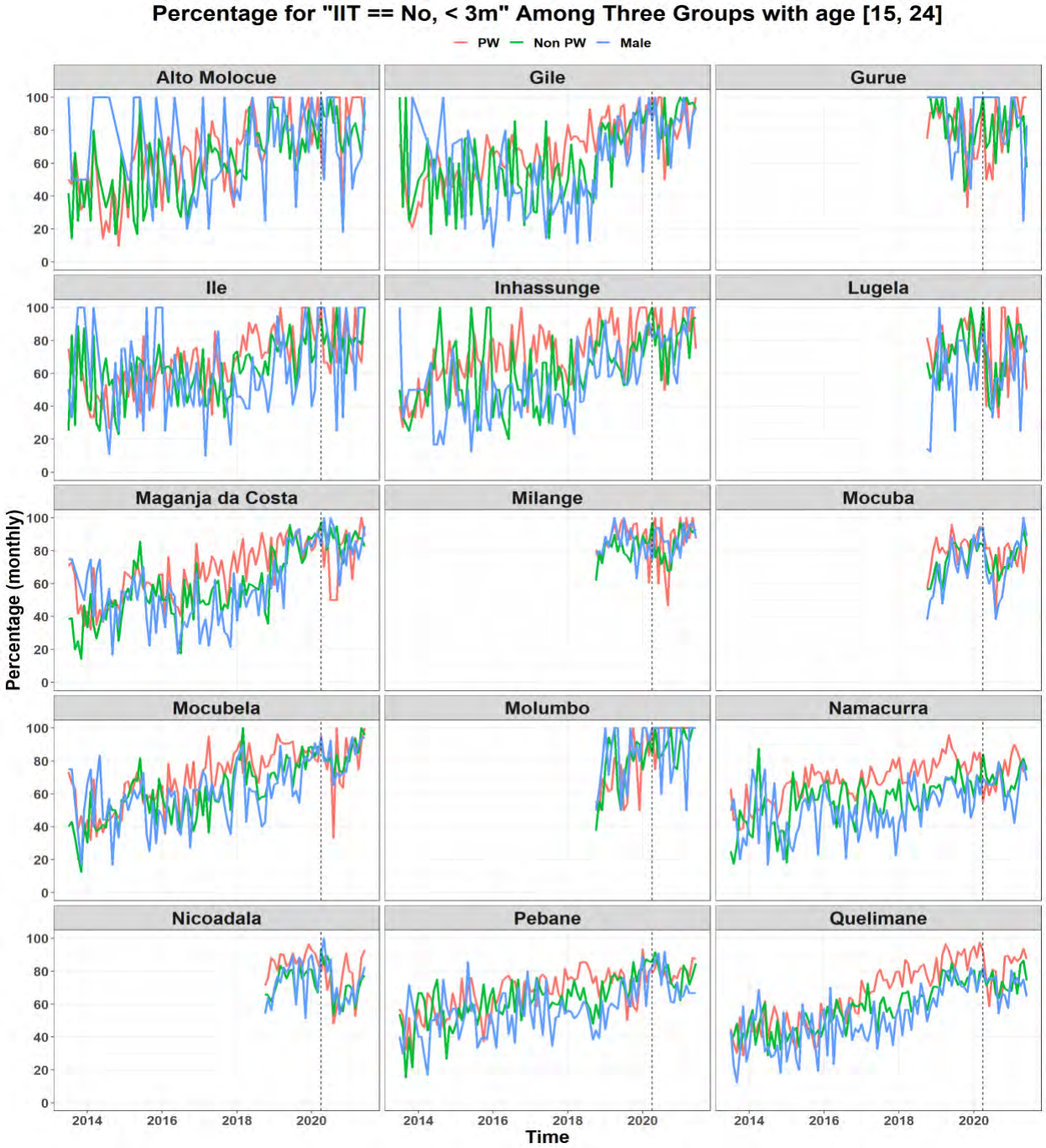

Figure S13a. Percentage of patients 15-24 years of age without an IIT < 3 months after ART initiation, per district, by group, over time: red line represents PW, green line represents non-PW, and blue line represents men. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

Figure S13b. Percentage of patients 25-34 years of age without an IIT < 3 months after ART initiation, per district, by group, over time: red line represents PW, green line represents non-PW, and blue line represents men. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

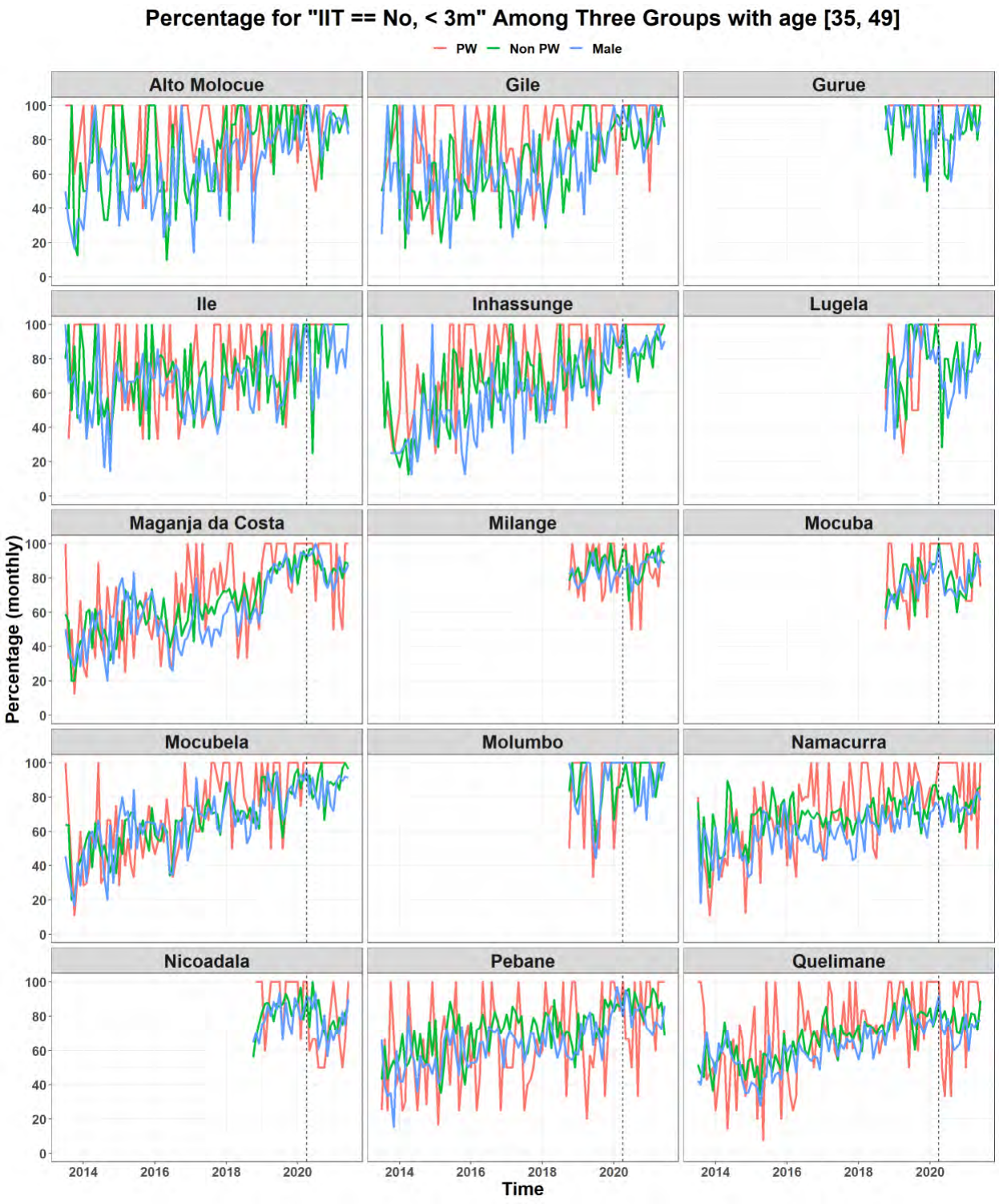

Figure S13c. Percentage of patients 35-49 years of age without an IIT < 3 months after ART initiation, per district, by group, over time: red line represents PW, green line represents non-PW, and blue line represents men. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

In the next three figures below (**Figures S14a, S14b, S14c**), we present trends in percentages of patients without an IIT 3-5 months, by group, by district and by age category.

Figure S14a. Percentage of patients 15-24 years of age without an IIT 3-5 months after ART initiation, per district, by group, over time: red line represents PW, green line represents non-PW, and blue line represents men. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

Figure S14b. Percentage of patients 25-34 years of age without an IIT 3-5 months after ART initiation, per district, by group, over time: red line represents PW, green line represents non-PW, and blue line represents men. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

Figure S14c. Percentage of patients 35-49 years of age without an IIT 3-5 months after ART initiation, per district, by group, over time: red line represents PW, green line represents non-PW, and blue line represents men. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

In the next three figures below (**Figures S15a, S15b, S15c**), we present trends in percentages of patients without an IIT >=6 months, by group, by district and by age category.

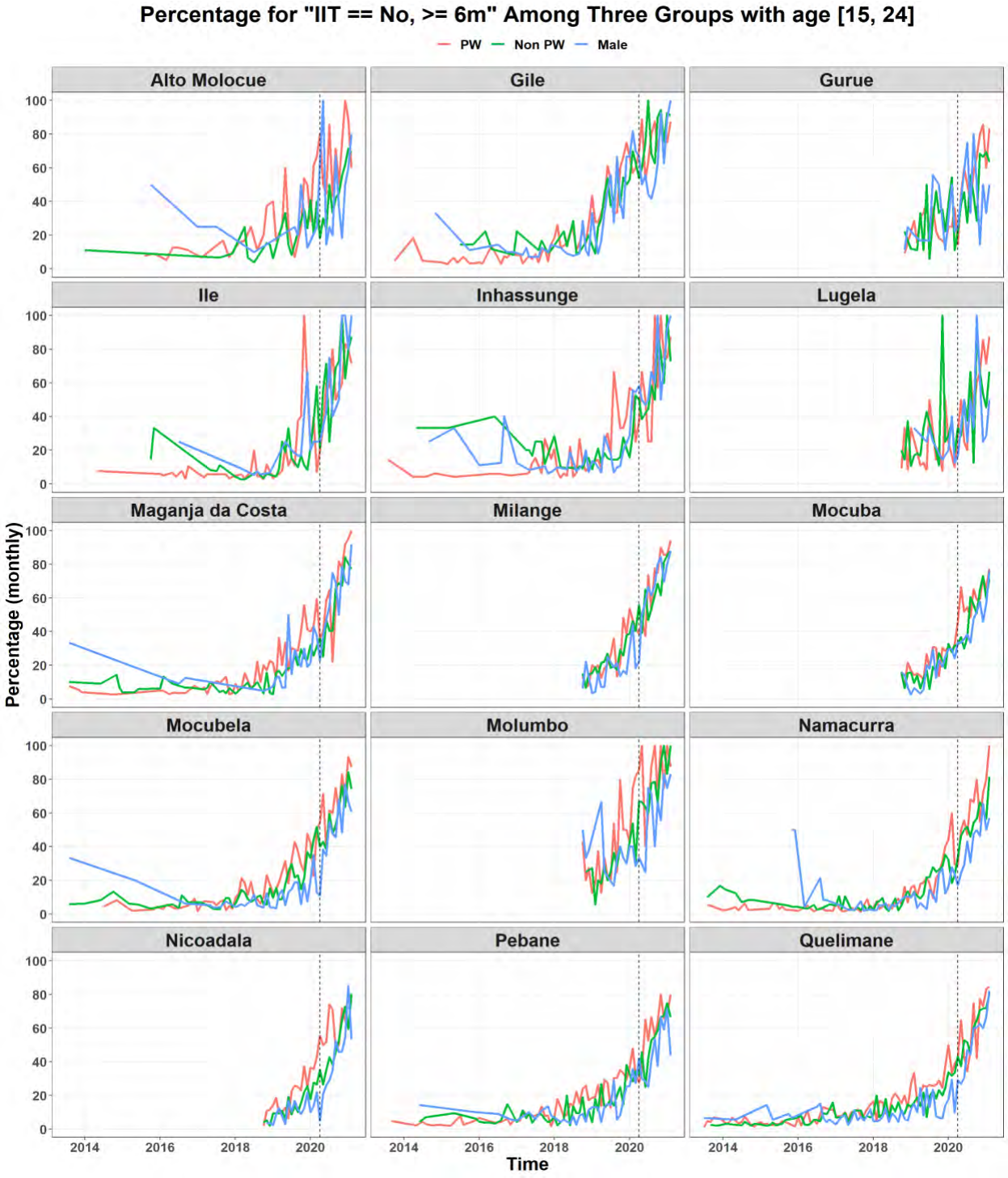

Figure S15a. Percentage of patients 15-24 years of age without an IIT >= 6 months after ART initiation, per district, by group, over time: red line represents PW, green line represents non-PW, and blue line represents men. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

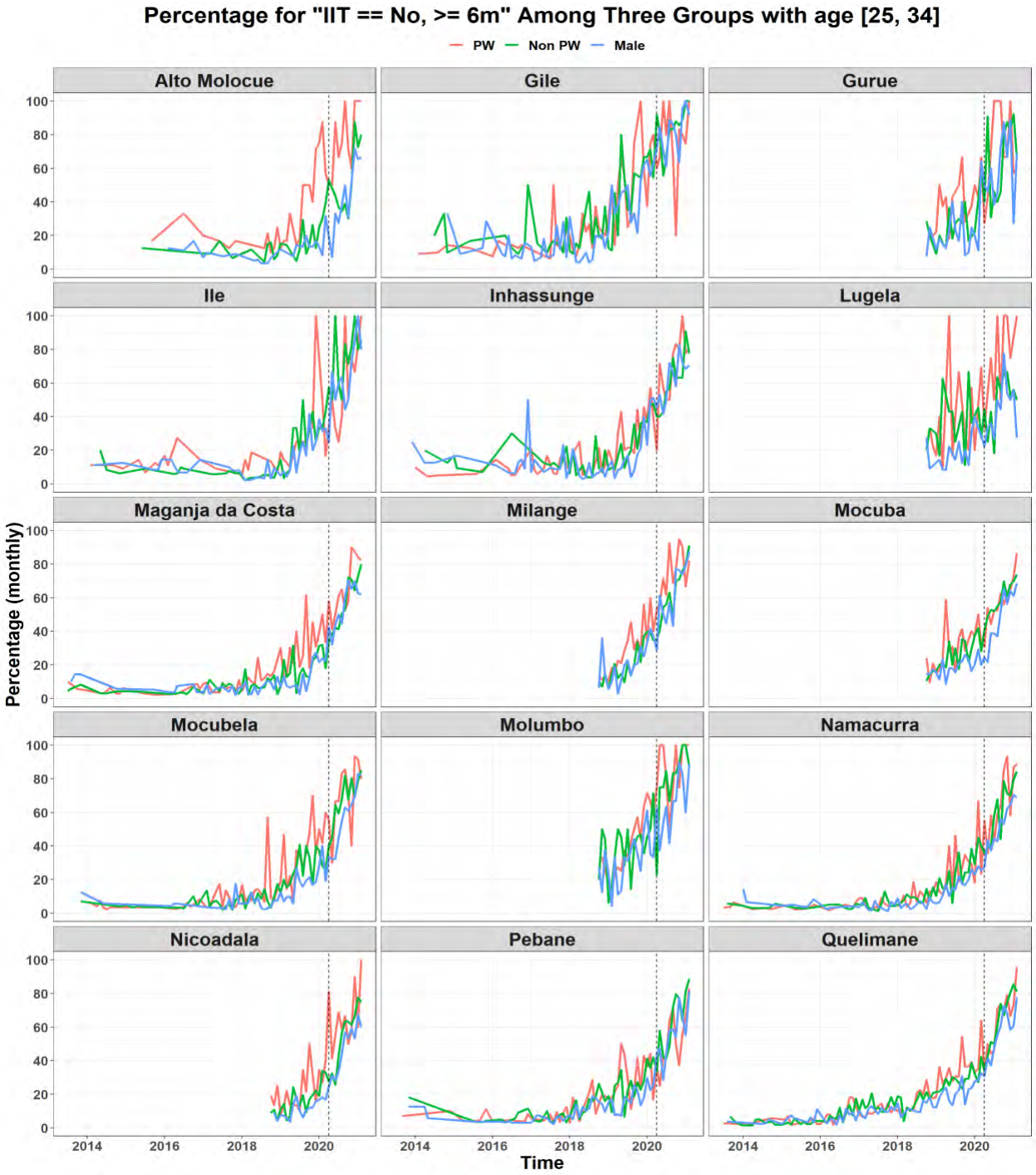

Figure S15b. Percentage of patients 25-34 years of age without an IIT >= 6 months after ART initiation, per district, by group, over time: red line represents PW, green line represents non-PW, and blue line represents men. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

Overall, all patient groups in this age category had improving trends in proportions not experiencing an IIT >= 6 months over the evaluation period, with improving trends increasing rapidly in all districts starting in mid-2019. PW had far more variability in this indicator over time, however had seemingly higher proportions than non-PW, who consistently had higher proportions than men in this age category.

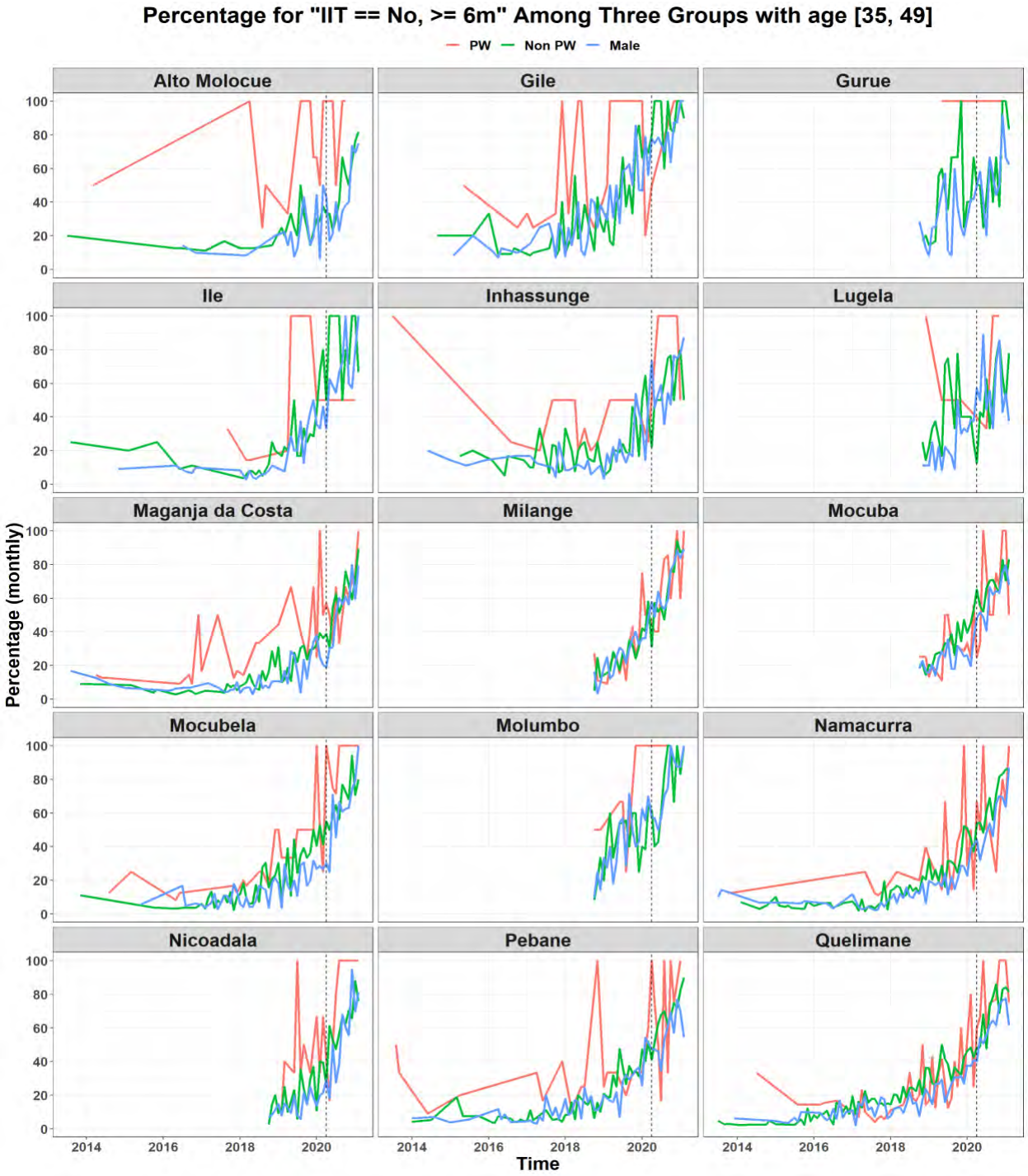

Figure S15c. Percentage of patients 35-49 years of age without an IIT >= 6 months after ART initiation, per district, by group, over time: red line represents PW, green line represents non-PW, and blue line represents men. (Dotted line: time point when COVID-19 mitigations were put in place in Mozambique.)

Supplemental results related to Sub-analysis: MCH outcomes related to COVID-19 measures

ART Coverage among PW

Table S10. Proportions for ART coverage among PW pre- and post-COVID-19 mitigation measures in place, by district.

District	Group	Min	Q1	Median	Q3	Max	Mean	SD
Alto Molócuè	Pre_COVID-19	1	1	1	1	1	1	0
	Post_COVID-19	1	1	1	1	1	1	0
	All	1	1	1	1	1	1	0
Gilé	Pre_COVID-19	0.99	1	1	1	1	0.999	0
	Post_COVID-19	1	1	1	1	1	1	0
	All	0.99	1	1	1	1	1	0
Gurué	Pre_COVID-19	0.97	1	1	1	1	0.994	0.01
	Post_COVID-19	1	1	1	1	1	1	0
	All	0.97	1	1	1	1	0.997	0.01
Ile	Pre_COVID-19	0.98	1	1	1	1	0.998	0.01
	Post_COVID-19	1	1	1	1	1	1	0
	All	0.98	1	1	1	1	0.999	0
Inhassunge	Pre_COVID-19	0.99	1	1	1	1	0.999	0
	Post_COVID-19	1	1	1	1	1	1	0
	All	0.99	1	1	1	1	0.999	0
Lugela	Pre_COVID-19	0.97	1	1	1	1	0.997	0.01
	Post_COVID-19	1	1	1	1	1	1	0
	All	0.97	1	1	1	1	0.999	0.01
Maganja da Costa	Pre_COVID-19	1	1	1	1	1	1	0
	Post_COVID-19	1	1	1	1	1	1	0
	All	1	1	1	1	1	1	0
Milange	Pre_COVID-19	0.98	1	1	1	1	0.999	0.01
	Post_COVID-19	0.99	1	1	1	1	0.999	0
	All	0.98	1	1	1	1	0.999	0
Mocuba	Pre_COVID-19	0.99	0.99	0.995	1	1	0.995	0
	Post_COVID-19	0.97	0.99	0.996	1	1	0.993	0.01
	All	0.97	0.99	0.995	1	1	0.994	0.01
Mocubela	Pre_COVID-19	0.97	0.99	0.996	1	1	0.992	0.01
	Post_COVID-19	1	1	1	1	1	1	0
	All	0.97	1	1	1	1	0.996	0.01
Molumbo	Pre_COVID-19	1	1	1	1	1	1	0
	Post_COVID-19	1	1	1	1	1	1	0
	All	1	1	1	1	1	1	0
Namacurra	Pre_COVID-19	0.99	1	1	1	1	0.998	0
	Post_COVID-19	0.99	1	1	1	1	0.999	0
	All	0.99	1	1	1	1	0.998	0
Nicoadala	Pre_COVID-19	0.98	0.99	0.998	1	1	0.996	0.01
	Post_COVID-19	0.99	0.99	1	1	1	0.997	0
	All	0.98	0.99	1	1	1	0.997	0.01
Pebane	Pre_COVID-19	0.98	0.99	1	1	1	0.995	0.01
	Post_COVID-19	0.99	1	1	1	1	0.997	0.01
	All	0.98	0.99	1	1	1	0.996	0.01
Quelimane	Pre_COVID-19	0.98	0.98	0.992	1	1	0.989	0.01
	Post_COVID-19	0.99	1	0.997	1	1	0.996	0.01
	All	0.98	0.99	0.996	1	1	0.993	0.01

Overall, the maternal ART coverage increases along time (see **Figure S16** below). The odds of HIV-positive PW being covered by ART service increases about 6.8% (Odds Ratio [OR] 1.068 [1.020-1.119], p=0.005) every month in the evaluation period regardless of pre- or post-COVID-19 periods.

The odds increase to 1.75 times (OR 1.75 [0.461-6.613], p=0.412) (compared to an assumptive odds at this time if there is no COVID-19) right after COVID-19 started, though this instantaneous change is not statistically significant. Overall, the trend of ART coverage among PW is the same in pre- and post-periods.

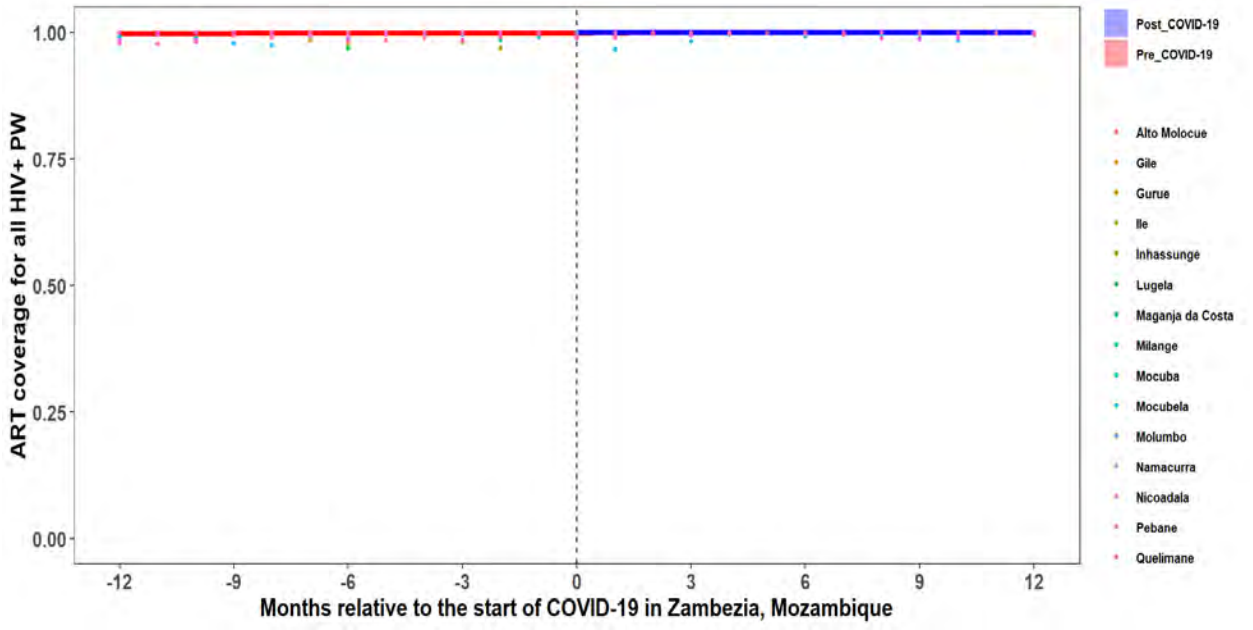

Figure S16. Comparisons for ART coverage among PW pre- and post-COVID-19 mitigation measures starting (as represented by dotted line).

Appendix 3: Other Supporting Materials

1. *Approved evaluation concept note/ protocol*

This secondary data analysis is covered under the "blanket" program evaluation protocol "*Quality Improvement for HIV Care and Treatment in Zambézia province of the Republic of Mozambique under the President´s Emergency Plan for AIDS Relief (PEPFAR)*", which has approvals from Mozambique ethics committee, CIBS-Z, and the VUMC IRB. The concept note describing this evaluation was reviewed and approved by CDC-Mozambique ADS team. The approved blanket protocol and concept note for this specific evaluation are submitted electronically along with this final report for reference.

2. *Data collection instruments/tools*

Not applicable (as no data collection instruments or tools were developed for the purposes of this secondary data analysis).

3. *Informed consent*

Informed consent was not required for use of data in this evaluation, as it was a secondary analysis of routinely collected, de-identified, programmatic data. A waiver of consent was approved, as the evaluation involved no more than minimal risk, would not have been possible without the waiver, and the waiver did not adversely affect the rights nor welfare of the patients whose data were included in the evaluation.

4. *Biosketches*

Biosketches are provided below for the first (Caroline De Schacht) and senior (C. William Wester) co-authors of this evaluation.

Biosketch for Co-Investigator Caroline De Schacht

BIOGRAPHICAL SKETCH

NAME: Caroline De Schacht

eRA COMMONS USER NAME (credential, e.g., agency login): cdeschacht

POSITION TITLE: Director of Evaluations

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Ghent University, Ghent, Belgium	Licentiate	07/1998	General Medicine
Ghent University, Ghent, Belgium	Specialization	07/2000	Family Medicine
Prince Leopold Institute of Tropical Medicine, Antwerp, Belgium	Diploma	02/2001	Tropical Medicine
London School of Hygiene and Tropical Medicine (Distance learning)	MSc	07/2008	Clinical Trials
Ghent University, Ghent, Belgium	PhD	11/2015	Biomedical Science

A. Personal Statement

For about 20 years, I have been working as an HIV technical advisor and researcher in resource-poor settings, including the last 16 years in Mozambique. As technical advisor, I worked closely with the Ministry of Health and the Provincial Health authorities, and have gained valuable insight into the Mozambican Health System which I will use to help develop study protocols and design. In addition, I managed the start-up of an HIV care and treatment project in Tete and Gaza Provinces, which involved bringing together and coordinating a diverse group of stakeholders. As a researcher, I have been coordinating clinical and operational research activities since 2008. I have been the lead investigator on several studies in Mozambique, of which several related to PMTCT/ HIV prevention. I have been collaborating with the Polana Caniço Research Centre in HIV prevention research among young adults, such as the HIV incidence study, HIV vaccine trial (Tamovac I) and socio-behavioral studies on HIV prevention trials in Maputo city. In my current position, I am the lead of several HIV-related operational research projects in Zambézia province, and manage various secondary data analyses of HIV-program results.
Together with the Provincial Health services, and/ or National Institute of Health Mozambique, I have been serving as a trainer in different capacity building areas (quantitative and qualitative research methods, GCP/research ethics, protocol/abstract/manuscript writing, etc.), and mentor/supervise young researchers and PhD students, since 2005. I am also invited member of the UEM/INS Jury for the Masters in Field Epidemiology (FELTP), and member of the scientific committee of the Mozambican Health Conference where capacity building on dissemination of scientific results is an important component.

I'd like to highlight the following ongoing projects:

Ongoing Research Support

R01MH113478-01 NIH (Audet, PI) 05/14/2017-05/30/2022
The primary objectives of Partners-based HIV Treatment for Sero-concordant Couples attending Antenatal Care are to evaluate the impact and cost-effectiveness of couples-centered services for HIV-infected

seroconcordant pregnant women and their partners. Our intervention includes: (1) ANC-based couples HIV testing, ART enrollment, and care for HIV+ expectant couples; (2) Couple-based treatment in the post-partum period; (3) Couple-based education and skills building; and (4) Treatment continuity with the support of expert-patient (peer) supporters from couples who have successfully navigated EMTCT.
Role: In-Country Principal Investigator

U2GGH001943 Centers for Disease Control and Prevention (PI: Wester) 06/01/2020-12/01/2022
Title: Impact of COVID-19 epidemic on clinical outcomes and service delivery among people living with HIV and health care workers in Mozambique. The goal of this protocol is to determine the incidence, prevalence, and clinical manifestations of SARS-CoV-2 among adults living with HIV and healthcare the health care providers, and to assess the impact that COVID-19 has on them and on the healthcare system.
Role: Co-principal Investigator

GH002367-01-00 Centers for Disease Control and Prevention (PI: Wester)
9/30/2021 - 9/29/2026
Title: Quality Improvement for HIV Care and Treatment in Zambézia province of the Republic of Mozambique under the President´s Emergency Plan for AIDS Relief (PEPFAR)
The purpose of the protocol is to review and summarize all routinely collected data from the HIV care and treatment program in Zambézia province from 2012 onwards. This data will be used for program evaluation, continuous program improvement, and to help inform evidence-based decisions on policies/guidelines, approaches, programs, and interventions that can best address the HIV/AIDS epidemic in Zambézia province. Key programmatic areas include: i) prevention; ii) adult care, support and treatment; iii) HIV/TB; and iv) pediatric care, support, and treatment.
Role: Co-Investigator

R34 MH127975-01A1 **NIH (Audet, PI)** 10/1/2022 - 09/302025
Title: Estamos Juntos (We are Together): Improving HIV care delivery by capacitating health care providers. The long-term goal of this research is to develop an intervention to improve resilience and reduce stigmatizing behaviors among health care workers, and test two such interventions in 4 health care facilities in Zambézia province, Mozambique.
Role: In-Country Principal Investigator

B. Positions and Honors

2017 - present Evaluations Director, Friends in Global Health, Mozambique
2014 - 2017 Project Coordinator/Research Advisor, Health Alliance International, Maputo, Mozambique
2008 - 2014 Public Health Evaluation Coordinator, Elizabeth Glaser Pediatric AIDS Foundation, Maputo, Mozambique
2006 - 2008 Clinical Advisor, Care and Treatment, Elizabeth Glaser Pediatric AIDS Foundation, Gaza, Mozambique
2005 - 2006 HIV Advisor/Project Manager, Pharmaccess Foundation, Maputo, Mozambique
2003 - 2004 HIV Clinical Advisor, Prince Leopold Institute of Tropical Medicine, Tete, Mozambique
2003 - 2004 HIV Clinical Advisor, Médecins sans Frontières, Ethiopia and Cambodia
2002 - 2003 HIV Clinician, Prince Leopold Institute of Tropical Medicine, Antwerp, Belgium
2001 - 2002 Project Coordinator, Médecins sans Frontières, Benin

2015; 2018; 2019 Member of Scientific Committee Provincial and National Health Conferences Mozambique
2016- Member of Jury – Masters Course in Field Epidemiology and Laboratory Practices
2010- Member of International Aids Society (IAS)

C. Contributions to Science

HIV epidemiology

Dr. De Schacht contributed to major studies in the epidemiology of HIV in Mozambique. She participated in the first cohort HIV incidence studies among vulnerable populations in Mozambique (youth, pregnant and breastfeeding women). She was PI on the HIV incidence cohort study of pregnant and breastfeeding women. Through the research work, we have been able to estimate the incidence of HIV among pregnant and breastfeeding women in a high HIV prevalence regions of Mozambique, found to be very high.

Viegas EO, Tembe N, Macovela E, Gonçalves E, Augusto O, Ismael N, Sitoe N, ***De Schacht C***, Bhatt N, Meggi B, Araujo C, Sandström E, Biberfeld G, Nilsson C, Andersson S, Jani I, Osman N. Incidence of HIV and the prevalence of HIV, hepatitis B and syphilis among youths in Maputo, Mozambique: a cohort study. PLoS One. 2015 Mar 23;10(3):e0121452

Caroline De Schacht, Heather J. Hoffman, Nédio Mabunda, Carlota Lucas, Catharina L. Alons, Ana Madonela, Adolfo Vubil, Orlando C. Ferreira Jr, Nurbai Calú, Iolanda S. Santos, Ilesh V. Jani, Laura Guay High HIV seroconversion in pregnant women and low reported levels of HIV testing among male partners in Southern Mozambique: results from a mixed methods study. PlosOne 9(12): e115014

De Schacht C, Mabunda N, Ferreira Jr OC, Ismael N, Calú N, Santos I, Hoffman JH, Alons C, Guay L, Jani IV. High HIV incidence in the postpartum period sustains vertical transmission in settings with generalized HIV epidemics: a cohort study in Southern Mozambique. JIAS 2014, 17:18808

Mother-to-Child Transmission of HIV

These publications are result of the contributions to research on mother-to-child transmission of HIV, looking at several aspects that influence retention to PMTCT care, and interventions to decrease vertical transmission rate, such as partner-based treatment.

Jani IV, De Schacht C. Innovations and challenges in early infant diagnosis of HIV. Curr Opin HIV AIDS 2018 Nov 1

Sack DE, Frisby MB, Diemer MA, De Schacht C, et al. Interpersonal reactivity index adaptation among expectant seroconcordant couples with HIV in Zambézia Province, Mozambique. BMC Psychol. 2020 Aug 28;8(1):90

Audet CM, Graves E, Barreto E, De Schacht C, et al. Partners-based HIV treatment for seroconcordant couples attending antenatal and postnatal care in rural Mozambique: A cluster randomized trial protocol. Contemp Clin Trials. 2018 Jun 5;71: 63-69

De Schacht C, Lucas C, Mboa C, Gill M, Macasse E, Stélio AD, Bobrow EA, Guay L. Access to HIV prevention and care for HIV-exposed and HIV-infected infants: a qualitative study in rural and urban Mozambique. BMC Public Health 2014, 14:1240

HIV and TB Care

Arinze F, Gong W, Green AF, ***De Schacht C***, Carlucci JG, Silva W, Claquin G, Tique JA, Stefanutto M, Graves E, Van Rompaey S, Alvim MFS, Tomo S, Moon TD, Wester CW. Immunodeficiency at Antiretroviral Therapy Start: Five-Year Adult Data (2012-2017) Based on Evolving National Policies in Rural Mozambique. AIDS Res Hum Retroviruses. 2020 Jan;36(1):39-47

De Schacht C, Mutaquiha C, Faria F, Castro G, Manaca N, Manhiça I, Cowan J. Barriers to access and adherence to tuberculosis services, as perceived by patients: A qualitative study in Mozambique. PLoS One. 2019 Jul 10;14(7):e0219470

Lynen L, Zolfo M, Huyst V, Louis F, Barnardt P, Van de Velde A, ***De Schacht C***, Colebunders R. Management of Kaposi's sarcoma in resource-limited settings in the era of HAART. AIDS Rev. 2005 Jan-Mar; 7(1):13-21

De Schacht C, Smets RME, Callens S, Colebunders R. Bilateral blindness after starting Highly Active Retroviral Treatment in a patient with HIV infection and cryptococcal meningitis. Acta Clin Belg. 2005 Jan-Feb;60(1):10-2

Colebunders R, ***De Schacht C***, Vanwolleghem T, Callens S. Lopinavir/ritonavir- and indinavir-induced thrombocytopenia in a patient with HIV infection -Letter to the editor. Int J Infect Dis. 2004; 8(5):315-6

Colebunders R, Schueremans L, Robertson-Bell D, Alvarez-Valdes VG, ***De Schacht C***, Mispelters J, Gillisjans F, De Lee G, Ostyn B. Optimal delivery of HAART during hospitalisation. AIDS Read. 2004; 14(4): 198-200. Review

Callens S, ***De Schacht C***, Huyst V, Colebunders R. Pancreatitis in an HIV-infected person on a tenofovir, didanosine and stavudine containing highly active antiretroviral treatment. J Infect 2003; 47(2):188-9

Mother and Child Health Care/ EPI program

Main achievements are the results of research understanding coverage of the vaccination program in Mozambique, contributing to improvement of access to health care for mothers and children.

Small area estimation of under-5 mortality in Bangladesh, Cameroon, Chad, Mozambique, Uganda, and Zambia using spatially misaligned data. Dwyer-Lindgren L, Squires ER, Teeple S, Ikilezi G, Allen Roberts D, Colombara DV, Allen SK, Kamande SM, Graetz N, Flaxman AD, El Bcheraoui C, Asbjornsdottir K, Asiimwe G, Augusto Â, Augusto O, Chilundo B, **De Schacht C**, Gimbel S, Kamya C, Namugaya F, Masiye F, Mauieia C, Miangotar Y, Mimche H, Sabonete A, Sarma H, Sherr K, Simuyemba M, Sinyangwe AC, Uddin J, Wagenaar BH, Lim SS. Popul Health Metr. 2018 Aug 13;16(1):13.

Jani JV, **De Schacht C**, Jani IV, Bjune G. Risk factors for incomplete vaccination and missed opportunity for immunization in rural Mozambique. BMC Public Health. 2008 May 16

Arts M, Geelhoed D, ***De Schacht C***, Prosser W, Alons C, Pedro A. Knowledge, beliefs and practices regarding exclusive breastfeeding of infants younger than 6 months in Mozambique: a qualitative study. J Hum Lact. 2011 Feb;27(1):25-32

Biosketch for Co-Investigator C. William Wester

BIOGRAPHICAL SKETCH

NAME: Wester, C. William

eRA COMMONS USER NAME (agency login): wwester

POSITION TITLE: Associate Professor of Medicine

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable.)*

INSTITUTION AND LOCATION	DEGREE (if applicable)	Completion Date MM/YYYY	FIELD OF STUDY
Bowdoin College , Brunswick, ME	BA	06/1987	Biology and Economics
Dartmouth Medical School , Hanover , NH	MD	06/1991	Medicine
Harvard School of Public Health, Boston, MA	MPH	11/2010	Quantitative Methods

A. Personal Statement

The goal of my present research includes long-term HIV complications with a focus on implementation science and HIV-associated kidney disease and in resource-limited settings of the world. In addition, I have served as Co-Chair of the IeDEA Site Assessment Working Group (with Denis Nash and Stephany Duda) for the past 3 years and have been actively engaged in the collection and analysis of site level data for the purposes of informing and improving ongoing clinical initiatives/programs in such settings. Recently completed grant-funded studies include the determination of clinical, laboratory, and host genetic risk factors associated with the development of lactic acidosis, pancreatitis, nevirapine-related cutaneous hypersensitivity reactions, and other metabolic/potentially inflammatory mediated complications including HIV-associated renal, hepatic, and cardiovascular disease. This work has bridged outcomes-epidemiology and clinical-translational research domains and has allowed me to successfully attain NIH-funded grants on which I serve as Principal or Co-Principal Investigator.

With my extensive implementation science research experience in resource-limited settings, focused on long-the scale-up of comprehensive HIV services, the prevention of mother-to-child transmission, complications of HIV, as well as work focused on identifying risk factors for untoward outcomes, coupled with my extensive regional experience, namely working (and residing full-time) in Botswana for 8 years (2000-2008) where I worked for the T.H. Chan Harvard School of Public Health and was actively involved in clinical trials, as well as my active involvement (including frequent travel to Mozambique) as Project Director of our large (currently supporting > 110 ART sites) ongoing U.S. government Centers for Disease Control and Prevention (CDC) / President's Emergency Plan for AIDS Relief (PEPFAR)-funded "*Avante: Towards Epidemic Control"* (Cooperative agreement 1NUGGH001943) technical assistance initiative (with renewed funding through 2021), I am uniquely qualified to serve as primary research mentor for team members (both in Mozambique as well as Vanderbilt-based) for many of the program evaluations (plus relevant research protocols) that the "*Avante: Towards Epidemic Control*" team is conducting. Specifically, in this leadership role, I will continue to mentor technical staff and assist them to: a) develop stakeholder-informed context-specific interventions, b) learn approaches to community engagement and intervention design, c) further develop their research skills in HIV implementation science, and d) help them garner the requisite skills to independently lead HIV research studies in Mozambique and other similar settings.

B. Positions and Honors

Positions and Employment

1994 - 1998	Clinical Instructor, Rush Medical College , Chicago, IL
1998 - 2000	Infectious Diseases Attending Physician, Cook County (Stroger Memorial) Hospital, Chicago, IL
1998 - 2000	Assistant Professor of Medicine , Rush Medical College, Chicago, IL
1999 - 2000	Principal Investigator, Terry Beirn Community Programs for Clinical Research on AIDS (CPCRA) , The Core Center, Cook County Hospital, Chicago, IL
1999 - 2000	Co-Investigator, Adult Clinical Trials Group (ACTG) Research Trials, The CORE Center, Cook County Hospital, Chicago, IL
2000 -	Research Associate, Harvard School of Public Health, Boston, MA
2000 - 2008	Co-Study Coordinator/Site Leader/Site PI; Adult Antiretroviral Treatment and Drug Resistance ("*Tshepo*") Study, Botswana-Harvard School of Public Health AIDS Initiative Partnership for HIV Research and Education (BHP), Gaborone
2001 - 2002	Director; Infectious Disease Care Clinic (outpatient HIV/AIDS clinic) , Princess Marina Hospital; Ministry of Health, Botswana, Gaborone

2007 - 2008	Site Leader/Site Principal Investigator, ACTG and the Gaborone PTT/CRS , Botswana-Harvard School of Public Health AIDS Initiative Partnership Clinical Trials Unit (CTU), Gaborone
2008 - 2014	Assistant Professor of Medicine, Vanderbilt University School of Medicine, Vanderbilt Institute for Global Health (VIGH), Nashville, TN
2014 -	Associate Professor of Medicine, Vanderbilt University School of Medicine, Vanderbilt Institute for Global Health (VIGH), Nashville, TN
2014 -	Co-Director of Global Health Pathway (Internal Medicine Residency, Vanderbilt University School of Medicine)

Other Experience and Professional Memberships

1994 -	Member, Alpha Omega Alpha (AOA) Honor Medical Society
2011 -	Member, International AIDS Society (IAS)
2014 -	Member, International Society of Nephrology (ISN)

Honors

1991	Outstanding Medical Resident Teaching Award, (Six Consecutive and Maximum Eligible Terms), Rush-Presbyterian St. Luke's Medical Center
1992	Outstanding Internal Medicine Resident Annual Award, Rush-Presbyterian St. Luke's Medical Center
1994	Full Scholarship Recipient, SHEA-CDC Training Course
1994	Aesculapios Award (Outstanding Medical Resident), Rush Medical College
2010	William Schaffner Teaching Award Recipient in Infectious Diseases, Vanderbilt University School of Medicine, Division of Infectious Diseases
2010	Teacher Recognition Award , Vanderbilt University School of Medicine
2016	Selected for Vanderbilt University Department of Medicine Mid-Career Leadership Program (year-long leadership skills development program; commenced January 2017)

C. Contribution to Science

Scale-up of Comprehensive HIV/AIDS Services in Resource-limited settings / Implementation Science:

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Prevention of Mother-to-Child Transmission (PMTCT):
Aliyu MH, Blevins M, Audet C, Shepherd BE, Hassan A, Onwujekwe O, Gebi UI, Kalish M, Lindegren ML, Vermund SH, Wester CW. Optimizing PMTCT service delivery in rural North-Central Nigeria: protocol and design for a cluster randomized study. *Contemp Clin Trials*. 2013 Sep;36(1):187-97. PMCID: PMC3786261.
Dunlap J, Foderingham N, Bussell S, Wester CW, Audet CM, Aliyu MH. Male involvement for the prevention of mother-to-child HIV transmission: A brief review of initiatives in East, West, and Central Africa. *Curr HIV/AIDS Rep*. 2014 Jun;11(2):109-18. PMCID: PMC4371528.
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Risk Factors for Untoward HIV/AIDS Outcomes (mortality, loss to follow-up, etc.):
Mujugira A, Wester CW, Kim S, Bussmann H, Gaolathe T. Patients with advanced HIV type 1 infection initiating antiretroviral therapy in Botswana: treatment response and mortality. *AIDS Res Hum Retroviruses*. 2009 Feb; 25(2):127-33. PMID: 19239353.
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A full list of my publications (67+) may be found at:
http://www.ncbi.nlm.nih.gov/sites/myncbi/1HSsewwv6gd5A/bibliography/43390763/public/?sort=date&direction=ascending.
D. Research Support
Active Research Support

1NU2GGH001943-02 (PI: Wester)	9/30/2016 - 9/29/2021	6.48 calendar
CDC (PEPFAR)		

Avante: Towards Epidemic Control
The purpose of the Avante program is to control the HIV epidemic by supporting the sustainable implementation of Ministry of Health (MOH) HIV and TB services in Zambézia province. Avante will provide technical assistance (TA) to the Government of the Republic of Mozambique (GRM) at the national, provincial, district and health facility level for activities that have a significant impact to control the epidemic, leveraging community structures that can catalyze program implementation. Key programmatic areas include: i) prevention; ii) adult care, support and treatment; iii) HIV/TB; and iv) pediatric care, support, and treatment.

1U01DK1122770 (MPI/Contact PI: Wester) 9/15/2017 – 8/31/2022 2.4 calendar
NIH/NIDDK
Optimal Management of HIV Infected Adults at Risk for Kidney Disease in Nigeria
In this clinical trial, we plan to determine the optimal means to prevent or slow the progression of kidney disease among genetically at-risk northern Nigerian HIV-infected adults. Based on data from studies of diabetic kidney disease that used medications that block the renin angiotensin aldosterone system (RAAS), we plan to evaluate whether or not RAAS inhibition (using a widely available medication that blocks RAAS) in HIV-infected adults produces similarly promising results.

Integrated Malaria Program (IMaP) in Mozambique
Chemonics International, Inc. (PI: Wester) 12/05/2017 - 07/30/2022 0.72 calendar
U.S. Agency of International Development

Table S11. Brief description of roles of all evaluation collaborators.

Name, Title and Affiliation	Role	Responsibilities
C. William Wester Professor of Medicine Vanderbilt University Medical Center (VUMC) William.wester@vumc.org	Principal Investigator	Concept note development, results interpretation, technical oversight of program and data collection, report writing, dissemination of results
Caroline De Schacht, MD, Msc, PhD Director of Evaluations Friends in Global Health (FGH), Maputo caroline.deschacht@fgh.org.mz	Co-investigator	Concept note development, technical oversight of program and data collection, results interpretation, report writing, dissemination of results
Magdalena Bravo National Maternal Child Health/ PMTCT Advisor Friends in Global Health (FGH), Maputo magdalena.bravo@fgh.org.mz	Co-investigator	Assist in concept note development, technical oversight of program, results interpretation, dissemination of results
Zhihong Yu Biostatistician II Department of Biostatistics VUMC Zhihong.yu@vumc.org	Collaborator	Data analysis, results interpretation, dissemination of results
Erin Graves Lead Program Manager VUMC erin.r.graves.1@vumc.org	Collaborator	Assist in concept note development, technical oversight of program and data collection, report writing, dissemination of results
Kwalila Tibana PMTCT Advisor of HIV Program Ministry of Health, National Directorate for Public Health ktibana@pedaids.org	Collaborator	Technical oversight of program implementation, review of concept note, report and dissemination products
Cristina Cugara Maternal Child Health (MCH) Nurse; Operational Investigation Committee of Zambézia (NIOZ)	Collaborator	Technical oversight of program implementation, review of concept note, report and dissemination products

Provincial Health Directorate, Zambézia cristinacugara83@gmail.com		
Cheinaze Veríssimo Provincial HIV Supervisor Provincial Health Directorate, Zambézia cheinaze24@gmail.com	Collaborator	Technical oversight of program implementation, review of concept note, report and dissemination products
Celso Belo Evaluations Manager Friends in Global Health (FGH), Maputo celso.belo@fgh.org.mz	Collaborator	Assist in concept note development, technical oversight of data collection, report writing, dissemination of results
Gustavo Amorim Research Assistant Professor Department of Biostatistics VUMC Gustavo.g.amorim@vumc.org	Collaborator	Support for data analysis, results interpretation, dissemination of results
José Tique Technical Director Friends in Global Health (FGH), Maputo jose.tique@fgh.org.mz	Collaborator	Technical oversight of program implementation, review of concept note, report and dissemination products
Aleny Couto Head of HIV Program Ministry of Health, National Directorate for Public Health aleny78@hotmail.com	Collaborator	Technical oversight of program implementation, review of concept note, report and dissemination products

5. *Conflict of interest statement.*

The collaborators in this evaluation have no conflicts of interest to declare.

6. *Evaluation costs*

Evaluation costs were limited to the personnel time required for extraction and analysis of routine secondary data, results review and discussion, and report preparation, with estimated expenditures equal to $47,166.00 for the FGH personnel effort and $30,608.35 for the VUMC personnel effort, for an estimated total of $77,774.35 (which includes salary and benefits).

7. Evaluation logical framework

Please see below a framework demonstrating the hypothesized / intended pathway for improved outcomes related to the implementation of Option B+ (maternal and infant) and Test & Start (all non-pregnant/lactating adults) strategies.

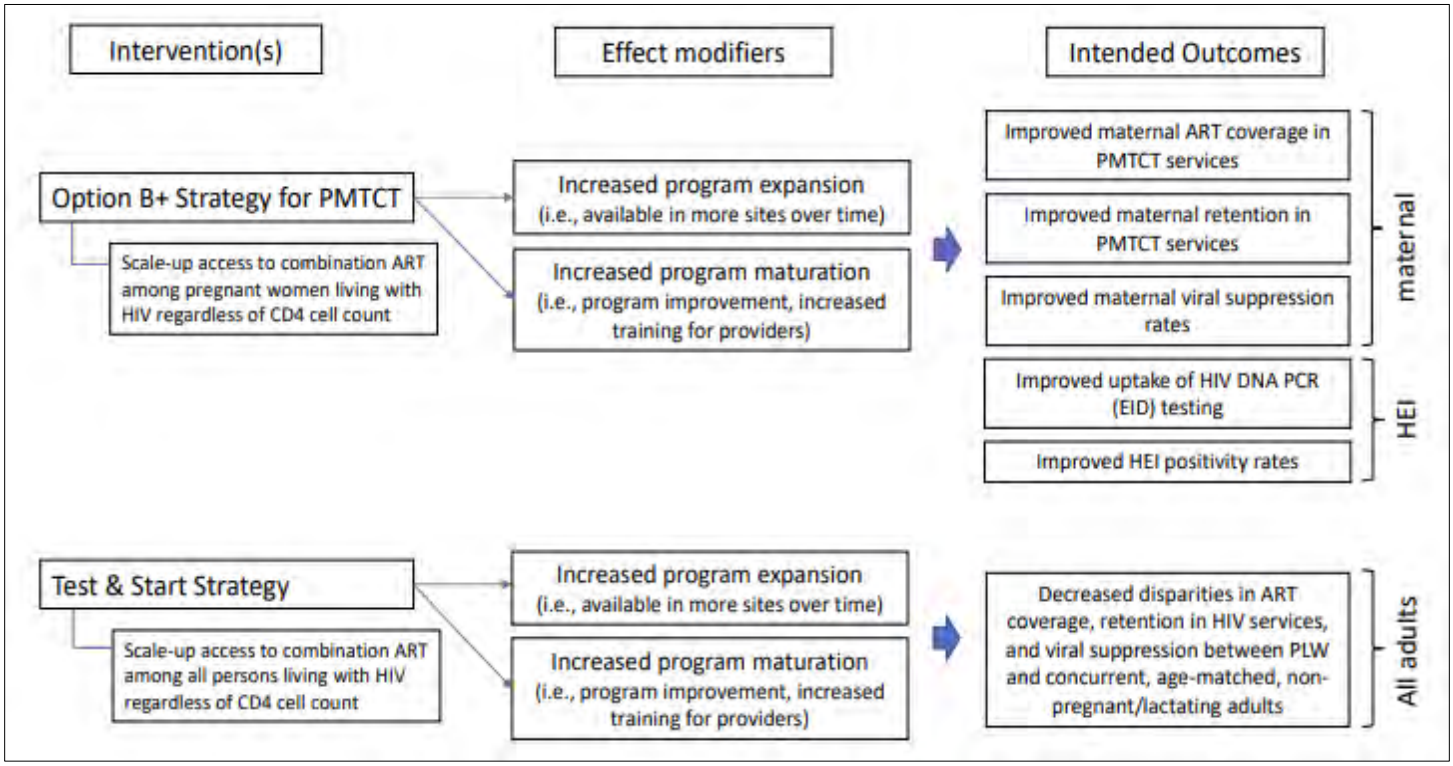

Figure S17. Framework of intended pathway for outcome improvement.

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