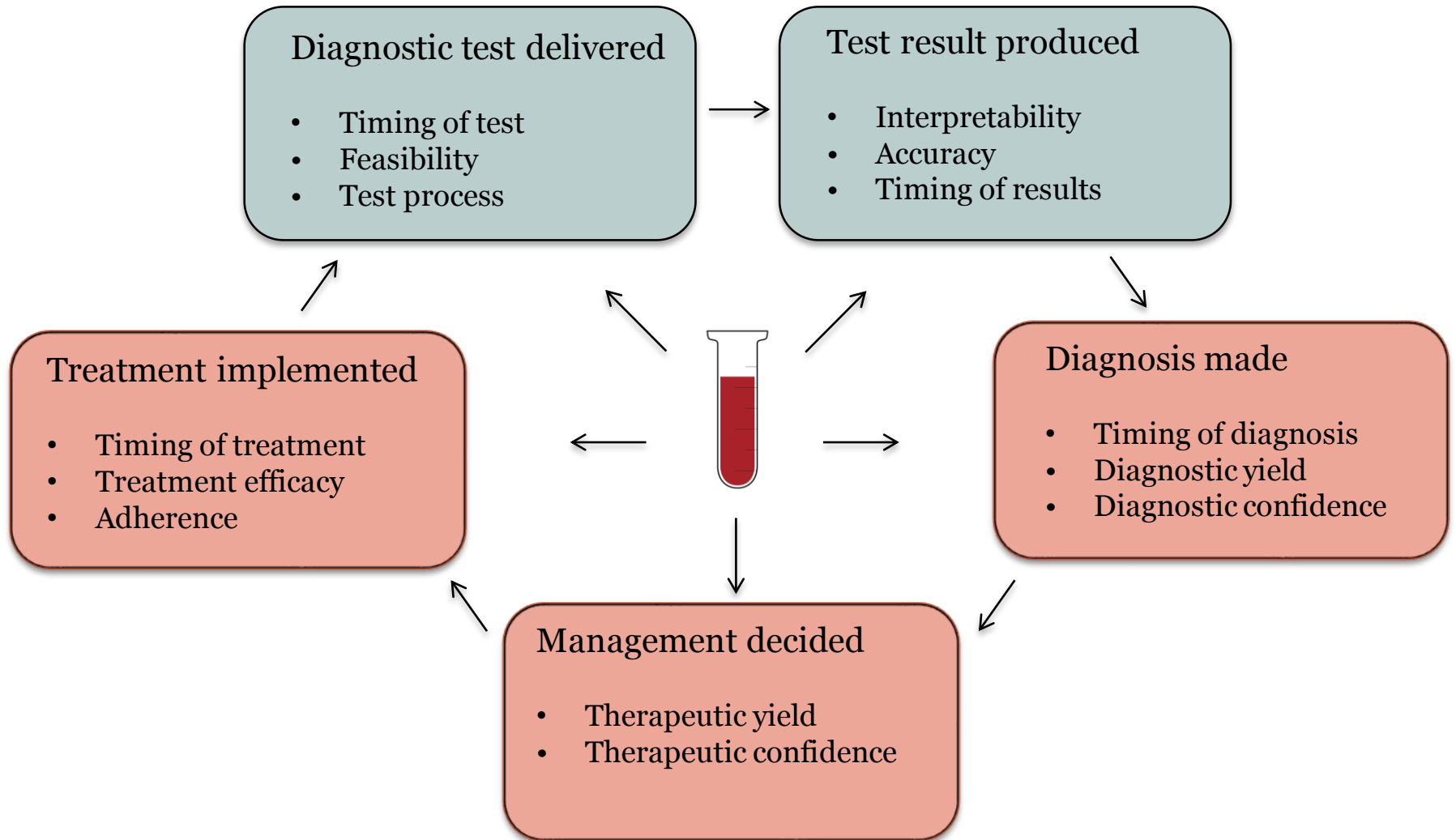


Laboratory Test Use and Cost in Kampala, Uganda

Lee Schroeder, MD, PhD
University of Michigan, U.S.A.

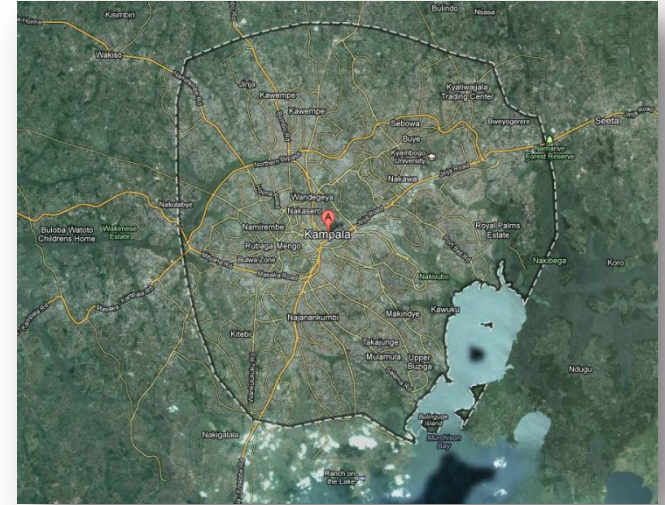
How the laboratory impacts patient outcomes



Available

Affordable

Goal was to count and inspect EVERY lab in Kampala using the WHO-SLIPTA 0- to 5-star lab quality tool



- Kampala is the largest city and capital of Uganda.
- Population of 2 million

Kampala lab survey - Methods

- 2-3 surveyors to each of the 5 districts of Kampala
- 20% redundant coverage
- Survey door to door ON FOOT
 - Documentation of test menus
 - Laboratory-wide testing volumes
 - Subsampling of test prices

Availability: Can a patient get a test if they need the test?

Test utilization: Which tests are patients receiving?

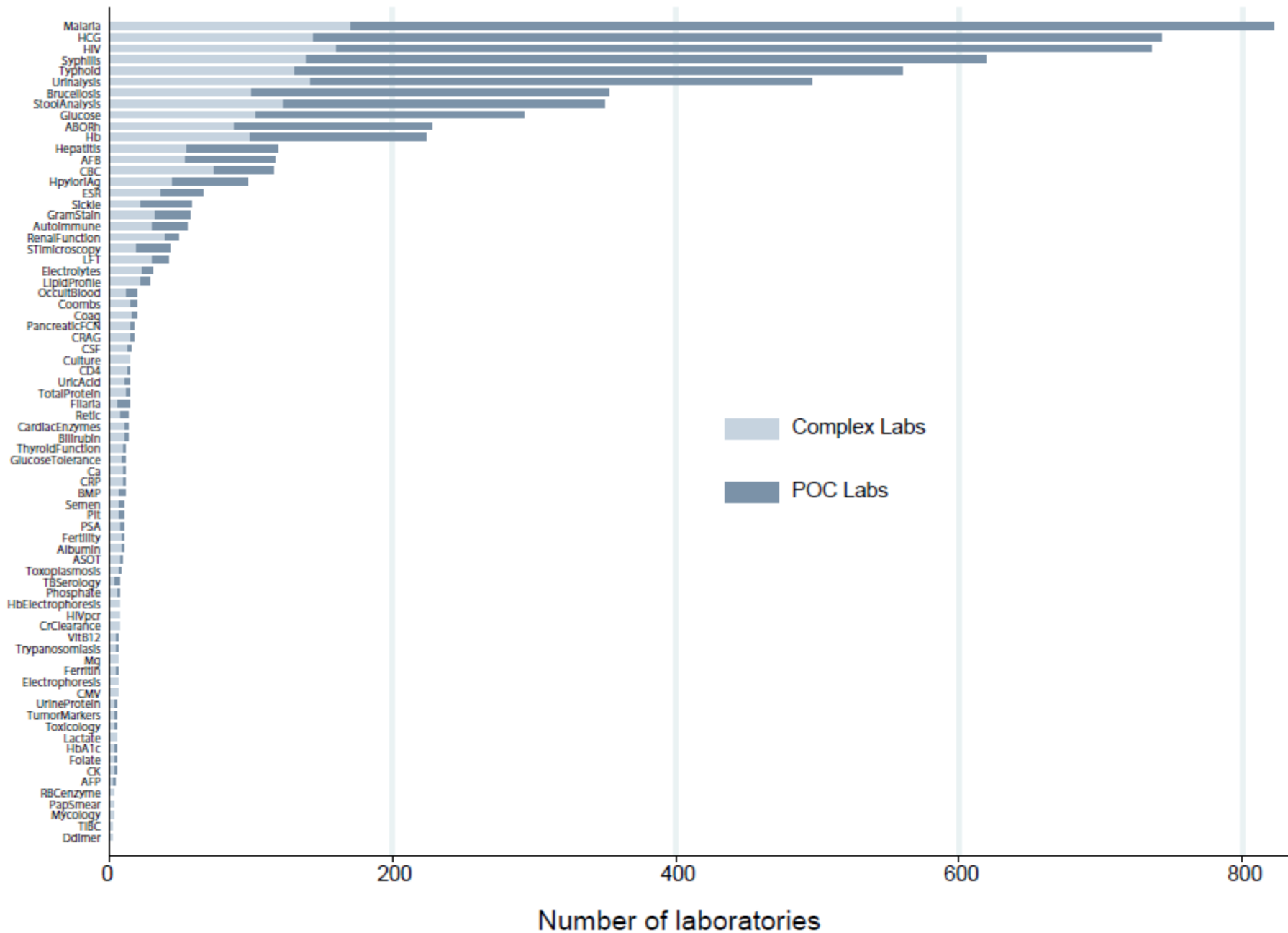
Availability: Can a patient get a test if they need the test?

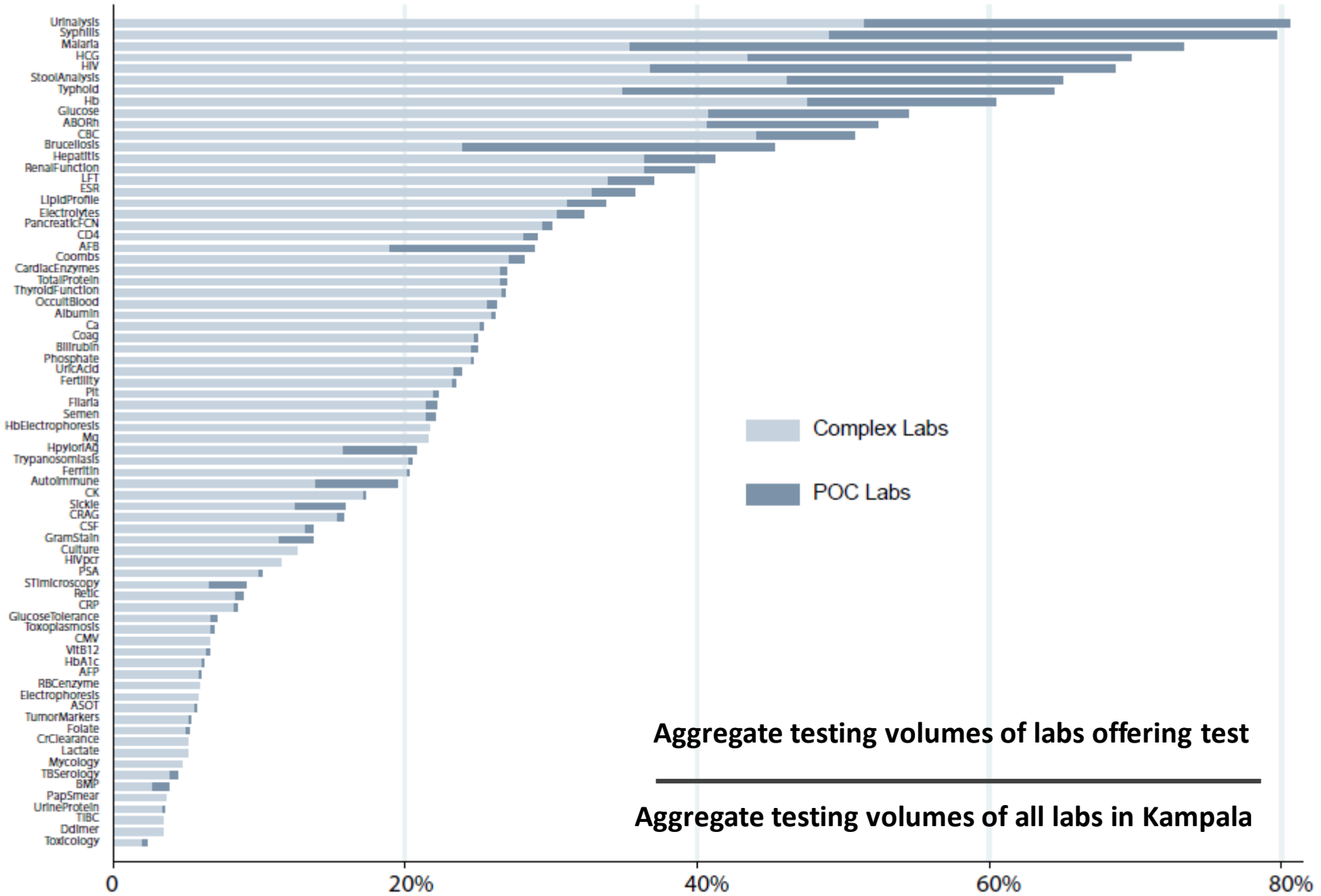
-Number of labs performing a test

Test utilization: Which tests are patients receiving?

Most commonly offered tests in Kampala

Test Type	Number of Labs	Percent of Labs
Malaria	822	91%
HCG	743	82%
HIV	736	81%
Syphilis	619	68%
Typhoid	560	62%
Urinalysis	496	55%
Brucellosis	353	39%
Stool analysis	350	39%
Glucose	293	32%
ABORh	228	25%
Hematocrit	224	25%

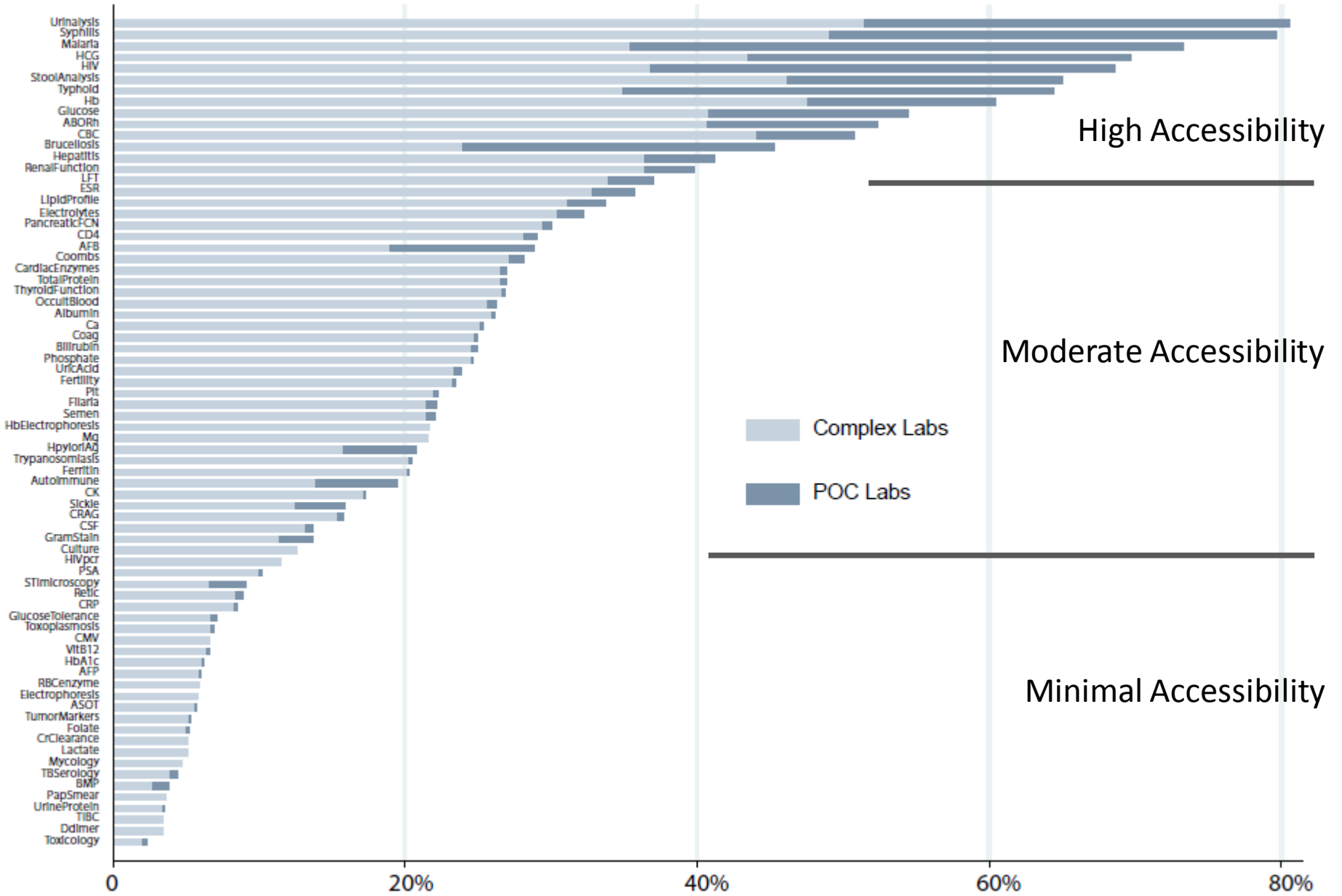




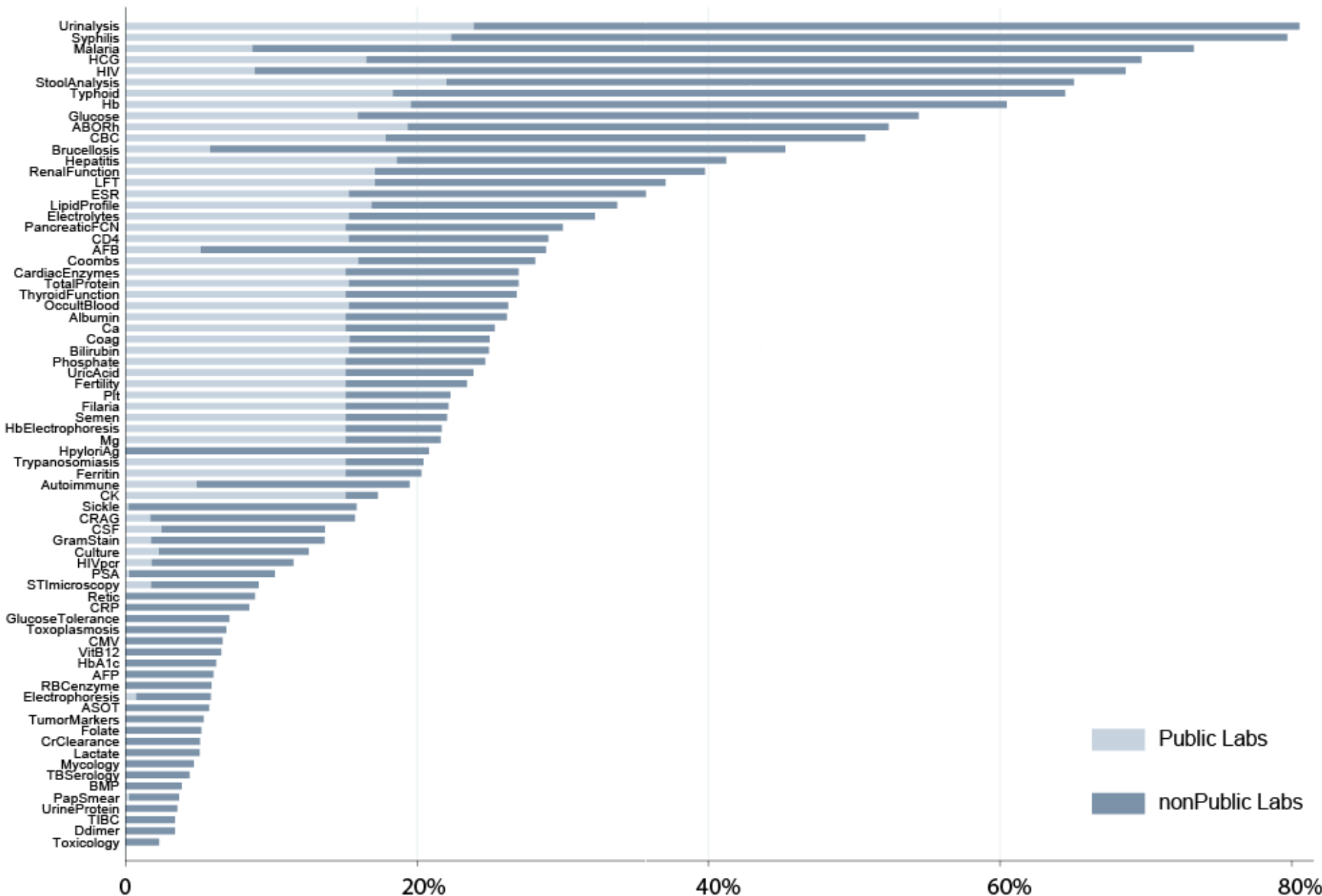
Aggregate testing volumes of labs offering test

Aggregate testing volumes of all labs in Kampala

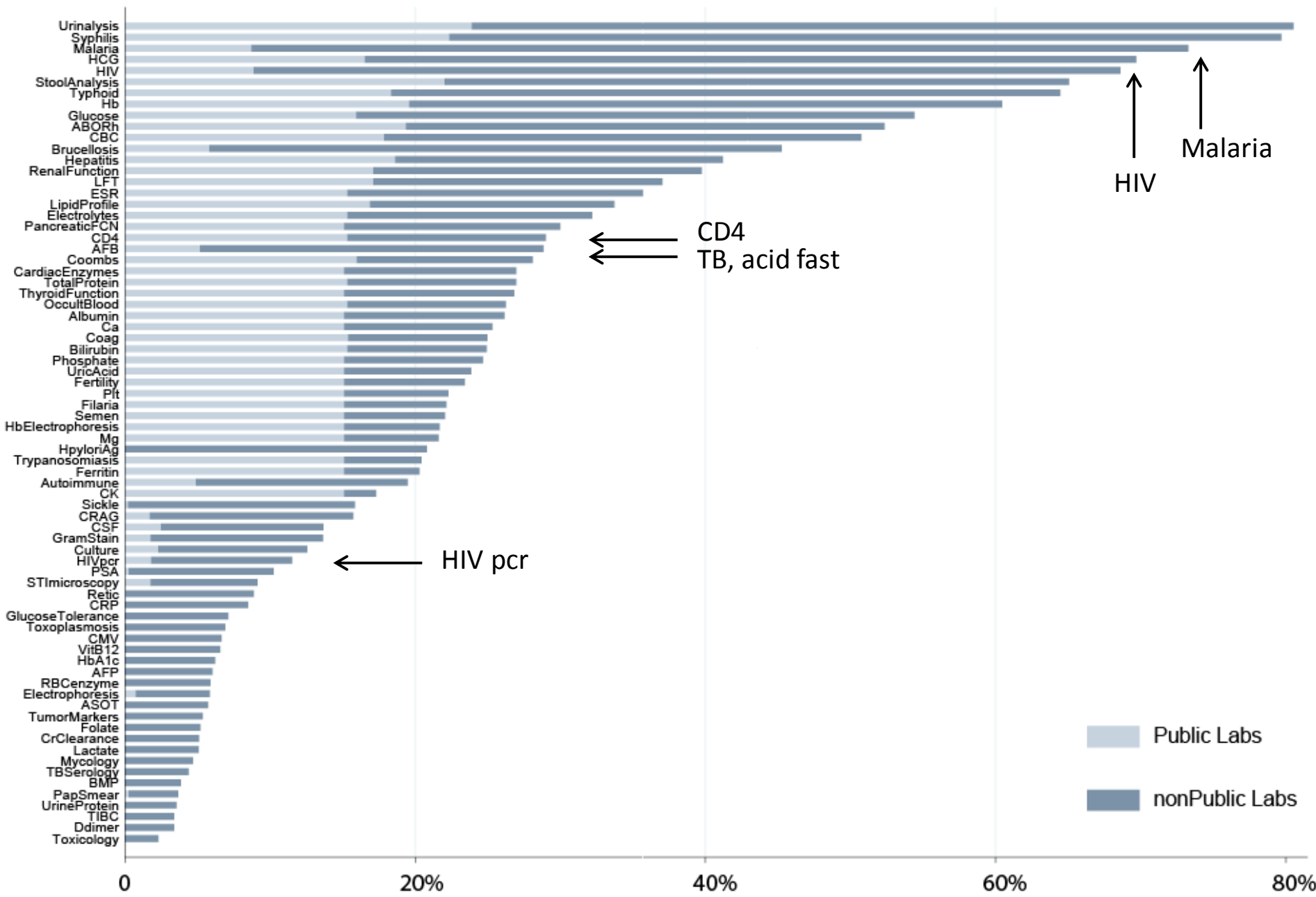
Percent of laboratories offering the test, weighted by size of laboratory



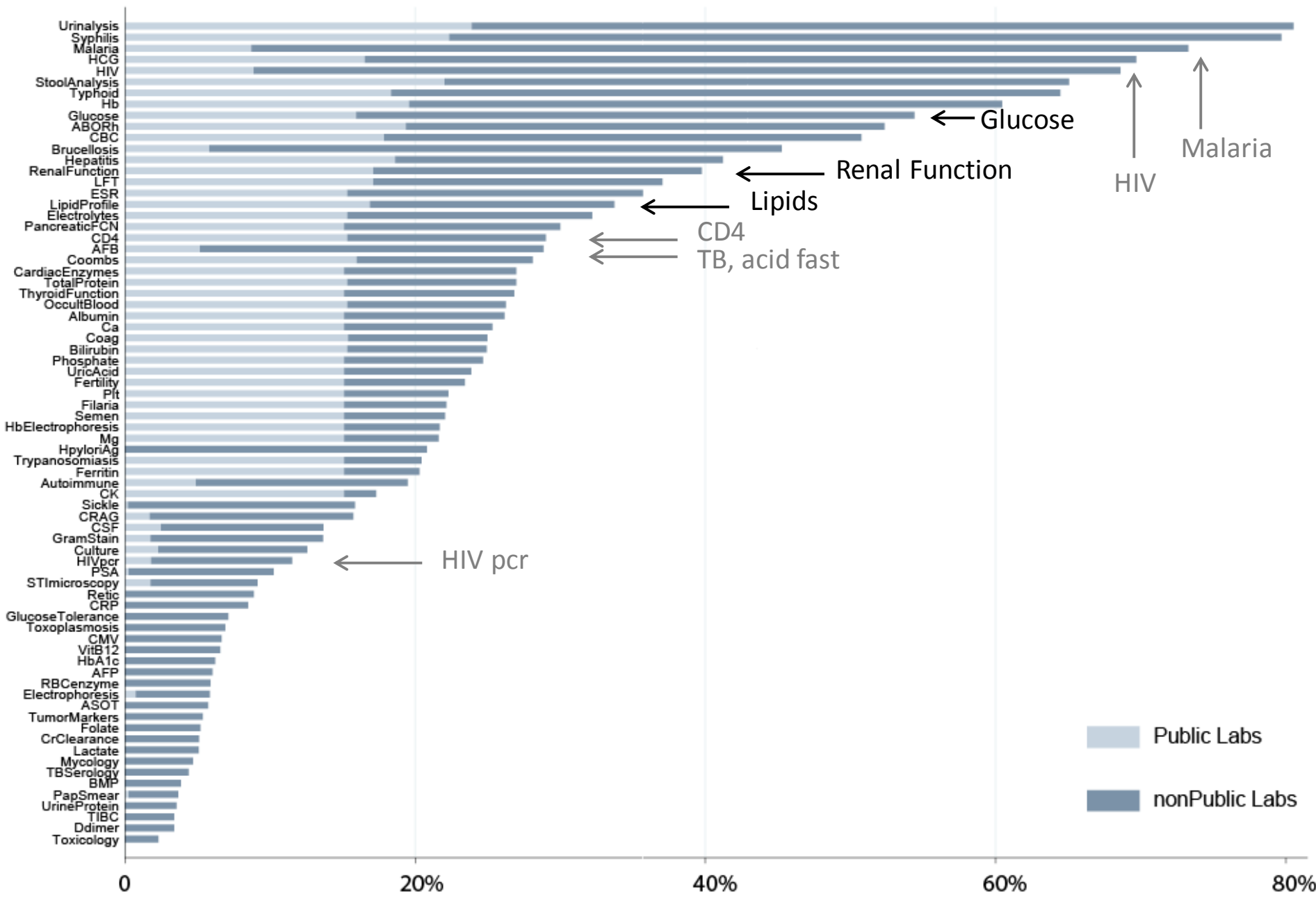
Percent of laboratories offering the test, weighted by size of laboratory



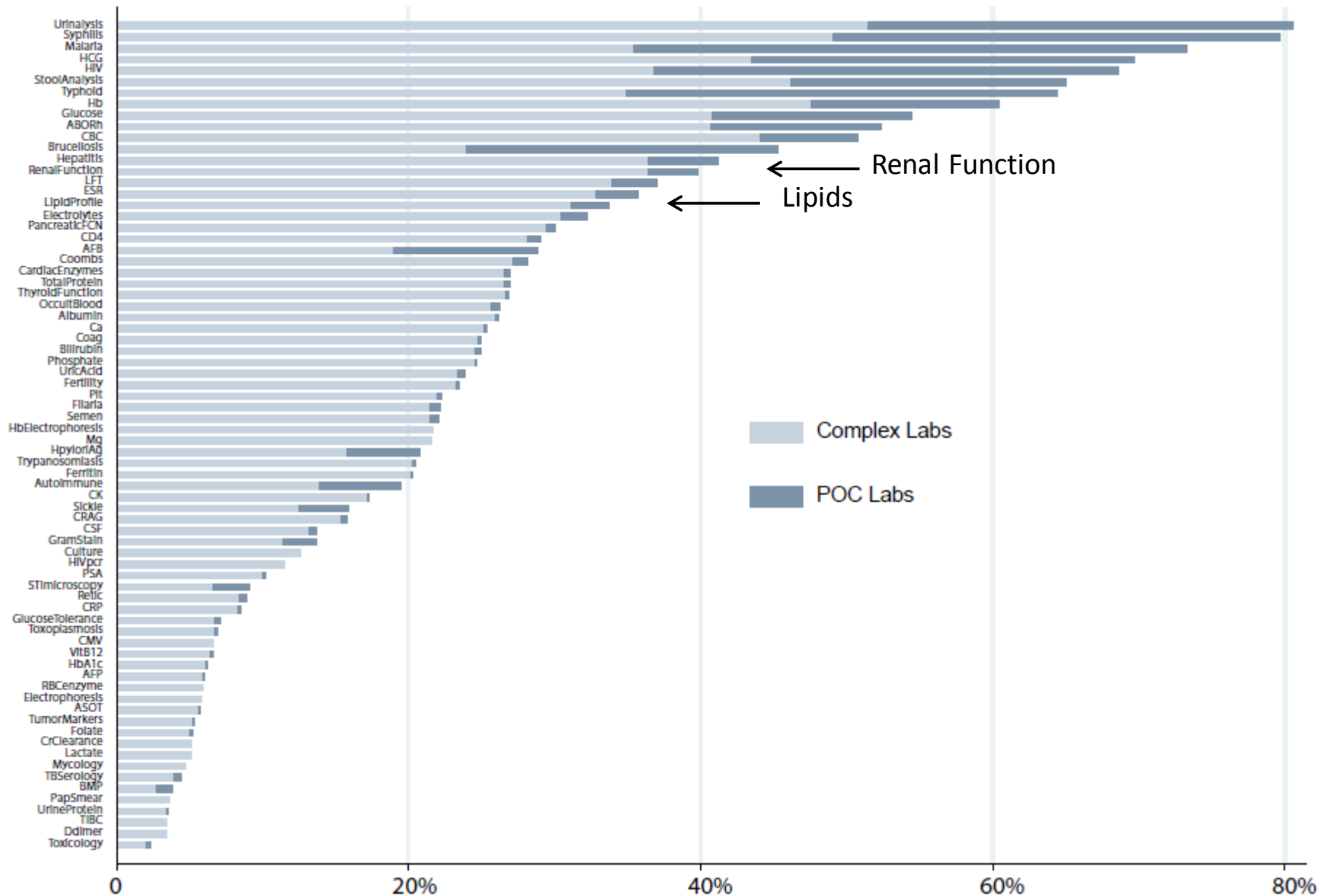
Percent of laboratories offering the test, weighted by size of laboratory



Percent of laboratories offering the test, weighted by size of laboratory



Percent of laboratories offering the test, weighted by size of laboratory



Percent of laboratories offering the test, weighted by size of laboratory

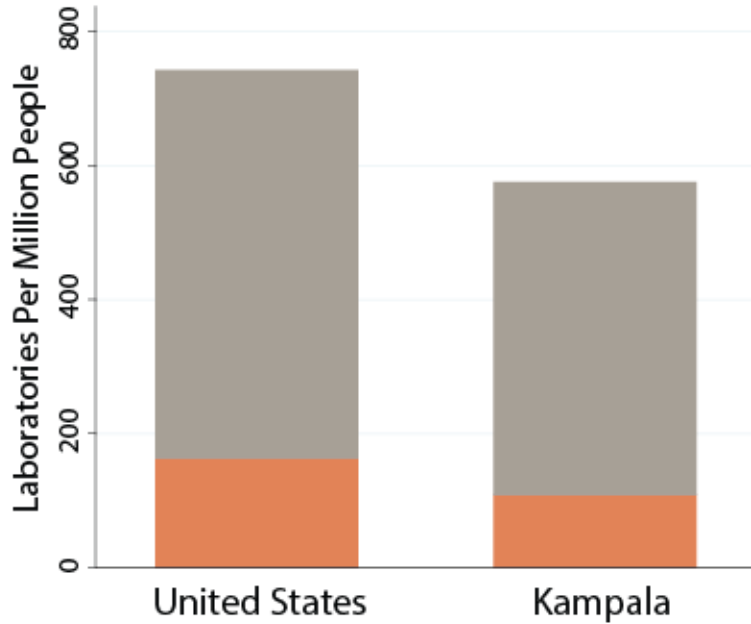
Prices of the most commonly offered tests ~\$2-\$4 (Private labs)

Most commonly offered tests in Kampala, Uganda

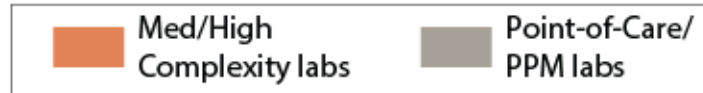
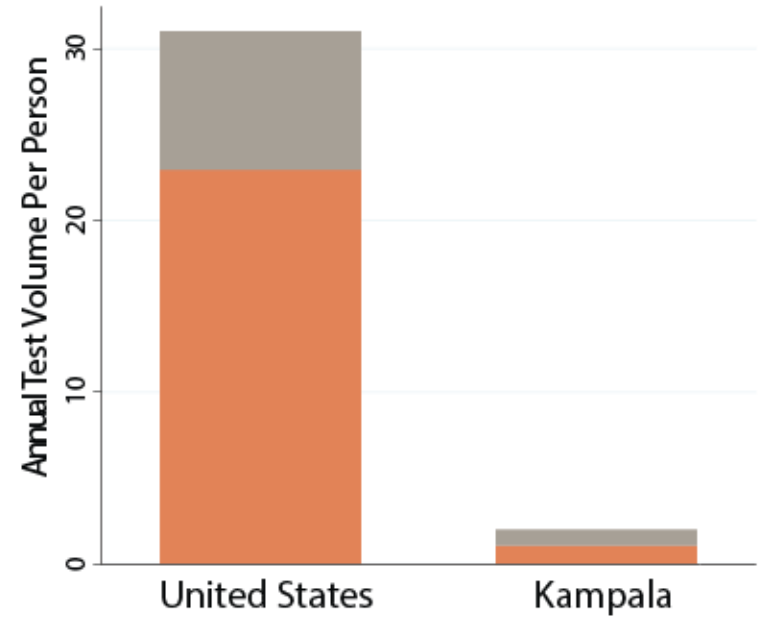
Test Type	Number of Labs	Percent of Labs	Price per test		
			in Kampala (Uganda Shilling)	Price per test in Kampala (US\$)	Price per test in US (US\$)
Malaria	822	91%	4,000	1.60	8.35
HCG	743	82%	5,000	2.00	11.80
HIV	736	81%	5,000	2.00	18.87
Syphilis	619	68%	6,000	2.40	7.35
Typhoid	560	62%	4,500	1.80	18.13
Urinalysis	496	55%	8,000	3.20	3.81
Brucellosis	353	39%	missing	missing	.
Stool analysis	350	39%	5,000	2.00	18.08
Glucose	293	32%	5,000	2.00	4.40
ABORh	228	25%	11,000	4.40	4.10

Average prices: \$2.30 \$10.54

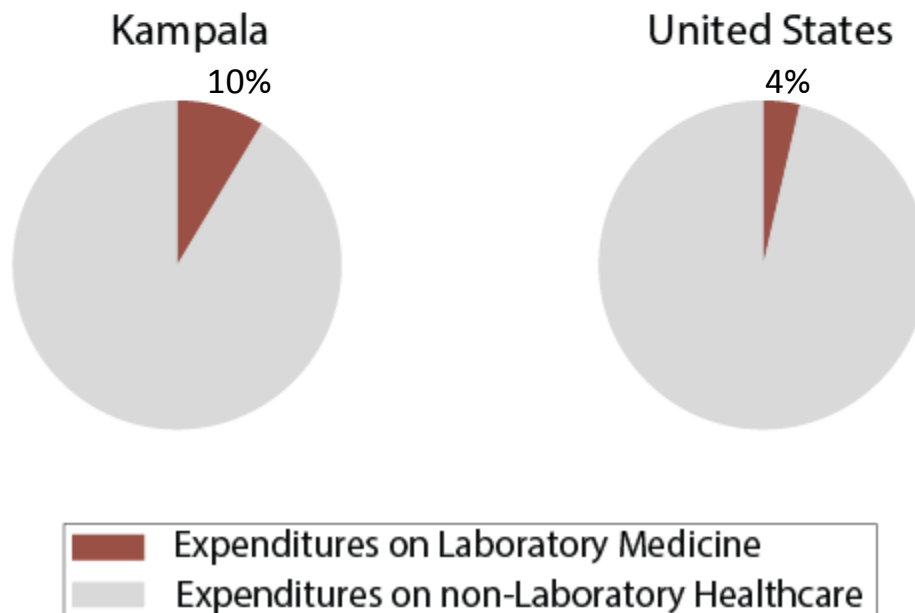
Laboratory density



Testing volume per person



	Average cost of a test	Annual number tests per person	Spending on tests per person	Total health spending per person *	Health spending on lab
Kampala	\$2.30	2	\$5	\$50	10%
U.S.	\$9.70	30	\$300	\$8,360	4%



*Total health spending per person taken from The World Bank, using the estimate for Uganda as a proxy for Kampala.

Acknowledgements



- Timothy Amukele MD, PhD
- Ali Elbireer PhD, MBA, MT

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High Accessibility Test-Types
(accessible via POC & complex Labs)

ABORh	HIV
Brucellosis	Malaria
CBC	StoolAnalysis
Glucose	Syphilis
Hb	Typhoid
HCG	Urinalysis

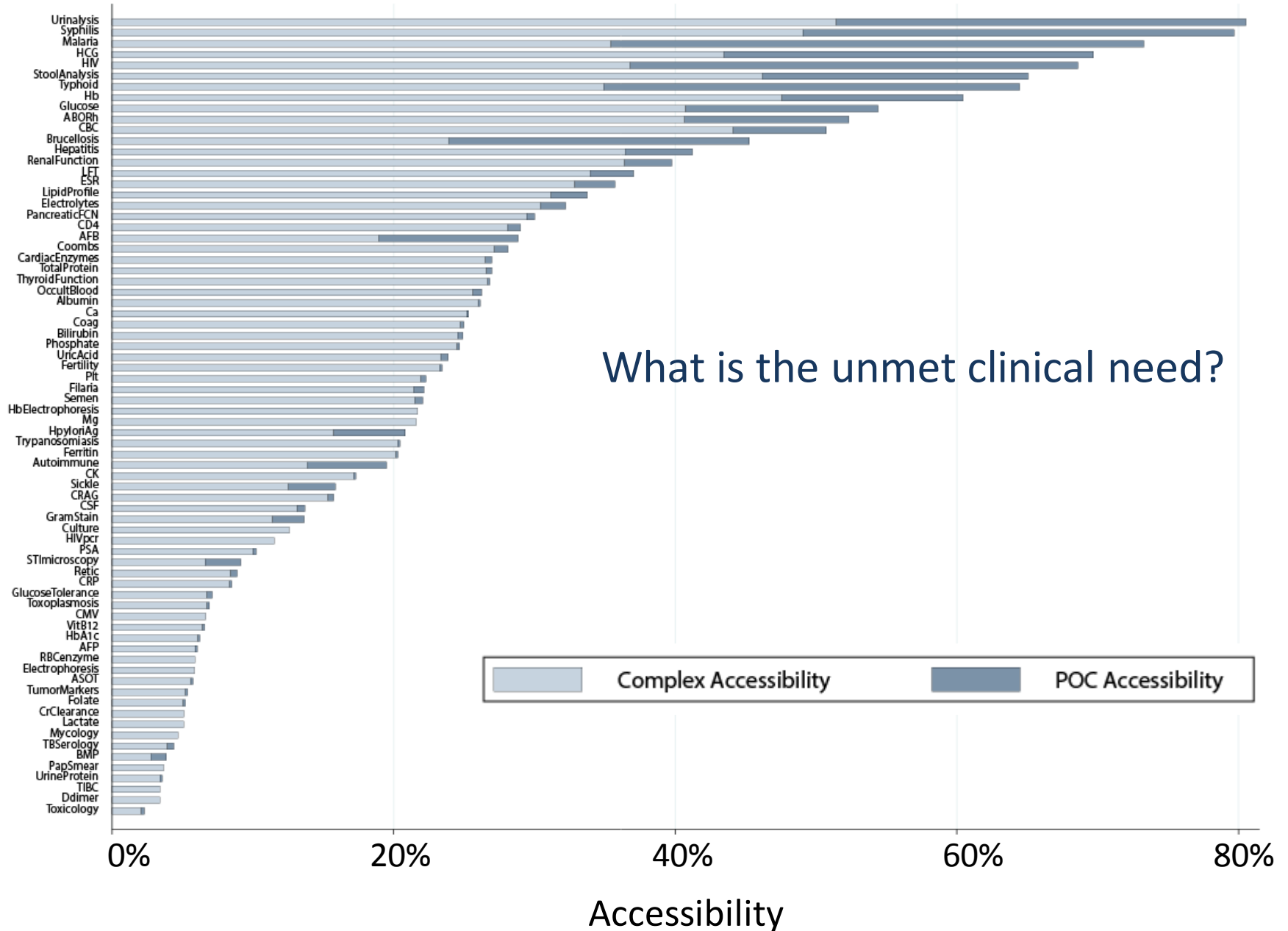
Moderate Accessibility Test-Types
(accessible via complex labs)

AFB	Coag	Hepatitis	Plt
Albumin	Coombs	HpyloriAg	RenalFunction
Bilirubin	ESR	LFT	Semen
CD4	Electrolytes	LipidProfile	ThyroidFunction
CK	Ferritin	Mg	TotalProtein
Crag	Fertility	OccultBlood	Trypanosomiasis
Ca	Filaria	PancreaticFCN	UricAcid
CardiacEnzymes	HbElectrophoresis	Phosphate	

Minimally Accessible Test-Types
(accessible in few complex labs)

AFP	Candida	GramStain	Nutrition	TBSerology
ASOT	Chlamydia	HIVpcr	PNH	TIBC
Adenovirus	CoagFactors	HbA1c	PSA	TST
Allergy	CrClearance	HbUrine	PapSmear	Testosterone
AspirateAnalysis	Culture	Hormone	RBCenzyme	Toxicology
Autoimmune	Ddimer	Immunoglobulin	Retic	Toxoplasmosis
BMP	Electrophoresis	Indialnk	Rotavirus	Trichomonas
Bilharzia	Folate	Insulin	Rubella	TumorMarkers
Bone	GlucagonUrine	Lactate	STImicroscopy	UrineProtein
CMV	GlucoseTolerance	Lithium	Shigellosis	VitB12
CRP	GlucoseUrine	Mycology	Sickle	VitD
CSF	Gonorrhea			

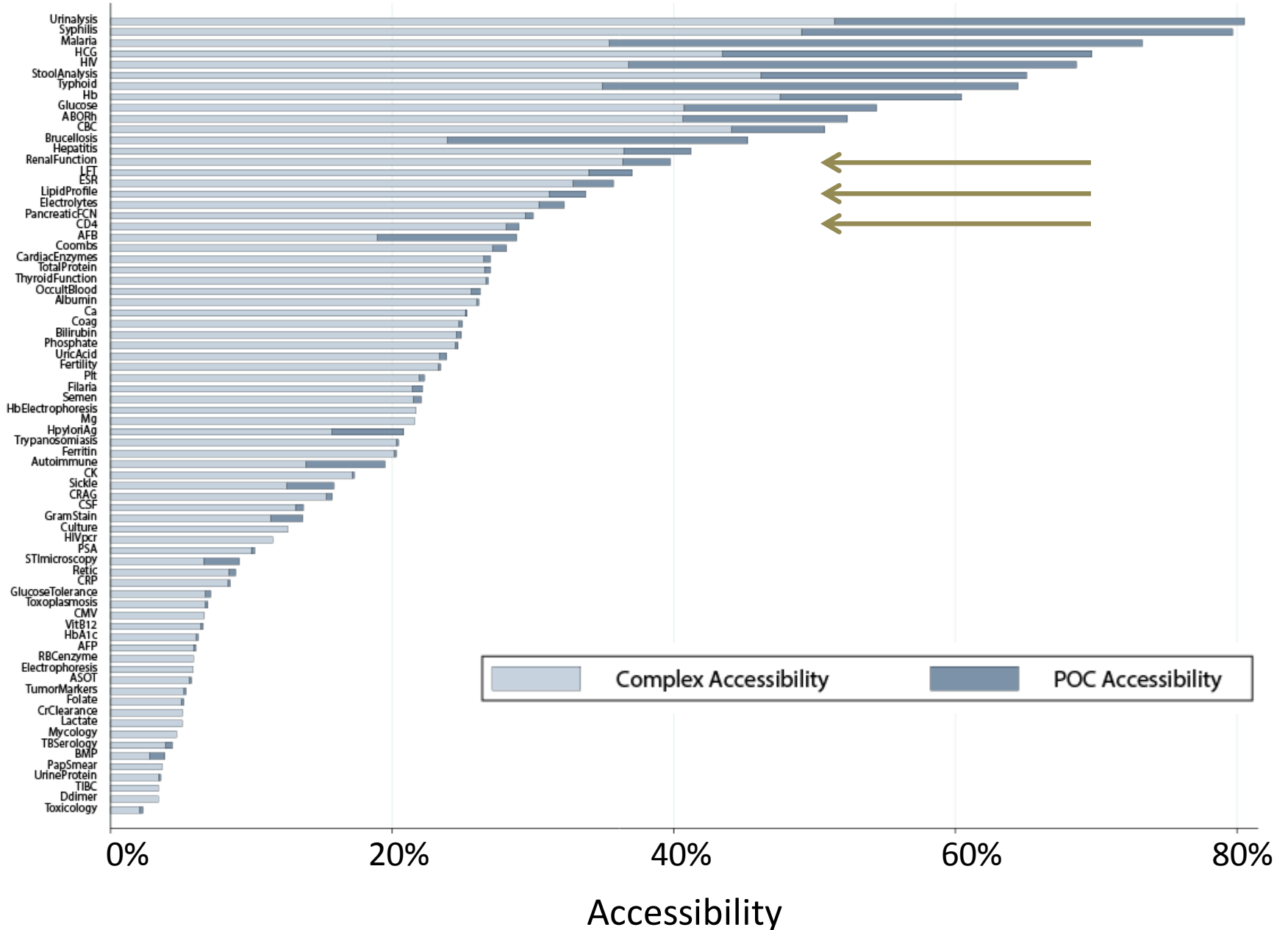
Laboratory tests in Kampala, ranked by accessibility

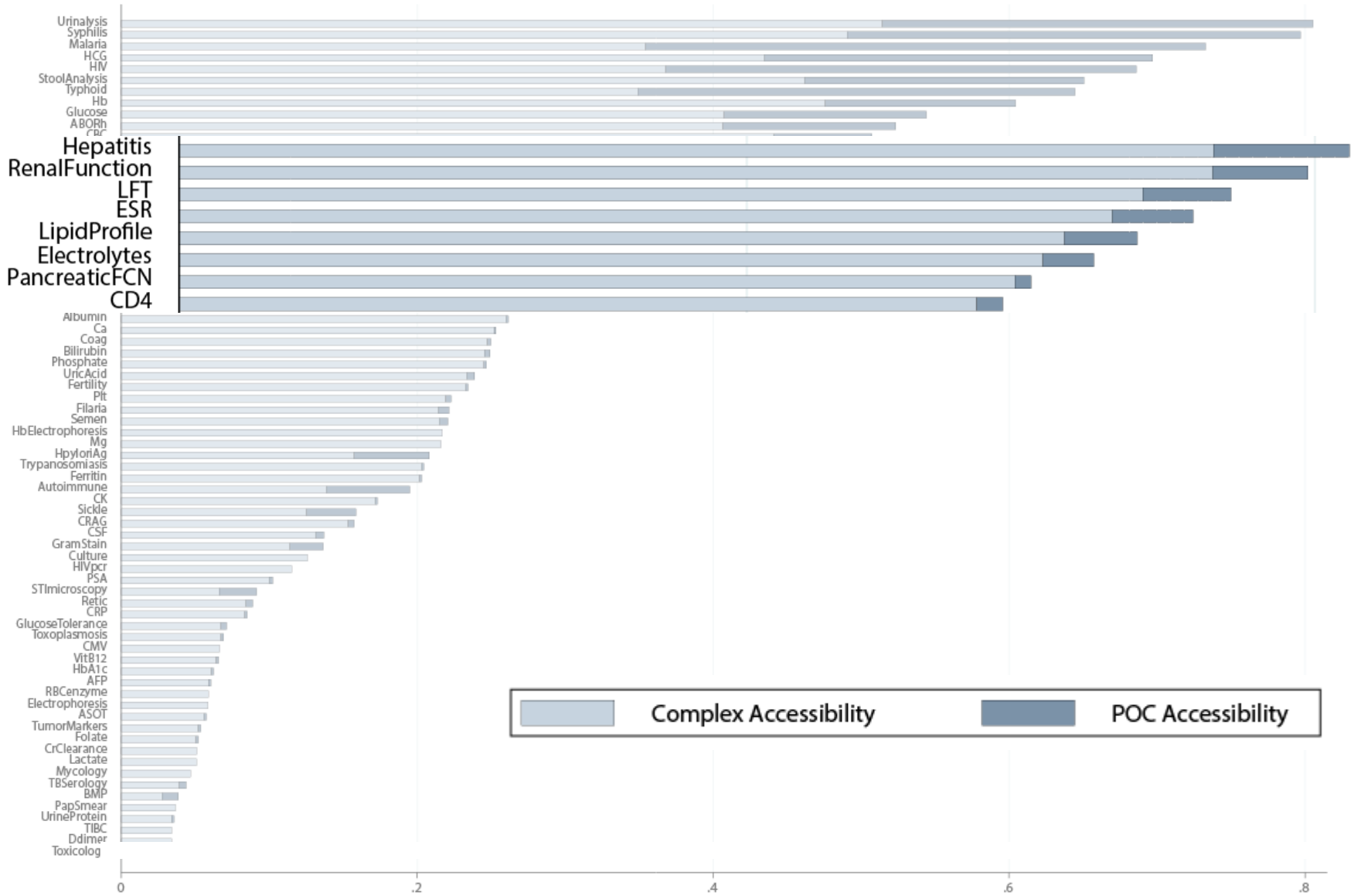


What is the unmet clinical need?



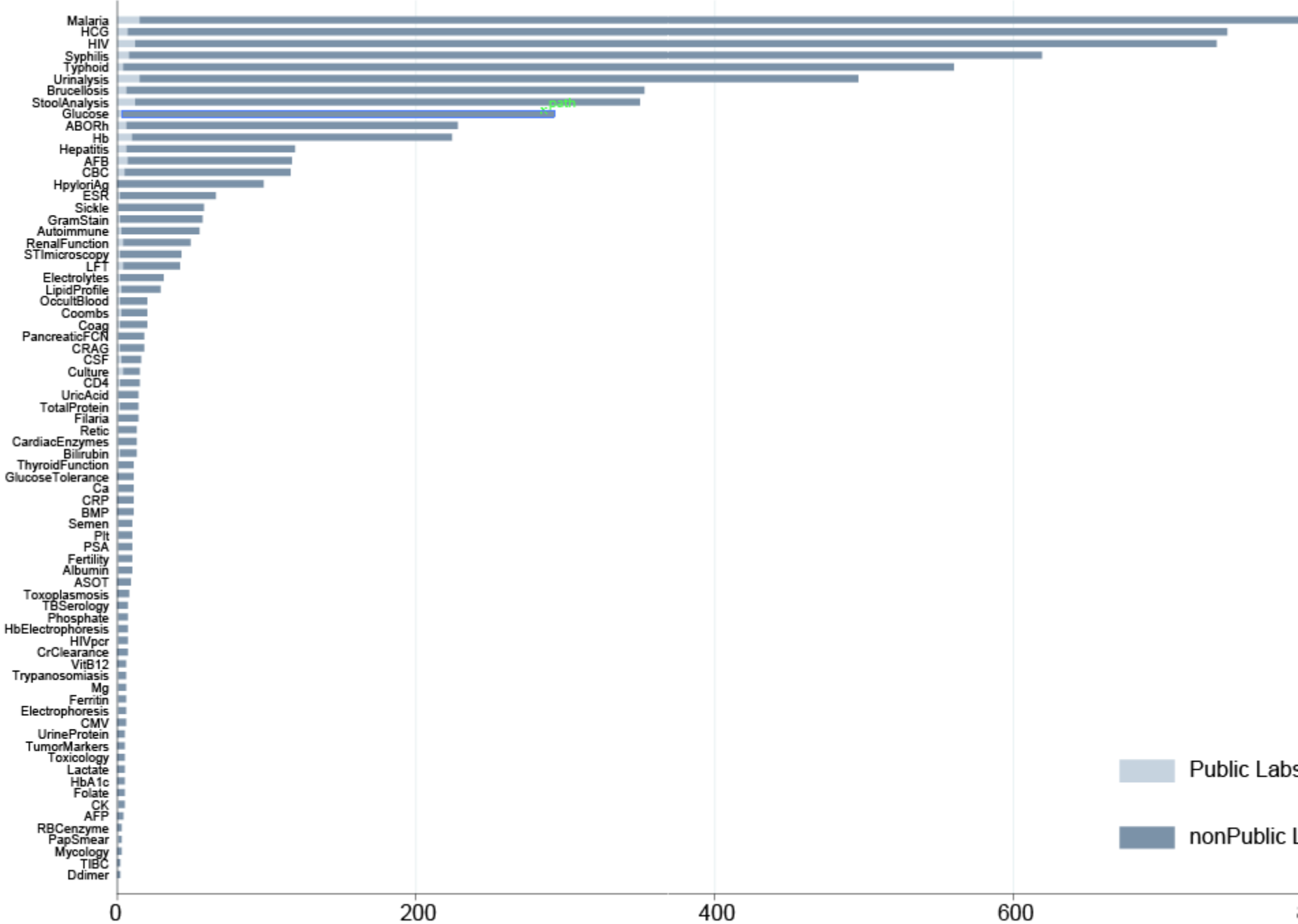
Laboratory tests in Kampala, ranked by accessibility





Complex Accessibility POC Accessibility

Rank	Kampala, by test volume, 1 lab	Kampala by Accessibiliity
1	Hb	Malaria
2	CBC	Urinalysis
3	Urinalysis	HIV
4	RenalFcn	Hb
5	CRP	Syphilis
6	Malaria	CBC
7	Glucose	HCG
8	HIV	StoolAnalysis
9	ABORh	Glucose
10	Syphilis	ABORh



Number of Laboratories

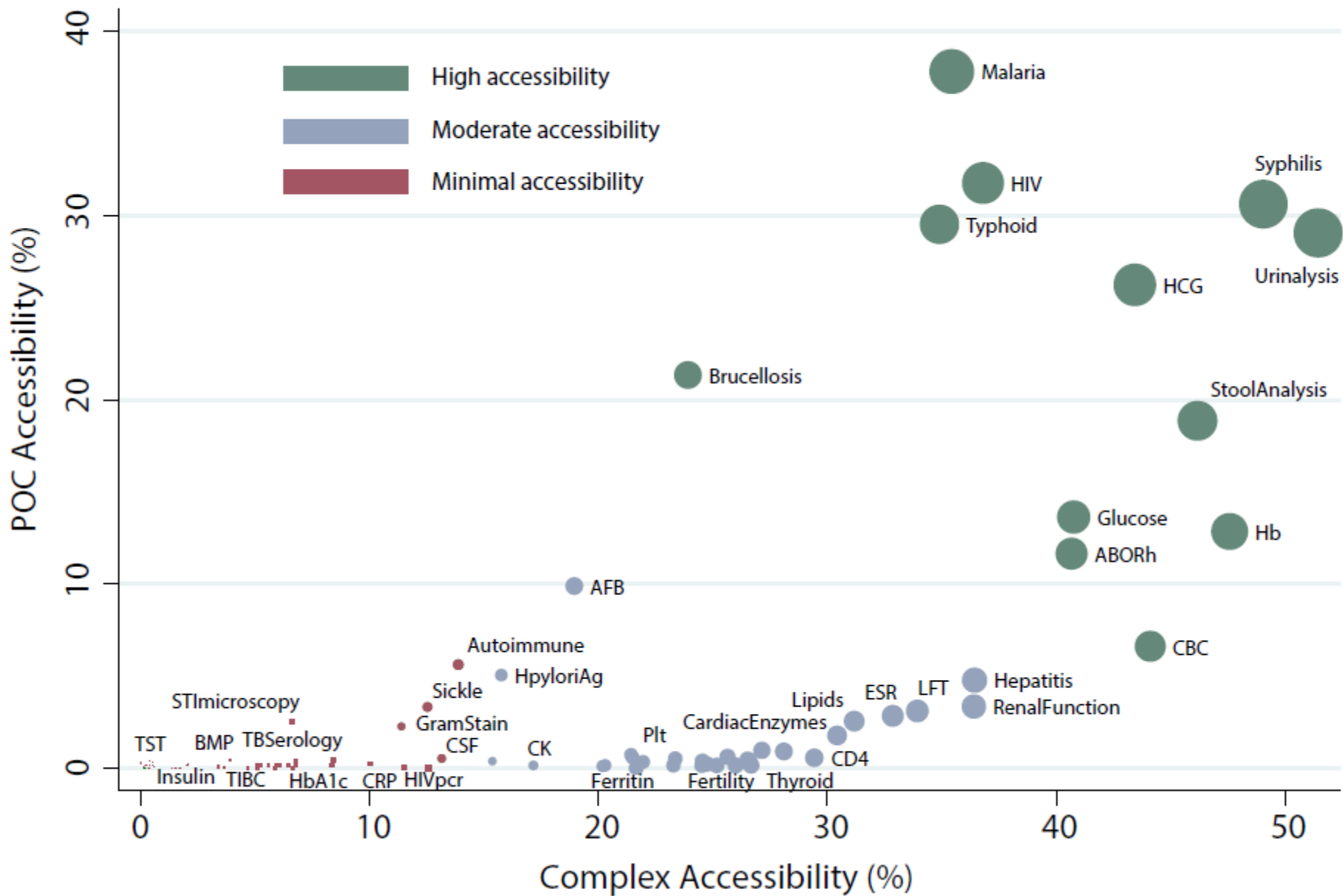
Public Labs
nonPublic Labs

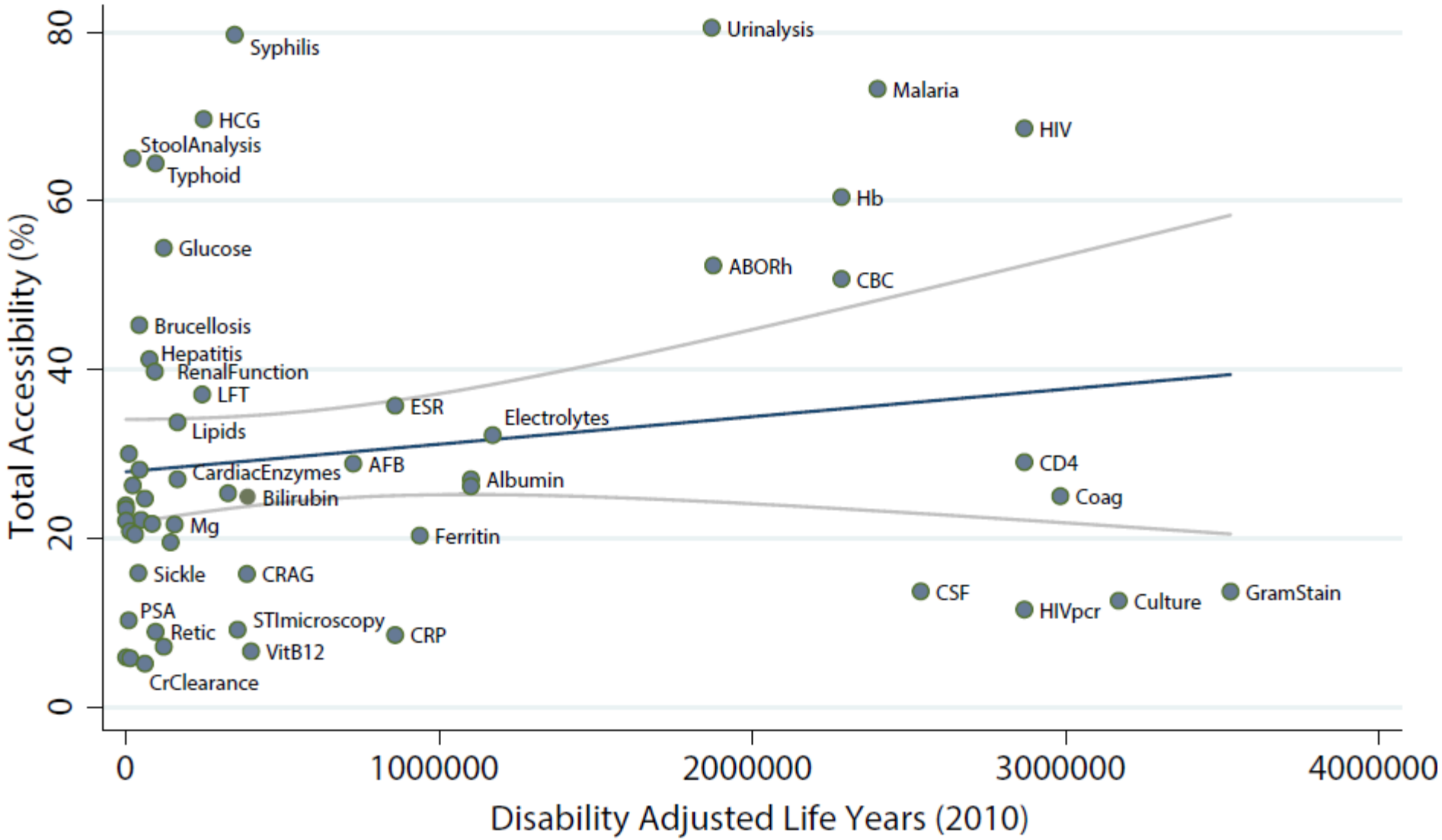
POC Labs, Kampala

Test Type	% of Labs
Malaria	89%
HCG	82%
HIV	78%
Syphilis	65%
Typhoid	58%
Urinalysis	48%
Brucellosis	34%
Stool Analysis	31%
Glucose	26%
Hb	17%

POC Labs, USA

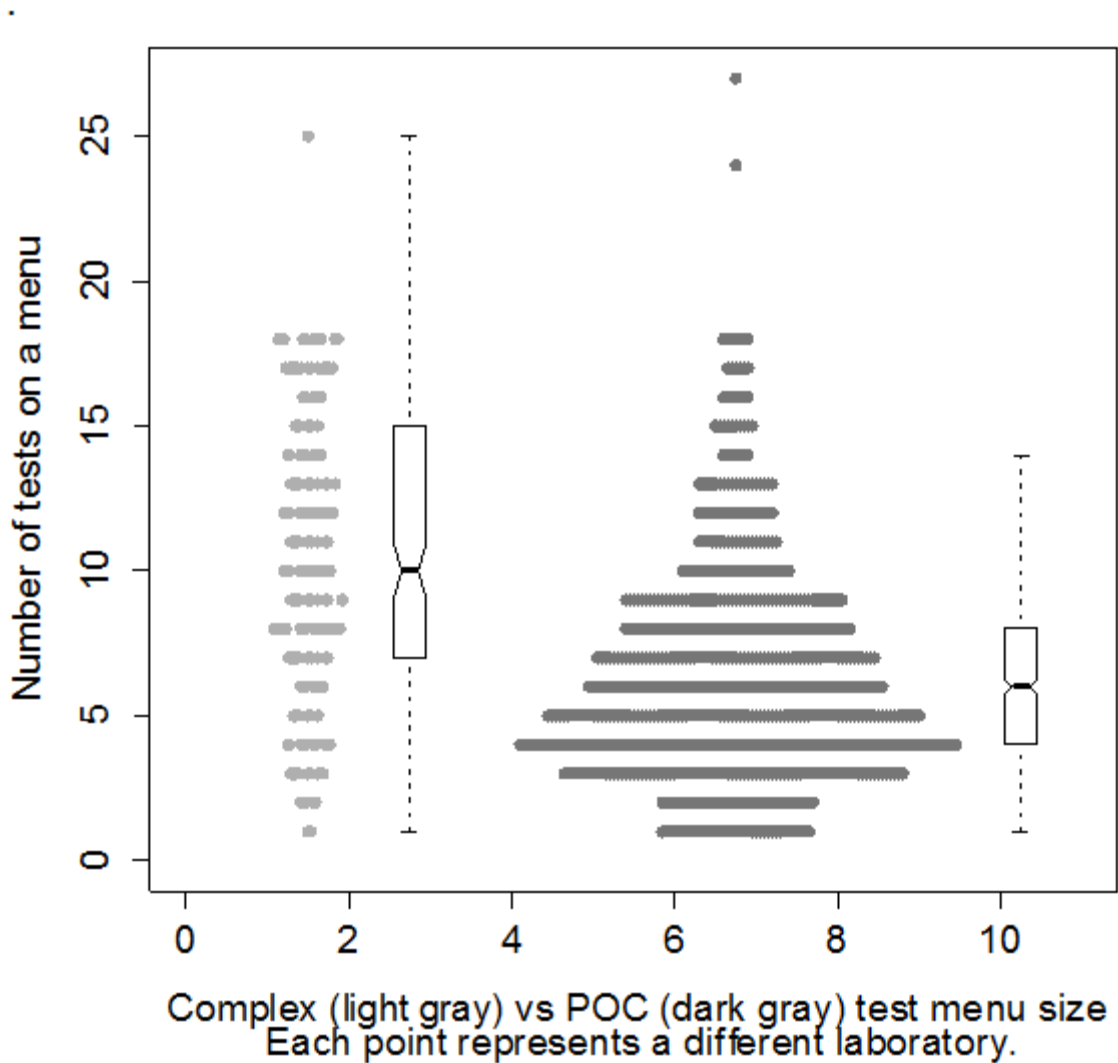
Test Type	% of Labs
Urinalysis	98%
Fecal occult blood	92%
HCG	87%
Rapid strep	87%
Vaginal smear	77%
Glucose, waived	68%
Urine, microscopic	61%
Infectious mononucleosis	39%
Prothrombin time	39%
Glucose, whole blood dipstick	35%





— 95% CI — Fitted values

Complex laboratories are different, POC laboratories tend to look the same

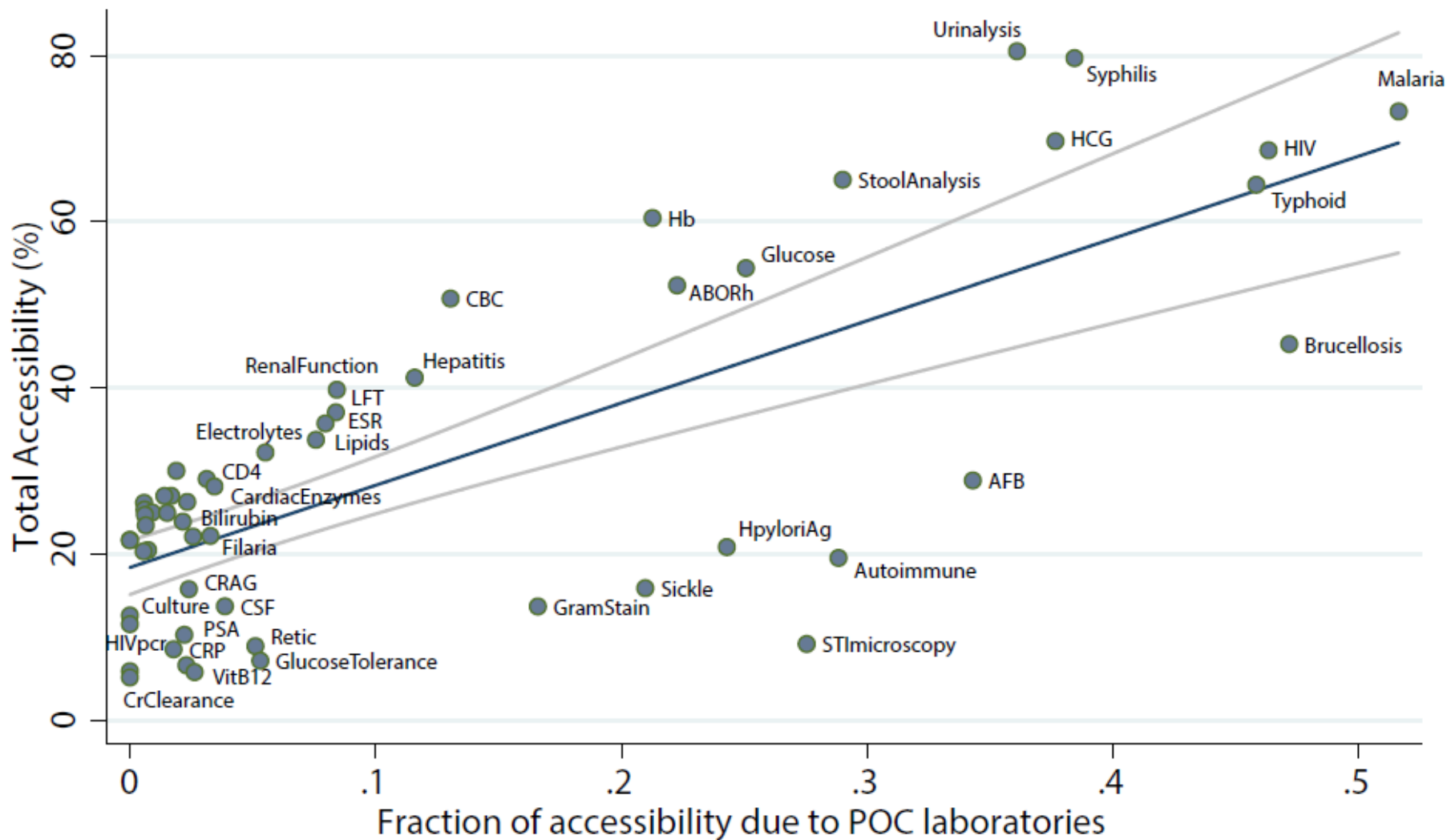


Total accessibility correlates with provision in POC labs

Regression results, beta-coefficients (95% CI)

	Single Variable Models					Multiple Variable Model
	1	2	3	4	5	6
POC (fraction)	1.00 (0.73 1.27)***					1.11 (0.72 1.50)***
Private (fraction)		0.21 (-0.07 0.49)				-0.41 (-0.63 -0.18)**
Quality (stars, mean)			-0.14 (-0.19 -.093)***			-0.05 (-0.09 -0.01)*
DALYs (millions)				0.03 (-0.03 0.09)		0.03 (-0.01 0.06)
Communicable vs NCD					-0.06 (-0.19 0.07)	0.05 (-0.03 0.13)
R ²	0.54	0.05	0.45	0.03	0.01	0.69

Single and Multivariable Linear regression models of several factors against total accessibility of each test-type. The factors were: POC fraction, the fraction of the daily test volume for each test-type performed in POC laboratories; Private fraction, the fraction of the daily test volume for each test-type performed in Private laboratories; Laboratory Quality based on the World Health Organization – Africa regional office (WHO-AFRO) laboratory strengthening checklist; Disability-Adjusted Life Years (DALYs) - burden of disease addressed by each test-type; Communicable vs Non-Communicable Diseases, the type of disease addressed by each test-type. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$



Accessibility defined

$$\text{Accessibility} = \frac{\text{Aggregate testing volumes of labs offering test}}{\text{Aggregate testing volumes of all labs in Kampala}}$$

	Number of labs	Lab-wide daily test volumes of labs offering test	Accessibility
HIV	736	9,039	69%
Lipid Profile	23	3,144	24%

In Kampala, unlike USA, the most accessible tests overall are the same that are most accessible in POC labs

Rank	All labs, Kampala	POC labs, Kampala
1	Urinalysis	Malaria
2	Syphilis	HIV
3	Malaria	Syphilis
4	HCG	Typhoid
5	HIV	Urinalysis
6	StoolAnalysis	HCG
7	Typhoid	Brucellosis
8	Hb	StoolAnalysis
9	Glucose	Glucose
10	ABORh	Hb

Rank	All labs, USA	POC labs, USA
1	CBC	Urinalysis, dipstick
2	CMP	Fecal occult blood
3	LipidProfile	Urine pregnancy
4	ThyroidFunction	Rapid strep
5	Urinalysis, dipstick	Vaginal smear
6	Urinalysis, microscopy	Glucose, waived
7	BMP	Urinalysis, microscopy
8	LFT	Infectious mononucleosis
9	ESR	Prothrombin time
10	RenalFunction	Glucose, whole blood dipstick