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Diagnostic performance of an albuminuria point-of-care test in screening for chronic kidney disease among young people living with HIV in Uganda: a cross-sectional study

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ABSTRACT

Objectives The main aim was to determine the diagnostic performance of an albuminuria point-of-care test (POC) for diagnosis of chronic kidney disease among young people living with HIV (YPLHIV) in Uganda.

Design We conducted a cross-sectional study comparing the diagnostic performance of MicroalbuPHAN (Erba Lachema, Czech Republic), an albuminuria POC test against the laboratory-measured albumin and creatinine as the reference standard.

Setting The study was set in seven HIV clinics in Kampala, Uganda that provide antiretroviral therapy to adults and children living with HIV. The study took place from April to August 2023.

Participants 497 YPLHIV aged 10–24 years who were diagnosed with HIV before 10 years of age were randomly selected from the HIV clinics. Pregnant YPLHIV were excluded.

Procedures Participants provided a spot urine sample that was tested for albumin and creatinine using the POC and in the laboratory and proteinuria using urine dipstick. The sensitivity, specificity, negative and positive predictive values (NPV, PPV) of the POC versus the laboratory test were calculated, and factors associated with having a positive POC test were estimated using logistic regression.

Outcome measures The primary outcome was a diagnosis of albuminuria defined as an albumin creatinine ratio above 30 mg/g.

Results Of the 497 participants enrolled, 278 (55.9%) were female and 331 (66.8%) were aged 10–17 years. The POC test had a sensitivity of 74.5% (95% CI 70.6% to 78.4%) and specificity of 68.1% (95% CI 63.9% to 72.3%). The PPV was 21.5% (95% CI 17.8% to 25.1%) and the NPV was 95.8% (95% CI 94.0% to 97.6%), with an accuracy of 68.8%. There was strong evidence that a positive POC test was associated with having proteinuria (OR 2.82; 95% CI 1.89 to 4.22, p<0.001); body mass index <19.5 (OR 1.69 95% CI 1.17 to 2.45, p=0.005) and being male (OR 1.48; 95% CI 1.02 to 2.14, p=0.04).

Conclusions The albuminuria POC test had low sensitivity and specificity. However, it can be used to exclude kidney disease given its high NPV. It should be validated against the 24-hour urinary excretion rate to further determine its diagnostic performance.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Large representative sample of young people living with HIV.
⇒ Single measurement of albuminuria as opposed to repeated at 6 months.
⇒ This albuminuria point-of-care test has not been validated in people living with HIV.
⇒ Used a reference standard test for albuminuria as opposed to the gold standard 24-hour urinary albumin excretory rate.

INTRODUCTION

According to the 2020 global burden of disease study, almost 700 million people were diagnosed with chronic kidney disease (CKD) globally.[1] The prevalence of CKD is increasing due to increases in hypertension, diabetes and infectious diseases such as HIV.[2] Young people living with HIV (YPLHIV) aged 10–24 years have a growing burden of CKD with a fourfold risk of developing CKD during their lifetime compared with those of a similar age without HIV.[3] They have a higher risk of CKD due to HIV infection of an immature kidney, long-term exposure to antiretroviral therapy (ART), drug toxicity and chronic viral infection of the kidney.[3] The prevalence of CKD diagnosed by albuminuria was 20%–32% among children and adolescents living with HIV in sub-Saharan Africa (SSA).[4–6]

CKD has an insidious onset with variable presentation depending on the underlying cause.[7] People living with CKD are initially asymptomatic, and symptoms manifest as kidney damage progresses.[8] Diagnosis is

usually made after the patient has progressed to kidney failure which requires expensive kidney replacement therapies such as kidney transplant or dialysis.[9] These therapies are not accessible to the majority of the population in SSA because of the prohibitive cost, and even then, mortality following treatment remains high.[7] If diagnosed early, there are treatments to delay progression and stop further kidney damage such as the use of ACE inhibitors and more recently sodium glucose transporter II receptor inhibitors.[10 11] Therefore, screening and early diagnosis are important to delay progression, halt kidney damage and plan for the public health response.[12]

It is recommended that YPLHIV should be screened at ART initiation then annually and more frequently for those with additional risk such as the use of nephrotoxic drugs or diagnosis with hypertension.[13] According to the Kidney Disease Improving Global Outcomes (KDIGO) recommendations, those on a TDF-based ART regimen with a boosted protease inhibitor benefit from more frequent screening (2–3 times a year).[14] Screening involves determining the glomerular filtration rate (GFR) and measuring proteinuria or albuminuria.[15] These guidelines are implemented suboptimally in low-income and middle-income countries.[9] In Uganda, annual screening for high-risk groups is recommended annually but the ideal screening method is not mentioned and screening is not routinely done.[16]

Albuminuria is an early marker of endothelial and kidney damage due to increased inflammation.[17] The 24-hour urinary albumin excretion (UAE) rate which is inconvenient and not always accurate is the gold standard for measuring urinary albumin.[18] Urinary albumin to creatinine ratio (ACR) is considered a viable alternative as it shows a high correlation with the UAE.[18] ACR determination together with GFR estimation is better at confirming CKD, enabling assessment of CKD progress, development of complications and mortality risk.[15 19] Significant decreases in GFR come after extensive kidney damage has occurred, and kidney impairment should be determined before this occurs.[20]

Point-of-care (POC) tests for albuminuria give immediate results, aid early diagnosis, are easy to use and do not require specialised laboratory equipment.[21] According to a recent systematic review that assessed use of POCs for albuminuria, the most commonly used were Siemens (Amesdata Biotech Co.), Clinitek (Siemens Medical Solutions Diagnostics Mishawaka, Indiana, USA), Uropaper (Eiken; Eiken Chemical, Tokyo, Japan), Microsalbustix (Siemens Healthcare Diagnostics, Frimley, UK), Urisys (Roche Diagnostics, Mannheim, Germany), URiSCAN (YD-Diagnostics Co., Yongin, Korea) with no clear explanation as to why one was chosen over another.[22] The MicroalbuPHAN urine test strips (Erba Lachema Czech Republic) provide a visual semiquantitative assessment for albumin and creatinine and can be used to detect low levels of albumin in urine, aiding early detection of kidney damage.[23] These strips have been used to detect albuminuria in the general population (sensitivity 95%, specificity 64%), in smokers, in people with chronic obstructive pulmonary disease and on burn patients and have consistently shown good accuracy.[24–27] They are relatively cheaper than the other POCs on the market, which could make them affordable for a resource-limited setting such as Uganda.

The use of urinary POC tests has been evaluated in resource-limited settings among different populations and more research is needed to determine their clinical utility especially among children and adolescents who are under-represented in kidney research.[28] The aim of this study was to determine the diagnostic performance of an albuminuria POC test (MicroalbuPHAN) for screening for CKD among YPLHIV in Uganda.

METHODS

Study design and setting

In this cross-sectional study, we compared the diagnostic performance of the albuminuria POC test against immunoturbidimetric assay measured urinary albumin and creatinine as the reference standard. The study was set in seven urban public health sites in Kampala, Uganda that offer free comprehensive HIV services including screening for comorbidities. These facilities were selected as they have the highest numbers of YPLHIV enrolled in Uganda. YPLHIV attend the ART clinic monthly, or every 3 months if HIV is virally suppressed. They receive ART refills, adherence counselling and support.

Study participants

Eligibility criteria were YPLHIV aged 10–24 years, diagnosed with HIV before 10 years of age and registered at the ART clinics of the participating health facilities. We excluded YPLHIV who were registered as pregnant at the last clinic visit as pregnancy leads to a 40%–50% increase in GFR and slight proteinuria.[29] Those with urinary tract infections or known kidney disease were not excluded as we sought to determine the POCs ability to correctly diagnose those with kidney abnormalities. We used systematic random sampling to recruit participants from April to August 2023. To do this, all YPLHIV active in care at each of the seven facilities were arranged in alphabetical order and every third name was invited to join the study (online supplemental figure 1). The sample size was determined by assuming a prevalence of albuminuria of 10% with significance set at 0.05 and power of 80% to be able to get a sensitivity CI between 70% and 83%. We needed to enrol 495 participants with at least 45 cases.[30]

Study procedures

All eligible YPLHIV were invited by phone call to the facility where they were screened further and enrolled after obtaining written informed consent from the caregivers and assent from the minors. We collected demographic (age, sex, religion, tribe and marital status) and medical history (date of HIV diagnosis and current ART regimen) data for each participant through an interview

and chart review. Each participant provided 20 mL of a spot mid-stream urine sample that was used for POC testing, urine dipstick and laboratory analysis. The study nurses performed the POC test and urine dipstick at the facility within 4 hours of urine collection and results were recorded within 60 s. The sample was then kept in a cooler box before being transferred to the central laboratory for further testing. The urine was stored at −80°C prior to batch analysis. The laboratory staff was not aware of the results of the POC when they tested the laboratory samples.

Urinary albumin and creatinine POC test

Urinary albumin and creatinine levels were determined using MicroalbuPHAN (Erba Lachema Czech Republic). This test is a semiquantitative measurement of albumin and creatinine and can be used to estimate the ACR. Urine albumin content measurement by dye-binding technique is read off after the reaction of an acid-base indicator, and urine creatinine measurement is based on the reaction of creatinine with 3,5-dinitrobenzoic acid in alkaline medium.[23] The colour change is read off 60 s after dipping in urine. The different colours correspond to <10, <30, <80 and >5000 mg of urinary albumin.

Urinary albumin and creatinine laboratory quantification

The urine albumin was quantified using the immunoturbidimetric assay. This was done on the Roche Cobas C311 platform using Tina-quant Albumin Gen2, (Roche Diagnostics). Prior to testing, the machine was calibrated

Table 1 Demographic characteristics of the young people living with HIV in the study stratified by sex

Variable	Male n=219 (44%)	Female n=278 (56%)	Total n=497	P value
Age mean (SD)	16.5 (3.8)	16.3 (3.5)	16.4 (3.6)	0.57
Age categories	N (%)			
10–17	142 (64.8)	189 (67.9)	331 (66.8)	0.46
18–24	77 (35.2)	89 (32.0)	166 (33.4)	
Religion				
Christian	158 (72.1)	202 (72.7)	360 (72.4)	0.48
Moslem	61 (27.9)	73 (26.2)	134 (27.0)	
Other	0 (0)	3 (1.1)	3 (0.6)	
Tribe				
Ganda	148 (67.6)	172 (61.9)	320 (64.4)	0.07
Other*	65 (29.7)	86 (30.9)	151 (30.4)	
Non-Ugandan	6 (2.7)	20 (7.2)	26 (5.2)	
Address				
Kampala	123 (56.2)	169 (60.8)	292 (58.8)	0.11
Wakiso	79 (36.1)	99 (35.6)	178 (35.8)	
Other†	17 (7.8)	10 (3.6)	27 (5.4)	
Marital status				
Never married	216 (98.6)	262 (94.2)	478 (96.2)	0.01
Married‡	3 (1.4)	16 (5.8)	19 (3.8)	
Had a comorbidity				
Yes	18 (3.4)	34 (12.3)	52 (10.6)	0.16
No	197 (91.6)	242 (87.7)	439 (89.4)	
Time on ART				
<5 years	30 (13.9)	38 (13.8)	68 (13.8)	0.39
6–10 years	88 (40.7)	129 (46.9)	217 (44.2)	
>10 years	98 (45.4)	108 (39.3)	206 (42.0)	
Duration of living with HIV				
<10 years	89 (41.6)	132 (48.2)	221 (45.3)	0.15
>10 years	125 (58.4)	142 (51.8)	267 (54.7)	

*Included those with no religion and those practising African traditional religion.
†People from all other districts of Uganda.
‡Those who were married or living with their partners.
ART, antiretroviral therapy; n, number; SD, Standard deviation.

according to manufacturer instructions. Creatinine was measured using the enzymatic calorimetric method on the Cobas Integra 400 plus machine with Creatinine Plus Version 2 (CREP2), Roche Diagnostics.

Definitions

An abnormal ACR was defined as 30 mg/g and above according to the KDIGO criteria.[31] A normal urinary albumin was defined as below 30 mg, and normal creatinine was between 0.5 and 1.2 mg/dL, proteinuria on dipstick was defined as all that had trace proteins, 1+, 2+ and 3+. Positive predictive value (PPV) is the probability that a participant who screens positive on the test in reality has the disease and negative predictive value (NPV) is the probability that a participant who screens negative on the test is actually disease-free.[32]

Statistical analysis

Demographic data were analysed descriptively, with categorical variables analysed using a χ^2 test to test for differences in proportions by sex and a t-test to test for differences in means. Laboratory measurements of the participants were summarised using medians, means and proportions by sex and age. The CKDEPI 2021 equation was used to calculate the estimated glomerular filtration rate (eGFR) according to serum creatinine for participants above 18 and the Bedside Schwartz was used for participants below 18 years.[33 34]

We determined the diagnostic performance of the POC test by calculating the sensitivity, specificity, NPV, PPV, negative and positive likelihood ratios as well as the accuracy compared with the laboratory quantified albumin and creatinine that were the reference standards.[32] The area under the ROC curve was also determined.[32] Subgroup analysis was done according to sex, age, body mass index (BMI) and proteinuria to determine if the POC test had better performance in different subpopulations.

ORs and 95% CIs for factors associated with having a positive POC test were assessed using both univariate and multivariate logistic regression. Variables known to be associated with albuminuria such as age, sex, proteinuria and BMI and those with a p<0.1 on univariate analysis were included in the final multivariable model.

Participants with results for both the POC and the reference standard were included in the diagnostic accuracy analysis. All analyses were done in STATA statistical software V.18 (STATACorp). The results were reported according to the Standards for Reporting of Diagnostic Accuracy Studies statement.[35]

Patient and public involvement

The patients and the public were not involved in the study design. They were first involved in the study of recruitment and follow-up. The peers talked to fellow adolescents about the study benefits and also arranged for the follow-up visits. They agreed to the study dissemination plan.

RESULTS

A total of 497 participants were enrolled in the study. The majority were females (n=278; 55.9%), aged 10–17 years (n=331; 66.8%) of the Christian religion (n=360; 72.4%) and living in Kampala district (n=292; 58.8%). Females are more likely to be married than males (5.8% vs 1.4%;

Table 2 The laboratory characteristics of the participants

Age	10–17 years			18–24 years		
Sex	Male	Female	P value	Male	Female	P value
Albumin (median, range)	3.0 (3–130)	3.1 (3–165)	0.61	3.2 (3–525)	3.1 (3–238)	0.57
POC ACR (mg/g)						
<30	81 (57.0)	127 (67.2)	0.12	48 (62.3)	62 (69.7)	0.39
30–299	60 (42.3)	61 (32.3)		27 (35.1)	23 (25.8)	
>300	1 (0.7)	1 (0.5)		2 (2.6)	4 (4.5)	
Laboratory ACR						
<30	128 (92.1)	167 (89.8)	0.59	67 (89.3)	74 (85.1)	0.68
30–299	11 (7.930)	18 (9.7)		7 (9.3)	12 (13.8)	
>300	0	1 (0.5)		1 (1.3)	1 (1.1)	
Creatinine (mean, SD)	0.63 (0.1)	0.58 (0.1)	<0.001	0.83 (0.2)	0.69 (0.1)	<0.001
eGFRscr mean (SD)	103.3 (18.3)	110.3 (20.3)	0.002	125.3 (12.8)	122.1 (13.4)	0.12
eGFRscr categorised						
>90 mL/min/1.72 m^2	109 (78.4)	167 (88.8)	0.01	74 (97.4)	85 (96.6)	0.6
<90 mL/min/1.72 m^2	30 (21.6)	21 (11.2)		2 (2.6)	3 (3.4)	

ACR, albumin creatine ratio; ART, antiretroviral therapy; eGFRscr, estimated glomerular filtration rate from serum creatinine; POC, point of care.

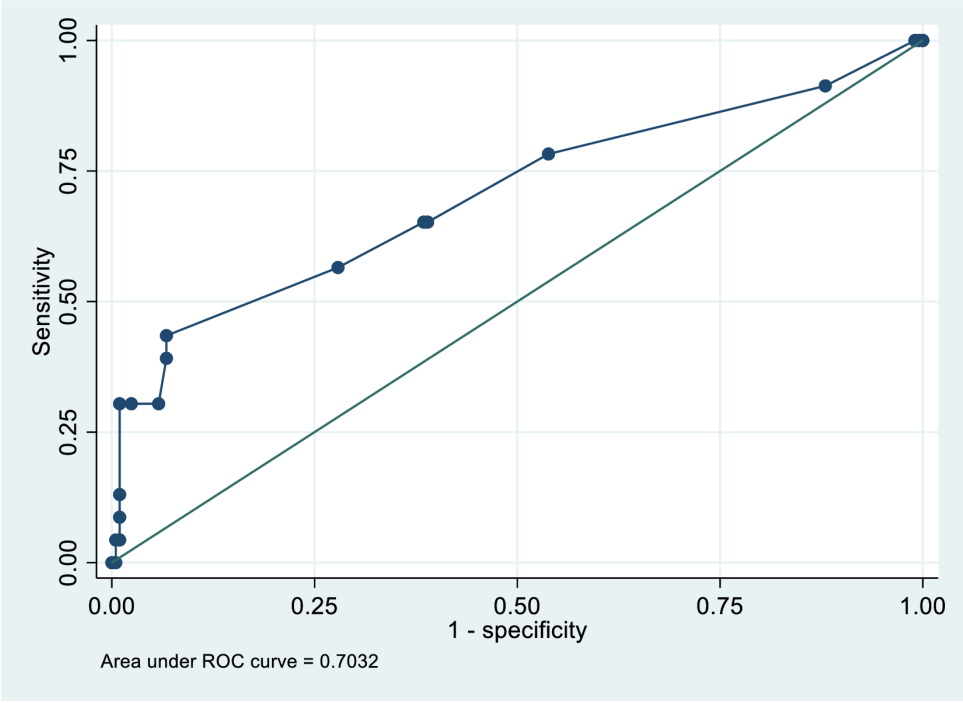

Figure 1 Receiver operating curve (ROC) for the POC and laboratory measured albumin and creatinine. POC, point of care.

p=0.01). Demographic characteristics are shown by sex in table 1.

Laboratory characteristics of the participants

There was no evidence of a difference in mean albumin levels by age or sex (table 2). Male participants had a higher mean creatinine than females (p<0.001) for both age groups. Among 10–17 years, males had a higher mean eGFR than females (p=0.002) but there was no evidence of a difference in eGFR for those aged 18–24 years (p=0.12). Similarly, among those aged 10–17 years, the proportion with eGFR<90 mL/min/1.72 m^2 was higher for males than for females (21.6% vs 11.2%; p=0.01) (table 2).

Diagnostic performance of the urinary albumin and creatinine POC test

The proportion of participants with ACR<30 mg/g on the laboratory measured ACR was greater than for the POC (89.5% vs 63.6%; p<0.001) (online supplemental table 1). The POC test had a sensitivity of 74.5% (95% CI 70.6% to 78.4%) and specificity of 68.1% (95% CI 63.9% to 72.3%). The PPV was 21.5% (95% CI 17.8% to 25.1%)

Table 3 Diagnostic performance of the POC test by specific subgroups

Variable	Sensitivity	Specificity	PPV	NPV	P value*
Sex					
Males	73.7 (67.8–79.6)	61.0 (54.5 to 67.6)	15.6 (10.7–20.4)	95.9 (93.3–98.6)	0.70
Females	75.0 (69.9–80.1)	73.9 (68.6 to 79.1)	27.6 (22.3–32.7)	95.7 (93.3–98.1)	
Age in years					
Age <18	80.0 (75.6–84.4)	67.1 (62.0 to 72.3)	19.8 (15.5–24.2)	97.1 (95.2–98.9)	<0.001
Age >18	66.6 (59.4–73.9)	70.2 (63.2 to 77.3)	25.0 (18.3–31.7)	93.4 (89.6–97.2)	
Body mass index (BMI)					
BMI<19.5	70.8 (65.0–76.7)	60.5 (54.2 to 66.7)	17.0 (12.2–21.8)	94.8 (91.9–97.6)	0.07
BMI≥19.5	77.8 (72.6–82.9)	75.6 (70.2 to 80.9)	27.6 (22.1–33.2)	96.6 (94.3–98.8)	
Proteinuria status					
Proteinuria	80.5 (73.9–87.0)	58.4 (50.3 to 66.5)	44.0 (35.8–52.2)	88.1 (82.7–93.4)	<0.001
No proteinuria	50.0 (44.7–55.3)	71.0 (66.3 to 75.8)	4.9 (2.6–7.2)	97.9 (96.4–99.4)	

*Calculated only for sensitivity.
NPV, negative predictive value; POC, point of care; PPV, positive predictive value.

and the NPV was 95.8% (95% CI 94.0% to 97.6%). The positive likelihood ratio was 2.34, the negative likelihood ratio was 0.37 with an accuracy of 68.8% (95% CI 55.3% to 68.2%) and a prevalence of 10.5% (95% CI 7.8 to 13.2%). The area under the curve was 0.70 (figure 1).

Subgroup analysis of diagnostic performance according to specified groups

The sensitivity was highest among those aged 10–17 years (80.0%; 95% CI 75.6% to 84.4%) and those with proteinuria (80.5%, 95% CI 73.9% to 87.0%) respectively. Specificity was highest among those with a high BMI (75.6%, 95% CI 70.2% to 80.9%). PPV was highest among those with proteinuria (44.0%, 95% CI 35.8% to 52.2%) and NPV was highest among those without proteinuria (97.9%, 95% CI 96.4% to 99.4%) (table 3).

Associations between having a positive POC and specific variables

After adjustment for sex, age, BMI and proteinuria, there was strong evidence that a positive POC test was associated with having proteinuria (OR 2.99; 95% CI 1.98 to 4.51, p<0.001); and weaker evidence of an association with low BMI (OR 1.63; 95% CI 1.01 to 2.50, p=0.005). There was no evidence of an association with eGFR, age group, comorbidity, duration of living with HIV, duration on ART or sex (table 4).

DISCUSSION

The diagnostic performance of a POC albuminuria test for screening for CKD among YPLHIV showed very low sensitivity, specificity and PPV and high NPV against the reference-standard laboratory test. A positive POC test result was associated with having proteinuria and low BMI.

This is the first study to assess the diagnostic performance of this POC test among people living with HIV. We identified four studies that used this POC in the general population globally.[24–27] One assessed diagnostic performance and three estimated prevalence. Our results

Table 4 Associations between having a positive POC and different exposures

Variable	Unadjusted OR (95% CI)	P value	Adjusted OR* (95% CI)	P value
Sex				
Female	Ref			
Male	1.48 (1.02 to 2.14)	0.04	1.38 (0.92 to 2.04)	0.12
Age				
>18 years	Ref			
<18 years	1.16 (0.78 to 1.72)	0.45	1.11 (0.71 to 1.73)	0.65
BMI				
>19.5	Ref			
<19.5	1.69 (1.17 to 2.45)	0.005	1.63 (1.01 to 2.50)	0.02
Proteinuria				
Negative	Ref			
Positive	2.82 (1.89 to 4.22)	<0.001	2.99 (1.98 to 4.51)	<0.001
eGFR				
>90 mL/min/1.72 m^2	Ref			
<90 mL/min/1.72 m^2	0.94 (0.63 to 1.41)	0.77	–	–
Had a comorbidity				
Yes	Ref		–	–
No	1.45 (0.73 to 2.95)	0.28		
Time on ART				
<5 years	Ref			
6–10 years	0.72 (0.41 to 1.24)	0.45	–	–
>10 years	0.71 (0.41 to 1.23)			
Duration of living with HIV				
<10 years	Ref		–	–
>10 years	0.88 (0.61 to 1.28)	0.51		

*adjusted for age, sex, BMI and proteinuria
ART, antiretroviral therapy; BMI, body mass index; eGFR, estimated glomerular filtration rate; POC, point of care.

contrast with those from a study in Thailand with 100 adult patients who had either kidney disease or diabetes mellitus. In this study where the prevalence of albuminuria was 45.5%, the POC test for albuminuria had a sensitivity of 95%, specificity of 64%, a PPV of 84%, NPV of 86% and an accuracy of 84%.[24] This study was conducted on adults, had a smaller sample size than ours and had mostly people with confirmed kidney disease. They might have found a higher PPV due to a higher prevalence of CKD than in our study. A study among 162 college students using this POC test found that 95% of participants had microalbuminuria.[25] Another study among smokers and non-smokers found that vape smokers had higher levels of albuminuria compared with non-smokers.[26] The fourth study showed that people living in low mountainous areas in Kyrgyz Republic with chronic pulmonary obstructive disease had a 9% prevalence of albuminuria.[27] However, there was no comparison of the POC test with any gold standard in these last three studies, precluding assessment of its diagnostic performance.

Sensitivity of the POC for detecting ACR was low in our population (74.5%). In assessing a semiquantitative POC such as the MicroalbuPHAN, sensitivity is considered more important than specificity as a negative test implies no further testing.[36] A high sensitivity is desirable to avoid missing true cases as kidney disease is a serious but potentially modifiable disease if diagnosed early.[37] The American Association for Clinical Chemistry and the American Diabetes Association recommend that an albumin POC test has a sensitivity of 95% to be considered for clinical use.[38] With the observed sensitivity of 74.5%, this POC falls short. The POC also had low specificity at 68.1%. This means that about one-third of people screened who do not have kidney disease will test positive, subjecting them to further tests that might not be necessary and causing unnecessary concern for the patient and caregivers.[37]

In our population, sensitivity was higher among 10–17 than 18–24 years. This was also found in a Nigerian study where the Micral-Test strips (Roche Diagnostics, USA) were used to test for albuminuria among children aged 5–15 years with sickle cell anaemia. They found differing sensitivity and specificity in younger children aged less than 10 years vs older children aged more than 10 years.[39] The reasons for this difference according to age need further research.

NPV and PPV are dependent on disease prevalence and address the question of how likely the patient is to have the disease if the test is positive and vice-versa.[37] With a PPV of 21.5%, this test is not informative that a patient truly has albuminuria if it is positive. However, with an NPV of 95.8%, which rises to 97.1% for those aged 10–17 years of age and 97.9% for those without proteinuria, one can be confident when negative, that the patient does not have albuminuria. This high NPV was also seen in a large population-based cohort in South Africa where the Sysmex Corporation (Kobe, Japan) POC test had an NPV of 96.8%.[40] We found the prevalence of albuminuria was 10.5% (95% CI 7.8% to 13.2%). The relatively low prevalence could also affect the PPV and NPV and might explain the low PPV of 21.5%.[37] This prevalence was lower than that found among 185 Ugandan adults who were ART-naïve (18.9%, 95% CI 14% to 25%).[41] This could be because the participants were older and ART-naïve, both increasing their risk for kidney disease.[42]

We found that those with a positive POC test had almost three times the odds of having proteinuria on dipstick. This is similar to a study done in the USA on adults living with HIV where they found that adults with albuminuria had 2.9 times the odds of developing overt proteinuria during follow-up.[43] This POC test could be useful as a predictor of proteinuria.

The area under the curve was 0.7 meaning that this was a relatively good test despite the low sensitivity and specificity.[37] This warrants further assessment of this POC as some factors could have led to the observed low sensitivity and specificity. The fact that we did not use 24-hour UAE rate as the gold standard test for urinary albumin also means that we could be judging the POC test unfairly as the reference standard might be flawed.[36] However, studies have shown that ACR and UAE give very similar results and can be used interchangeably.[18]

A systematic review and meta-analysis showed that the sensitivity and specificity of albumin POC tests improved when a laboratory professional performed the test as opposed to a clinician.[36] This could explain the low sensitivity and specificity found as all the POC testing was done by clinicians in this study. This was an important observation as clinicians should potentially be the ones utilising POC technologies to hasten diagnosis.[40] The reasons for this should be explored and addressed to make POCs of value to clinicians. However, another systematic review showed that POC tests for albuminuria generally have low sensitivity and specificity and should be evaluated further to determine clinical utility if any.[22]

POC tests to assess kidney function could be useful in resource-limited settings, however, the context and the setting should dictate the particular test to be used.[44] Most POC tests have been validated in populations traditionally at risk of kidney disease such as people living with diabetes or hypertension.[36 44] There is need to validate these technologies among people living with HIV in a resource-limited setting as they are also at increased risk for kidney diseases.[45]

Strengths and limitations

We had a large representative sample size of YPLHIV meaning our results could be generalised to YPLHIV in resource-limited settings. This POC test has never been validated among people living with HIV so we had no similar studies to compare our results to. As a limitation, we did not repeat the uACR measurements over a 6-month period as one needs to have two out of three samples positive to be diagnosed with albuminuria.[36] There was no laboratory quantification of the proteinuria and only a urinary dipstick was used. We did not collect data on the smoking status of the participants, but this

would not impact on the validity of the POC test rather on who develops kidney disease.

CONCLUSION

The urinary ACR test did not show a high sensitivity and specificity among YPLHIV in Uganda. However, it is still useful to rule out kidney disease given its high NPV and ability to tell those with signs of kidney damage. It can be used as a screening test for those who need further evaluation. Its use should be validated among people living with HIV compared with 24-hour albumin excretion rate prior to roll out as a screening test among YPLHIV.

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