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Selected Dimensions of Primary Health Care Readiness for Chronic Kidney Disease Detection in Brazzaville, Republic of the Congo: A Cross-Sectional Study

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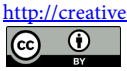

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Abstract

Background: Chronic kidney disease (CKD) is often diagnosed late in sub-Saharan Africa, where access to dialysis and transplantation remains limited. Earlier detection in primary care could change this trajectory, but only if first-level health workers are prepared to do it. We assessed selected dimensions of the readiness of the integrated health centers (IHCs) of Brazzaville to detect CKD. Methods: We conducted a cross-sectional study from November 1 to December 15, 2025, in all 37 functional public IHCs of the ten included health districts of Brazzaville (Île Mbamou was excluded for logistical reasons). A facility grid and a standardized questionnaire, built on WHO-PEN and current CKD guidance, explored facility resources and the training, knowledge, questionnaire-assessed skills, and perceptions of health professionals. Results: Only 13 of the 37 IHCs (35.1%) had at least one physician. Urine dipsticks were available in 33 IHCs (89.2%), but on-site blood chemistry, including creatinine, in only 20 (54.1%). Of the 333 professionals interviewed, 268 (80.5%) completed the questionnaire; only 4 (1.5%) were physicians, and 73.9% had never been trained in noncommunicable diseases. Most participants reported being able to measure blood pressure (98.5%) and use a glucometer (97.4%), and 94.8% knew that the kidney must be monitored in diabetes. However, only 44.4% cited serum creatinine to detect CKD and 31.7% cited the combination of creatinine and a urine test, whereas 55.6% cited urine tests alone. The diagnostic thresholds for hypertension and diabetes were correct for 64.2% and

57.8% of participants, respectively, and only 35.1% reported being able to recognize the warning signs of kidney failure. Overall knowledge was poor in 73.5%; only 28.0% felt competent and 97.4% asked for further training. Conclusion: The assessed dimensions of primary care readiness for CKD detection in Brazzaville reveal substantial gaps, particularly in kidney-specific knowledge, recent NCD training, the use of serum creatinine for CKD screening, and on-site access to blood chemistry, despite high self-reported proficiency in basic procedures. Training, correct diagnostic thresholds, simple screening algorithms combining creatinine-based eGFR and urine testing, reliable access to creatinine measurement, and clear referral criteria to nephrology services should be the priorities.

Keywords

Chronic Kidney Disease, Primary Health Care, Screening, WHO-PEN, Health Workers, Brazzaville, Republic of the Congo

1. Introduction

Chronic kidney disease (CKD) is defined by abnormalities of kidney structure or function that persist for more than three months and carry consequences for health [1]. It has become a major and growing contributor to morbidity, cardiovascular death, and health spending worldwide.

Sub-Saharan Africa is particularly exposed. CKD is common in the region, driven by hypertension, diabetes, obesity, infections, and some kidney diseases that are more frequent in people of African ancestry [2]. Screening systems are weak, so many patients are diagnosed late.

Because CKD usually progresses without symptoms for years, patients often come to medical attention at an advanced stage, when there is little left to do to slow the disease. This is precisely why primary care matters so much: it is where at-risk people are seen long before they need a nephrologist.

The KDIGO 2024 guideline stresses the identification of at-risk individuals and the assessment of both kidney function and albuminuria, with people living with hypertension or diabetes as the main targets [1]. In practice, early detection relies on three simple measurements: blood pressure, serum creatinine to estimate the glomerular filtration rate (eGFR), and a search for albuminuria or proteinuria.

In low-resource settings, this work cannot be left to specialist services alone. The WHO Package of Essential Noncommunicable Disease Interventions (WHO-PEN) was designed for exactly this purpose, giving first-level facilities an integrated approach to the main noncommunicable diseases (NCDs) and their risk factors [3]. The approach makes even more sense for kidney disease, since dialysis and transplantation are expensive and remain out of reach for many people in sub-Saharan Africa [4]. Preventing CKD, detecting it early, and slowing its course are therefore the realistic priorities.

Such a strategy only works if health facilities have the basic equipment, trained staff, protocols, and skills needed to recognize people at risk, look for kidney damage, and refer them in time. In the Republic of the Congo, integrated health centers (IHCs) are the first point of contact with the health system for much of the population, yet very little is known about their ability to take on this role.

We therefore set out to assess selected dimensions of the readiness of the IHCs of Brazzaville for the detection of CKD, focusing on the training, knowledge, and questionnaire-assessed skills of health workers rather than on an overall evaluation of readiness. Initial management and referral decisions were not directly assessed. More specifically, we described the characteristics and resources of the centers, examined the NCD training of health workers, measured their knowledge of diagnostic thresholds for hypertension and diabetes and of CKD screening, assessed by questionnaire the skills needed to detect kidney risk and recognize kidney failure, and collected their perceptions and the difficulties they face in daily practice.

2. Methods

2.1. Study Design, Setting, and Period

This cross-sectional study took place between November 1 and December 15, 2025, in the public integrated health centers of Brazzaville, which form the first level of the health pyramid and deliver primary care services. The present analysis focuses on kidney care and draws on a broader survey of the performance of first-level health facilities in the management of noncommunicable diseases, carried out as part of a master's degree in public health at the Faculty of Health Sciences, Marien Ngouabi University.

In the Republic of the Congo, the IHC is the first-level facility of the health district. It delivers a minimum package of preventive, curative, and promotional activities and refers patients to the district reference hospital, which forms the second level of care. All health districts of Brazzaville were covered except Île Mbamou, which was left out for logistical reasons; the study therefore covered all functional public IHCs of the ten remaining districts, not all IHCs of the city. The 37 IHCs studied were spread over these ten health districts: Makélékélé (n = 7), Madibou (n = 5), Djiri (n = 4), Mfilou (n = 4), Talangaï (n = 4), Bacongo (n = 3), Moungali (n = 3), Poto-Poto (n = 3), Kintélé (n = 2), and Ouenzé (n = 2).

2.2. Study Population and Eligibility

The study had two units of observation: the IHCs themselves and the health professionals who worked in them. All public IHCs of the ten included health districts that were functional during the study period were eligible, as were the health professionals working there; professionals were included if they were present on the day of the visit and gave their informed consent. Secondary and tertiary hospitals were not included, nor were patients.

2.3. Sampling

We did not sample facilities: the sampling frame was the list of first-level public health facilities in the ten included health districts, and every functional public IHC in these districts was included, giving 37 centers. Within each center, recruitment of health professionals was based on availability: the health professionals present on the day of the visit were invited to take part. In total, 333 health professionals were interviewed; 65 of them (19.5%) did not complete the detailed questionnaire and were excluded, so the present analysis includes the 268 professionals (80.5%) who completed it. The total number of eligible staff, the number of professionals absent on the day of the visit, and the number of refusals were not recorded. Based on the staff-size categories reported by the centers (**Table 1**), the 37 IHCs employed at least about 840 staff members, including non-clinical staff, so the 268 participants represent at most about one third of their total workforce.

2.4. Data Collection

Two tools were used: a facility assessment grid and a health professional assessment grid. Both were developed from WHO recommendations, the WHO-PEN package, and the core elements recommended for the screening and early management of CKD. In each IHC, the facility grid was completed during an individual interview with the head of the center or his or her deputy. Health professionals were then interviewed face to face using the second grid. Data were entered directly into electronic forms programmed in KoboCollect (version 2022.4.4). The items, answer options, and scoring of both instruments used in this analysis are provided in **Supplementary File S1**.

2.5. Variables

At the facility level, we recorded the health district, the qualification of the facility respondent (head of the center or deputy), the total number of staff, the presence of each cadre (physicians, nurses, health assistants, midwives, pharmacists), the availability of NCD protocols and algorithms, a glucometer and urine dipsticks, the on-site performance of blood chemistry (blood glucose, creatinine, and cholesterol, recorded as a single item), the availability of antihypertensive and antidiabetic drugs, and medicine stock-outs. For health professionals, we recorded their profession and years of professional experience.

For health professionals, training was assessed by asking whether they had ever been trained in NCD management and, if so, whether this training was recent (less than two years) or older. Knowledge was explored through questions on the blood pressure threshold for diagnosing hypertension, the fasting blood glucose threshold for diagnosing diabetes, the follow-up interval for a patient with stable hypertension, the complications that should be screened for systematically in people with diabetes, and the essential test(s) for detecting CKD. The CKD item was a closed question ("Which test(s) are essential to detect CKD?") with four answer options: serum creatinine, urine dipstick, albuminuria, and "all of the above". It

was programmed as a multiple-selection field, so participants could choose one or more options, and it had no "do not know" option; the interviewer read the question and its answer options aloud. The diabetes complications item was built in the same way (foot, kidney, eye, "all of the above"). An answer of "all of the above" was counted as citing each of the listed options. Each of the five knowledge items was scored 1 if correct and 0 otherwise. The answers considered correct were 140/90 mmHg for the diagnosis of hypertension, 1.26 g/L (7 mmol/L) for the fasting glucose threshold of diabetes, every three months for the follow-up of stable hypertension, citation of the eye, the kidney, and the foot together for the complications to be screened for in diabetes, and the combination of serum creatinine and at least one urine test (dipstick or albuminuria, including the answer "all of the above") for the detection of CKD. The three-month reference interval follows the WHO guideline for the pharmacological treatment of hypertension, which recommends monthly follow-up after the initiation or a change of treatment until the target is reached, and follow-up every three to six months once blood pressure is controlled [5]. A patient with "stable" hypertension was understood as a patient whose blood pressure is controlled on an unchanged treatment, without a recent complication, for whom monthly review is not the recommended routine. Because monthly visits may nonetheless be justified in some situations (recent change in treatment, doubtful adherence, monthly drug dispensing), we also report the proportion of participants who proposed either interval. The overall knowledge score therefore ranged from 0 to 5 and was classified as good (≥4/5), average (3/5), or poor (≤2/5). These thresholds were set a priori by the investigators, adapted from Bloom's cut-offs of ≥80%, 60% - 79%, and <60% of the maximum score. The score was developed for this study and has not been externally validated.

Skills were assessed by questionnaire and were not directly observed. Participants were asked whether they were able to perform each of the following: blood pressure measurement, use of a glucometer, body mass index (BMI) calculation, and recognition of the warning signs of severe hypertension, severe hyperglycemia, and kidney failure. Finally, we asked participants whether they felt sufficiently competent to manage NCDs, whether they needed further training, and what difficulties they faced in their daily practice.

To avoid ambiguity, three terms are used consistently in this paper. Knowledge refers to answers to factual questions that were scored as correct or incorrect (diagnostic thresholds, follow-up interval, complications to screen for, CKD screening tests). Questionnaire-assessed skills refers to the six practical items listed above. Results for these items are expressed as self-reported proficiency, that is, the proportion of participants who reported being able to perform the task.

2.6. Operational Definition of Readiness

Readiness was not treated as an individual clinical diagnosis. We defined it as the capacity of first-contact services to bring together what is needed to identify peo-

ple at risk, perform basic screening tests, recognize probable kidney damage, put preventive measures in place, and refer patients who need specialist expertise. This study did not assess all of these dimensions. It focused on selected components: facility characteristics and the training, knowledge, questionnaire-assessed skills, and perceptions of the health professionals working in the IHCs.

2.7. Statistical Analysis

After cleaning, data were exported from KoboCollect and analyzed with Stata version 18 (StataCorp LLC, College Station, TX, USA). Qualitative variables are described as frequencies and percentages. For multiple-response questions, we report the proportion of participants who selected each option, with each participant being counted only once per option; the proportion citing at least one urine test (dipstick and/or albuminuria) was likewise computed at the participant level.

2.8. Ethical Considerations

The study was approved by the Health Sciences Research Ethics Committee of the Republic of the Congo (Comité d'Éthique de la Recherche en Sciences de la Santé, CERSSA). Participation was voluntary, and every participant gave free and informed consent. Data were collected anonymously and kept confidential.

3. Results

3.1. Characteristics of the Health Centers

In most IHCs, the facility respondent (head of the center or deputy) was a health assistant (24 centers, 64.9%); the respondent was a physician in only six centers (16.2%), a nurse in two (5.4%), and another cadre (public health assistant, midwife, or pharmacy technician) in five (13.5%). Only 13 centers (35.1%) had at least one physician, whereas 30 (81.1%) had at least one nurse. Most centers (64.9%) had between 20 and 50 staff members, while six (16.2%) had fewer than 20 and seven (18.9%) more than 50. A glucometer was available in all 37 centers and urine dipsticks in 33 (89.2%), but only 20 (54.1%) performed blood chemistry (glucose, creatinine, cholesterol) on site. An NCD protocol was available in 16 centers (43.2%) and an NCD algorithm in 13 (35.1%). Antihypertensive and antidiabetic drugs were available in 28 (75.7%) and 23 (62.2%) centers, respectively, and 19 (51.4%) reported medicine stock-outs (**Table 1**). A total of 268 health professionals working in these centers were included in the analysis.

3.2. Characteristics and Training of Health Professionals

Nurses (115, 42.9%) and midwives (68, 25.4%) made up more than two thirds of the participants, followed by health professionals with post-university training (EPU, 43, 16.0%) and health assistants (38, 14.2%); only four participants (1.5%) were physicians. Two thirds (179, 66.8%) had five years of experience or less. Nearly three quarters of the participants (198/268, 73.9%) had never received any training in NCD management. Among the 70 who had (26.1%), the training was

more than two years old for 55 (20.5% of all participants); only 15 (5.6%) had been trained in the previous two years (Table 2).

Table 1. Characteristics and resources of the integrated health centers (N = 37).

Variable	n	%
Qualification of the facility respondent		
Health assistant	24	64.9
Physician	6	16.2
Nurse	2	5.4
Other (public health assistant, midwife, pharmacy technician)	5	13.5
Total staff		
<20	6	16.2
20 - 50	24	64.9
>50	7	18.9
Cadres present in the center		
At least one physician	13	35.1
At least one nurse	30	81.1
Resources for NCD and CKD detection		
Glucometer available	37	100.0
Urine dipsticks available	33	89.2
On-site blood chemistry (glucose, creatinine, cholesterol)	20	54.1
NCD protocol available	16	43.2
NCD algorithm available	13	35.1
Antihypertensive drugs available	28	75.7
Antidiabetic drugs available	23	62.2
Medicine stock-outs reported	19	51.4

IHC: integrated health center; NCD: noncommunicable disease. Facility respondent: head of the center or deputy who answered the facility grid. On-site blood chemistry was recorded as a single item (blood glucose, creatinine, cholesterol).

3.3. Knowledge

The hypertension diagnostic threshold of 140/90 mmHg was given by 172 participants (64.2%), but nearly a third (87, 32.5%) cited 160/100 mmHg. Similarly, 155 (57.8%) gave the correct fasting glucose threshold for diabetes (1.26 g/L, *i.e.*, 7 mmol/L), while 100 (37.3%) cited 2 g/L. For a patient with stable hypertension, 158 (59.0%) proposed a monthly follow-up, 73 (27.2%) a follow-up every three months (reference answer), and 33 (12.3%) did not know; overall, 231 participants (86.2%) proposed either a monthly or a three-monthly interval.

The kidney was almost always cited among the complications to be screened for systematically in people with diabetes (254 participants, 94.8%), but only 65

(24.3%) mentioned the eye and 58 (21.6%) cited the foot, the eye, and the kidney together. For the detection of CKD, 156 participants (58.2%) cited the urine dipstick, 139 (51.9%) albuminuria, and 119 (44.4%) serum creatinine; counting each participant once, 234 (87.3%) cited at least one urine test. Only 85 participants (31.7%) combined serum creatinine with a urine test, as recommended: 48 (17.9%) by choosing only "all of the above" and 37 (13.8%) by explicitly selecting creatinine together with a urine test. Conversely, 149 (55.6%) cited urine tests without creatinine and 34 (12.7%) creatinine without a urine test. Overall, knowledge was rated as good in 48 participants (17.9%), average in 23 (8.6%), and poor in 197 (73.5%) (Table 2).

Table 2. Characteristics, training, and knowledge of health professionals (N = 268).

Variable	n	%
Profession		
State-registered nurse	82	30.6
Midwife	68	25.4
Post-university training (EPU)	43	16.0
Health assistant	38	14.2
Other nurse	33	12.3
Physician	4	1.5
Professional experience		
<2 years	60	22.4
2 - 5 years	119	44.4
6 - 10 years	44	16.4
>10 years	45	16.8
Training in NCD management		
Never trained	198	73.9
Trained more than 2 years ago	55	20.5
Trained in the past two years	15	5.6
Blood pressure threshold for diagnosing hypertension		
≥140/90 mmHg (correct)	172	64.2
≥160/100 mmHg	87	32.5
≥130/80 mmHg	5	1.9
Does not know	4	1.5
Fasting glucose threshold for diagnosing diabetes		
≥1.26 g/L (7 mmol/L) (correct)	155	57.8
≥2 g/L	100	37.3
≥1.10 g/L	9	3.4
Does not know	4	1.5

Continued

Follow-up interval for stable hypertension		
1 month	158	59.0
3 months (correct)	73	27.2
12 months	4	1.5
Does not know	33	12.3
Complications to screen for in diabetes*		
Kidney	254	94.8
Eye	65	24.3
Foot, eye, and kidney together (correct)	58	21.6
Essential test(s) to detect CKD*		
Urine dipstick	156	58.2
Albuminuria	139	51.9
Serum creatinine	119	44.4
Serum creatinine + urine test (correct)	85	31.7
of which "all of the above" only	48	17.9
Serum creatinine without a urine test	34	12.7
Urine test(s) without serum creatinine	149	55.6
At least one urine test†	234	87.3
Overall knowledge		
Good	48	17.9
Average	23	8.6
Poor	197	73.5

*Multiple answers are possible; percentages are calculated based on the 268 participants, each participant being counted once per option; the answer "all of the above" was counted under each option (48 participants selected only this answer for the CKD item). †Dipstick and/or albuminuria. Reference answers are marked "(correct)"; see **Supplementary File S1**. CKD: chronic kidney disease; NCD: noncommunicable disease.

3.4. Questionnaire-Assessed Skills

Self-reported proficiency in routine procedures was high: 264 participants (98.5%) reported being able to measure blood pressure, 261 (97.4%) to use a glucometer, and 239 (89.2%) to calculate the BMI. Most also reported being able to recognize the warning signs of severe hypertension (94.0%) and severe hyperglycemia (91.0%). In sharp contrast, only 94 (35.1%) reported being able to recognize the warning signs of kidney failure (Table 3).

3.5. Perceptions and Difficulties

Only 75 participants (28.0%) felt sufficiently competent to manage NCDs, and almost all (261, 97.4%) expressed a need for further training. The difficulties most often reported were lack of training (251, 93.7%), lack of equipment (206,

76.9%), and lack of medicines (117, 43.7%); only 7 (2.6%) mentioned workload (Table 4).

Table 3. Questionnaire-assessed skills of health professionals: self-reported proficiency (N = 268).

Skill	n	%
Blood pressure measurement	264	98.5
Glucometer use	261	97.4
BMI calculation	239	89.2
Warning signs of severe hypertension	252	94.0
Warning signs of severe hyperglycemia	244	91.0
Warning signs of kidney failure	94	35.1

BMI: Body mass index.

Table 4. Perceptions and difficulties reported by health professionals (N = 268).

Variable	n	%
Feels sufficiently competent to manage NCDs.	75	28.0
Expresses a need for further training.	261	97.4
Difficulties reported*		
Lack of training	251	93.7
Lack of equipment	206	76.9
Lack of medicines	117	43.7
Workload	7	2.6

*Multiple answers are possible; each participant is counted once per answer. NCD: non-communicable disease.

4. Discussion

4.1. Main Findings

Our study paints a contrasting picture of primary care in Brazzaville. Almost all health workers reported being able to perform the basic procedures of NCD care, such as blood pressure measurement and glucometer use, and nearly 95% knew that the kidney is at risk in diabetes. Yet, kidney-specific knowledge was poor. Fewer than half of the participants thought of serum creatinine to detect CKD, only about one in three combined a blood and a urine test, often by choosing "all of the above", and more than half relied on urine tests alone. Barely a third reported being able to recognize the warning signs of kidney failure, and three quarters had never been trained in NCDs. At the facility level, urine dipsticks were almost always available, but only half of the centers could measure creatinine on site and only about one in three had a physician. In our view, the gap between high self-reported proficiency in basic procedures and poor kidney-specific knowledge is the main lesson of this work.

4.2. Awareness without Know-How: Comparison with Other African Studies

CKD remains asymptomatic for a long time, so diagnosis must come from active case-finding in people at risk, especially those with hypertension, diabetes, or cardiovascular disease [1] [6]. KDIGO recommends assessing both kidney function (serum creatinine with eGFR) and albuminuria in these groups [1], and these are exactly the patients followed in primary care [6] [7]. Against this background, the fact that only 31.7% of the health workers we surveyed combined the two recommended tests, and only 13.8% when the answer "all of the above" is set aside, and that fewer than half thought of creatinine, is a real concern. Because the question offered an "all of the above" option, some of the combined answers may reflect a non-specific choice rather than a deliberate one; the item is reported in full in **Supplementary File S1**. Most knew that the kidney had to be monitored in diabetes, but not how to do it. At least one urine test was cited by 87.3% of participants, and dipsticks were available in nearly nine centers out of ten, which is a reasonable starting point where quantitative albuminuria is hard to obtain. However, more than half of the participants (55.6%) relied on urine tests alone, which miss patients whose GFR declines without albuminuria and prevents any staging of the disease.

This pattern is consistent with what has been reported elsewhere in Africa, although most previous studies were conducted among physicians or in hospital settings. In Cameroon, Choukem *et al.* surveyed 114 general practitioners and non-nephrology specialists in Douala and Bamenda: only 58.8% knew the definition of CKD, 44% knew that it has five stages, and 21.9% would refer late or did not know when to refer [8]. In Ethiopia, the mean CKD knowledge score of 326 care providers in Jimma was about 9 out of 14, below the 70% threshold the authors considered adequate [9]. In Niger, 96% of 150 health workers in the Zinder region, mostly nurses and midwives, had poor knowledge of kidney failure management, and knowledge was associated with profession and experience [10]. Our study extends these findings to first-level health centers, where nurses and midwives made up more than two thirds of the participants and physicians only 1.5%. It also shows that the gap concerns the practical choice of screening tests even more than general awareness of kidney risk. Bello and Johnson have argued that such knowledge gaps among primary care providers are a major barrier to better kidney care [11].

4.3. Diagnostic Thresholds and Targeted Screening

Universal screening of the whole population is not realistic in a resource-limited setting, and a strategy targeting people with hypertension and diabetes is far more feasible. Such a strategy, however, depends on these conditions being diagnosed correctly in the first place. In our study, a third of participants used a threshold of 160/100 mmHg to diagnose hypertension, and more than a third used 2 g/L for diabetes. With such thresholds, many patients with hypertension or diabetes, and

therefore at risk of CKD, would simply not be identified. Correcting these thresholds is a simple and inexpensive step that would directly widen the population eligible for kidney screening. Almost all health workers reported being able to measure blood pressure and blood glucose, although these skills were not directly observed. Adding a kidney check to the routine follow-up of these patients would build on an existing activity rather than create yet another parallel program. The facility data point to a practical constraint: urine dipsticks were available in 89.2% of the centers, but blood chemistry including creatinine could be performed on site in only 54.1%, so creatinine-based screening will require either on-site testing or a reliable system for sending samples to a laboratory.

4.4. Training, Supplies, and Building on WHO-PEN

Nearly three-quarters of the participants had never been trained in NCDs, and only 5.6% had been trained in the past two years. Health workers are well aware of this: only 28.0% felt competent, 97.4% asked for more training, and lack of training was by far the most frequently reported difficulty. Studies from Nigeria and Niger have also shown that training and professional experience are major determinants of health workers' knowledge of NCDs and kidney disease [10] [12]. A structured CKD module could cover the identification of at-risk patients, correct diagnostic thresholds, the definition and KDIGO classification of CKD, the interpretation of creatinine, eGFR and albuminuria or proteinuria, avoidance of nephrotoxic drugs, the warning signs of kidney failure and referral criteria, supported by simple algorithms posted in consultation rooms.

In most IHCs, the facility respondent was a health assistant, only 13 of the 37 centers (35.1%) had at least one physician, and physicians represented only 1.5% of the participants, whereas nurses and midwives made up 68.3%. Which cadres actually deliver NCD and kidney care in each center was not recorded, but these figures indicate that kidney care in primary care will rely largely on non-physician health workers, which calls for simple, protocol-based tools; yet an NCD protocol was available in fewer than half of the centers and an algorithm in about one third. WHO-PEN was designed precisely for such settings [3]. CKD has never been a separate program within it, but much of its prevention overlaps with the management of hypertension, diabetes, and cardiovascular risk, so WHO-PEN could serve as the vehicle for bringing kidney health into Congolese primary care. More than three quarters of the participants also reported a lack of equipment and over two fifths a lack of medicines, and half of the centers reported stock-outs, which shows that training will have to go hand in hand with a reliable supply of tests and drugs.

4.5. Recognizing Severity, Referral, and Implications for the Congo

Only 35.1% of participants reported being able to recognize the warning signs of kidney failure, compared with more than 90% for severe hypertension or hyper-

glycemia. This gap may contribute to late referral, a well-known problem in sub-Saharan Africa, although referral decisions were not assessed in the present study. In Cameroon, Halle *et al.* had already described the difficulties surrounding the referral of patients with kidney impairment [13], and a fifth of the physicians surveyed by Choukem *et al.* would refer late or did not know when to refer [8]. When patients reach the nephrologist late, there is less room to investigate the cause, slow progression, and prepare for kidney replacement therapy, which is expensive and has limited availability in many countries of the region [4]. A recent systematic review also found that CKD screening during the follow-up of high-risk patients in sub-Saharan Africa is highly variable and often inadequate [14].

These findings point to a pragmatic, stepwise approach for the Republic of the Congo. People at risk would first be identified using correct diagnostic thresholds for hypertension and diabetes, then screened with blood pressure, serum creatinine with eGFR, and a urine test. Chronicity would be confirmed and the disease staged according to KDIGO whenever the necessary tests are available. Nephroprotection would then be delivered within primary care, and patients would be referred to the nephrologist using standardized criteria, including the warning signs of kidney failure. Organized in this way, the IHC would become the entry point of a genuine kidney care pathway.

4.6. Strengths and Limitations

This study has several strengths. It covered all 37 functional public IHCs of the ten included health districts of Brazzaville (Île Mbamou excluded), included a large number of health workers, combined facility and individual data, and, as far as we know, provides one of the first structured descriptions of how ready primary care in Brazzaville is to detect CKD.

It also has limitations. Its cross-sectional design does not allow us to follow changes in practice over time. Skills were assessed by questionnaire rather than by direct observation with a standardized checklist, so they reflect self-reported proficiency and may be overestimated. Health professionals were recruited on the basis of their availability on the day of the visit. The number of eligible staff and refusals was not recorded, 65 of the 333 professionals interviewed (19.5%) did not complete the questionnaire, and the 268 participants represent at most about one third of the estimated workforce of the centers. The unavailability of some professionals was the main practical difficulty during data collection, and those interviewed may differ from their absent colleagues, for instance in workload, shift, or interest in NCDs, which may have introduced a participation bias of unknown direction. The original survey covered several NCDs and was not designed as a detailed nephrology assessment: on-site blood chemistry was recorded as a single item covering glucose, creatinine, and cholesterol, and indicators such as automated eGFR reporting, the urine albumin-to-creatinine ratio, and access to renin-angiotensin system inhibitors or SGLT2 inhibitors were not collected; they deserve a dedicated survey. The knowledge score was developed for this study and

has not been validated, and the CKD item, which offered an "all of the above" option, may be sensitive to question format. Finally, the questionnaire did not directly assess initial management or referral decisions, so our conclusions concern readiness for CKD detection only, and we assessed the readiness of health workers, not the actual care pathway of patients living with CKD.

5. Conclusions

The assessed dimensions of primary care readiness for CKD detection in Brazzaville reveal substantial gaps, particularly in kidney-specific knowledge, recent NCD training, the choice of appropriate CKD screening tests, and on-site access to creatinine measurement. Although almost all health workers reported being able to measure blood pressure and blood glucose, and nearly all knew that the kidney is at risk in diabetes, only 44.4% cited serum creatinine to detect CKD, 31.7% combined blood and urine tests, 35.1% reported being able to recognize the warning signs of kidney failure, and nearly three quarters had never been trained in NCDs. Only half of the centers could measure creatinine on site.

The priority is, therefore, to build knowledge and organize care around simple tools. Integrating CKD into primary care could rest on five pillars: targeted screening of high-risk groups based on correct diagnostic thresholds, training of health workers, standardized algorithms, access to essential kidney tests, and an organized referral pathway between IHCs and nephrologists. Such an approach could lead to earlier diagnosis of CKD in the Congo and reduce the number of patients who discover their disease only when they already need dialysis. Future studies should directly assess initial management and referral practices in primary care, as well as routine access to creatinine, eGFR, and albuminuria testing and to nephroprotective drugs.

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Ethical Approval and Consent to Participate

The study was approved by the Health Sciences Research Ethics Committee (CERSSA), Brazzaville, Republic of the Congo. All participants gave free and informed consent.

Data Availability

The data used in this study are available from the corresponding author upon reasonable request.

Author Contributions

Eyeni Sinomono Daniel Tony carried out the literature search and wrote the

full manuscript. Bani Ngoma Stephat collected and analyzed the data. Mvoungou Ondouma Princia and Niama Ange critically reviewed the manuscript. All authors read and approved the final version.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Supplementary File

Data collection instruments: items, answer options, and scoring key

Both instruments were administered in French through face-to-face interviews and programmed in KoboCollect v2022.4.4. Items are translated into English; the KoboCollect variable name is given in brackets. The complete original French forms are available from the corresponding author upon request.

Table S1. Scoring key of the knowledge items (health professional grid).

Item (KoboCollect variable)	Answer options	Reference answer (score 1)	Remark
K1. Blood pressure threshold for diagnosing hypertension (Valeur_seuil_dg_HTA)	≥130/80 mmHg; ≥140/90 mmHg; ≥160/100 mmHg; do not know (single choice)	≥140/90 mmHg	
K2. Fasting blood glucose threshold for diagnosing diabetes (valeur_seuil_glycemie_dg_diabetique)	≥1.10 g/L; ≥1.26 g/L (7 mmol/L); ≥2 g/L; do not know (single choice)	≥1.26 g/L (7 mmol/L)	
K3. Follow-up interval for a patient with stable hypertension (frequence_suivi_patient_HTA_stable)	1 month; 3 months; 12 months; do not know (single choice)	3 months	WHO 2021: every 3 - 6 months once BP is controlled; 1 or 3 months reported separately
K4. Complications to screen for systematically in diabetes (complication_depister_systematiquement)	Foot; kidney; eye; all of the above (multiple selections)	Foot + kidney + eye, or "all of the above"	
K5. Essential test(s) to detect CKD (examen_essentiel_depister_MRC)	Serum creatinine; urine dipstick; albuminuria; all of the above (multiple selection, no "do not know" option)	Serum creatinine plus at least one urine test, or "all of the above"	"All of the above" is counted under each option

Overall knowledge score = K1 + K2 + K3 + K4 + K5 (range 0 - 5): good ≥ 4/5; average 3/5; poor ≤ 2/5 (thresholds set a priori, adapted from Bloom's cut-offs of ≥80%, 60% - 79%, and <60%). The score was developed for this study and has not been externally validated. A stable hypertensive patient was understood as a patient whose blood pressure is controlled on unchanged treatment, without a recent complication. In the face-to-face interview, the interviewer read the question and its answer options aloud; for multiple-selection items, participants could choose one or more options.

Table S2. Facility assessment grid (head of the center or deputy, N = 37).

Item (KoboCollect variable)	Answer options	Used in this paper
Health district (DS); name of the IHC (CSI); type of facility (type_structure)	List	Description
Qualification of the head of the center or deputy (qualification_chef_centre)	Physician; nurse; health assistant; other (specify)	Table 1

Continued

Total number of staff (var_nbre_ressources_humaines)	<20; 20 - 50; > 50	Table 1
Number of physicians/nurses/health assistants/midwives/pharmacists (var_nbre_medecin_csi … var_nbre_pharmacien_csi)	Categories of number (none; 1 or more; …)	Table 1
Staff trained in WHO-PEN (formation_mnt_whopen)	Yes; no	—
NCD protocol available (disponibilite_protocole_mnt); displayed and accessible (Protocole_affiche_accessible)	Yes; no	Table 1
NCD algorithm available (disponibilite_algorithme_mnt)	Yes; no	Table 1
Hypertension/diabetes follow-up forms available	Yes; no	—
Antihypertensive drugs/antidiabetic drugs/insulin are available	Yes; no	Table 1
Urine dipsticks available (disponibilite_bandelette_urinaire)	Yes; no	Table 1
Medicine stock-outs (rupture_medicament)	Yes; no	Table 1
Scale/stethoscope/glucometer available	Yes; no	Table 1 (glucometer)
Blood glucose, creatinine, and cholesterol tests performed on site (realise_bilan_glycemie_creatinine_cholesterol)	Yes; no (single item)	Table 1
NCD consultations, NCD register, follow-up planning, referral/counter-referral system, data reporting to the district	Yes; no	—
Documentation in patient records (glucose, blood pressure, weight/BMI, suspected cancer), follow-up plan, lifestyle advice	Yes; no	—

Table S3. Health professional assessment grid (N = 268).

Item (KoboCollect variable)	Answer options	Used in this paper
Health district; IHC; type of facility	List	Description
Profession (qualification)	State-registered nurse; nurse; midwife; health assistant; physician; post-university training (EPU)	Table 2
Years of professional experience (annee_experience)	<2; 2 - 5; 6 - 10; >10 years	Table 2
Training in NCD management (avoir_formation_sur_MNT)	No; yes, recent (<2 years); yes, older (>2 years)	Table 2
Knowledge items K1 - K5	See Part A	Table 2
Able to measure blood pressure/use a glucometer/calculate BMI (savoir_mesurer_PA, savoir_utiliser_glucometre, savoir_calculer_IMC)	Yes; no	Table 3
Able to recognize warning signs of severe hypertension/severe hyperglycemia/kidney failure (savoir_signes_gravite_HTA, …_hyperglycemie_severe, …_IR)	Yes; no	Table 3
Feels sufficiently competent to manage NCDs (competences_suffisantes).	Yes; no	Table 4
Needs further training (besoin_formation_complementaire)	Yes; no	Table 4

Continued

Difficulties encountered (difficultes_rencontrees)	Lack of training; lack of equipment; lack of medicines; workload; other (multiple selections)	Table 4
NCD priority, patients per day, time per patient; cancer modules (breast, cervix, prostate)	Various	Not used (outside the scope of this paper)