Quantifying variability in time out of care among HIV-positive patients in Zambia

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Motivation

- The effectiveness of HIV services is dependent on continuous and consistent retention in care
- In resource-limited settings, patients frequently have lapses in care
- There is a rich literature on individual-level contributors to retention, but less on clinic-level attributes which are more likely to have health systems solutions
- Health systems interventions to improve retention need to understand the variability of time out of care and how it is distributed in a patient population
  - Evenly distributed time out of care in a patient population suggests structural or organizational drivers of lapses in care
  - Concentration of time out of care in a smaller subgroup of patients suggests more individual-level drivers of lapses in care

Objectives

1. Quantify the fraction of time spent out of care (defined as being late for a clinic visit by more than 3 days) in a network of clinics in Zambia

2. Assess the distribution of time out of care at each clinic across the network

3. Assess the distribution inequality of time out of care at the network and clinic-level

4. Examine clinic-level predictors of time out of care

Setting

- Zambia:
  - Population: 14.5 million
  - 1.1 million people living with HIV
  - Adult HIV prevalence is 13%
- Centre for Infectious Disease Research in Zambia (CIDRZ) is a Zambian non-governmental organization that supports HIV care and treatment services at a network of 76 clinics across 4 of 10 provinces in Zambia
- We examined HIV-positive patients in clinics supported by CIDRZ who had a visit between January 1, 2013 and February 28, 2015

Measurements

- Data Source:
  - Electronic medical record data collected for routine clinical purposes from Zambian national data system, SmartCare
    - Cohort of patients who had a clinic visit between January 1, 2013- February 28, 2015 and their historical data
- Measurements
  - Socio-demographic
    - Age
    - Gender
    - Location: Clinic, province
  - Clinical
    - CD4
  - Health Care utilization
    - Visit dates
    - Appointment dates

Outcomes

- Time out of care
  - Continuous measure in days
  - Proxy for lapses in ART use for ART patients
  - Calculated using visit and appointment dates
  - 3 day buffer beyond appointment date allowed
  - 90 day maximum for time out of care for each visit
- Percent of time out of care:
  - (Total days out of care)/(Total days in care) *100
- Proportion of population responsible for 50% of outcome
  - Derived from Lorenz curve for each outcome

Lorenz Curve
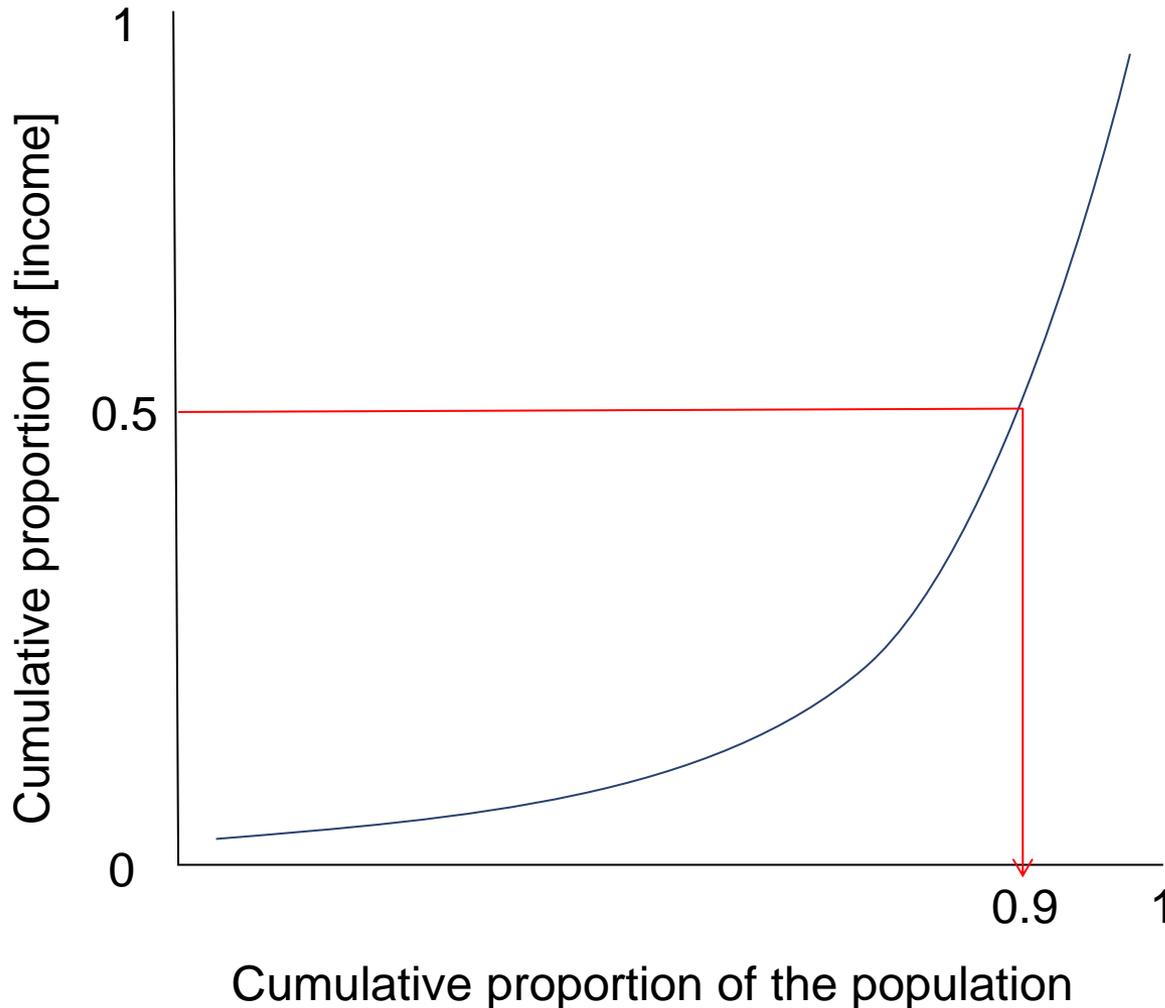
Common applications:
- Inequality in wealth
- Ecology/biodiversity
- Business modeling

Novel Application:
- Retention

Analysis

- Descriptive analysis of patient and clinic characteristics
- Descriptive analysis of time out of care
- Generate Lorenz curve for overall time out of care
  - Stratify by time on ART
- Generate Lorenz curves by clinic and examine variability of outcomes
- Multivariate linear regression of clinic-characteristics and:
  - Percent of time out of care
  - The percent of the clinic population responsible for 50% of clinic time out of care

Results: Characteristics of Study Population

	N (%)	
Total	168,537 (100)	3,871,679 observations
Female	109,549 (65)	

	Median	**IQR**
Age	35	[28, 41]
Time on ART (days)	1,095	[361, 2,068]
Time in care (days)	1,152	[346, 2124]
Time out of care (days)	126	[29, 246]

Descriptive analysis of Clinic Characteristics

	N (%)
Total	56 (100)
Province	
Eastern	11 (20)
Lusaka	24 (43)
Southern	10 (18)
Western	11 (20)
Facility Type	
Rural	18 (32)
Urban	24 (43)
Hospital	14 (25)

	Median	Min	Max	IQR
Clinic size	5,121	43	10,389	[2,852, 7,801]
Clinic median age	35	32	38	--
Clinic percent male	36	30	57	[34.1, 37.7]
Clinic median baseline CD4	233	175	347	[209, 242]

Variability of time out of care across clinics

Percent of time out of care (y-axis, bar chart). Reference lines marked at 25.5% and 7.3%.
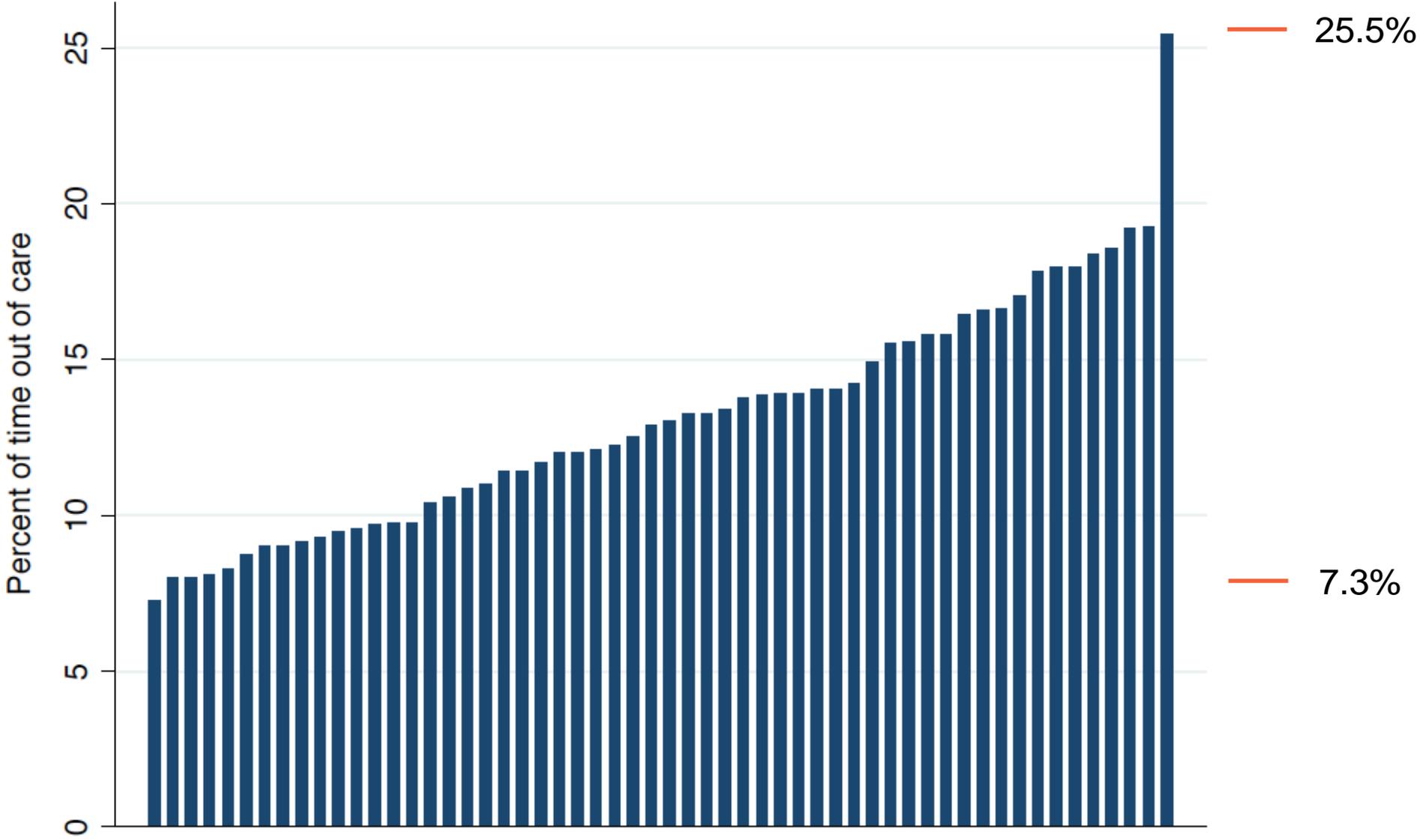
Overall Lorenz Curve: All Clinics
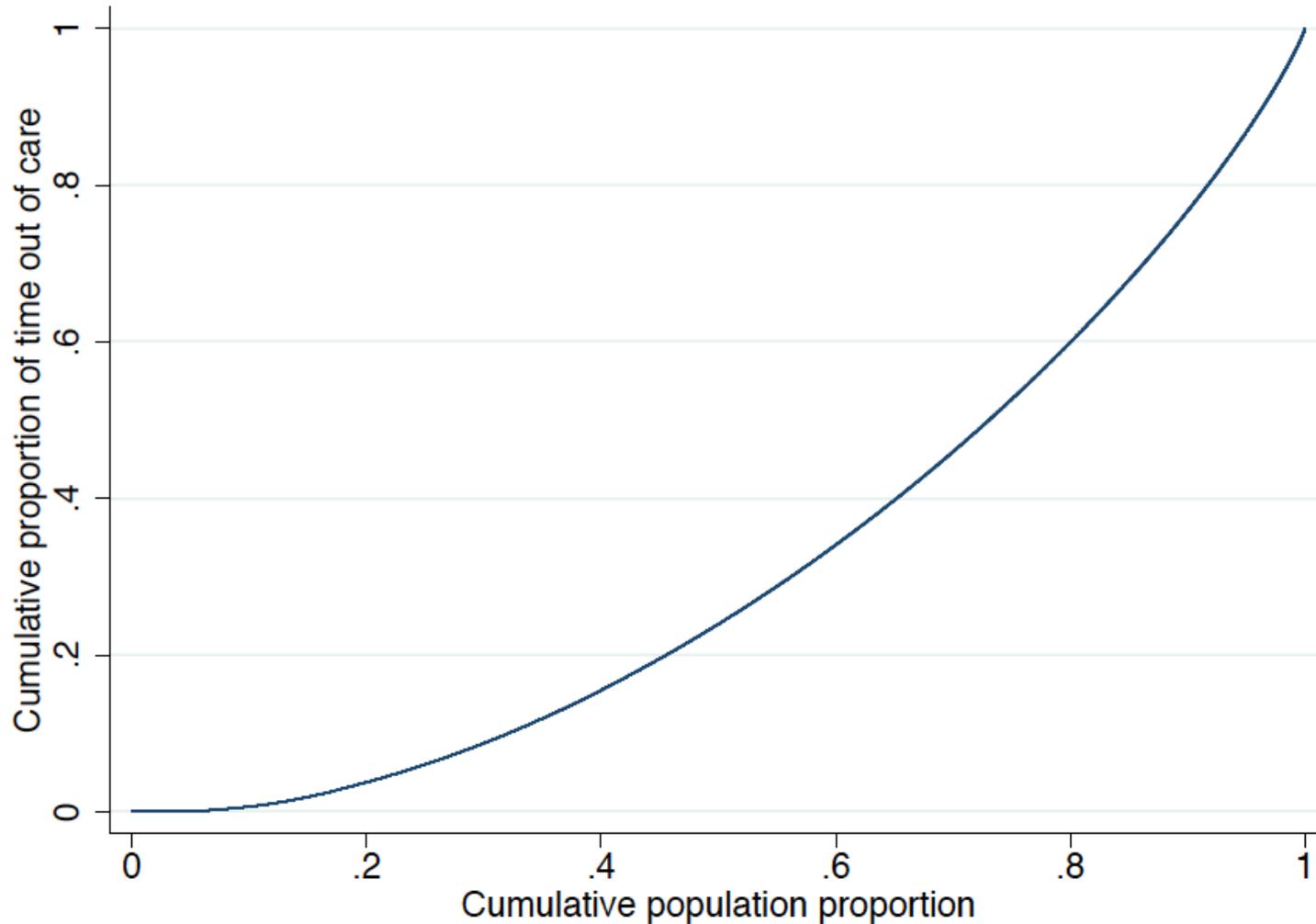
Overall Lorenz Curve: Outcome
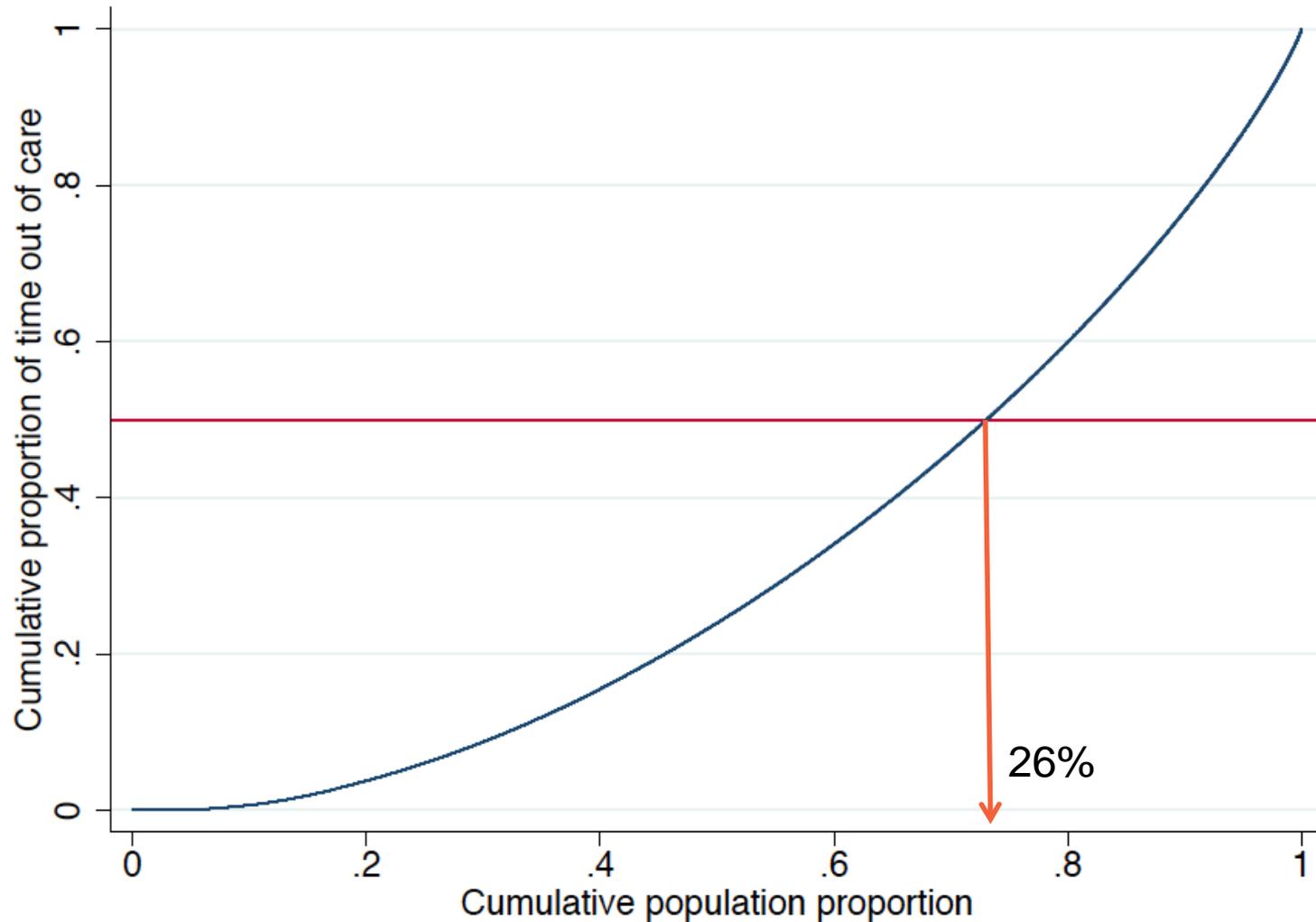
Lorenz Curve by time on ART

Legend: Pre-ART, 0-6M ART, 6M-1yr ART, 1-2yr ART, 2-3yr ART, >3yr ART, Ever
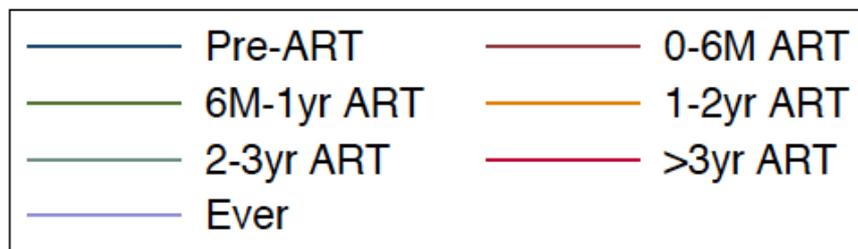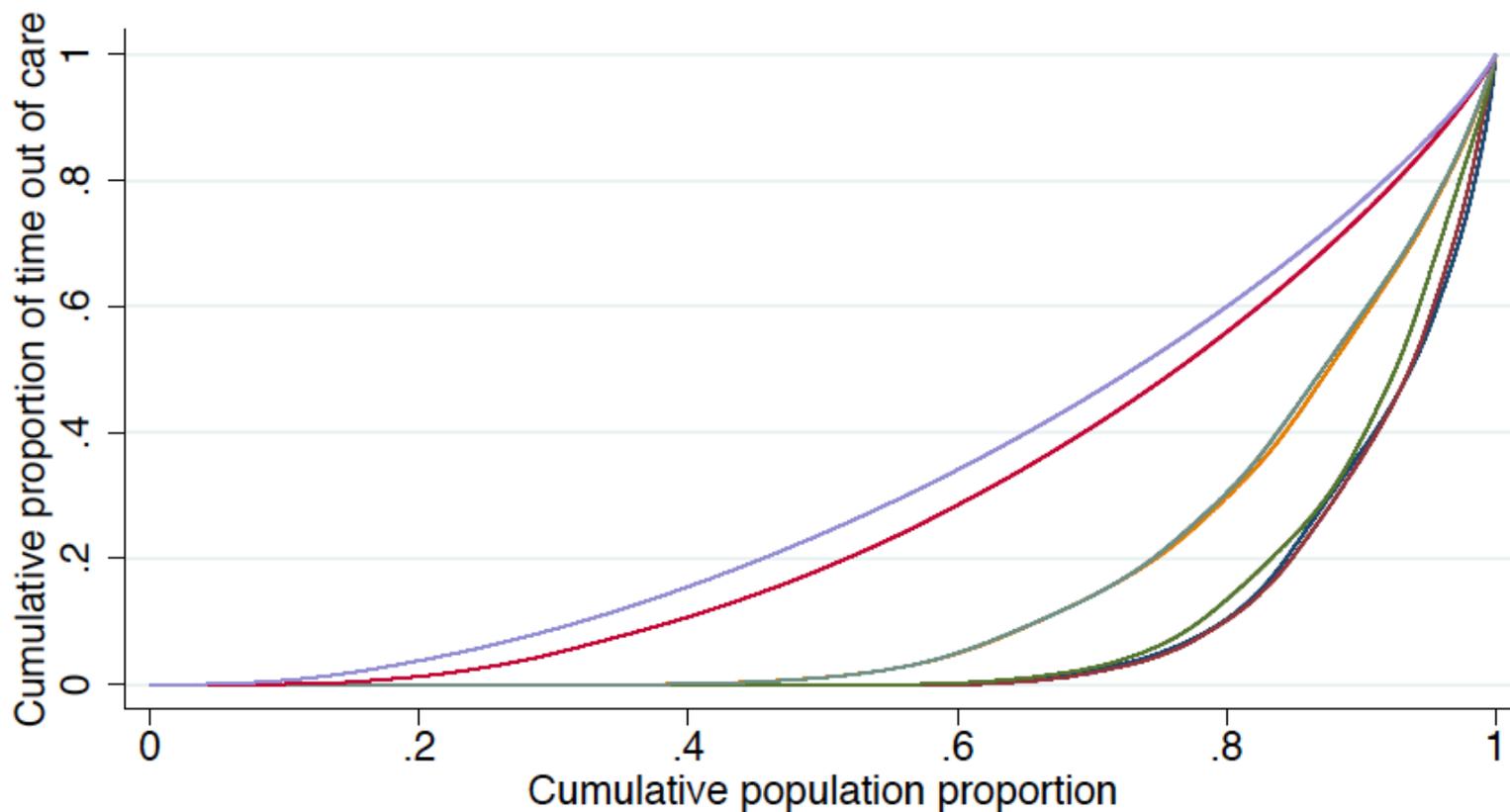
Pre-ART	6.3%
0-6M on ART	6.4%
6M-1 yr on ART	7.4%
1-2 yr on ART	12.4%
2-3 yr on ART	12.9%
>3 yr on ART	23.7%

Distribution of Lorenz Curve values by clinic
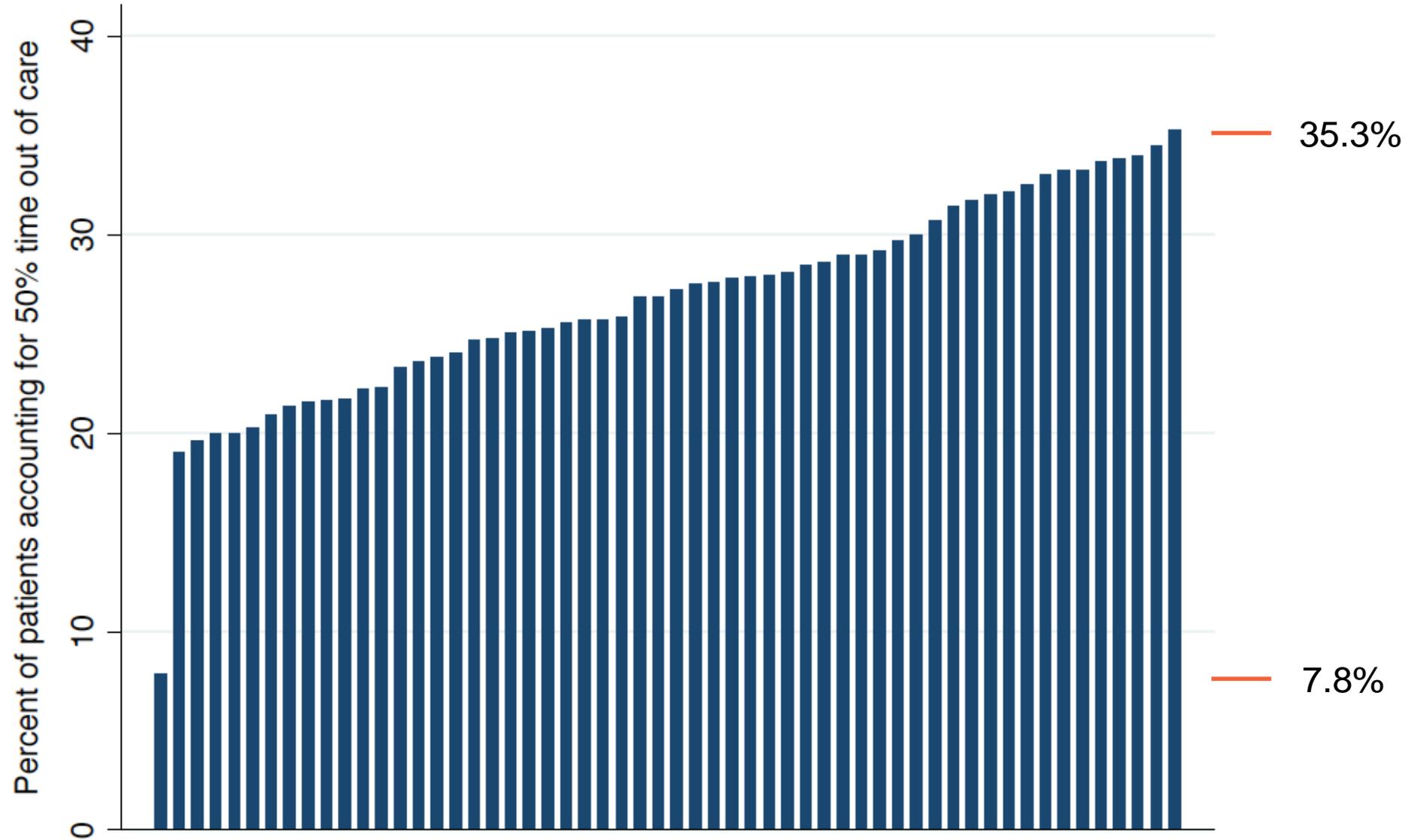
Clinic-level regression: percent time out of care

Percent of time out of care			
	Coefficient	**95% CI**	**P-value**
Clinic size (per 100)	0.04	(-0.01, 0.08)	0.087
Province			0.000
Eastern (Ref)	1.00		
Lusaka	-0.01	(-2.88, 2.85)	0.994
Southern	1.32	(-1.22, 3,85)	0.303
Western	8.14	(3.16, 13.13)	0.002
Clinic Type			0.000
Rural (Ref)	1.00		
Urban	2.56	(0.57, 4.56)	0.013
Hospital	-3.36	(-5.24, -1.48)	0.001
Median baseline CD4	0.02	(-0.01, 0.06)	0.167
Percent Male	22.70	(-3.53, 48.93)	0.088
Median Age	0.95	(-0.30, 2.19)	0.132

Clinic-level regression: Lorenz outcome

Percent of patients responsible for 50% of time out of care			
	Coefficient	**95% CI**	**P-value**
Clinic size (per 100)	0.09	(0.03, 0.15)	0.003
Province			0.008
Eastern (Ref)	1.00		
Lusaka	2.16	(-1.74, 6.07)	0.272
Southern	1.55	(-2.43, 5.53)	0.439
Western	8.67	(1.27, 16.09)	0.022
Clinic Type			0.000
Rural (Ref)	1.00		
Urban	2.11	(-0.99, 5.20)	0.178
Hospital	-5.61	(-8.56, -2.66)	0.000
Median baseline CD4	-0.003	(-0.06, 0.05)	0.913
Percent Male	17.55	(-35.20, 70.31)	0.508
Median Age	1.30	(-0.52, 3.13)	0.159

Summary

- We found that the percent of time out of care was 12% across the network of clinics and that it was not equally distributed
  - Varies across clinics (7.3-25%)
- Novel application of Lorenz curves to assess the distribution of time out of care across clinic network
  - Distribution is uneven and varies by time on ART (6.3-23.7%)
  - High variability across clinics, ranging from 7.8-35.3% of patients accounting for 50% of time out of care
- Examined clinic-level predictors of time out of care
  - Western province has a higher percent of time out of care (8%) and also greater distribution of time out of care across patients
  - The percent of time out of care was higher at urban clinics and lower at hospitals

Significance

- Lorenz curves provide a novel way to visualize and examine variability of retention at system and clinic-levels
  - Understanding variability and its predictors can inform type of intervention
- Lorenz distribution of time out of care varied by time on ART and clinic
  - More targeted interventions during first year on ART
  - Need to design more general interventions targeting long-term retention
  - Intervention needs may differ across clinics

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