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Orapuh Journal

ORIGINAL ARTICLE

Journal of Oral & Public Health

CT angiography profile of lower extremity arterial diseases in an imaging center in Kinshasa, Democratic Republic of the Congo

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ARTICLE INFO

Received: *13 March 2026*
Accepted: *15 April 2026*
Published: *21 May 2026*

Keywords:
CT angiography, peripheral arterial disease, lower limb ischemia, vascular imaging, Congo

Peer-Review: *Externally peer-reviewed*

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To cite:
Kabongo, K. C., Mukanga, Y. D., Iyoto, M. D., & Mukaya, T. J. (2026). CT angiography profile of lower extremity arterial diseases in an imaging center in Kinshasa, Democratic Republic of the Congo. *Orapuh Journal, 7*(4), e1436.
https://doi.org/10.4314/orapj.v7i4.36

ISSN: *2644-3740*

Published by **Orapuh, Inc.**, F. Gaye Res., Sukuta-Jamisa, Greater Banjul, The Gambia.

Editor-in-Chief: *Prof. V. E. Adamu (editor@orapuh.org)*

ABSTRACT

Introduction
The epidemiological transition in sub-Saharan Africa has led to an increasing burden of noncommunicable diseases, particularly cardiovascular diseases, including lower extremity peripheral arterial disease (PAD). However, imaging data remain limited in the Congolese context.

Purpose
To describe the CT angiography profile of lower extremity arterial diseases and to analyze the association between arterial anatomical variations and vascular pathologies in an imaging center in Kinshasa.

Methods
This was a retrospective, single-center observational analytical study including 124 CT angiography examinations performed between January 2015 and January 2020. Exhaustive sampling was used. Data were analyzed using SPSS version 21.0. Associations were assessed using the chi-square test and multivariate logistic regression. Results were expressed as odds ratios (ORs) with 95% confidence intervals (CIs). Statistical significance was set at $p < .05$.

Results
The mean age was 60 ± 11 years, with a male predominance. PAD (65.3%) and acute lower limb ischemia (25.8%) were the most frequent conditions. Anatomical variations were most frequent at the iliofemoral level (25.7%). In multivariate analysis, iliofemoral variations were significantly associated with PAD (OR = 11.90; 95% CI [3.23, 39.53]; $p < .001$) and acute ischemia (OR = 10.29; 95% CI [3.23, 41.79]; $p < .001$).

Conclusion
Lower extremity arterial diseases in Kinshasa are dominated by PAD and acute ischemia, both significantly associated with arterial anatomical variations. CT angiography is essential for accurate evaluation and therapeutic planning.

INTRODUCTION

The epidemiological transition in sub-Saharan Africa has resulted in a steady increase in noncommunicable diseases, particularly cardiovascular diseases, which now represent major cause of morbidity and mortality. This trend is driven by urbanization, population aging, and lifestyle changes.

Lower extremity peripheral arterial disease (PAD) is one of the main clinical manifestations of systemic atherosclerosis, with increasing prevalence in low-resource settings. However, data remain limited in sub-Saharan Africa, particularly regarding imaging-based morphological characterization.

Computed tomography angiography (CTA) is a noninvasive reference imaging modality for evaluating peripheral arterial disease. Advances in multidetector CT technology provide high spatial resolution and detailed vascular visualization (Aboyans et al., 2018; Conte et al., 2019; Song et al., 2019). CTA enables accurate evaluation of stenosis, occlusion, calcification, and anatomical variations, directly influencing therapeutic decisions.

Despite these advances, there is limited systematic CT angiographic characterization of lower extremity arterial disease in Congolese populations.

This study aimed to describe the CT angiography profile of lower extremity arterial diseases and to analyze the association between arterial anatomical variations and vascular pathologies in patients evaluated in Kinshasa.

METHODS

Study Design and Setting

This was a retrospective, single-center observational analytical study conducted at the Le Rocher Medical Imaging Center (CIMR), Kinshasa, Democratic Republic of the Congo, from January 2015 to January 2020.

Study Population

All patients who underwent lower limb CT angiography during the study period were eligible. Exhaustive sampling was used. Of 152 examinations identified, 124 were included after applying inclusion and exclusion criteria.

Inclusion Criteria

- All ages and sexes
- Complete CT angiography studies archived in PACS

Exclusion Criteria

- Follow-up examinations (to avoid duplication)
- Lower limb amputation
- Severe motion or venous contamination artifacts

Data Collection

Data were extracted from radiology reports and PACS images using the syngo.via workstation (Siemens Healthineers).

Variables

- Sociodemographic: age, sex
- Clinical: indication for CTA
- Imaging: lesion type, location, stenosis degree, anatomical variations

Imaging Protocol

Lower limb CT angiography examinations were performed using a 16-slice scanner (Siemens Healthcare) according to a standardized acquisition protocol. Following intravenous administration of iodinated contrast material using an automatic injector, images were reconstructed using multiplanar and three-dimensional techniques, including multiplanar reconstruction (MPR), maximum intensity projection (MIP), and volume rendering technique (VRT).

Technical acquisition parameters are summarized in **Table 1**. This protocol enabled accurate morphological assessment of arterial lesions, their extent, and associated anatomical variations.

Table 1:
CT Angiography Acquisition Parameters

Parameter	Setting
Number of detector rows	16
Tube voltage (kV)	120
Tube current–time product (mAs)	150
Rotation time	0.5 s
Pitch	1.2
Slice collimation	3 mm
Slice thickness / increment	2 mm / 1.4 mm
Iterative reconstruction	Model-based algorithm (ADMIRE; Siemens Healthcare, Forchheim, Germany)
Reconstruction strength	Level 3
Reconstruction kernel	Bf40
Post-processing techniques	Multiplanar reconstruction (MPR), volume rendering technique (VRT), maximum intensity projection (MIP)
Automatic injector	Envision CT Injector EHU 700 (Medrad)

https://doi.org/10.4314/orapj.v7i4.36

Operational Definitions

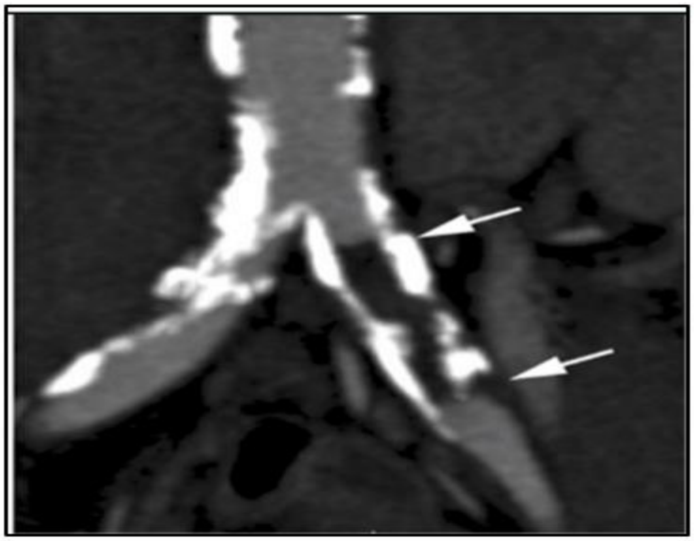
Image Quality

CT image quality was assessed using both objective criteria (arterial attenuation > 200 HU) and subjective criteria (4-point Likert scale). A score ≥ 2 was considered diagnostically acceptable.

Peripheral Arterial Occlusive Disease (PAOD)

PAOD was defined clinically using the Fontaine and Rutherford classifications and radiologically on CTA by the presence of atherosclerotic plaques and calcifications causing stenosis or occlusion **(Figure 1)**.

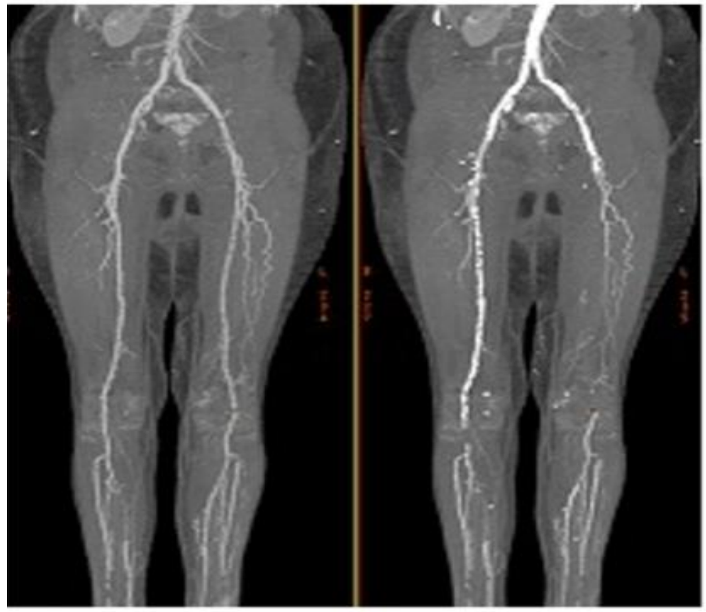
Figure 1:
Calcified atherosclerotic plaques at the iliac bifurcation on a zoomed MIP image (CIMR Archives)



Acute Lower Limb Ischemia

Acute lower limb ischemia was defined clinically using the Rutherford classification and radiologically on CTA by absence of arterial opacification indicating occlusion due to thrombosis, embolism, or trauma **(Figure 2)**.

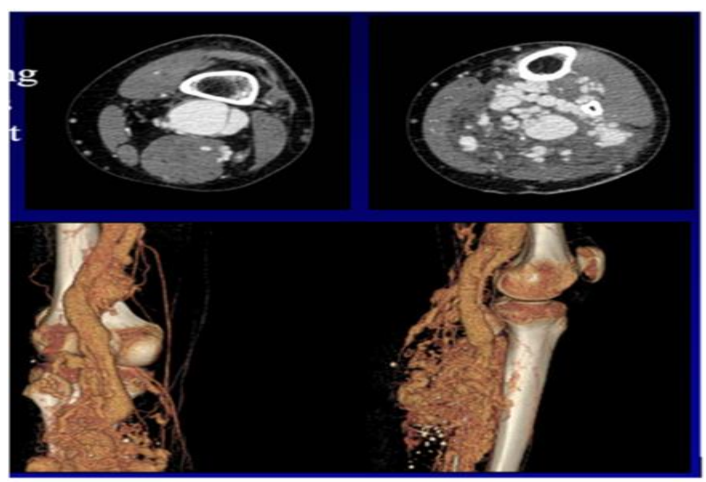
Figure 2:
Occlusion of the left superficial femoral artery on MIP CT angiography (CIMR Archives)



Vascular Malformations

High-flow malformations were defined by the presence of feeding arteries, a nidus, and draining veins **(Figure 3)**. Low-flow malformations were characterized by absence of arterial-phase enhancement **(Figure 5)**. Vascular tumors were defined by marked enhancement.

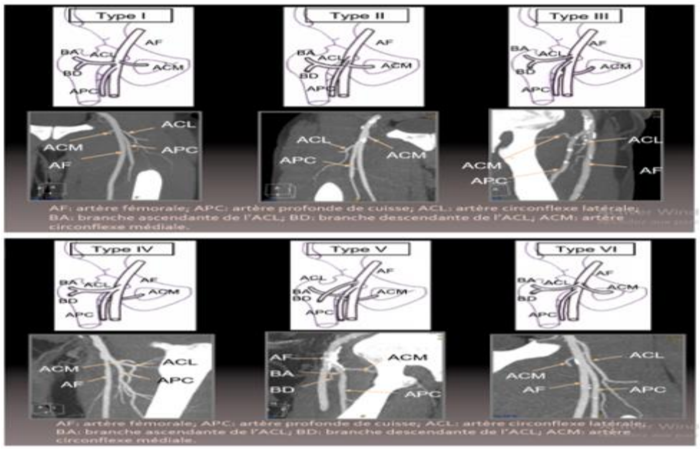
Figure 3:
Arteriovenous malformation of the solar plexus on axial sections and VRT images



Arterial Variations

Iliofemoral and tibial arterial variants were defined according to the Williams and Kim classifications **(Figures 4–5)**.

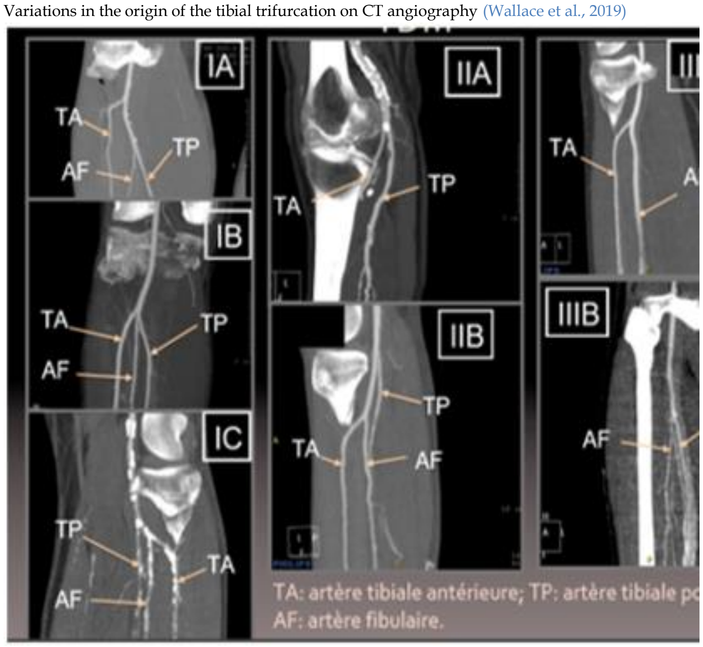
Figure 4:
Classification of femoral bifurcation (Wallace et al., 2019)



Stenosis and Calcification

Stenosis severity was graded as < 25%, 25–50%, > 50%, or occlusion. Calcifications were classified as mild, moderate, or severe.

Figure 5:
Variations in the origin of the tibial trifurcation on CT angiography (Wallace et al., 2019)



Statistical Analysis

Data were analyzed using SPSS software (version 21.0). Quantitative variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Associations were assessed using the chi-square test.

Multivariate logistic regression was performed to identify factors associated with PAD and acute ischemia. Variables included in the multivariate model were those with a p value < .20 in univariate analysis, as well as clinically relevant variables (age, sex, and anatomical variations). Results were expressed as odds ratios (ORs) with 95% confidence intervals (CIs). Statistical significance was set at $p < .05$.

Bias and Study Limitations

This study had several limitations, including potential selection bias due to recruitment of patients referred for CT angiography, limitations inherent to the retrospective design due to reliance on archived data quality, and indication bias related to variability in clinical referral patterns. However, the use of exhaustive sampling partially reduced these biases.

Ethical Considerations

The study was approved by the Ethics Committee of the School of Public Health, University of Kinshasa (Approval No. ESP/CE/14A./2020). Data were anonymized and managed in accordance with the principles of the Declaration of Helsinki.

RESULTS

General Characteristics

Of the 152 CT angiography examinations identified, 124 were retained after application of the eligibility criteria. The mean age of the patients was 60 ± 11 years, with a predominance of male patients. Peripheral arterial disease (PAD) was the main indication for CT angiography, followed by acute ischemia.

Angio-CT Profile of Arterial Diseases (Primary Objective)

Peripheral arterial disease was the most frequent condition (65.3%), followed by acute ischemia (25.8%). In patients with PAD, lesions predominantly involved the femoropopliteal segment, with a high proportion of occlusions and severe calcifications. In acute ischemia, lesions were mainly located in the infrapopliteal territory, with a predominance of advanced stages (Rutherford stage III).

The detailed characteristics of patients and lesions are presented in **Tables 3** and **5**.

Arterial Anatomical Variations (Secondary Objective)

Anatomical variations were more frequent at the iliofemoral level (25.7%) than at the infrapopliteal level (10.5%), suggesting a predominance of proximal anatomical variability. The distribution of these variants is presented in **Table 2** and **Figure 6**.

Association Between Anatomical Variations and PAD

Arterial anatomical variations were significantly associated with PAD. In multivariate analysis, iliofemoral variations were significantly associated with PAD (OR = 11.90, 95% CI [3.23, 39.53], *p* < .001). Infrapopliteal arterial variations were also associated with an increased likelihood of PAD (adjusted OR = 10.29; 95% CI: 2.94–36.00; p < 0.001) **(Table 4)**.

Association Between Anatomical Variations and Acute Ischemia

Arterial anatomical variations were also significantly associated with acute ischemia. In multivariate analysis, iliofemoral variations were significantly associated with acute ischemia (OR = 10.29, 95% CI [3.23, 41.79], *p* < .001). Infrapopliteal variations also showed a statistically significant association (**Table 6**).

Figure 6:
Frequency of variability of the lower limb arteries, expressed as a percentage

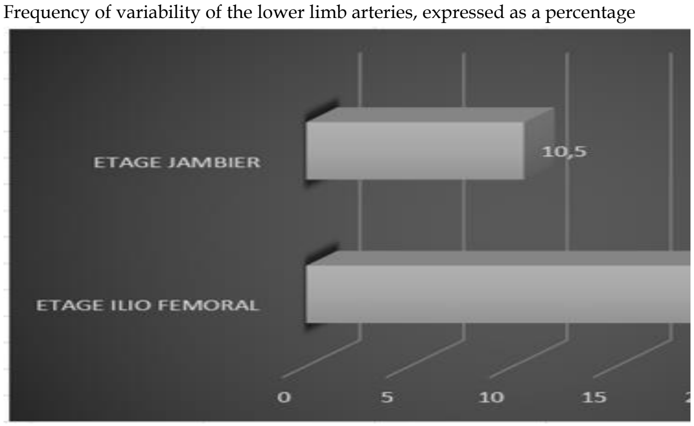


Table 2
Variability of the Arterial Network at the Iliofemoral Level

Variable	n	%
Persistent sciatic artery	1	0.8
Deep artery of the thigh (origin)		
Posterior origin	36	29.1
Posterolateral origin	56	45.2
Lateral origin	30	24.1
Medial origin	2	1.6
Femoral bifurcation (Williams classification)		
Variable	**n**	**%**
Type I	4	3.1
Type II	28	22.6
Type III	18	14.1
Type IV	66	52.2
Type V	6	5.1
Type VI	2	1.6

Note: Percentages may not total 100 due to rounding.

Table 3
Characteristics of Patients With Peripheral Arterial Occlusive Disease (PAD)

Variable	n	%
Mean age (years), mean ± SD	60.5 ± 14.4	–
Sex		
Female	17	21.0
Male	64	79.0
Risk factors		
Diabetes	66	81.4
Hypertension	55	67.9
Clinical classification		
Stage IIa	29	35.8
Stage IIb	13	15.9
Stage III	21	26.1
Stage IV	18	22.2
Anatomical characteristics of stenosis		
Site		
Aortoiliac	24	29.9
Femoropopliteal	34	42.9
Infrapopliteal	23	27.2
Stenosis severity (Bollinger score)		
Occlusion	39	48.3
Stenosis > 50%	21	25.8
Stenosis 25–50%	13	15.5
Plaque < 25%	8	10.4
Calcification score		
Mild (< 25% circumference)	9	11.5
Moderate (25–50% circumference)	33	41.3
Severe (> 50% circumference)	39	47.2

Note. SD = standard deviation.

Table 4:
Anatomical Variations Associated With Peripheral Arterial Disease (PAD)

Variable	OR (unadjusted)	95% CI	*p*	OR (adjusted)	95% CI	*p*
Iliofemoral arterial variations						
Presence vs. absence	3.52	[1.57, 7.87]	.002	11.90	[3.23, 39.53]	< .001
Leg/infrapopliteal arterial variations						
Presence vs. absence	8.80	[3.31, 23.31]	< .001	10.29	[2.94, 36.00]	< .001

Note: OR = odds ratio; CI = confidence interval.

https://doi.org/10.4314/orapj.v7i4.36

Table 5

Characteristics of Acute Ischemia in the Study Population

Variable	n	%
Mean age (years), mean ± SD	58.2 ± 12.2	–
Sex		
Female	2	6.3
Male	30	93.7
Etiology		
Atherosclerosis	17	53.1
Embolism	10	31.3
Trauma	5	15.6
Clinical stage (Rutherford)		
Stage I	2	6.3
Stage IIa	4	12.6
Stage IIb	8	25.2
Stage III	18	55.9
Site		
Aortoiliac	0	0.0
Femoropopliteal	2	6.3
Infrapopliteal	30	93.7

Note: SD = standard deviation.

Table 6:

Anatomical Variations Associated With Acute Lower Limb Ischemia

Variable	Unadjusted OR	95% CI	*p*	Adjusted OR	95% CI	*p*
Iliofemoral arterial variations (presence vs. absence)	8.80	[3.33, 23.37]	< .001	10.29	[3.23, 41.79]	< .001
Leg arterial variations (presence vs. absence)	2.50	[0.96, 6.45]	< .001	0.02	[0.00, 0.13]	< .001

Note: OR = odds ratio; CI = confidence interval.

DISCUSSION

Profile of Lower Extremity Arterial Diseases

In this study, peripheral arterial disease (PAD) was the most frequently observed condition, followed by acute ischemia, in a predominantly male population with a mean age of 60 ± 11 years. These findings are consistent with recent data indicating that PAD predominantly affects older individuals with cardiovascular risk factors. A global analysis estimated that the worldwide prevalence of PAD exceeds 230 million people, with a marked increase in low- and middle-income countries (Song et al., 2019).

In sub-Saharan Africa, a recent study reported an increasing burden of PAD between 1990 and 2021, with a strong association with diabetes and hypertension (Nadjingar et al., 2025). However, the relatively high proportion of acute ischemia observed in our series (25.8%) differs from many Western studies, in which chronic forms are more prevalent. This discrepancy may be explained by delayed diagnosis and limited access to vascular imaging in our setting, resulting in more advanced disease at the time of presentation.

Lesion Topography and Comparison With African Studies

In our study, PAD lesions predominantly involved the femoropopliteal segment, whereas acute ischemia mainly affected the infrapopliteal territory. These findings are partially consistent with international data reporting frequent involvement of the femoropopliteal segment in PAD (Conte et al., 2019). However, recent African studies, particularly from Côte d'Ivoire, have reported a predominance of distal (below-the-knee) lesions, especially among patients with diabetes (Kouakou et al., 2025).

These differences may reflect variation in patient selection, differences in clinical indications for imaging, the high prevalence of diabetes favoring distal arterial involvement, and differences in disease stage at presentation. This variability highlights the importance of the local epidemiological context and healthcare accessibility when interpreting lesion distribution.

Anatomical Variations and Interpretation

Arterial anatomical variations were significantly associated with acute ischemia in our study, particularly at the iliofemoral level (OR = 10.29, 95% CI [3.23, 41.79], $p < .001$). The magnitude of this association was greater than that reported for traditional risk factors (OR ≈ 2–5) in the literature (Howard et al., 2015).

This finding, which remains poorly documented, may be explained by hemodynamic changes induced by certain anatomical variants, potentially promoting turbulence and thrombosis. This hypothesis is supported by studies describing the role of wall shear stress in atherogenesis (Chatzizisis et al., 2007; Shwaiki et al., 2021).

However, the wide confidence interval and the retrospective nature of the study require cautious interpretation, and the association should not be considered causal. In addition, recruitment based on CT angiography referrals may have introduced selection bias. Nevertheless, these results suggest that anatomical variations may represent a morphological marker associated with severe forms of acute ischemia, warranting confirmation in prospective studies.

Contribution of CT Angiography and Clinical Implications

CT angiography enabled precise evaluation of lesion topography, severity, and associated anatomical variations. Recent recommendations from the American College of Cardiology/American Heart Association and the European Society of Cardiology emphasize the central role of CTA in planning revascularization strategies, particularly in complex or multisegmental disease (Gornik et al., 2024). Clinically, these findings suggest that systematic integration of CT angiography into diagnostic pathways may improve patient stratification, therapeutic planning, and functional outcomes.

Implications for Health Systems in Africa

In sub-Saharan Africa, access to advanced vascular imaging remains limited, contributing to delayed diagnosis and suboptimal management. Recent evidence indicates that the burden of PAD is increasing in these regions, while diagnostic resources remain insufficient (Nadjingar et al., 2025). Therefore, improving access to advanced imaging techniques, developing context-adapted diagnostic protocols, and strengthening training in vascular imaging are critical priorities.

Study Limitations

This study has several limitations. Its retrospective design may have introduced bias due to incomplete or inconsistent archived data. Its monocentric nature limits generalizability. In addition, recruitment of patients referred for CT angiography may have introduced selection bias, potentially overrepresenting severe cases.

Data Availability: Because participants' consent did not provide for unrestricted data sharing, anonymized datasets may be made available to qualified investigators upon reasonable request addressed to the corresponding author.

Authors' Contribution: Study conception and design: C.K.K. and J.M.T. Data acquisition: C.K.K. Manuscript drafting: C.K.K. and D.I.M. Data analysis and interpretation: C.K.K. and D.M.Y. Final revision and approval of the manuscript: J.M.T., C.K.K., D.M.Y., and D.I.M.

Acknowledgements: The authors express their sincere gratitude to all individuals who contributed to data collection and manuscript preparation, particularly the staff of Le Rocher Medical Imaging Center for facilitating and supervising data acquisition.

Ethical Approval: This study was reviewed and approved by the Ethics Committee of the School of Public Health of the University of Kinshasa, acting as the National Ethics Committee (Approval No. ESP/CE/14A./2020). All procedures were conducted in accordance with ethical standards and the principles of the Declaration of Helsinki (1964) and its subsequent amendments.

Conflicts of Interest: None declared.

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